

**COMPUTERIZATION OF WATER SUPPLY TO
IRRIGATION FARM**

BY

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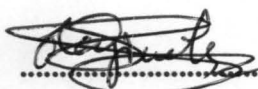
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**BEING A FINAL YEAR PROJECT REPORT SUBMITTED IN PARTIAL FUFILMENT
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FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE.**

FEBRUARY, 2010.

DECLARATION

I hereby declare that this project work is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any university or institution. Information derived from personal communications, published and unpublished work were duly referenced in the text.



.....

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17-02-2010
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Date

CERTIFICATION

This project entitled "Computerization of Water Supply to Irrigation Farm" by Michael Alaba Oluwasegun, meets the regulations governing the award of the degree of Bachelor of Engineering (B.ENG.) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary presentation.



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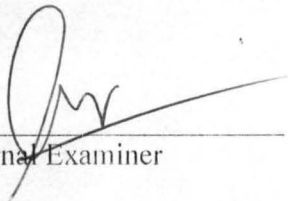
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DEDICATION

This project is dedicated to God almighty for seeing me through this year of my academic endeavours glory be to his name. (Amen)

ACKNOWLEDGEMENT

All praise, gratitude and appreciations go to GOD Almighty for seeing me through all my vigorous difficulties of this programme.

I am indebted to my able supervisor, Mr. John Jiya for his patience, understanding, and encouragement and for giving this project work its proper shape and form.

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I wish to thank my parents for their financial support to make me successful in this citadel institution. My prayer is that GOD in his infinity mercy should guide, protect, and shower his blessings contentiously on her (Amen). I will never forget the contribution of my brother, Engineer Taiwo, I. D., Sir kay, Matico, Kenny, Taiwo, Mummy Twins, Aunty, who helps me both financially and morally.

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ABSTRACT

An irrigation field of two hectares were design and used for the software analysis. The program irrigate 2009 were designed using Microsoft visual basic. The program will accept inputs such as soil type, temperature, relative humidity and irrigation factor to perform irrigation. During the compilation of the software, the field size, quantity of water to provide into the water tank, type of crops to be planted, Irrigation factor for the crops considered. The programme was run on the computer, is about 10MB in size and it takes less than a minute to schedule irrigation activity.

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Notations and Symbols

F_c = Field capacity

E_S = Reservoir storage efficiency

W_s = amount of water diverted for irrigation

W_{so} = amount of water diverted to the storage

E_C = water conveyance efficiency.

W_f = water delivered to the farm.

W_r = water diverted from the river or reservoir.

E_a = water application efficiency.

W_{r2} = water stored in the soil root-zone during irrigation.

W_f = water delivered to the farm.

R_f = surface runoff from the farm.

D_f = deep percolation below the farm root-zone soil.

CU = consumption use.

ET = evapotranspiration.

Q = quantity of water supply.

T = time.

D = dept of water supply.

A = area of the field

F = head friction

R_n = Raynold number

H = energy loss by friction (Hazen equation)

Q = total discharge in the pipe, l/sec

CHAPTER ONE

1.0 Introduction:

1.1 Background of Study

The pressure for survival and the need for additional food supplies are causing the rapid expansion of irrigation throughout the world.(Michael,2001). The area of land irrigated in the world is more than 248 million hectares, nine countries-china ,India ,the united state of America, Pakistan ,Indonesia, Mexico ,Iran, Thailand and Uzbekistan-have the largest irrigation areas, amounting to almost 70 per cent of the world total irrigation area.(F.A.O,1998).

The oceans occupy about 70.8 per cent of the earth's surface and only 29.2 per cent is land. About 97.5 per cent of the world water resource is in the oceans and is saline (F.A.O, 1998). Of the remaining, 2.5 per cent of the global water resource, and about 2 per cent is in ice caps and glaciers and is generally not available for the requirement of mankind. a major part of the balance amount of water occurs as ground water, of which about half the volume lies in water bearing formations deeper than 800m below ground surface and is not ordinary available for economical development. The amount of water available for development by man is mainly from streams, rivers, fresh water lakes and about half of the quantity of ground water which occur at depths less than 800m from ground surface.(Bugliarello,1974).

Water, being a limited resource, its efficient use is basic to the survival of the ever-increasing population of the world in the comprehensive strategy needed for the conservation and development of water resources, several factors are to be kept in view. These include the availability of water, its quality, location, distribution and variation in its occurrence, (Adedeji and Kola). The objective of efficient irrigation is to increase agricultural production per unit volume of water per unit of cropped land in a unit of time.

Water is the most valuable asset in agriculture and accurate measurement of irrigation water lead to its economic and efficient utilization. Efficient conveyance and proper distribution of water on the farm leads to increased in agricultural productivity of crop. (Michael, 1999).

Water takes some percentage of soil moisture - plant relationship which permits irrigation system to be designed for applying water in correct quantities when needed. (New Delhi, 2003).

Water for irrigation is normally stored in a reservoir; although large scale reservoir system serves many other important purposes like water supply, flood control and low flow augmentation. Reservoir operation problem is how best to use the facilities that are available with less stress better prediction and improved monitoring method. This brings about the need for design a program on how or when to apply irrigation to crops. (Kola and Ogedengbe.2008).

Human use of water has increased more than 35 folds over the past three centuries. Globally, 3200km of fresh water are withdrawn and used annually. (F.A.O,2002). Of this total 69 per cent is used for agriculture, 23per cent for industry and 8 per cent for domestic use. Water use varies considerably around the world. In Africa, Asia and South America, agriculture is the primary use; Asia uses 86 per cent of its water for irrigation. But in most of European, North America domestic and industrial requirement of water exceed agricultural needs. Water also contribute in some other areas of farming, apart from domestic uses in dairy farm, poultry farm, and other livestock farming. (Adedeji and Michael, 2002).

Irrigation management is the keystone of successful plant production. Given the number and complexity of different hybrid crops that have been produced over these years, to boost food production. And the huge influence of the climate change, an efficient use of the available

water for irrigation is becoming inevitable. This can only be achieved through the automation of irrigation methods. According to www.arguscontrols.com. The term “automated” irrigation applies to any irrigation system that is controlled by something other than the direct actions of a person. Typically it means any irrigation system where irrigation is initiated by a control system using operator settings and measured environmental conditions.

The purpose of automating the irrigation system is to water more efficiently so that the plant receives just what it requires at a particular growing stage. But what should you measure to assess the plant’s needs? Most methods have advantages and disadvantages. www.HortiWorld.nl

1.2 Description of the Irrigation Automation System

The irrigation system shown in figure 1.1, consists of three units, namely: the Field, the water storage unit and the control unit. The field is where the crops to be irrigated are planted. The size of the field, type of the crop and environmental condition will affect the rate of irrigation. The water storage unit is to store the water to be used for irrigation of the crops planted in the field. Lastly the control unit will control when and at what rate irrigation is to take place. The control unit uses the factors such as environmental conditions read by the sensors in the field to perform irrigation through the installed software..

The components of the various units described above are grouped into two categories, the hardware and the software.

1.2.1 Hardware

The hardware required for the implementation of the system been discussed is as follows:

- Water Tanks: store the water to be used for irrigation, the number of tanks will depend on the size of the field to be irrigated.
- Feeder Pipes/Hose: carries water from the tanks to the drip emitters.

- Valves: connects to the controller to physically control the water.
- Drip emitters: emits water into the soil, at a designed rate.
- Computer: store the software that controls the irrigation process based on the signal received from the sensors in the field.
- Sensors: read the environmental and soil conditions and send signal to the computer.
- Controller: allows for the automation of the irrigation system. Controllers 1, control the sensors, controller 2, control the valves, while controller 3, controls the irrigation timing.

1.2.2 Software

The software controls all the hardware listed above. That is when and how the hardware relates with each other. This shall be discuss in chapter three of this project write up.

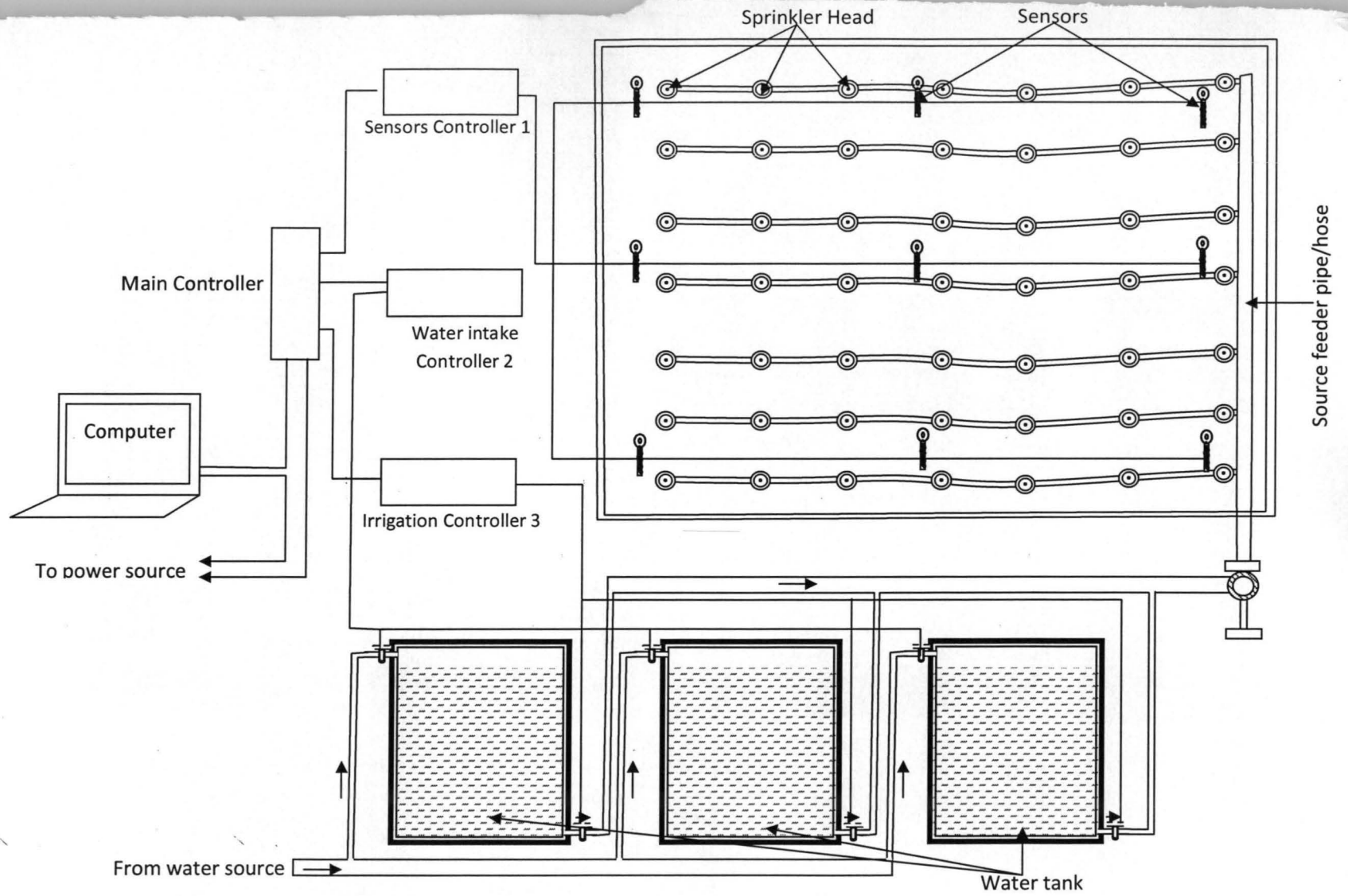


Figure 1.1: Design Layout of the Automated Irrigation system

1.3 Problem Statement

Population growth and increased urbanization has increased the demand for limited water supplies. Environmental regulations are becoming stricter in the face of global warming, thus, the pressure on farmers to use water more efficiently will increase, for both economical and environmental reasons. Plants need less water than you would expect. However, plant water needs are not constant and as you may expect, increase as the plant grows. That raises the question of how automated irrigation systems can adjust the irrigation amounts based on actual plant water needs. www.HortiWorld.nl.

One common problem faced by farmers that have practice irrigation is that they applied water directly to their farms, instead of consulting an expert. The need for increase production for the low and subsistence farming, water plays very important parts in the life of a farmer .Hence for both low and subsistence farmer, Water has to be sourced especially for irrigation. (Van,2006).

1.4 Justification of Study

Since water is a universal materials and common in origin, man has to employ ways of its utilization not only for drinking, but for other public and agricultural uses. This project will help in understanding and determine the quantity of water to be irrigated with by farmers, and provide a substantial agricultural development among the farmers, which will ensure prompt solution to our irrigation period as well as increasing agricultural product which may result in food self-sufficiency in the state and also to contribute to the development of minimizing water use on an irrigated farm.

An automated irrigation system is small, less complex and less costly than other fully automated systems and have the following advantage: enhanced irrigation capacity management, much lower operating costs with respect to labour, water, fertilizer, reduced disease, increased yield, reduced crop inventory 'shrinkage', improved crop quality and reduced waste water mitigation costs.

1.5 Aims and Objectives of Study

The aim and objective of this study is to design software for an automated irrigation system. The irrigator factor, soil condition, weather, were also determined for each crop plant in the field before irrigation can be performed This software can be installed in a microcontroller(s) to be used for the automation.

1.6 Scope of Study

This software will be develop using Microsoft visual basic and can be install on Intel controllers only. Hardware necessary for the automation of the irrigation system will be described in chapter three of the project. The system can only perform irrigation based on the measured environmental conditions, as plant water needs is a function of environmental conditions such as light, relative humidity, temperature, water movement, e.t.c.

CHAPTER TWO

2.0 Literature Review

The modernization of irrigation system operation is a major key in the success of, increasing yield and productivity in agriculture and in enhancing the management of limited natural resources such as water. This brought about the introduction of new hardware and software, in this project but rather should be seen as fundamental transformation of the management of water resources. (Adedeji,2008).

As early as 1963, Hall and Howell described a procedure for the optimization of a single purposed reservoir using a dynamic programming scheme. The scheme which used return function over interval of time was coupled with a Monte Carlo technique, possible in practice only through the use of a digital computer. So also, several reservoir simulations are being written in recent time and most of them address the oil and gas sector of engineering, (Kola, 2008).

2.1 Irrigation

Irrigation is the application of water to soil to assist in the production of crops. Irrigation water is supplied to supplement the water available from rainfall, soil moisture and the capillary rise of ground water. In many areas of the world, the amount and timing of rainfall are not adequate to meet the moisture requirement of crop. Hence successful crop production often requires adequate provision for irrigation, (Michael, 2002).

Irrigation is an age-old practice as old as civilization. The importance of water in agriculture has been realized from time immemorial. It can be traced to the Vedic times. narmada smriti xi, 9 state that ‘no grain is ever produced without water, but too much water tends to spoil the grain; an inundation is as injurious to crop rulers laid stress on scientific water management is revealed from the writing of magasthens, the Greek ambassador in the court of emperor chanda gupta,near patna in the year 300BC which state that ‘the whole

country was very prosperous because of two crops grown in the year with irrigation facilities.(bugliarello,1974).

The scope of irrigation science extends from the watershed to the farm and on to the drainage channel. The watershed yielding the irrigation water the storage and conveyance of water, the management and distribution of water, and the drainage problems arising from faulty irrigation practices and water logging are of concern to the irrigationist.(Egharevba,2002).

Irrigation project require large investment. Casual economic analyses and unjustified benefit claims are often made for particular irrigation project, for a variety of political and social reasons. The rapid increase in irrigation development, especially in the developing countries and increasing project costs have focused the attention of governments, financing institutions and users on the need to established the economic feasibility of project proposals. (Benami,1993).

2.1.1 Irrigation Methods

The manner in which irrigation water is applied to land is called method of irrigation, presented in figure 2.1

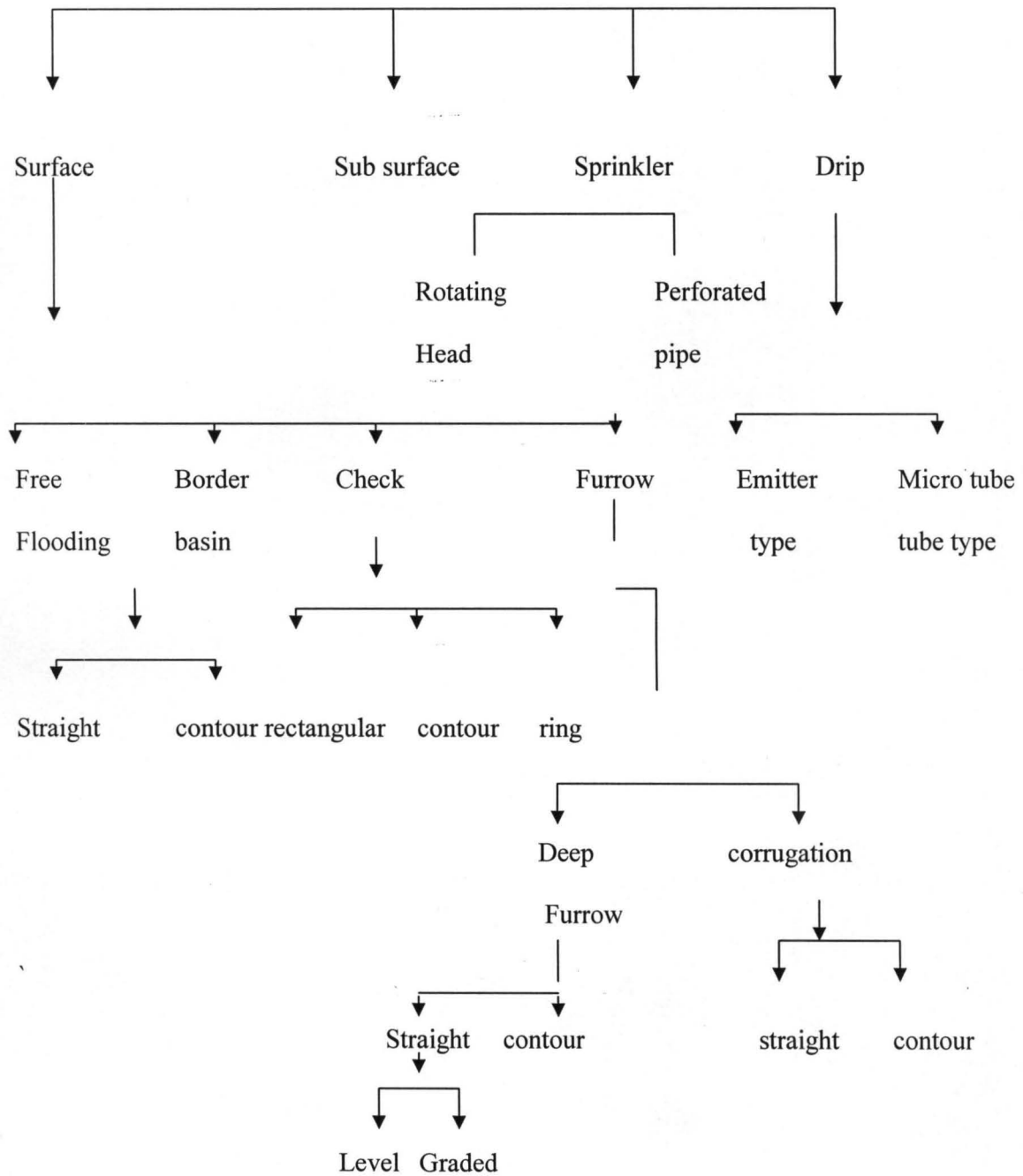


Figure 2.1: Showing Types of Irrigation.

Surface irrigation systems convey water from the source earlier tested for quantity and availability to fields in lined or unlined open canals. Flooding basin, borders and furrow are

the primary method of applying water. Basins are suitable for rice row crops mostly irrigated by furrows. Surface irrigation system design involves developing specification for economically and technically feasible layout of application, delivery and drainage facilities. (Benami,1993).

2.1.2 Flooding:

This is when water is applied from field channel without any levees to guide its flow or otherwise restrict its movement to a farm land. Water brought across the field, usually at right angles to the direction of natural slope, in head ditches placed at convenient intervals, according to the steepness of the natural slope and type of soil these ditches at such intervals will allow for fairly uniform distribution over the land without undue over-lapping,(Cohen, 1993).

2.1.3 Border

Border irrigation makes use of parallel earth ridges called border to guide a sheet of flowing water across a field. The area between two borders is the border strip it is best to make the slope between 0.2% and 0.4%. The size of stream turned into a single border strip varies from 15 -300,1/s depending on the kind of soil. Water is turned into upper end of each strip, which flows slowly toward the lower end in a thin sheet guided by the ridges.(Hanks,1980).

2.1.4 Check Basin

Check basin method of irrigation, the most common method in use in India, is especially advantageous in heavy soil with low infiltration rate where water is to stand for a long period for the desired quantity of water to infiltrate the soil. This method of irrigation consists of running water into relatively level of plots surrounding by small ridges, It's suited to irrigate grains and fodder crops. It may be either rectangular or contour. (Michael, 1978).

2.1.5 Furrow:

Furrow method of irrigation is used in the irrigation of row-crop with furrow developed between the crop rows in planting and cultivating process. The method is suitable for row-crops like maize, sorghum, sugarcane, cotton, tobacco, groundnut, potatoes, and vegetables. The size and shape of furrow depend on the crop grown, equipment used and spacing between crops-row. There is usually one furrow between each row of crop. Furrow irrigation requires proper land grading. The land must be graded so that water can travel the entire length of the furrow without ponding. This means that the high and low spots must be removed and the land given enough slope to let the water flow down the furrows once level, care in tillage operations can keep the land levelled.(Michael,1978).

Furrows are most commonly run directly down the slope but can also be run on the contour to control erosion from rainfall or irrigation water. (Michael,1978).

2.1.6 Sub-Surface Irrigation

These methods of irrigation include applying water below the ground surface either by raising the water table within or near the root- zone or by using a buried perforated or porous pipe system that discharge directly into the root-zone. The sub irrigation method requires rather special site condition since it is necessary to have complete control of the water table through controlled water application and drainage. Each site requires special investigation to determine its adaptability to sub-irrigation. The method is suited to soil having reasonably uniform texture and permeable enough for water to move rapidly, both horizontally and vertically, within and for some distance below the crop root-zone. The soil profile must contain a barrier against excessive losses through deep percolation. The barrier may be either a nearly impermeable layer in the sub stratum or a naturally high water table on which a perched or artificial water table can be maintained throughout the growing season. Topography must be smooth and early level or the slope very and uniform. (Knierim,1999).

Sub surface irrigation can be used for soil having a low water holding capacity and a high infiltration rate where surface irrigation method cannot be used and sprinkler irrigation

is expensive. in sub irrigation it's possible to maintain the water level at optimum depth for crop needs at different growth stages. Evaporation loss from ground surface is held to a minimum.

2.1.7 Sprinkler Irrigation

Sprinkle irrigation system consisting of a single large nozzle. That rotates and is self-propelled the name refers to the fact that the base is on wheels and can be moved by the irrigator affixed to a guide wire. Sprinkler irrigation system uses pressure energy to form and distribute rain like droplets over the land .surface sprinkler irrigation system is made of the following components sprinkler, riser-pipe, lateral distribution pipes, main-line pipe and the pumping plant .sprinkler irrigation is adaptable to many crops, soil and topographic conditions. Sprinkler irrigation can be used for almost all crops except rice and on most soils. Its however not usually suitable in very fine textured soils (heavy clay soil) where the infiltration rates are less than 4mm per hours. (Michael, 2000).

The flexibility of the sprinkler equipment and its effective control of water application make this method adaptable to most topographic conditions without extensive land preparation. It's ideally suited to steep slope or irregular topography. (Daskshinamurthy,1978).

Land preparation generally costs less where sprinkler systems are used because of the reduced cost of levelling investment in a permanent water distribution system consisting of channels or underground pipelines is unnecessary. The rates of water application can be controlled to correspond to the infiltrate rate of soil such a control reduces water loss due to deep percolation or run-off.(Michael,2001).

2.1.8 Drip (Trickle) Irrigation

Drip irrigation also referred to as trickle irrigation which consists of an extensive network or pipes usually of small diameter that deliver filtered water directly to the soil near

the plant. The water outlet device in the pipe is called an 'emitter, discharge only a few liters per hour. From the emitter, water spreads laterally and vertically by soil capillary forces augmented in the vertical movement by gravity, the area wetted by an emitter depends upon the flow rate of soil type, soil moisture, and the soil hydraulic properties. The application efficiency for drip or trickle irrigation is based on the water desired in the root-zone and is not based on the whole area in sprinkler or surface methods. Drip system maintain nearly a constant moist soil in the root-zone and hence a greater crop yield and better quality. When compared to the sprinkler system, the drip method operate on much lower line pressure, thus providing, a saving in energy requirement. The main advantage of drip irrigation is the high degree of control of water application that it offers.(Michael,2001).

On the other hands the disadvantage of drip method of water must be relatively clean, poor water distribution efficiency when a low pressure system is installed on steep slope or uneven land. Clogging of small conduits and openings in the emitter is the most serious problem, dissolved salt are left in the soil as the water is used by the pits (Egharovba, 2002).

The system components include the main, sub main, laterals emitters, pump, and fertilizers injector. Pressure regulator (gauge) and vacuum breaker. The filter system must remove essentially all debris, sand clay to reduce clogging of the emitters .lateral lines are generally in flexible PVC or polyethylene pipe 12-32mm in diameter.(Egharovba,2002).

Drip irrigation is one of the more advanced techniques being used today because, for certain crop its much more efficient than traditional spray irrigation. (Egharovba 2001) .

Irrigation process can be explained in two ways;

- a) Distribution of water in the field after reserving them and transporting them.
- b) Use of the input water in the most economical and efficient way in the agricultural system.

Use of the input water in the most economical and efficient way is a function of highest rate available between the plants need and the practical portion of water given through the irrigation system by the operator.

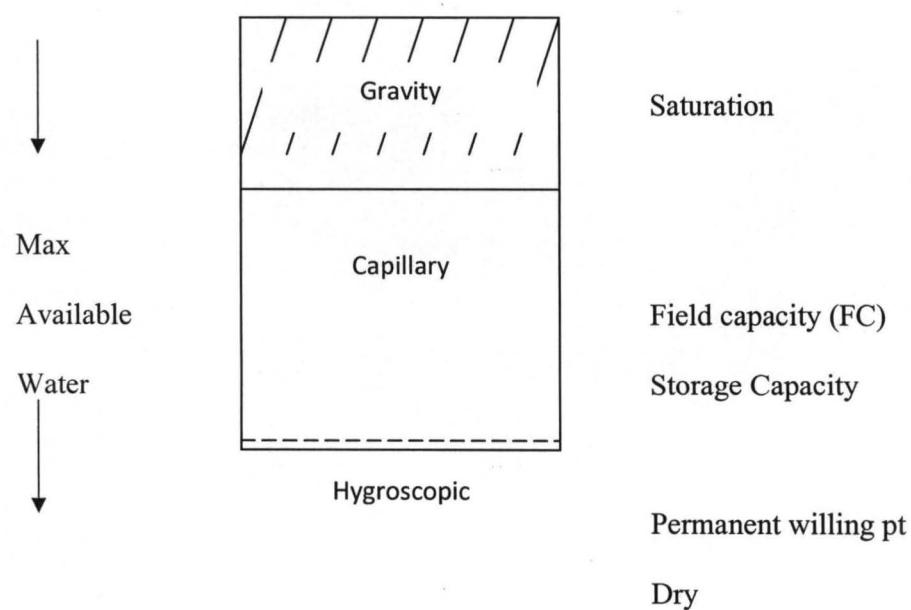
We can divide the irrigation system into

- a) Open system-gravitation flow
- b) Crossed system-pressurized flow.(F.A.O,1998-2002).

2.2 Crop Water Requirement:

The quantity of water needed to irrigate a given land area depend on a number of factors.

- ❖ Nature of crop.
- ❖ Crop growth cycle.
- ❖ Climatic condition.
- ❖ Type and condition of soil.
- ❖ Land topography.
- ❖ Conveyance efficiency.
- ❖ Water quality.
- ❖ Field application efficiency.



Soil moisture content

Figure 2.2

2.3 field capacity

The water content in the soil, 1-3days after water has been applied and drainage has largely ceased is defined as the FC for purpose. The FC expressed as a percentage of the soil dry weight is considered a constant of soil sample at F.C.

$$\text{F.C.} = \frac{\text{net weight at FC} - \text{oven dry weight}}{\text{Oven dry weight}} \times 100\%$$

Oven dry weight

The FC is lower in light than in heavy soil ranging roughly between 5 and 25-30 percent. (Egharevba, 2002).

2.4 Wilting Point

As water is extracted from the soil water reservoir through Evapotranspiration (ET) the surface tension is increased. At 15atm, plant can no longer extract the water and they wilt permanently. The soil-water content at that time, on a dry-weight basis is define as the permanent wilting point (PWP) or simply wilting point (WP). once this is reached, the soil-water reservoir is empty.

2.5 Irrigation Water Requirement

This case study shows how to calculate the total water requirement for a command area (irrigation blocks under various crops, soil textures and conveyance loss conditions) in order to evaluate the required irrigation for the entire command area a sample water demand for each irrigation block and the crops in each block are calculated by summing the following components.

1. Infiltration (percolation loss) through the soil (I)
2. Seepages (conveyance loss) through the channels(s)
3. Maximum evaporation of the crop (ETM)

The required irrigation gift for the entire command area is equal to the sum of water losses due to infiltration through the soil (S+I+ETM).

2.6 Frequency and Amount of Irrigation

Three major consideration influences, the time of irrigation and how much water should be applied, viz.

1. Water needs of crops.
2. Availability of water with which to irrigate.
3. Capability of the root-zone soil to store water.

2.6 Water Need of Crop

These shows amount of water the crop needed at a particular time or intervals for example maize crop, the consumptive use of maize is 7mm/day x10day=70mm of water to apply within 10days.

To find the frequency of any crop it is determined by dividing the amount of moisture to be depleted from the soil by the consumptive use (c u) per day.

The disadvantage of this method is that consumptive use (cu) or evapotranspiration (ET) is not easy to determine on daily basis. For potatoes the consumptive use of potatoes is 8.2mm/day and frequency is 11days.therefore, the amount of water to apply 8.2mm/day x11days=90.2mm.within the 11 day.(Egharovba,2002).

2.7 Availability of Water with Which to Irrigate

These depend on amount of water available to irrigate with and this shows that water require of any crop depend on the capacity to retain that water in root-zone of each soils.

2.8 Capacity of the Root-Zone Soil to Store Water

These depend on range of available water holding capacity of soil; various soils have different water holding capacity as shown in table 2.1.

Soil	Percentage moisture dry weight of soil	Depth of available water per unity depth of soil	
	Field capacity	Permanent wilting percentage	Cm/m depth soil
Fine sand	3-5	1-3	2-4
Sandy loam	3-15	3-8	4-11
Silt loam	12-18	6-10	6-13
Clay loam	15-30	7-16	10-18
Clay	25-40	12-20	16-30

Source (Russel,1999).

2.9 Irrigation Efficiencies

Adequate control and management of irrigation water requires that methods be available to evaluate irrigation practices from the time water leaves the point of diversion until it's utilized by the plants. The overall system efficiency is the product of the efficiency of each system component.(Woodward,1990).

Reservoir Storage Efficiency (ES) is calculate using equation..... 2.1

$$Es = \frac{W_s}{W_{so}} \times \frac{100\%}{1} \dots\dots\dots 2.1$$

Where W_s = amount of water diverted for irrigation

W_{so} = amount of water diverted to the storage

Water Conveyance Efficiency (EC) is calculate using equation2.2

$$Ec = \frac{W_f}{W_r} \times \frac{100\%}{1} \dots\dots\dots 2.2$$

Where, W_f = water delivered to the farm

$W_r =$ water diverted from the river or reservoir

Water Application Efficiency (Ea) is calculate using equation..... 2.3

$$Ea = \frac{W_{r2}}{W_f} \times \frac{100\%}{1} \dots\dots\dots 2.3$$

Where, $W_{r2} =$ water stored in the soil root-zone during irrigation

$W_f =$ water delivered to the farm.

Note common source of loss of irrigation water from the farm during application are represented thus.

$R_f =$ surface runoff from the farm

$D_f =$ deep percolation below the farm root-zone soil

An evaporation loss during the time water is being applied and immediate after it follows that:

$$W_f = W_{r2} + R_f + D_f$$

Therefore, $Ea = \frac{100 W_{r2} - (W_f + D_f)}{W_f} \dots\dots\dots 2.4$

Overall irrigation efficiency (Ei)

$$Ei = \frac{E_s}{100} \times \frac{E_c}{100} \times \frac{E_a}{100} \times \frac{100\%}{1} \dots\dots\dots 2.5$$

2.10 Method of Determining Amount of Irrigation

Three main method of determining amount of irrigation are

1. Use of Tensiometer

The main active root-zone should be defined for placing the tensiometer and the minimum soil water potential before onset of irrigation should be pre-determined tensiometer is used to indicate the rate of depletion of soil moisture. But cannot be use for the full moisture range. Because of its narrow range (0 to 80 centibars) the tensiometer is used for most and resistance blocks for dyer soil condition (Hansen et al, 1980).

2. Consumption Use (cu) Method

Considered the following case

If $cu=7\text{mm/day}$ and the frequency (known) $=10\text{days}$

The amount of water to apply $=7\text{mm/day} \times 10\text{days} = 70\text{mm}$. determine C.U or E.T for a crop Hence we can find out the frequency of irrigation. For example consider maize crop Maize, $CU=7\text{mm/day}$. If plant needs 42mm (i.e. amount of moisture to be depleted from the soil) frequency of irrigation can be determined by dividing the amount of moisture to be depleted from the soil by the CU per day, care being taken to ensure that the amount of moisture and the CU are measure in similar units. In the above case (maize) $\text{frequency} = 42/7 = 6\text{days}$. The disadvantage of this method is that CU or ET is not easy to determine on daily basis.

3. Available Moisture Method

Determined the FC and PWP when MC gets to QM ,we will then irrigate. The readily available moisture for such plant will then be the volume per unit surface area of soil water between FC and M where, M is the critical soil water content in percent by volume. Amount of water required $=d(FC-QM)$ where d =active root-zone depth.

2.11 Wastage of Irrigation Water in Farm

It is well know that when an area is irrigated excessively over an extended period of time the ground water level rises, but when it reaches a height which is equal to the capillary rise of moisture in the soil, the soil moisture is brought to the surface where it evaporate leaving the salts at the surface. This causes soil salinity and sometimes alkalinity which adversely affect plant growth.

Inadequate land development include lack of land grading wherever required improper layout of on farm irrigation and drainage system, adoption of unsuitable and unrealistic cropping pattern tilted in favour of water loving crops are the major factors leading to excess water, application and land degradation. Also effort to utilize and various

components of the water resources of an irrigation command area are lacking in most of the irrigation projects. These brought about drainage, agricultural drainage comprises of removal of excess surface and ground water from agriculture lands of farm. Drainage and irrigation are complementary processes which together have the end goal of creating a soil moisture regime and salt balance in the soil root-zone for optimum growth of crops plant and trees for sustaining them without adverse effects on the environment and ecology. Finally blocked drains and unplanned construction, building under capacity culverts and other structure which obstruct natural drainage.(Egharevba, 2002).

2.12 Irrigation Scheduling

The important decision as to when and how much water to apply to a growing crop must be repeatedly made through-out the growing season .these decision involves a commitment by the producer to optimally manage water, labour, and equipment. Poor management resulting in either under or over irrigation can reduce crop yields, degrade crop quality, enhance the field environment for disease, increase pumping costs, and leach soluble nutrient from root-zone.

2.13 Specific Problems Associated With Over Watering

Improper irrigation water management leads to number of physiological disorders and diseases. Water stress can occur from too much as well as from too little water. Producers know that stress caused by too little water reduces yield with the level of reduction depending on when stress occurs in relation to crop development. Quality can also be affected. Over irrigation may also stress the crop through reduced soil aeration and cause similar consequences? A major effect of excess water is the reduction of nitrogen levels within the root-zone to less than favourable levels. Symptoms of excessive water application on some common Idaho crops are presented below.

2.13.1 Potato

Excessive water can cause soft rot, early die, and promote brown centre, which can progress into hollow heart. Excessive water reduces soil temperature, creating a favourable environment for rhizoctonia root rot, black scurf, pink rot, and leaf blight. Also, excessive water can contribute to a more favourable environment for foliar disease, possibly requiring additional applications of fungicides and increasing production costs.

2.13.2 Corn

Water-saturated soil turns lower leaves of young plants yellow and caused them to die. Extended periods of waterlogged soil kill the crown area of plants. Many of the fungal disease infections in corn increase under excess irrigation. (Michael, 2002).

2.14 Determining the Amount of Irrigation Water Applied to a Field

Critical to any irrigation management approach is an accurate estimate of the amount of water applied to a field. Too often, growers apply water to make the fields and rows “look good” (blacken-up the beds) or continue irrigating until the water reaches the end of every furrow. However, quite often they never realize just how much water they have applied. When growers do not take their system’s efficiency into account, they may apply too little or too much water. Too little water causes unnecessary water stress and can result in yield reductions. Too much water can cause water logging, leaching, and may also result in loss of yield.

2.15 The Irrigator’s Equation

How Much Did I Apply?

Estimating the amount of water applied to a field or to a set is fairly easy for surface systems. The Irrigator’s Equation 2.6 can be used to estimate the depth of water applied.

$$Q \times t = d \times A$$

TABLE 2.2 conversions from cubic feet per second (cfs) to gallon per minute (gpm) to miners' inches.

FLOW RATE CONVERSION TABLE		
Cubic feet per second (cfs)	Gallons per minute gpm	Miner's inches
1	450	40
2	900	80
4	1800	160
6	2700	240
8	3600	320
10	4500	400

Source (Russel, 1999).

The one factor in irrigation that is most often overlooked is the efficiency of the irrigation system itself. There are many different types of efficiency and many different ways to define it. Efficiency here refers to the overall system's ability to apply an equal amount of water to all parts of the field. A system with 100% efficiency would be able to apply the same amount of water to every inch of the field, head end, tail end, canter, side, etc. No system is 100% efficient. Drip systems are the most efficient and they are usually near 95% efficient. Surface systems are notorious for inefficiency, but properly maintained fields can achieve efficiencies as high as some sprinkler systems.

Table 2.3 gives the range of efficiencies normally associated with different types of irrigation systems. In order to apply the proper amount of water to a field, first you must decide what efficiency to use in your calculations. Table 2.3 gives a range of values for seasonal and peak use periods. These are provided because some systems are better equipped

to handle large applications and during times of peak water use, when water demand is high, the system's efficiency is increased.

For example, all of the surface systems have an increase in their efficiency from seasonal to peak use periods because surface systems can apply large amounts of water more efficiently than smaller amounts. During the early part of the season, these systems are inefficient because they over-water.

Overall, seasonal efficiency is relatively low compared to the efficiency during peak use. Sprinkler and disesteems (with the exception of the traveller sprinkler System), on the other hand, maintain their efficiencies regardless of seasonal or peak use periods. This is because these systems apply large and small quantities of water at about the same efficiency.

Taking the average of the ranges in Table 2 is probably a good start, although many surface systems operate at the very low end of the ranges given. Also, many sprinkler systems with LEPA (Low Energy Precision Application) systems and drop nozzles achieve even higher efficiencies than those given. You can contact your local Natural Resources Conservation Service office or local consultant who may be able to perform an analysis on your system to determine the irrigation efficiency. Once the efficiency has been determined, use that to adjust your irrigation amounts.

Let's take the second example where the grower was determining how long the set time should be to irrigate 4.0 inches. If he has a system that is 75% efficient, then the target amount would be increased from 4.0 inches to 5.3 inches. In order to account for the system's inefficiency, the efficiency must be divided into the targeted amount. In the example above, the efficiency of 75% (or 0.75) is divided into the target amount of 4 inches:

$$4.0/0.75 = 5.3$$

Table 2. 3 Seasonal Average and Peak Water-Use Period Irrigation Efficiencies.

Type of Irrigation System		Efficiently Range	
		Seasonal Average	Peak Use Period
Surface	Furrow (without reuse)	55-77	77-80
	Border (without reuse)	63-84	77-87
	Basin	70-80	70-87
	Precision-leveled basin	77-84	80-87
Sprinkler	Moved lateral	70-80	70-80
	Traveler or boom	67-75	55-70
	Solid set	70-87	70-87
	Center pivot	80-87	80-87
	Lateral move	84-90	84-90
Drip	Point source	74-93	74-93
	Drip tape	85-95	85-95

Modified from (Hoffiman et al, (1990).

This gives the actual amount of water that needs to be applied to assure that the entire field receives at least 4 inches of water. Of course, some of the field will receive more water, but that is the cost of the system's inefficiency.

To determine the set time for the example above, we use the irrigator's equation and calculate for 5.3 inches instead of 4.0 inches:

$$5 \times t = 5.3 \times 3.8$$

$$Q \times t = d \times A$$

Solving for t we get

$$T = (5.3 \times 3.8)/5 = 4 \text{ hours}$$

The set time should be four hours to assure that all parts of the field receive at least 4.0 inches of water. Proper calculation and keeping records of irrigation amounts and set times, as well as a realistic estimate of system efficiency, will help to assure that your crop receives all the water in needs. The information provided in this bulletin is also available in an irrigation slide chart (1999), which helps to determine set times and flow rates. The slide chart is written in both English and Spanish and is easy to use. The slide chart is available through your local Cooperative Extension office.

2.16 Automation of Irrigation Systems

2.16.1 Timer

The most common way to automatically turn irrigation on and off is through the use of a timer, in plate 2.1. However, timers are unable to adjust watering based on changing water needs of the plants or as weather conditions change. An experienced grower can look at the plants to

Determine if they need water, but this approach is not practical for automation. There are different ways to automate irrigation based on crop water needs, and each method has benefits and drawbacks.(www.arguscontrol.com).

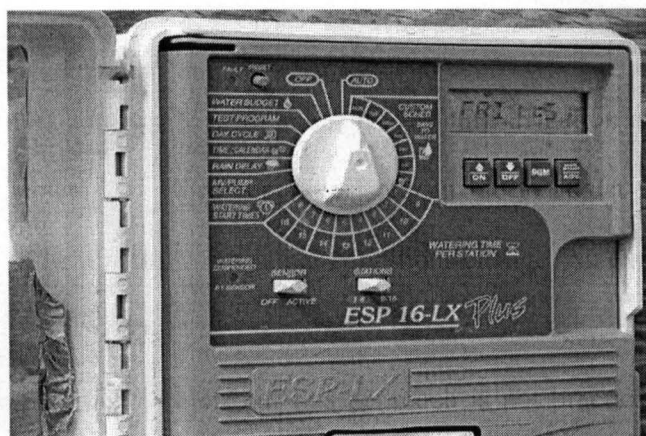


Plate 2.1: Timer (Bernard, 2006).

2.16.2 Measuring environmental conditions

The amount of water used by plants depends on a variety of environmental conditions, such as light, temperature, air movement, and relative humidity (which is closely related to the vapor pressure deficit or VPD). By measuring one or more of these parameters, you may be able to estimate the amount of water used by plants and irrigate accordingly. Computer models that estimate water use can be incorporated into the software for your greenhouse environmental control, and the greenhouse computer can control your irrigation. One approach is to control irrigation based on VPD. The simplest way to do this is to measure the relative humidity and air temperature in the greenhouse through the use of sensor in plate 2.2

from these two measurements, the computer can calculate how much water vapor is actually present in the air as well as how much water would be present at 100% humidity.

The amount of water vapor in the air at 100% humidity minus the actual amount of water vapor is the VPD. The larger the VPD, the more water plants will transpire, and VPD can thus be used to predict water needs.



Plate 2.2: Temperature and humidity sensor (Bernard, 2006).

To make these predictions more accurate, you can measure the temperature of the leaves. That would allow the computer to calculate the amount of water vapor inside the leaf. Transpiration depends on the difference between the amount of water vapor in the leaf and the amount of water vapor in the air. In many cases it is not practical to measure real leaves, and the temperature of an 'artificial leaf' is measured instead.

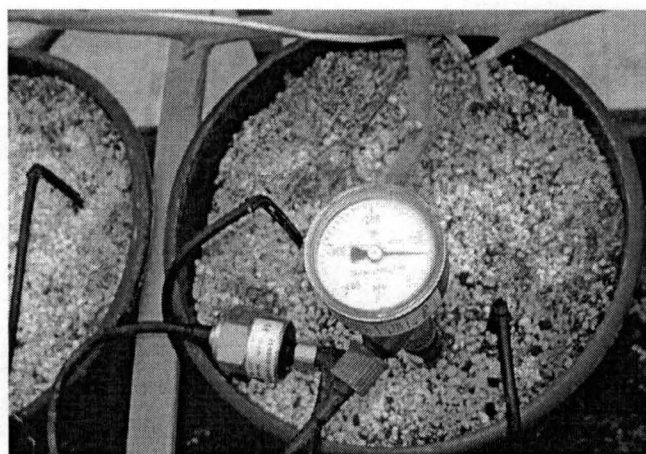


Plate 2.3: A Tensiometer (Bernard, 2006).

2.16.3 Direct Measurements of Water Needs.

It is also possible to measure water needs directly. This can be done in different ways. The first decision to make is what to measure: the water status of the plant or the substrate? Measuring the water status of the plant has the advantage that you may be able to directly determine if your plants are suffering from drought stress.(www.arguscontrols.com).

The drawback, though, is that plant water status changes gradually throughout the day, even if the plants are not too dry. This can make it difficult to distinguish between regular, diurnal changes and changes induced by drought. The other option is to measure the substrate water status. Instead of trying to determine whether plants are suffering from drought, this determines if there is enough water in the substrate for the plants. If there is too little water in the substrate, the irrigation is turned on.

2.16.4 Measuring the Plants

As plants transpire, leaves are cooled. Because of this, the leaf temperature of well-watered plants is normally slightly below the temperature of the air, while the leaf temperature of drought-stressed plants is above that of the air. Thus, the difference between leaf and air temperature may indicate plant water status. Leaf temperature can be measured in different ways using leaf temperature sensors or with infra-red thermometers. Because infra-red sensors are not attached to the plants, measurements are made via 'remote sensing'. Infra-red sensors are readily available and can easily be connected to many greenhouse control systems. Other remote sensing options under development are determining movement of the leaves and measuring specific wavelengths of light reflected by leaves. When plants dry out, leaves eventually wilt. By using remote sensing, it is possible to measure slight changes in leaf angles, and wilting can be determined well before the human eye can see it. Measuring the light reflected by leaves also can be used to determine drought at early stages. By measuring small changes in different wavelengths of infra-red radiation reflected by leaves, it

is possible to determine impending drought stress. This approach works in laboratory applications, and may be ready for 'real-world' applications in the near future.

Remote sensing techniques have the advantage that it is possible to measure many plants at once, and the readings can be averaged. That way, irrigation decisions are not based on measurements of one or a few plants, which may or may not be representative of the whole crop. A difficulty that many remote sensing techniques still struggle with is to distinguish between the plants and everything else in the picture. Because of this, remote sensing techniques are easier for crops with large canopies, such as greenhouse vegetables.

2.16.5 Measuring the substrates

Since irrigation and plant water use both directly affect the amount of water in the substrate, substrate water level is a logical measurement for use in irrigation control. There are two substrate parameters that can be measured, the water tension and the water content. Substrate tension, or water potential, determines how tightly water is held by the substrate. As a substrate dries out, the remaining water is held more and more tightly, until plants can no longer take it up. So as the water tension in the substrate approaches the minimum tension for plant use, irrigation is necessary. Water tension can be measured with tensiometers, which have been around for a long time. However, tensiometers have been difficult to use in soilless substrates, because of the required maintenance and the need for very close contact of the sensor with the substrate. With traditional tensiometers, any disturbance could break the contact between the sensor and the substrate, resulting in bad readings. Recent improvements in tensiometers have made them easier to use and their use in irrigation control is likely to increase (www.arguscontrol.com).

2.16.6 Water Content Measurement.

The other option for substrate water measurements is to measure the amount of water in the substrate (water content). Water content measurements traditionally have been either expensive or inaccurate. However, in recent years cheaper and more accurate soil moisture

sensors have become available, and these have great potential for irrigation control. The idea is similar to that behind the use of tensiometers: as plants use water, the amount of water in the substrate drops and when it drops below a certain level it needs to be replenished by irrigation. By using this approach, plants get watered when needed, excess irrigation can be prevented. We have worked with Brower Electronics Labs (Pittsboro, NC) on a controller that uses soil moisture probes (ECH2O-5 probes) made by Decagon Devices (Pullman, WA). This controller allows growers to set a minimum substrate moisture level at which the plants will be irrigated, the irrigation duration, and a minimum interval between subsequent irrigations. This single station controller can be interfaced with existing systems or used as a stand-alone controller. One to four moisture probes can be connected to the controller, and the controller will use the average reading from the probes for irrigation control.

Dynamax (Houston, TX) has developed a similar controller the Moisture Klik™. A soil moisture sensor can be buried in the substrate, and a 24 VAC relay is activated when the substrate water content drops below a grower-determined level. Although this controller was developed for regular soils, it works in soilless substrates as well. We have used this controller successfully in our greenhouse, but so far our experience is limited. It is likely that it will soon be possible to connect these soil moisture probes to a greenhouse environmental control system as well, so that they can control irrigation based on real-time measurements. Using a somewhat different approach, Rain Bird has developed an irrigation controller for outdoor use (model MS-100) with a soil moisture probe that is buried. As long as this probe measures a sufficient amount of water in the soil, it overrides the irrigation timer and prevents irrigation. Thus, a timer can be programmed for frequent irrigations, but as long as there is ample water in the soil, the irrigation system will not come on. Unfortunately, the soil moisture probe used by Rain Bird is highly sensitive to EC and thus not suitable for greenhouse use. However, a similar approach could easily be adapted for greenhouse applications (Bernard, 2006).

Another exciting new product, developed by Decagon Devices is a probe that can measure both the water content and EC of the substrate (ECH2O-TE). This may make it possible to automatically irrigate with plain water or fertilizer solution, based on the requirements of the plants. Fertilizer could be injected into the irrigation water when the substrate EC drops too low, while automatic leaching could occur when the substrate EC is too high.

CHAPTER THREE

3.0 Irrigation and software design.

The complete system design shall be consider under two specifications: hardware specifications and software design. Since this project work focuses mainly on software design, the hardware requires are listed in table 3.1

Table 3.1.

S/No	Hardware	Quantity	Description
1.	Tank	3	
2.	Water Level Sensors	3	Pressure sensor
3.	Controller	3	Main chips.(intel products)
4.	Computer	1	
5.	Feeder/Hose		φ12-32mm PVC pipes
6.	Drip Emitters		The spacing/discharge depends on the type of crop to be irrigated. 0.5 gph
7.	Valves /pumps	6	
8.	Pressure sensors	9	

3.1 Irrigation Design.

The design of a drip irrigation system for a particular field/crop(s) requires the following(s).

1. Soil condition: sandy loam, it water holding capacity for any crop are 3-5cm/m weight of soil and field capacity. Depth of available water permanent wilting percentages is 3-8, soil depth 4-11 cm/m.
Coarse sand - large than 2mm.
Fine sand - 0.05-2mm.
Silt - 0.002-0.05mm.
Clay - >0.002mm.
2. Weather; Temperature, relative humidity..
3. Crop water requirements; the quantity of water needed to irrigate at a given land area depend on a number of factors.
 - i. Types and condition of soil; sandy loam, it has high water capacity.
 - ii. Conveyance efficiency; proper channel of water to the farm.
 - iii. Water quality; the water should not contain any contaminants.

Basic of Equation of Drip Irrigation System

According to Michael, (2002). "Any of the following empirical equations can be used to estimate the loss of head by friction..." equation 3.1 (Blassius equation) estimate the friction coefficient,

$$f = \frac{0.316}{(R_n)^{1/4}} \dots\dots\dots 3.1$$

Where R_n is the Raynold number.

Equations 3.2 and 3.3, (Williams and Hazen equation) is to calculate energy loss by friction in the main and lateral or sub-main respectively.

$$\Delta H = 15.27 \left(\frac{Q^{1.852}}{D^{4.871}} \right) L \dots\dots\dots 3.2$$

$$\Delta H = 5.35 \left(\frac{Q^{1.852}}{D^{4.871}} \right) L \dots\dots\dots 3.3$$

Where Q = total discharge in the pipe, l/sec

L = length of the pipe section, m

D = Inside diameter of the pipe, cm.

Assuming a turbulent flow in the sub-main, for commonly used emitters, emitter flow and pressure head is expressed by equation3.4,

$$q_i = c\sqrt{h_i} \dots\dots\dots 3.4.$$

Where c = constant,

h_i = pressure head at i^{th} section.

3.3 Software Design

In designing the software, the first step in writing computer instructions to carry out a task is to determine what the output should be. The second step is to identify the data, or input, necessary to obtain the output. And lastly, is how to process the input to obtain the desired output, David, (1995).

For the purpose of irrigation, the outputs are what time to irrigate and what quantity of water to be discharge into the soil. The inputs will includes water, environmental conditions. The process of achieving this is complicated, to summarise the process sensors in the field sense the environmental conditions and send them inform of signal to micro controllers and the computer uses that to perform irrigation.

3.3.1 Program Planning

The following programming cycle help to efficiently design a program with minimal errors.

- Defining the problem – here the problem is to design and develop a computer program that can be use for drip irrigation control.
- Program Design – involves the determination of numbers of modules, their inputs, processing, logical and relational operators, and their outputs. i.e. Tank properties required to create a tank such as tank type, tank capacity, tank volume, tank current volume, e.t.c filling and refilling tank, irrigation the crops if it is required and tanks not empty, e.t.c.
- Choosing the interface – after choosing the program compiler visual basic, then selecting control objects such as forms, textboxes, command buttons, list boxes, compo boxes, frames, labels e.t.c. This determines how many inputs will be obtained and how outputs will be display. The control objects were arranged in a user-friendly manner to minimise the number of interaction between the user and the program before results are obtained.
- Coding – this the technical word for writing the program, Michael, (1995). During this stage, the algorithm designed in step 2 is entered into the visual basic compiler.
- Testing and debugging – at this stage, the program is tested with extreme values, and errors such as logical, syntax and runtime errors were debugged.

- Documentation – presented in the help module of this program, describes the organisation of this program and how another person can use the program with minimal hitch.

3.3.2 Programming Tools Used

- Pseudo-code – is an English like terms with some programming syntax to outline the task in steps as follows.

1. Start the Program

2. Select an item: a. Create Tank, b. Fill/Re-Fill Tank, c. Irrigate Crop, d. Help.

IF selection= "a" THEN

GOTO step 3

ELSEIF selection= "b" THEN

GOTO step 4

ELSEIF selection= "c" THEN

GOTO step 5

ELSEIF selection= "d" THEN

GOTO step 6

END SELECTION

3. Input tank properties, capacity and dimensions, type and name. then draw the tank using the tank height and width. Show the tank data. Save the tank data into a file, to be retrieved later when necessary.
4. List the tanks created, select one of the tank to fill/refill by retrieving its data from file. Check if the selected tank is empty or not, enter volume of the water to be fill into the tank. And resave the tank data into the file.
5. To carryout irrigation the selected tank(s) must not be empty and must have enough water to perform the irrigation. i.e.

IF tank Empty= False then

Add Volume to the Tank

Else

Fill the tank

End IF

6. Display information on how to use the program successfully and also a module to help design a drip irrigation system.
 - Flowchart – the flowchart for the pseudo-code is presented in chart 3.1. The main menu is first display were option such as create tank, fill/refill tank and perform irrigation are available.

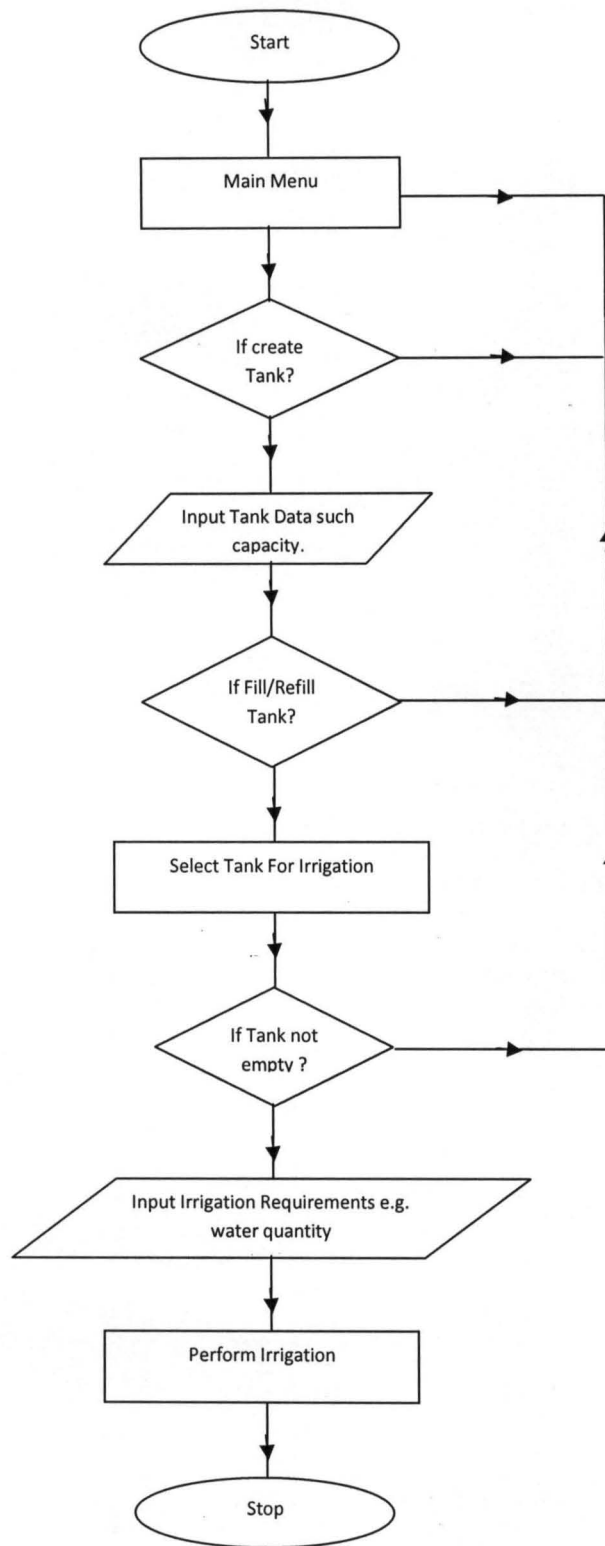


Chart 3.1: Main Flowchart.

- **Program Description**

The program was design and coded on a single form or screen, this is to make it user friend to reduce complication at the designing and application stage. The program code is presented in Appendix A. The plate 3.1-3.4 shows the program screen shots.

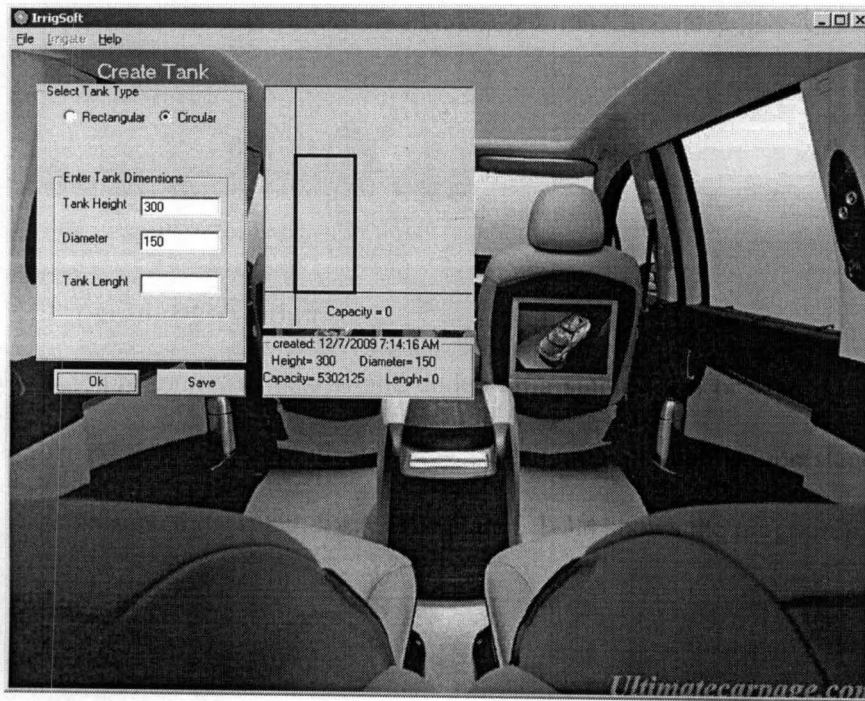


Plate 3.1: Create Tank Screen.

The screen in plate 3.1, is designed to create a visual water tank by supplying the tank type rectangular or circular and its dimensions. The program will use this to draw the tank and save it for future use. Plate 3.1 contains two frames, three textboxes, two option boxes, one picture box and two command buttons. To create a tank select tank type, enter tank data and click ok and save to save the tank.

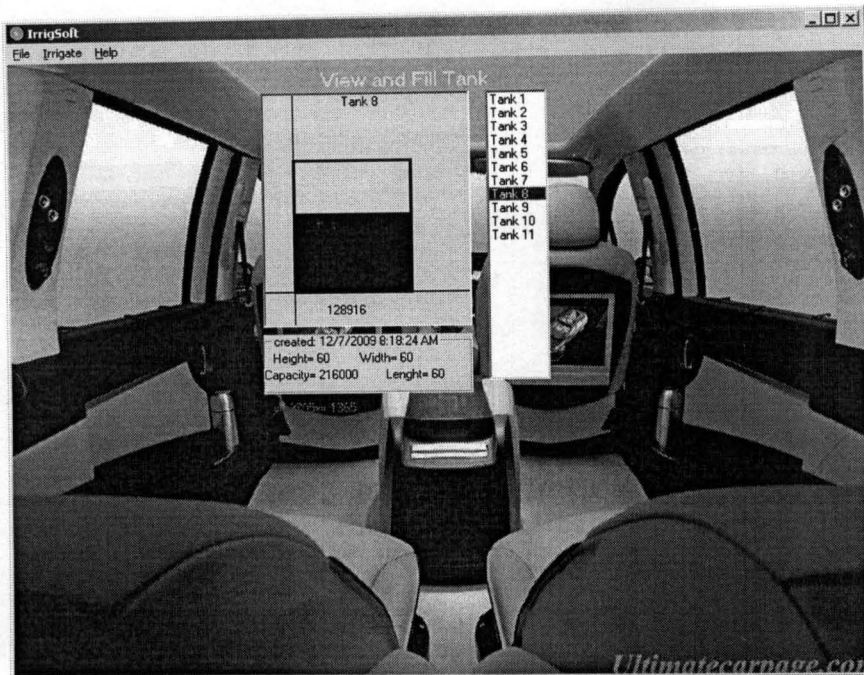


Plate 3.2: View Tank screen

Tanks that have been created and saved can be view with their properties for the purpose of filling the tank and performing irrigation. The plate 3.2 was design with a single picture box to display the tank, a frame to show the tank data and a list box list created tanks for selection. As a tank is selected, its data such as the height, width e.t.c/ is sent to sub-program called draw, which sketch the tank on the picture boxes.

Plate 3.3 shows the screen where irrigation can be performed. The screen simulate how water is been drain for irrigation from the tank. Plate 3.3 was designed to alongside the view screen. To perform irrigation select a tank that is not empty, enter irrigation factor which depend on the soil and type of crop been irrigated.

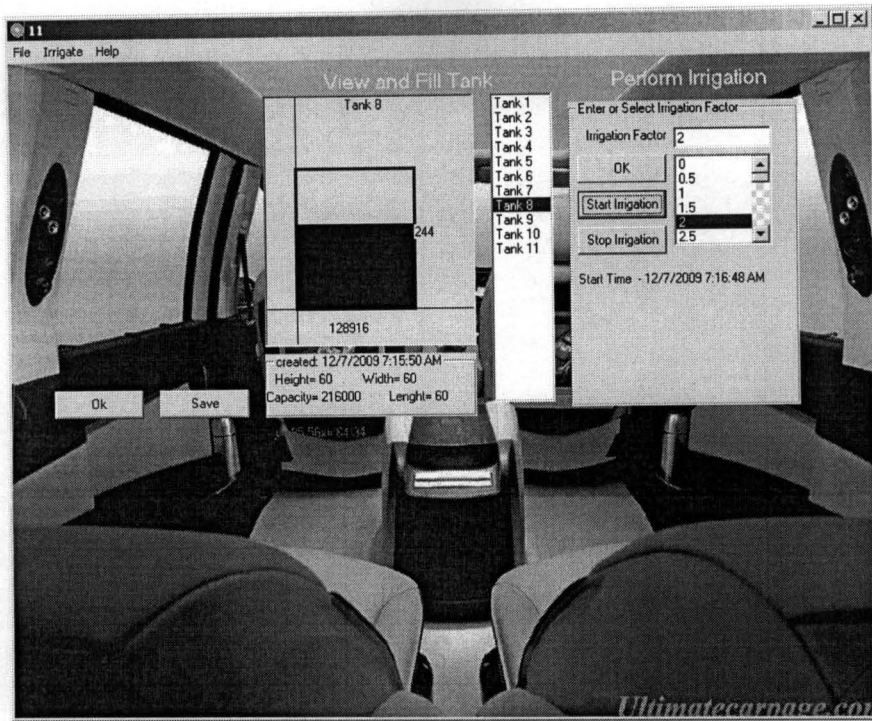


Plate 3.3: Irrigation screen.

Note that when performing irrigation other activities such as creating tank, filling tanks will interfere with the irrigation activities. Also I will to state here that, there is no particular way of designing or building software. The system analysis and programmer's imagination plays a very important role. Chart 3.4 shows all the three main modules in this program.

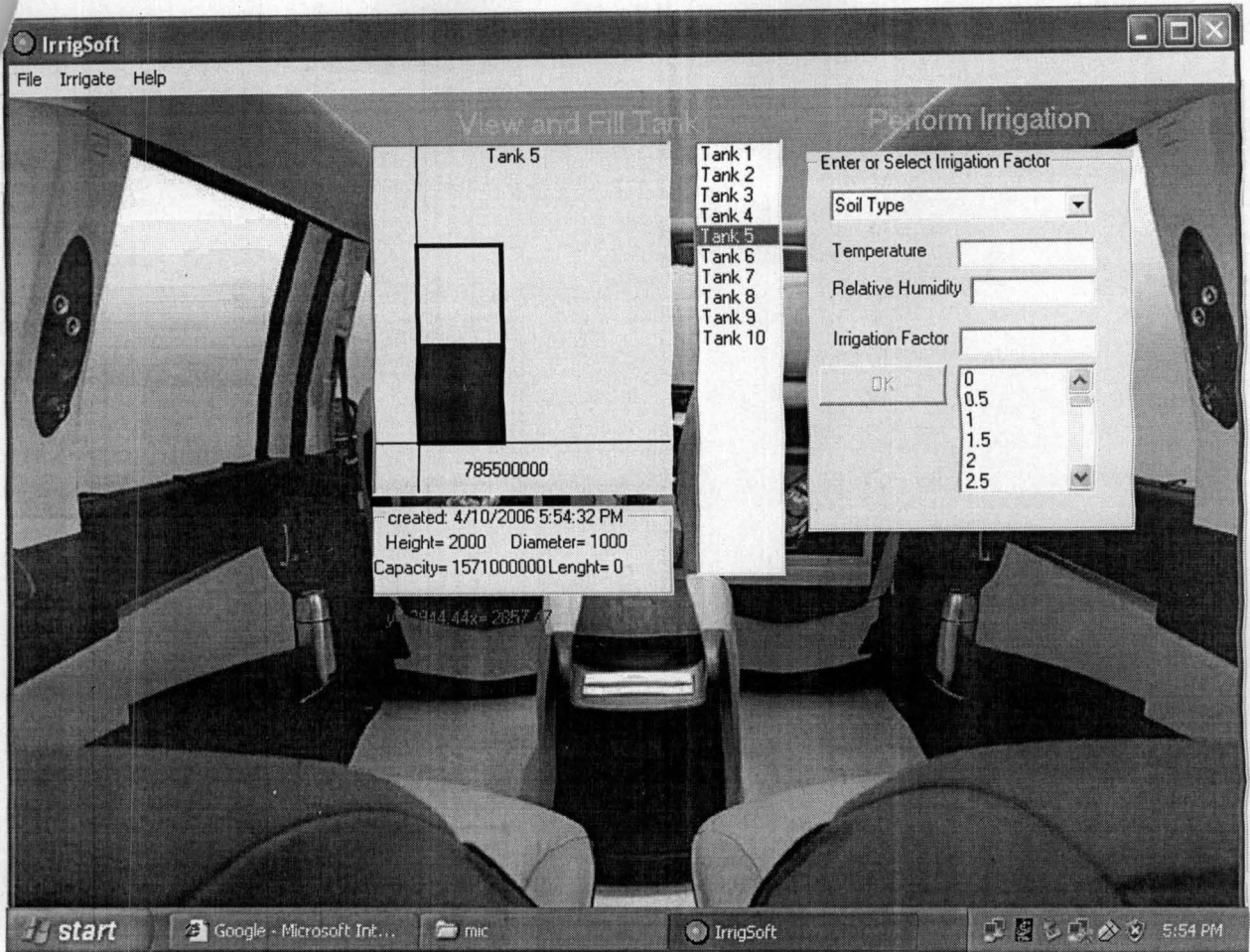


Plate 3.4: Complete Screen.

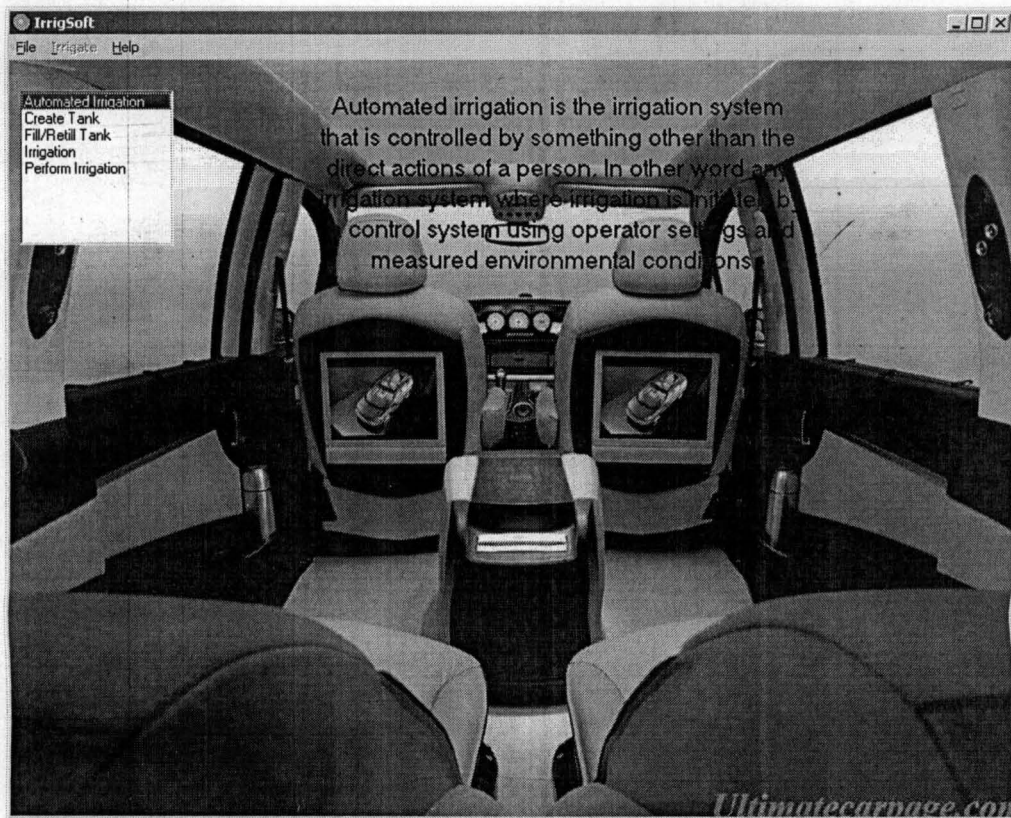


Plate 3.5: Help screen.

CHAPTER FOUR

4.0 Program Testing and Discussion of the Result

4.1 Program Testing

The package software IrrigateSoft2009, were burn into a CD plate and installed into a computer just like any other application software available in the market. Plates 3.1-3.5 are the screen shots from the installed software. It will take less than a minute to create, fill a tank and perform or schedule an irrigation activity.

The data used for the testing of the irrigatesoft2009 are as follows. two hectares of maize and potatoes each were considered. The two crop requires a water depth 0.007mm/day and 0.0082mm/day respectively.

Field size = two Hectare

= 100 x 100 x 2

= 20,000 m²

Quantity of water = 10,000 litres

Crops = Maize and Potatoes

Irrigation factors for Maize. = $d \times A / Q$

= $0.007 \times 20,000 / 10,000$

= 0.0014

Irrigation factor for Potatoes = $d \times A / Q$

= $0.0082 \times 20,000 / 10,000$

= 0.0164

The input pressures for the pipes to discharge the water depend on the irrigator factor for each crop.

4.1.1 Program maintenance

This program needs no special maintenance like the operating systems and other data processing software. This program has been design to shutdown open nay error or virus, worms and malicious infection. But upgrading of the software may be necessary in the near future if there are any system design changes.

4.1.2 System Requirements

An average computer today's standard will perform well running this application. Generally, the more the RAM the better, since this application is mostly input/output bound, i.e. basically a data processing application.

4.1.3 Software Installation

After the completion of the program, the extension name was changed from .vb to .exe. This makes the program a stand alone and can run in any operating system without the compiler. The .exe flee have been packaged for installation into any computer that meets the requirement stated in section 4.4.

CHAPTER FIVE

5.0 Conclusions and Recommendations

5.1 Conclusions

In view of the fact that every profession is moving towards computerization and automation of their system, it has become imperative too, automating the present available irrigation methods (such as drip irrigation). Irrigate Software program have been developed successfully, the program was packaged into a folder Irrigation Software and contain one folder (support) and three files (setup.exe, setup.lst and IrrigationSoftware.rar), all less than 10MB. This software will provide a solution for automated irrigation system. Irrigation activities can be schedule at any time and require minimal human or physical intervention, this made possible by the development of this program.

5.2 Recommendations

The following recommendations were deemed necessarily for further research direction.

1. More group of student should be put together to implement the hardware component of this project.
2. Further research on the networking of the irrigation filed far apart is also suggested.

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Appendix A

Main form Code

```
Dim tankSelected As Boolean, iRRigating As Boolean, tankEmpty As Boolean
Dim tankName, currentTankVolume As Double, currentWaterLevel As Double
Dim callOver As Boolean, y1, tankCreated As Boolean, valuesCompleted As Boolean, tankVolume As Double,
rtankVolume(1000) As Double
Dim tankHeight As Double, tankWidth As Double, tankLenght As Double, IrrigationTime1, irrigationTime2
Dim tankCapacity As Double, tankDiameter As Double, irrigationFactor As Double, v As Double
Dim tankType As Integer, reCords As Integer, waterLevel As Double, rtankDiameter(1000), soilNumber As
Double
Dim rTankHeight(1000), rTankWidth(1000), rTankLenght(1000), rTankCapacity(1000), rwaterLevel(1000),
rTankType(1000)
Private Sub abouthelpmenu_Click()
    List5.Visible = True
    List5.AddItem "Irrigation"
    List5.AddItem "Create Tank"
    List5.AddItem "Perform Irrigation"
    List5.AddItem "Fill/Retill Tank"
    List5.AddItem "Automated Irrigation"
    Label15.Visible = True
    Label15.Left = List5.Width * 2
    Label15.Top = List5.Top
End Sub
Private Sub authormenu_Click()
    List5.Visible = False
    Label15.Visible = True
    Label15.Caption = "This Program was developed by Michael Alaba Alowasegun (2004/18387EA). Graduaed
from the Department of Agricultural Engineering and Bio-resourses ENgineering. I was born at Akure, Akure
SOUTH-west, Ondo state - Nigeria. Christian by religion. cell: - 08094752494, alibarca@yahoo.co.uk"
    Label15.Top = 10
    Label15.Left = Form1.Width / 2 - Label15.Width / 2
End Sub
Private Sub Combo1_Change()
    If Combo1.ListIndex = 0 Then
        Frame3.Visible = True
        Frame2.Visible = False
    ElseIf Combo1.ListIndex = 1 Then
        Frame2.Visible = True
        Frame3.Visible = False
    End If
End Sub
Private Sub Combo1_Click()
    If Combo1.Text = "CAPACITY" Then
        Frame3.Visible = True
        Frame2.Visible = False
    ElseIf Combo1.Text = "DIMENSIONS" Then
        Frame2.Visible = True
        Frame3.Visible = False
    End If
End Sub
Private Sub cmbSoilCond_LostFocus()
    Select Case cmbSoilCond.ListIndex
    Case 0
        soilNumber = 0.002
    Case 1
        soilNumber = 2
    Case 2
        soilNumber = 1.025
    Case 3
```

```

        soilNumber = 0.0275
    End Select
End Sub
Private Sub Command1_Click()
    If y1 <> 0 Then
        If valuesCompleted = True Or callOver = True Then
            Pic1.Visible = True
            Frame4.Visible = True
            Call calculateTankCapacity

            Call showTankData
            Pic1.Cls
            Call drawTank
        Else
            MsgBox ("Values Not Completed")
        End If
        tankCreated = True
    Else
        End If
    End Sub
Private Sub saveData()
    waterLevel = 0
    If tankType = 2 Then
        tankWidth = tankDiameter
    End If
    Open "babawuya.txt" For Append As #1
        Write #1, tankType, tankHeight, tankWidth, tankLenght, tankCapacity, waterLevel
    Close #1
End Sub
Private Sub Command1_GotFocus()
    callOver = True
    If Frame2.Visible = True Then
        If txtHeight = "" Or tankHeight = 0 Then
            MsgBox ("Enter Tank Height")
            txtHeight.SetFocus
            callOver = False
        ElseIf txtWidth = "" Or Val(txtWidth) = 0 Then
            MsgBox ("Enter Tank Width")
            txtWidth.SetFocus
            callOver = False
        ElseIf txtLenght = "" Or tankLenght = 0 Then
            If tankType = 1 Then
                MsgBox ("Enter Tank Lenght")
                txtLenght.SetFocus
                callOver = False
            End If
        End If
    End If
End Sub
Private Sub Command2_Click()
    If Command2.Caption = "Save" Then
        If tankCreated = True And Frame2.Visible = True Then
            List1.Clear
            Call saveData
            Call CLEARvALUES
            Call NumberOfRecords
            Form1.Caption = reCords
            Call readData_Array
            Frame1.Visible = False
            Label16.Visible = False
        End If
    End Sub

```

```

        Pic1.Visible = False
        Frame4.Visible = False
    Else
        MsgBox ("No Tank to Save")
    End If
ElseIf Command2.Caption = "Fill" Then
    'rwaterLevel(List1.ListIndex + 1) = waterLevel
    Call ReSaveData
End If
If reCords = 0 Then
    viewTanksMenu.Enabled = False
Else
    viewTanksMenu.Enabled = True
End If
End Sub
Private Sub Command3_Click()
    tankSelected = False
    Select Case Command3.Caption
    Case "Start Irrigation"
        v = 0
        iRRigating = True
        Label13.Caption = "Start Time - " & Now
        If tankVolume = 0 Then
            Else
                Timer1.Enabled = True
                Timer1.Interval = 100
            End If
        List3.Clear
    Case "Continue Irrigation"
        Command3.Caption = "Start Irrigation"
        Timer1.Enabled = True
    End Select
End Sub
Private Sub Command3_GotFocus()
    IrrigationTime1 = Now
    Label9.Caption = IrrigationTime1
End Sub
Private Sub Command4_Click()
    If iRRigating = True Then
        Timer1.Enabled = False
        Select Case Command3.Caption
        Case "Start Irrigation"
            Command3.Caption = "Continue Irrigation"
        Case "Continue Irrigation"
            Command3.Caption = "Start Irrigation"
        End Select
        rwaterLevel(List1.ListIndex + 1) = currentWaterLevel
        waterLevel = currentWaterLevel
        Call ReSaveData
        Call readData_Array
    Else:
        iRRigating = False
    End If
    Label18.Caption = "Stop Time - " & Now
End Sub
Private Sub Command5_Click()
    Command3.Visible = True
    Command4.Visible = True
End Sub
Private Sub Command6_Click()

```

```

Picture1.Print 500
End Sub
Private Sub createtankmenu_Click()
    List5.Visible = False
    Label15.Caption = ""
    Frame1.Visible = True
    Label16.Visible = True
    Command1.Visible = True
    Command2.Caption = "Save"
    Command2.Visible = True
End Sub
Private Sub emptymenu_Click()
    If tankEmpty = True Then
        rtankVolume(List1.ListIndex + 1) = 0
        Call ReSaveData
    Else
        MsgBox ("Tank Already Empty")
    End If
End Sub
Private Sub endmenu_Click()
    End
End Sub
Private Sub filltankmenu_Click()
    Command2.Visible = True
End Sub
Private Sub Form_DblClick()
    Load frmSplash
    frmSplash.Show
End Sub
Private Sub Form_Load()
    y1 = 0
    tankCreated = False
    Call NumberOfRecords
    Form1.Caption = "IrrigSoft "
    Call readData_Array
    If reCords = 0 Then
        viewTanksMenu.Enabled = False
    Else
        viewTanksMenu.Enabled = True
    End If
End Sub
Private Sub Frame1_DblClick()
    Frame1.Visible = False
    Label16.Visible = False
    Command1.Visible = False
End Sub
Private Sub Frame4_Click()
    Form1.Caption = tankEmpty
End Sub

Private Sub helpmenu_Click()
End Sub
Private Sub irrigatemenu_Click()
    Frame5.Visible = True
    Label17.Visible = True
    List4.Clear
    For i = 0 To 1000 Step 0.5
        List4.AddItem Round(i, 2)
    Next i

```



```

End Sub
Private Sub Label9_Click()
    Label9.Caption = v - tankVolume
End Sub
Private Sub List1_Click()
    Label9.Caption = ""
    tankName = Label10.Caption
    Pic1.Cls
    Label10.Caption = "Tank " & List1.ListIndex + 1
    Call viewTanks
    ' Label9.Caption = rwaterLevel(List1.ListIndex + 1)

    If rwaterLevel(List1.ListIndex + 1) <= 0 Then
        Label11.Caption = "Empty "
    Else
        Label11.Caption = tankVolume
    End If
    Command3.Caption = "Start Irrigation"
    Timer1.Enabled = False
    tankSelected = True
    irrigatemenu.Enabled = True
    filltankmenu.Enabled = True
    If tankVolume > 0 Then
        irrigatemenu.Enabled = True
    End If
End Sub
Private Sub List1_DblClick()
    List1.RemoveItem List1.ListIndex
    Label9.Caption = waterLevel
End Sub
Private Sub List1_GotFocus()
    Frame4.Visible = True
    Pic1.Visible = True
End Sub
Private Sub List1_MouseDown(Button As Integer, Shift As Integer, X As Single, Y As Single)
    Pic1.Visible = True
End Sub
Private Sub List2_GotFocus()
    List2.Clear
    List2.AddItem "tank height =" & tankHeight
    List2.AddItem "tank width =" & tankWidth
    List2.AddItem "water level =" & waterLevel
    List2.AddItem "tank volume =" & tankVolume
    List2.BackColor = vbGreen
End Sub
Private Sub List4_Click()
    irrigationFactor = Val(List4.Text)
    txtIrrigation.Text = irrigationFactor
    If irrigationfactor > 0 Then
        End If
End Sub
Private Sub List4_MouseDown(Button As Integer, Shift As Integer, X As Single, Y As Single)
    Command5.Enabled = True
End Sub
Private Sub List5_Click()
    If List5.ListIndex = 0 Then
        Label15.Caption = "Automated irrigation is the irrigation system that is controlled by something other than
the direct actions of a person. In other word any irrigation system where irrigation is initiated by a control
system using operator settings and measured environmental conditions"
    ElseIf List5.ListIndex = 1 Then

```

```

Label15.Caption = "when creating and installed tank for irrigation in the program, all its dimension will be
required"
Elseif List5.ListIndex = 2 Then
Label15.Caption = "Fill a tank means adding water to the tank. you do that by specifying of the water"
Elseif List5.ListIndex = 3 Then
Label15.Caption = "Irrigation is the artificial applicaion of water to supplement insuffucient rainfall"
Elseif List5.ListIndex = 4 Then
Label15.Caption = "To perform irrigation using this program, an non-empty tank must be selected. "
End If
End Sub
Private Sub menu100_Click()
If tankSelected = True Then
If tankEmpty = False Then
waterLevel = tankHeight
rwaterLevel(List1.ListIndex + 1) = waterLevel
Call calculateTankVolume
Pic1.Cls
Call fillTank
Call viewTanks
Command2.Caption = "Fill"
Else
MsgBox ("Tank Not Empty")
End If
Else
MsgBox ("Select Tank to Fill")
End If
End Sub

Private Sub menu25_Click()
If tankSelected = True Then
If tankEmpty = False Then
waterLevel = tankHeight * 0.25
rwaterLevel(List1.ListIndex + 1) = waterLevel
Call calculateTankVolume
Pic1.Cls
Call fillTank
Call viewTanks
Command2.Caption = "Fill"
Else
MsgBox ("Tank Not Empty")
End If
Else
MsgBox ("Select Tank to Fjll")
End If
End Sub

Private Sub menu50_Click()
If tankSelected = True Then
If tankEmpty = False Then
waterLevel = tankHeight * 0.5
rwaterLevel(List1.ListIndex + 1) = waterLevel
Call calculateTankVolume
Pic1.Cls
Call fillTank
Call viewTanks
Command2.Caption = "Fill"
Else
MsgBox ("Tank Not Empty")
End If
Else
MsgBox ("Select Tank to Fill")
End Sub

```

```

End If
End Sub
Private Sub menu75_Click()
    If tankSelected = True Then
        If tankEmpty = False Then
            waterLevel = 0.75 * tankHeight
            rwaterLevel(List1.ListIndex + 1) = waterLevel
            Call calculateTankVolume
            Pic1.Cls
            Call fillTank
            Call viewTanks
            Command2.Caption = "Fill"
        Else
            MsgBox ("Tank Not Empty")
        End If
    Else
        MsgBox ("Select Tank to Fill")
    End If
End Sub
Private Sub Option1_Click()
    tankType = 1
    valuesCompleted = False
End Sub
Private Sub Option2_Click()
    tankType = 2
    Label3.Caption = "Diameter"
End Sub
Private Sub othersmenu_Click()
    If tankSelected = True Then
        If tankEmpty = False Then
            tankVolume = InputBox("Enter Water Volume Not more than " & tankCapacity, "Fill Tank")

            If tankType = 1 Then
                waterLevel = tankVolume / (tankWidth * tankLenght)
            ElseIf tankType = 2 Then
                waterLevel = tankVolume / (3.142 * (tankDiameter / 2) ^ 2)
            End If
        Else
            MsgBox ("Tank Not Empty")
        End If
    Else
        MsgBox ("Select Tank to Fill")
    End If
    rwaterLevel(List1.ListIndex + 1) = waterLevel
    Call calculateTankVolume
    Pic1.Cls
    Call fillTank
    Call viewTanks
    Command2.Caption = "Fill"
End Sub
Private Sub Text1_Click()
End Sub
Private Sub Pic1_MouseMove(Button As Integer, Shift As Integer, X As Single, Y As Single)
    Label12.Caption = "y= " & Round(X, 2) & "x= " & Round(Y, 2)
End Sub
Private Sub Timer1_Timer()
    Call currentTankValues
    If currentTankVolume > 0 Then
        Label9.Caption = v
        v = Str(Val(v) + irrigationFactor)
    End If
End Sub

```

```

List3.AddItem currentTankVolume & ", " & currentWaterLevel
Label9.Top = currentWaterLevel
Label9.Left = tankWidth
Else
    Timer1.Enabled = False
End If
List2.Clear
List2.AddItem tankVolume
End Sub
Private Sub txtCapacity_GotFocus()
End Sub
Private Sub txtCapacity_LostFocus()
    tankCapacity = Val(txtCapacity)
End Sub
Private Sub txtHeight_LostFocus()
    tankHeight = Val(txtHeight)
End Sub
Private Sub txtIrrigation_LostFocus()
    irrigationFactor = Val(txtIrrigation)
    If irrigationFactor > 0 Then
        Command5.Enabled = True
    End If
End Sub
Private Sub txtLenght_LostFocus()
    If tankType = 1 Then
        tankLenght = Val(txtLenght)
    End If
    tankCreated = False
    If txtHeight <> "" And txtWidth <> "" And txtLenght <> "" Then
        valuesCompleted = True
    End If
End Sub
Private Sub txtRelative_LostFocus()
    relativeH = Val(txtRelative)
    irrigationFactor = Round(soilNumber / (txtTemp * txtRelative), 2)
    If irrigationFactor > 0 Then
        Command5.Enabled = True
    End If
End Sub
Private Sub txtTemp_LostFocus()
    tempeRaure = Val(txtTemp)
End Sub
Private Sub txtWidth_LostFocus()
    If tankType = 1 Then
        tankWidth = Val(txtWidth)
    ElseIf tankType = 2 Then
        tankDiameter = Val(txtWidth)
    End If
    If txtHeight > txtWidth Then
        y1 = txtHeight
    Else
        y1 = txtWidth
    End If
End Sub
Sub
calculateTankCapacity()
tankType = 1 Then

```

```

    tankCapacity = Round(tankHeight * tankWidth * tankLenght, 2)
ElseIf tankType = 2 Then
    tankCapacity = Round(3.142 * (tankDiameter / 2) ^ 2 * tankHeight, 2)
End If

End Sub

Sub calculateTankVolume()
    If tankType = 1 Then
        tankVolume = Round(waterLevel * tankWidth * tankLenght, 2)
    ElseIf tankType = 2 Then
        tankVolume = Round(3.142 * (tankDiameter / 2) ^ 2 * waterLevel, 2)
    End If
    rtankVolume(List1.ListIndex + 1) = tankVolume
    If tankVolume <= 0 Then
        tankEmpty = False
    Else
        tankEmpty = True
    End If
End Sub

Sub showTankData()

    Label5.Caption = "Height=" & tankHeight
    If tankType = 1 Then
        Label6.Caption = "Width=" & tankWidth
        Label8.Caption = "Lenght=" & tankLenght
    ElseIf tankType = 2 Then
        Label6.Caption = "Diameter=" & tankDiameter
        Label8.Caption = "Lenght= 0" \
    End If

    Label7.Caption = "Capacity=" & tankCapacity
    Frame4.Caption = "created: " & Now
End Sub

Sub drawTank()
    Call waterColor
    Call scalePic1
    Pic1.Line (0, 3 * y1 / 2)-(0, -y1 / 2)
    Pic1.Line (3 * y1 / 2, 0)-(-y1 / 2, 0)
    Pic1.DrawWidth = 3
    If tankType = 1 Then
        Pic1.Line (0, 0)-(tankWidth, tankHeight), , B
    ElseIf tankType = 2 Then
        Pic1.Line (0, 0)-(tankDiameter, tankHeight), , B
    End If

End Sub

End Sub
Sub CLEARvALUES()
    txtHeight.Text = ""
    txtWidth.Text = ""
    txtLenght.Text = ""

    Frame2.Visible = False
End Sub

Sub NumberOfRecords()
    Dim n, index, a1, a2, a3, a4, a5, a6
    n = 0
    Open "babawuya.txt" For Input As #1
    Do While Not EOF(1)

```

```

    Input #1, a1, a2, a3, a4, a5, a6
    n = n + 1
Loop

Close #1
reCords = n
End Sub
Sub readData_Array()
List1.Clear
Open "babawuya.txt" For Input As #1
For i = 1 To reCords
    Input #1, rTankType(i), rTankHeight(i), rTankWidth(i), rTankLenght(i), rTankCapacity(i),
rwaterLevel(i)
    List1.AddItem "Tank " & i

    If rTankType(i) = 2 Then
        rtankDiameter(i) = rTankWidth(i)
    End If
Next i
Close #1
End Sub
Sub viewTanks()
    tankType = rTankType(List1.ListIndex + 1)
    tankHeight = rTankHeight(List1.ListIndex + 1)
    tankWidth = rTankWidth(List1.ListIndex + 1)
    tankLenght = rTankLenght(List1.ListIndex + 1)
    tankCapacity = Round(rTankCapacity(List1.ListIndex + 1), 2)
    waterLevel = rwaterLevel(List1.ListIndex + 1)
    tankDiameter = rtankDiameter(List1.ListIndex + 1)
    Call calculateTankVolume
    If tankHeight > tankWidth Then
        y1 = tankHeight
    Else
        y1 = tankWidth
    End If

    Call showTankData

    Call fillTank
    Call drawTank
End Sub
Sub fillTank()
    Call waterColor
    Pic1.DrawWidth = 1
    If y1 < 0 Then
        Pic1.Scale (-y1 / 4, 3 * y1 / 2)-(3 * y1 / 2, -y1 / 4)
    End If

    If tankType = 1 Then
        Pic1.Line (0, 0)-(tankWidth, waterLevel), FillColor, BF
    ElseIf tankType = 2 Then
        Pic1.Line (0, 0)-(tankDiameter, waterLevel), FillColor, BF
    End If
End Sub
Sub ReSaveData()

    Open "babawuya.txt" For Output As #1
    For i = 1 To List1.ListCount + 1

```