PERFORMANCE EVALUATION OF SELECTED IRRIGATION PUMPS

(A CASE STUDY OF KWARA STATE)

BY

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Being a final year project submitted in partial fulfilment of the award of Bachelor of Engineering (B.ENG), Agricultural Engineering.

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CERTIFICATION

This is to certify that this project was carried out by Yusuf Abiodun in the department of Agricultural Engineering, Federal University of Technology, Minna.

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DEDICATION.

This project is dedicated to my parents, Alhaji and Mrs G.A. Yusuf for their sincere love and care for me.

ACKNOWLEDGEMNT

I whole heartedly express my profound gratitude and thanks to the Almighty God, the most exalted for sparing my life.

I wish to humbly express my sincere appreciation and thanks to my project supervisor, Engr. (Dr) N.A. Egharevba for his commitment and assistance towards the successful completion of this project. Same goes to The Head of Department, Engr. (Dr) M.G. Yisa for his fatherly advice, and in making us to see the need for an Agric Engineer as well as the place and reality of the profession in the society; thank you very much sir.

My sincere regards, appreciation and thanks to Engr. Mohammed Bashir who has shared his time and knowledge to assist on my project. My regards and appreciation to all my lecturers in the Department of Agricultural Engineering who spared their wealth of knowledge and experience liberally.

In a very special way, while giving all the Glory to the Lord God Almighty the giver of life. I would like to express my gratitude to my Father (Mr) Garba Alabi Yusuf and Mother (Mrs) Abiola Ayodele Yusuf who made success in my life their priority. Special thanks to my brothers and sister: Mr Olufemi Yusuf, Mrs Modupe-ore Wuraola, Engr. Lanre Yusuf and Engr. Tunde Yusuf.

Finally, I wish to express my sincere thanks to all my friends.

ABSTRACT

Survey of irrigation pumps used during dry season was carried out in Kwara State. Questionnaires were administered to the farmers in the state, details of which shows that four major types of pumps are in circulation, Honda, Yamaha, pacer and industrial plus pumps Honda pumps was found to be the most widely acceptable with 46.88% of respondents using it. 28.13% of the respondents uses Yamaha pumps, 18.25% uses pacer pumps while 6.25% uses industrial plus pumps. Pump specification and problems encountered in the process of operating irrigation pumps were also analysed.

Performance evaluation test was carried out on Honda pump, the average discharge of 8.92 l/s was recorded when the pump is operating at maximum speed of 3600 rpm. The water horse power for Honda pump was 0.90 KW as a delivery head of 15.2m. The delivery head increases as the water horse power increases.

The water budget for Kwara State for a decade was evaluated to determine the viability of irrigation schemes it was observed that irrigation will be required between November and March. There is a deficit of 656.58 mm and surplus of 456.58 mm.

TABLE OF CONTENTS

CHAPTER ONE

1.0 INTRODUCTION.

When water requirement exceeds the precipitation for any length of time, Irrigation water must be applied to maintain the soil moisture for satisfactory crop growth. Irrigated Agriculture plays an important role in the world food production. Man has extracted water from rivers, lakes and canals for centuries to supplement the available rainfall water for crop production. Lifting of water was formerly done largely by human or animal power which usually keep the rate of withdrawal within the recovery rate of the aquifer during normal rainfall years. In some areas of the world, human and animal power are still being used to pump Irrigation water.

Water is one the most important variables influencing Agricultural production and crop yields are strongly influenced by the availability of water. The effectiveness of other production inputs such as fertilizers, pesticides and others are dependent upon an adequate water supply.

In most cases, Irrigation water sources lies below the point of utilization, pumping is therefore resulted to in order to provide the required total pressure head.

1.1 SELECTION OF PUMPS

The proper selection of pump is an integral part of the design of Irrigation schemes. Pumps are often used in drainage, Irrigation and other areas such as Industries, where it is used mainly to transport fluid. Pumps are generally required to add hydraulic energy to the fliud to be transported.

The basic hydraulic concept of pumps will be outlined to provide sufficient understanding of their design, selection, operation and maintenance. Pumps are required when water is to be moved by gravity at an adequate discharge and pressure. This add energy to water. There are many types of pumps used in the various technological fields.

The Shaduf is a simple device for lifting water using the principle of a lever. This was in the time past before the influx manual and motorised pumps, The shaduf was mostly used in the Fadama (low-lying land : often with low water table). The main advantages of Shaduf System of Irrigation includes **"low capital cost" and "low level Technology".** The Shaduf System requires about 150 man-hour per hectare to apply one Irrigation, an input which clearly limits the area to be cultivated by any family unit (N.A. Egharevba. 1988).

Presently, there are many kinds of pumps used in the various technology fields. The three main classes of pumps are the **Centrifugal, Rotary, and Reciprocating pumps**. These classes refers to the different ways pumps move the liquid. The different classes could be further subdivided into pumps of different types.

1.2 EVALUATION TEST FOR IRRIGATION PUMPS

Evaluation tests are aimed at setting the specifications for optimal pumps design for Nigerian rural areas for greater objectivity, which will provide sufficient understanding of their design, selection, operation and maintenance.

Due to increasing cost of purchase and maintenance and the urgency for Agricultural Mechanization to meet the needs of the increasing population. Food production has to be increased. Irrigation is therefore paramount, in the process of adopting Agricultural mechanization. It is usually required to supplement the available rainfall or when there is short period of drought. In the course of evaluating the performance of Irrigation Schemes in Kwara State, there is an urgent need for the estimate of the consumptive use of crops and total water requirement for the crop.

1.3 OBJECTIVES OF THIS PROJECT

i. Make a careful analysis of the selected pumps and make recommendations based on their performance characteristics on the field of operation. Trouble-shooting and diagnosis of the problem encountered in the process of operation.

ii. To determine the pump specification and classification of the different types of pumps

iii. To assess the pump's present state and problems that are encountered in the process of operation

iv To make useful recommendations that are related to the problems encountered in the process of operation.

v. Determine the discharge of the pumps at different such on head.

vi. Estimate the water budget for Kwara State.

CHAPTER TWO

2.0 LITERATURE REVIEW

About three quarters of the earth surface suffers from lack of adequate moisture for successful crop production. Half of the Irrigated areas lies in the developing countries (BIWAS. 1978). The total estimated land area of Nigeria is 98.3 million hectares out of which 70.8 million hectares are adjudged arable. Only about 24.78 million hectares is under cultivation in 1975. While as at 1984 only 6.3722 million hectare were cultivated and put into Agricultural use (Chukwu 1998). Currently, only about 101,600 hectares is under Irrigation in Nigeria (Maurya 1984).

Motorised pumps (Centrifugal pumps) are gaining popularity for both small and large-scale Irrigation farms in Nigeria. Many brands of pumps are being imported into the country and put to use under diverse conditions but investigation of their performances as claimed by their manufacturers have not been given adequate attention (Egharevba. 1987). Most of the pumps used for Irrigation don't have sufficient information given about their performance characteristics.

2.1 REFERENCE EVAPOTRANSPIRATION

Evapotranspiration, or consumptive use denotes the quantity of water transpired by plants during growth, or the water retained in the plant tissues plus the moisture evaporated from the surface of the soil and the vegetation. The concept of evapotranspiration (ETO) was suggested by Thronthwaite (1978) who defined it as the evapotranspiration from a large vegetation covered land surface with adequate moisture at all times. Penman (1984) defined ETo as the ET from an actively growing green vegetation completely shading the ground and never short of moisture availability. Though Penman's definition is complete, it does not specify the name of vegetation. Jensen (1968) assumed ETo as the upper limit of ET that would occur with a well-watered crop having an Aerodynamically rough surface. It can be defined as the upper limit of ET that occurs when the ground is completely covered by actively growing vegetation and there is nom limitation in the soil moisture. It may be considered as the upper limit of ET for a crop in a given climate.

2.2 THE SPECIFIC SPEED OF A PUMP

The selection of the type of pump for a particular service is based on the relative quantity of discharge and energy needed. In Irrigation purposes where large quantities of water is to be lifted over a repetitively small elevation from the canal or river on to the field requires a different kind of pump than when a relatively small quantity of water is to be pumped to great heights. To make the proper selection for any application one need to be familiar with basic concepts of operation of the main types of pumps. To simplify things, the discharge head and speed at optimum performance of various pumps are consolidated into one number called **Specific Speed.** The specific speed n_s of a pump is computed from:

$$n_s = rpm\ (sq.rt.)\ LPM / H3/4$$

Where :-

----> n_s = the specific speed in, rev\min

----> **rpm** is the rotational speed of the shaft

----> **LPM** = the discharge, in litres per minute.

----> **H** = the total dynamic head, in metres (m)

The equation is applicable at optimum efficiency.

2.3 HEAD REQUIREMENTS

The dynamic head H to be developed by a pump is computed as follows. The pressure or head to be developed is the sum of the height to which the water to be lifted from the level of the reservoir or river where the water is pumped. The friction losses occurring at the suction and discharge pipes must be included. Other losses such as foot valve, elbow valves are ignored.

Pumps of the same type are manufactured in various types. The pump size is expressed by the diameter of the exit pipe.

The most common problem facing the water engineer is when he knows the amount of water to be pumped, the length of pipe and the static head. The next thing to do is to find the optimum diameter of pipe that will result in minimum friction losses that will be added to the Static Head to give him the total Dynamic Head. This will enable to select the right pump for the job and also establish the power required.

2.4 POWER REQUIREMENT FOR PUMPING

Work is defined as the force multiplied by distance. Power is defined as work per unit of time or the rate of doing work. Work is required to lift water out of a well and the amount of water delivered in a unit of time can be related to power and this is referred to in units of horsepower by the following formula:-

$Hp = Qh/273$ ……………………………… 2.1

Where Hp = horsepower

Q = discharge, in m3/hr

h = vertical lift, in m Or

$Hp = Qh/76$ ……………………………… 2.2

Where Q = discharge, in L\S

h = vertical lift, in m

2.5 EFFICIENCY OF A PUMP

Efficiency is output divided by input, thus the efficiency of a motor would be the energy output of the motor divided by the input energy of the motor. The input power of a pump is often called the brake horsepower and the output power is called water horsepower. The pumps' efficiency is :-

$$Ep = Output/Input = WHP/BHP \qquad \ldots\ldots\ldots\ldots\ldots\ldots 2.3$$

Thus combining equation 2.2 and equation 2.3

The output can be defined as:-

$$WHP = BHP * efficiency = QhEp/76 \qquad \ldots\ldots\ldots\ldots\ldots\ldots 2.4$$

The horsepower required for various discharges and vertical lifts assuming that the efficiency of the pump is 50% and above. This will be proved based on field and experimental conditions of the various pumps that will be investigated. It is assumed that the overall efficiency of the pump should be about 65%.

The economic implications of operating a pump at a low efficiency is considerable power cost and more time will be required to apply the needed Irrigation water.

2.6 THE ALLOWABLE SUCTION HEAD

The allowable suction head in a given pump is the highest elevation above the downstream water level at which the pump will operate without a noticeable loss of efficiency due to cavitation. This height is expressed in terms of the total head H, which the pump is required to deliver by a factor of proportionality @ called **Cavitation parameter.** The value is determined by the manufacturer.

2.7 TROUBLESHOOTING IN PUMPS

The use of pumps for Irrigation and drainage purposes has gone a long way. The manufacture of pumps has reached such a level of sophistication that a pump is expected to give trouble free services for a long period of time. Troubles may arise from improper design or installation or from poor maintenance.

Some common problems and their probable causes that are encountered on the farm will be highlighted in this project. Each of these problems will be duely discussed based on the observation of the farmer.

2.8 PUMP CHARACTERISTICS

Pump characteristics are required in order to use modern pumps most profitably to obtain Irrigation water, it is essential to select pumps that are well adapted to the particular conditions of operation and to obtain a relatively high efficiency. If the quantity of water pumped is appreciably less than the quantity for which the pump is designed, and the

2.9 PUMP SELECTION AND ALTERATION

Pump selection and alteration means changing the pump performance characteristics and certain basic laws are valid for centrifugal pumps which are helpful. These laws called Affinity laws are as follows:-

A. Changing the impeller diameter D in the pump results in changes of : discharge ,(Q), total head, H, and power, P, according to the relations:

$Q1/Q2 = D1/D2$ ....a

$H1/H2 = (D2/D1)^2$ ....b   2.4

$P1/P2 = (D1/D3)^3$ c

B Changing the motor speed of a pump, The resultant changes follows these relationships:

$Q1/Q2 = N1/N2$ ....a

$H1/H2 = (N1/N2)^2$ ....B   2.5

$P1/P2 = (N1/N2)^3$ c

The subscripts 1 and 2 refers to values of the parameters before and after the change, respectively. Change of Impeller has the same influence on pump performance as the change of speed.

2.10.1 **BLANEY-CRIDDLE (TEMPERATURE) METHOD**

Blaney and Ciddle (1950) observed that the amount of water consumptively used by crops during their growing season was closely related correlated with the mean monthly temperatures and day light hours. In order to adjust the method to adjective climatic condition sand to take into account local climatic conditions of wind, sunshine, humidity and an adjustment factor C, has been introduced. The equation is given as:-

$$ET = C[0.46T+8]$$

Where;

C= adjustment factor which depends on mean humidity & wind condition

ET = Evapotranspiration in mm/day

P = mean daily percentage of total annual day time hours for a given month and latitude.

2.10.2 **RADIATION METHOD**

The strong dependence of evapotranspiration on the radiation has given rise to a formula based upon the solar radiation measurements. This formula eliminates the effect of the albedo reflectivity) and minimise the contribution of the aerodynamic term. The radiation method is only an adaptation of the Makkink formula (1957). This method requires measured Air temperature and sunshine, cloudiness or radiation. The relationship is given by:-

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$$ET = C(W.R_S) \text{ mm/day}$$

Where;

ET= Evapotranspiration in mm/day for the period to be considered.

R_S= Solar radiation in equivalence of mm/day.

W= Weighing factor which depends on temperature and altitude.

2.10.3. Penman Method

Penman (1948) proposed an equation for evaporation from an open water surface, based on a combination of energy balance and sink strength which is given by:

$$Eo = DQn + YEa/D+Y$$

Where;

Eo = Evaporation from open water surface, mm/day

D = Scope of saturation vapour pressure

Qn = Net radiation, mm of water

Y = Psychometric constant.

Ea = Aerodynamic component.

Based on the literature and studies of the climatic and measured evapotranspiration data from the various research stations in the world, Doorenbos and Pruit (1977) proposed a modified Penman method to facilitate the computation of evapotranspiration. The formula is given by:

$$ET= C[WRn + (1-W). F(U). (e_a-e_d)] \qquad \dots\dots(1)$$

Where:

ET = Evapotranspiration in mm/day.

W = Temperature related weighing factor.

Rn = Net Radiation in equivalent mm/day.

F(U) = Wind related function

C = Adjustment factor.

(ea-ed)= difference between saturation vapour pressure at mean air temperature and mean actual vapour pressure of the air, both in Mbar.

2.10.4. Blaney-Morin Nigeria (Et Model)

This method predicts evapotranspiration with accuracy and consistency under Nigerian conditions. It is generally accepted that radiation is an important determinant in evapotranspiration model.The sunshine hours in Blaney-Morin formula was replaced by ratio-ratio in the Blaney-Morin model. The formula is given by:

$$Etp = r_t(0.45T+8)(520-R^{1.31})/100$$

Where:

T = Summation of the mean temperature

R = Relative humidity

r_t = Radiation ratio

Etp = Evapotranspiration

CHAPTER THREE

3.0 METHODOLOGY

The method used for the accomplishment of the objectives of this project was in two stages. First is the investigative survey research approach (ISRA). The concept involves the collection , collation and analysisof the data obtained from the questionnaire. The respondents were accorede an opportunity to comment on several issues relating to pump specification, type , pump selection and problems encountered on the field operation. The questionnaire were administered by personal contact with farmers in the area. The second stage is to carry out a practical work to obtain some data which were not available or incomplete data on the performance evaluation of the pumps. The parameters observed during the investigation includes:-

i. Measure the discharge of pumps at different suction heads.

ii Pump speed in revolution per minute (r.p.m.) using the available information (manual) and computations.

iii Power output in Kilowatts(KW) by computation.

iv Discharge (flow rate) in L/S obtained from the experiment.

v Total head developed in metres (m).

3.1. INVESTIGATIVE SURVEY

The data used for this case study were obtained from various farms where Irrigation schemes were being practised in Kwara State.

The complete data were obtained from the following Local Government Areas within the State: Ilorin-East, Ilorin-West, Ilorin-South, Moro, Asa, Irepodun and Isin L.G.A.s.

Overall, 100 questionnaires were printed out for administering, the mode of distribution seems to be simple but there were lot of difficulties during the collection and collation of the completed and uncompleted samples. This was due largely to communication barriers between the farm workers and I.

Also, all required necessary information were not made available to us as at the time of this exercise. Some of the information supplied were contradictory while some were not complete or irrelevant. As such the processing of this data by computer as originally envisaged and planned was practically unrealistic, since most of the farms has to produce their individual data which requires certain amount of interpretations.

3.1.1. AVAILABLE DATA

The sample of the questionnaire is shown in appendix F., with all the relevant information that is required to assess the performance of the Irrigations pumps in Kwara State.

3.2. METHODOLOGY FOR ASSESSING THE PERFORMAMNCE OF IRRIGATION PUMPS

The methodology that is used in this assessment in line with the objective of the project; to evaluate the performance of Irrigation schemes in terms of pump performance. The questionnaires were distributed to all the farms in the state, after which we now carry out a fieldwork by going to the site to extract the required information. The exercise involves the use of survey equipment to measure the actual landmass where the Irrigation schemes covers. The study and analysis of the various types of pumps and problems associated with respective pumps.

3.3. EXPERIMENT 1.

The pump discharge for Honda WX20X was determined on the field using a stopwatch and a bucket of 14 litres capacity. The average discharge of the pump in litres at a specified suction head and rotational speed. The delivery head of the pump is diverted into the bucket, the pump is switched on, while the time taken to fill the bucket is observed. The experiment was repeated four or five times at the same head and corresponding time interval was recorded.

The varying speed used for the experiment are 3600rpm, 2750rpm and 2600rpm respectively. The specification of the pump used for the experiment is:-

Honda WX 20X

Total Head 26m

Delivery volume 600L/min.

Rpm 3600

Impeller diameter 50mm

Rated power 5.0Hp

Discharge in litres per/second Volume of container/Time taken 3.1

$$\text{Average discharge} = \frac{1^{st}\text{ discharge} + 2^{nd}\text{ discharge} + n_{th}\text{ discharge}}{\text{No. of set of Experiment}}$$

3.4 PUMP DISCHARGE

The analysis of the pumps to be used for the experiment are:-

A. Honda WX 20X

Connection diameter	50mm (inch)
Delivery Volume	600 2/min.
Total Head	26m

B. Honda WB30T

Connection diameter	80mm (3inch)

Delivery volume 1100 L/min

Total Head 28m

The analysis of the pump capacities shows that

Discharge Q_A= 600 L/min. = 600L/60sec. =10 L/sec.

Discharge Q_B = 1100 L/min. = 1100/60sec. =18.3 L/sec.

From the law of Continuity of flow:- Q =AV 3.2

The volume of water discharged in pump A= 5092m^3

The volume of water discharged in pump B= 3,650m^3

3.4. TOTAL HEAD OR TOTAL DYNAMIC HEAD

The total dynamic head was calculated as:

Total head= Static head + Friction head ... .

Friction head= Coefficient of friction x pipe length/100

The coefficient of friction is obtained from the water friction loss chart in Appendix...

3.5 COMPUTING EVAPOTRANSPIRATION

Evapotranspiration is not easy to measure either in the atmosphere or in the soil. It is often estimated in relation to indicators in the atmospheric evaporative demand. Many methods with differing data requirements and level of sophistication have been developed for computing evapotranspiration, some of these methods require duly relative humidity, solar radiation, wind and air temperature data, while others needed only mean monthly temperatures.

ETo for each month of crop growth was determined by using the Blaney-Morin-Nigeria Evapotranspiration Model: with the formula stated as :

$$ETo=rt(0.45T+8)(520-R^{1.31} / 100 \quad \ldots\ldots\ldots 3.3$$

Where;

T= Summation of mean monthly temperature (Oc) over a month

R= Relative humidity (mean)

r_t= Radiation Ratio

3.6 IRRIGATION WATER REQUIREMENT

The Irrigation water requirement for the period which the survey was carried out was estimated by the equation:-

IWR= ETo – Effective Rainfall / Water Application Efficiency … …3.4

Where;

IWR= Irrigation water requirement or field Irrigation requirement

ETo= Reference evapotranspiration

Ea= water application efficiency

$$Ea= Vbu / Va \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots 3.5$$

Vbu= Volume of water beneficially used the crops in the area

Va= Volume of water applied to the area.

3.6 PARAMETERS FOR CALCULATING CROP EVAPOTRANSPIRATION (CONSUMPTIVE USE)

THE CROP FACTOR OR CROP COEFFICIENT K FOR IRRIGATED CROPS. The crop coefficient Kc for crops varies on the length of season and depends largely on the length variety and time of year when the crop is grown. Based on the experiment data obtained from (A.M. Michael 198) as shown in Appendix F

MEAN MONTHLY TEMPERATURE AND RAINFALL.

These data were collected from the meteorological department of the Nigerian Airports Authority, Ilorin. The data was for a period of 11 years, (1989 to 1999).

Daily minimum temperature (Tmin.) and maximum (Tmax.) are available at the station from there, the estimate of daily mean and the monthly mean temperature was computed as shown in Appendix A

The mean monthly rainfall was computed from the daily minimum and maximum rainfall. The computed data is shown in Appendix B

RELATIVE HUMIDITY AND RADIATION RATIO

Relative humidity is the ratio of actual amount of water vapour contained in the air to the amount the air would hold, If it were to be saturated at the same temperature expressed in percentage, it is shown in Appendix C

Radiation Ratio:- This is obtained from the radiation from the sun which is the most important source of energy. Global short-wave radiation is direct and diffused radiation received on a horizontal surface. It is either measured directly with a Pyranometers or indirectly from measurement of sunshine hours and cloudiness observations.

Radiation Ratio is shown in Appendix D daytime sunshine hours data were collected from the National Centre for Agricultural Mechanization (NCAM), Ilorin Kwara State. The data is shown in Appendix A table 6.

3.7 COMPUTER PROGRAM FOR DETERMINATION OF ETo

The Computer program is based on Blaney-Morin- Nigerian Evapotranspiration Model, to calculate reference crop evapotranspiration as presented in chapter 4. The program can be used to calculate on a routine basis. The monthly ETo data for several locations in development projects. Since large amounts of computations are involved, the program will provide an efficient means to perform these calculations at reasonable cost.

3..8 WATER DEFICIT AND WATER SURPLUS

Water deficit and water surplus was computed with :-

Wd = ETo-p 3.6

Ws = ETo-p 3.7

ETo = reference evapotranspiration in mm/day

P = precipitation or effective rainfall.

CHAPTER FOUR

4.0 RESULTS

Based on the investigative survey research carried out on some selected farms in Kwara State. The four major types of motorised pumps that were in use are Honda, Yahama, Pacer and Industrial plus. While the pacer and Industrial plus were recently introduced by the Kwara State Government. The percentage by total of the different brands of pumps are shown in table 4.1. The analysis of the performance characteristics of the pumps were based on the performance evaluation test carried out on the field operation and practical test to know the volume discharged per time.

The pump specification are shown in table 4.2.and the specifications were given by the manufacturers on the name plate label.

The total arable land that is put under Irrigation Kwara State was estimated, so also the water budget and the source of water that is available to supplement the rainfall. The total area to be Irrigated and the source of water plays an important role in pump selection.

2.4 PUMP AND BRAND TYPES

This shows the popularity or the ratio of acceptability of the different brands of Irrigation pumps among the farmers in the state. The choice of the pump shows the percentage acceptability of the respondents on the pump brands.

TABLE 4.1:-BRANDS OF PUMP AND PERCENTAGE OF RESPONDENTS.

S/NO.	BRAND OF PUMP	% OF RESPONDENT
1	Honda	46.88
2	Yamaha	28.13
3	Pacer	18.75
4	Industrial Plus	6.25

4.2. PUMP SPECIFICATIONS

This contains information on the total head of the pump, capacity, diameter and Hp of the pump. It is a major determinant in the choice and selection of pumps. It answers the question on what necessitate the use of Irrigation pumps to supplement the rainfall, such as suction distance, discharge capacity, input energy required and speed of rotation.

TABLE 4.2:- PUMP SPECIFICATIONS

MAKE AND MODEL NO.	RATE OF POWER(Hp)	TOTAL HEAD (m)	CAPACITY (L/MIN.)	SPEED (KPM)	IMPELLER(MM) DIAMETER
HONDA WX20X	3.0	26	600	3600	50
HONDA WB 30T	5.0	28	1100	3600	80
PACER	5	24	1000	2600	75
INDUSTRIAL PLUS	5	28	600	2600	50
YAMAHA YB 20E	5.0	36	1000	3600	75

4.2 PUMP AND MACHINERY MAINTENANCE

Figure 4.3 Indicates that 65.6% of the farmers use preventive maintenance while 34.4% use need-base maintenance. The effective use of farming machinery is considerably dependent on quality of maintenance and repairs. With a high level mechanization in Agriculture, preventive or routine maintenance is recommended, to avoid dead period of machines during intensive fieldwork. Need-base maintenance reduces the overall period of machines and it is not recommended for machine.

4.4 SPARE PARTS AND MATERIAL AVAILABILITY

Figure 4.4 Indicates that 90.6% of the respondents get their spare parts ready, while 9.43% of the farmers hardly get the spare parts and materials for their machines.

The availability of spare parts is due to parts interchange ability. This allow for repairing of machine by replacing old parts with spares that are often from different manufacturers.

This shows that 90.6% of the respondents have moderately available spare parts while 9.4% of the respondents hardly get spare parts.

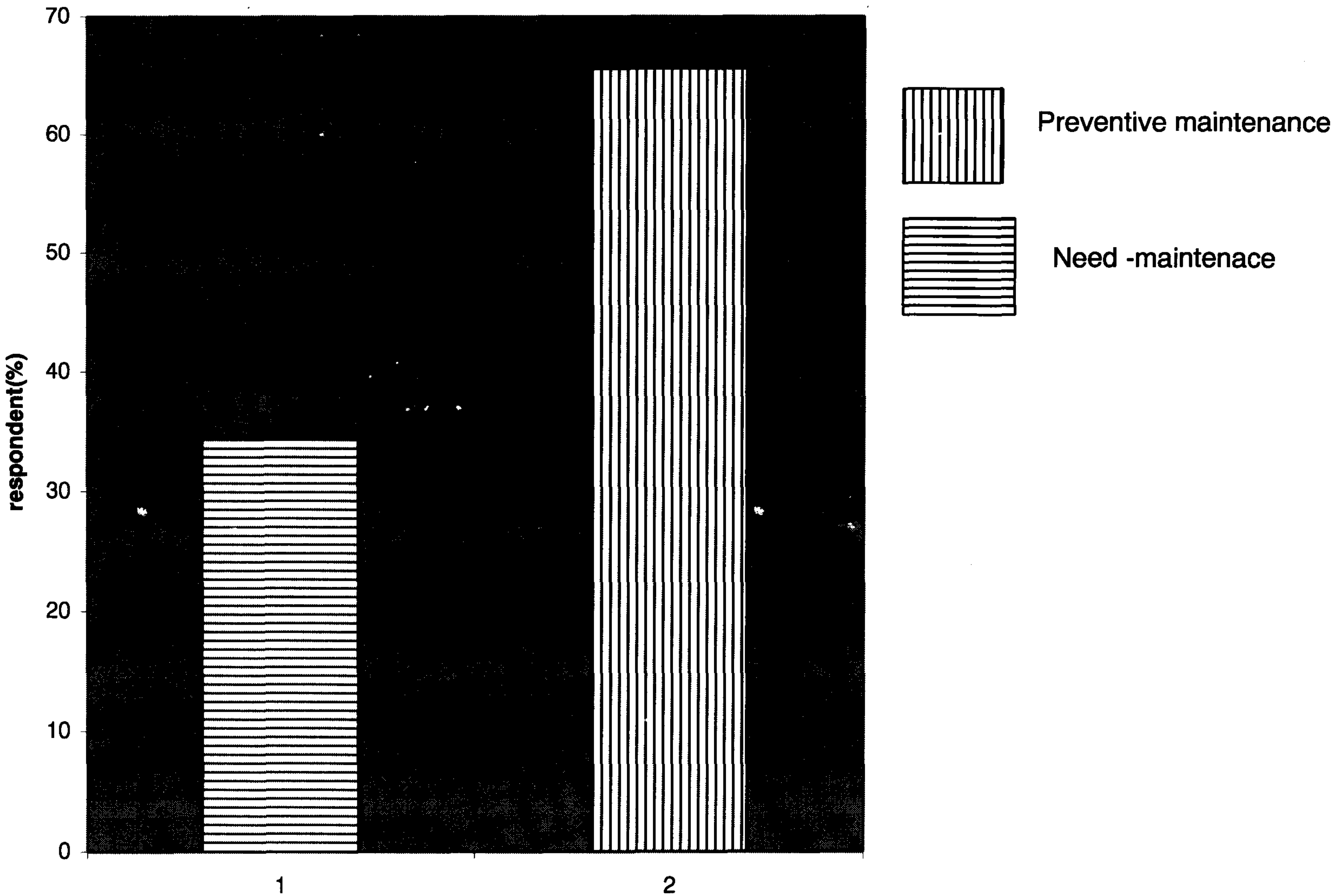

Fig 4.3 pump machinary maintenance

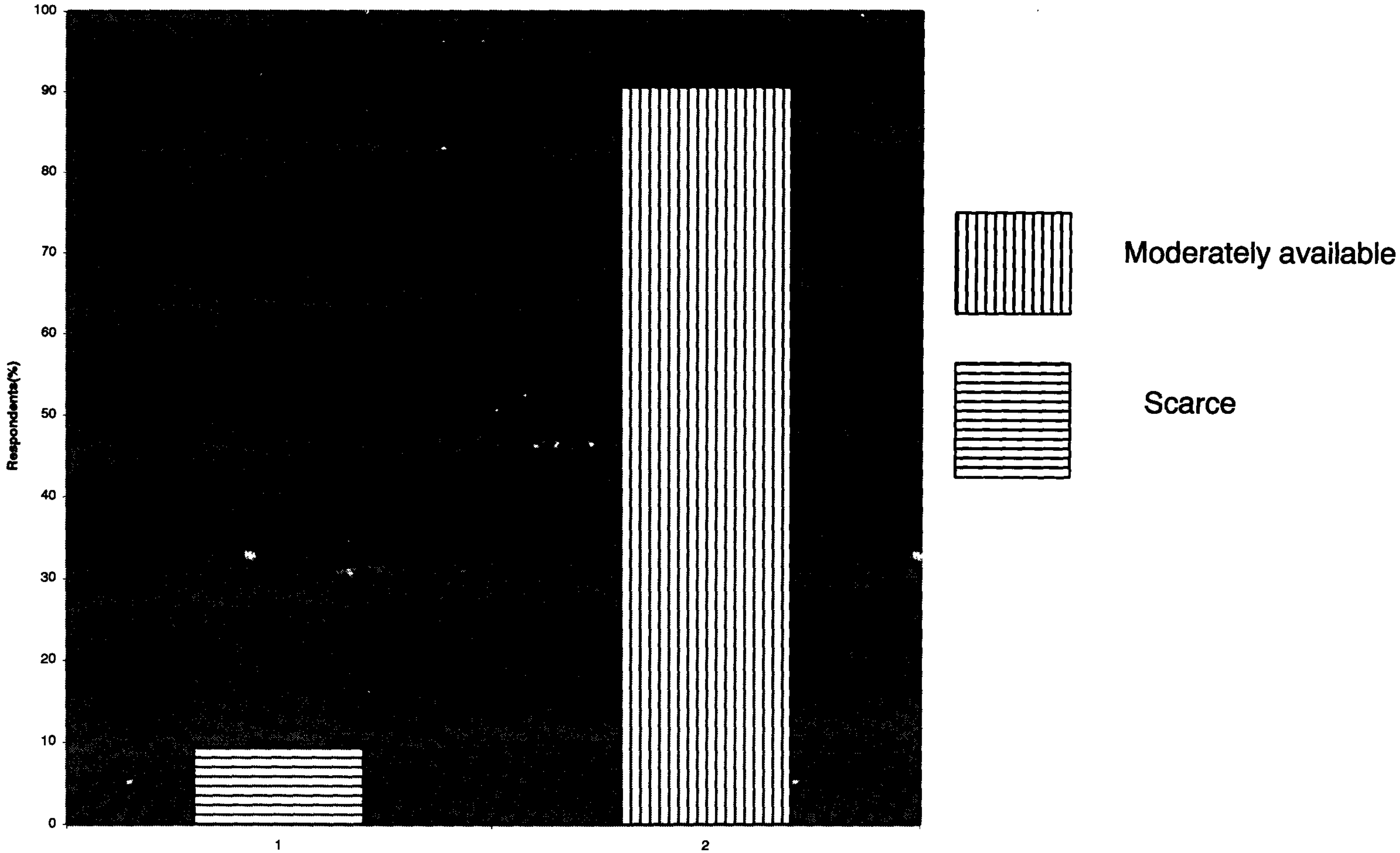

Fig 4.4 Spare parts and material availability

4.5 ANALYSIS OF REFERENCE POTENTIAL EVAPOTRANSPIRATION

The result of potential evapotranspiration was obtained to be the maximum ETO of 4.89mm / day in march and a minimum ETO of 2.78mm / day in September using blaney-Morin Nigeria Model. The result is presented in Table 4.4. It shows that irrigation will be required to supplement the available rainfall between November , December , January , February and March. The ETO was computed for a decade 1990 to 1999.

Comparing this value with the average annual rainfall values for Kwara state, it shows that there is virtually no rainfall between the periods stated above, while the peak or the high rainfall is recorded in September with 338mm with least ETO value of 2.78mm / day.

4.6 WATER BUDGET FOR THE STATE

The water budget for the state for a decade were determined with period of water deficit and surplus clearly indicated. From Table 4.4 the results shows that there was a deficit of 656.65mm and a surplus of 456.58mm for a decade. A graphical evaluation of the water budget for state is presented in figure 4.5

Table 4.3 Evapotranspiration Etp (mm/day) from 1989-1999

YEARS	JAN	FEB	MAR	APR	MAY	JN	JUL	AUG	SEP	OCT	NOV	D
1989	5.44	3.33	4.36	3.89	3.88	2.72	3.21	2.55	2.67	3.78	4.62	4.
1990	5.56	4.3	5.67	3.46	3.81	3.49	2.83	3.22	2.62	3.46	3.45	4.
1991	4.45	3.80	5.09	4.05	3.39	3.43	3.45	3.14	2.29	3.64	3.81	4.
1992	4.11	4.65	5.36	4.27	3.70	3.55	2.98	3.31	2.91	3.71	4.20	4
1993	4.0	5.75	4.57	4.52	3.59	3.00	3.44	2.54	3.01	3.92	4.70	4
1994	4.36	5.82	4.19	3.88	3.75	3.21	3.00	3.07	2.51	2.26	4.37	4
1995	5.33	3.68	4.90	3.96	3.97	3.17	2.80	2.67	2.66	3.06	3.77	4
1996	3.48	3.80	4.74	4.15	4.09	3.26	2.78	2.67	2.56	3.57	3.57	5
1997	4.25	3.47	5.27	4.00	3.59	2.87	2.64	3.15	2.87	3.45	3.82	4
1998	4.84	5.60	4.99	4.81	3.43	3.54	2.90	2.99	2.85	3.16	3.87	4
1999	4.55	5.19	4.65	3.19	3.69	3.66	3.14	2.77	2.96	3.05	3.91	[illegible]
TOTAL	50.73	49.39	53.79	44.9	40.89	35.9	32.87	32.84	36.6	37.15	44.09	[illegible]
MEAN	4.61	4.49	4.89	4.08	3.71	3.62	2.98	2.91	2.78	3.38	4.01	[illegible]

4.7 COMPUTER PROGRAM TO CALCULATE EVAPOTRANSPIRATION

```
DIM rad (1 to 12) as single

DIM ETp (1 to 12) as single

DIM Temp (1 to 12) as single

DIM Rel (1 to 12) as single

FOR Counter = 1 to 12

INPUT "Enter the temperature from January to December"; Temp
(Counter)

      Next Counter

For Counter = 1 to 12

INPUT "Enter the relative humidity from January to December"; Rel
(Counter)

      Next Counter

Rad R= 0

For Counter = 1 to 12

INPUT "Enter the radiation ratio from January to December";

      Rad (Counter)

Rad R =Rad R +Rad (Counter)

Next Counter

For Counter = 1 to 12
```

KT = rad(Counter)/Rad R.

ETp (Counter) = (RT(0.45Temcounter) + 8)(520 - Rel(Counter)^1.31/100

Next Counter

For Counter 1 to 12

Print rad(Counter), Temp(Counter), Rel(Counter) ETp(Counter)

Next Counter.

4.8 RESULTS OF THE EXPERIMENT CARRIED OUT ON HONDA PUMP

4.8.1 The pump discharge capacity at an operating speeds of 3,600, 2,750, and 2,600rpm are given below.

Table 4.7: Pump discharge at 3600rpm

Time(s)	Volume (L)	Discharge (L/S)
1.56	14	8.97
1.57	14	8.92
1.57	14	8.92

Table 4.8: Pump discharge at 2,750rpm

Time(s)	Volume (L)	Discharge (L/S)
1.67	14	8.38
1.66	14	8.43
1.66	14	8.43
1.68	14	8.33

Table 4.7: Pump discharge at 2,600rpm

Time(s)	Volume (L)	Discharge (L/S)
1.89	14	7.40
1.88	14	7.45
1.88	14	7.49
1.88	14	7.49

Table 4.10: **The Maximum Delivery Head at 3,600rpm**

Suction Head (M)	Delivery Head (M)	Friction Head (M)	Total Head (M)	Volume (Lit.)	Time(s)	Discharge (L/S)	WHP (KW)
3	0	0	0	14	0	8.92	0
3	3	0.186	3.10	14	2.02	6.93	0.29
3	6.1	0.186	6.29	14	2.25	6.20	0.51
3	9.1	0.186	9.29	14	2.33	6.00	0.73
3	12.5	0.186	12.39	14	2.57	5.68	0.93
3	15.2	0.186	15.39	14	2.96	4.73	0.96

Table 4.11: **The Maximum Delivery Head at 2,750rpm**

Suction Head (M)	Delivery Head (M)	Friction Head (M)	Total Head (M)	Volume (Lit.)	Time(s)	Discharge (L/S)	WHP (KW)
3	0	0	0	14	0	8.39	-
3	3	0.186	3.19	14	2.65	5.29	0.22
3	6.1	0.186	6.29	14	2.95	4.74	0.39
3	9.1	0.186	9.29	14	3.01	4.58	0.56
3	12.5	0.186	12.39	14	3.23	4.34	0.71
3	15.2	0.186	15.39	14	3.89	3.61	0.73

Table 4.12: **The Maximum Delivery Head at 2,600rpm**

Suction Head (M)	Delivery Head (M)	Friction Head (M)	Total Head (M)	Volume (Lit.)	Time(s)	Discharge (L/S)	WHP (KW)
3	0	0	0	14	0	17.46	-
3	3	0.186	3.19	14	2.65	3.82	0.16
3	6.1	0.186	6.29	14	2.95	3.45	0.29
3	9.1	0.186	9.29	14	3.01	3.30	0.40
3	12.5	0.186	12.39	14	3.23	3.13	0.51
3	15.2	0.186	15.39	14	3.89	2.6	0.53

4.9 PERFORMANCE CHARACTERISTIC RESULT ANALYSIS

A. HEAD CHARACTERISTICS

The head characteristics is the graph of the discharge (l/S) and the Total head in (M). The head capacity curve shown in figure 4.6, shows how much water a given pump will deliver at a given head. As the discharge increases the head decreases.

The characteristic curve showed that the total head and the discharge follow inverse relationships, which agree with the laws of affinity.

B. THE BRAKE HORSE POWER

From table 4.11 The brake horse power curve for centrifugal pump usually increases over most of the range as the discharge increases, reaching a peak at a period when the rate it discharge produces the maximum efficiency.

C. POWER OUTPUT (WHP) AND TOTAL HEAD

From table 4.12 The power output increases with increase in the total dynamic head increase. This means that the efficiency of the pump is reducing as the total head increase. Thus, power output is directly proportional to the total head.

CHAPTER FIVE

5.1 CONCLUSION

1. It can be concluded from the investigative survey research that was carried out that four major types of motorized pumps were in use. They are Honda, Yamaha, Pacer and Industrial plus. Honda pump was found to be the most widely acceptable with 46.88% of the farmer using it.

2. Lack of preventive maintenance has lead to the failure of most of the irrigation pumps in Kwara. It can also

3. The result obtained from the potential T_0 shows that irrigation will be required to supplement the available rainfall between November and march, while the water budget shows that there is a deficit of 656.65 mm/day and surplus of 456.58 mm/day.

4. It can be concluded that the efficiency of Honda pump reduces as the total head increases.

5.2 RECOMMENDATIONS

In order to use modern pumps most profitably to obtain Irrigation water, it is essential to select pumps that are well adapted to the particular field of operation and to obtain a relatively high efficiency.

A low efficiency results when the quantity of water pumped is appreciably less than the quantity for which the pump is designed, this results in excessive head. Likewise, a pump may deliver more water than it is designed to deliver at a lower than the normal head, this also results in low efficiency. It strongly recommended that manufactures manuals are strictly followed.

The pump characteristic curves should always be used as a guide for selecting a pump. This shows the inter relationship between speed, head, discharge and horse power of a pump and are usually represented by characteristic curves, which enables one to select a pump which will fit the operating condition for which the pump is required and thus, attain a relatively high efficiency with low operating cost.

The water budget prepared for the state can be used by farmers in preparing their cropping schedule. The computer programme developed is recommended for use on the farm for irrigation.

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APPENDIX A.

MEAN MONTHLY TEMPRATURE (°C)
(1989-1999)

Year /month	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
JAN	29.8	28.0	27.2	25.1	25.5	26.9	25.6	27.8	25.6	24.9	22.1
FEB	27.4	28.1	29.4	28.5	27.8	27.8	27.3	27.7	26.7	27.5	26.9
MAR	29.2	29.9	29.2	30.0	28.2	30.1	29 4	29.4	27.4	29.4	27.4
APR	23.2	28.2	27.5	29.3	27.4	28.3	29.1	27.1	26.6	29.5	28.1
MAY	27.2	26.9	26.6	26.5	26.6	26.9	27.1	28.8	26.3	26.9	26.6
JUN	20.5	26.8	26.6	25.8	24.8	26.3	26.5	24.7	25.9	27.0	28.1
JULY	25.4	25.0	25.1	25.3	25.1	25.0	24.3	25.5	24.2	24.3	27.7
AUG	25.2	25.5	24.6	24.5	24.8	24.9	24.9	25.1	24.2	23.9	23.7
SEPT	25.4	24.5	25.3	24.6	25.1	25.7	25.7	25.6	24.7	24.7	24.4
OCT	26.1	26.8	25.6	25.6	26.9	25.5	26.3	26.5	26.5	26.0	25.1
NOV	28.0	28.4	27.4	26.0	27.4	26.4	25..8	26.4	26.5	27.1	26..8
DEC	26.4	27.2	26.3	26.3	26.4	24.5	26.9	26.8	25.8	26.0	25..5

SOURCE NIGERIA AIRPORT AUTHORITY, ILORIN.

APPENDIX C

RELATIVE HUMIDITY IN % (1989 – 1999)

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
JAN	63	58	69	72	74	66	67	84	64	53	62
FEB	84	74	78	68	58	54	65	60	80	60	65
MAR	72	59	57	64	73	58	75	79	61	54	73
APR	72	75	76	71	72	76	70	68	77	70	74
MAY	74	80	83	78	79	82	81	74	80	80	79
JUNE	81	81	83	80	74	82	78	78	85	79	80
JULY	86	86	85	80	81	84	83	84	83	86	82
AUG	83	82	81	83	85	79	83	85	84	84	81
SEP	84	87	83	81	80	84	86	86	84	83	86
OCT	77	80	79	78	80	83	84	77	79	82	85
NOV	73	76	75	71	74	72	77	76	78	74	78
DEC	64	65	57	64	77	63	66	78	75	60	68

APPENDIX D

SOLAR RADIATION (M^3/ day) (1989- 1999)

YEAR	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
JAN	161	152	153	158	154	163	161	160	138	157	160
FEB	160	155	150	154	157	155	157	152	154	162	164
MAR	152	151	138	160	158	162	158	152	157	153	138
APR	156	157	159	163	160	149	159	157	163	159	149
MAY	163	156	161	162	140	162	156	163	158	144	163
JUN	151	152	163	160	156	150	185	159	150	153	163
JUL	157	147	164	136	157	151	139	143	132	157	145
AUG	129	150	148	158	131	136	130	140	162	154	148
SEPT	142	142	146	138	134	124	132	149	145	155	165
OCT	157	147	160	160	147	157	148	143	157	147	162
NOV	169	129	147	155	156	161	155	150	160	136	167
DEC	139	139	143	141	138	153	148	158	149	137	153
TOTAL	1836	1777	1834	1845	1789	1823	1809	1826	1825	1819	1876

XI

THE FEDERAL UNIVERSITY OF TECHNOLOGY MINNA
DEPARTMENT OF AGRICULTUREAL ENGINEERING
QUESTIONAIRE ON THE SURVEY OF IRRIGATION FARMS IN KWARA STATE.

) Name of Organization/Farm ....

) Name of Farm Manager/Qualification ----------------------

) Total Number of Employees -----------------

) Source of Finance ------------------
☐ Government ☐ Private ☐ Both ☐ Partnership

) Total Number of Hectares Covered

) Source of water Supply
☐ Deep Well ☐ Dam ☐ River ☐ Lakes

) Source of power supply
☐ Solar Energy ☐ Electricity ☐ Manual

) Type of Irrigation System that is practiced
☐ Surface ☐ Sub-Surface ☐ SPRINKLER ☐ DRIP

) Actual Specification
☐ Furrow Irrigation ☐ Sprinkler ☐ Check Basin ☐ Others

0) Period of use of Irrigation (~~Irrigation frequency~~) from ------------------
To -----------------

1) Period of peak consumptive use -----------------------

2) Cost of Establishment -----------------------

3) Running cost or Maintenance Cost ---------------------

4) Average Annual Income per annual -----------------

5) Type of crops
☐ Food Crops ☐ Cash Crops ☐ Perishable Crops (VEGETABLES) ☐ Others

16. Please state the specification of the pump------------------------------------

----

17. what type of problem do you normally encounter in using the pump------------------

---.

18. How long does it take you to irrigate your farm at a time.-----------------------------

----

19. How many time do your irrigate

A. in a day---

B. in a week--

20. The type of pump in use -----------------------------