PERFORMANCE EVALUATION OF SELECTED IRRIGATION PUMPS

BY

AKPAN, JUDE EFFIONG.

MATRIC No. 2004/18347EA

DEPARTMENT OF AGRICULTURAL AND BIORESOURCES ENGINEERING.

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

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BEING A FINAL YEAR PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIRMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG.) DEGREE IN AGRICULTURAL AND BIORESOURCES ENGINEERING, 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 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 Information derived from personal communications, published and unpublished work were duly referenced in the text.

Akpan J. E.

Akpan, Jude Effiong

18/02/2010

Date

CERTIFICATION

This project entitled "Performance Evaluation of Selected Irrigation Pumps" by Akpan, Jude Effiong, meets the regulations governing the award of 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.

17/02/10 — 17/02/10

Mr. Halilu Adamu — Date

Supervisor

17/02/10

Engr. Dr. A.A. Balami — Date

HOD, Department of Agricultural and Bioresources Engineering

09-02-10

Engr. Prof. G.O. Chukwuma

External Examiner — Date

DEDICATION

This project is dedicated to Almighty God, my parents Mr. and Mrs. Effiong Akpan for all their support, prayers and encouragement throughout my education.

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ABSTRACT

Survey of irrigation pumps used was carried out in farms of five local government areas in Niger State; these are Agaie, Chanchanga, Bida, Paikoro and Mokwa. Questionnaires were distributed to the farmers in the selected local government areas of the state. Details of which three major types of pumps were used, Honda, Maritza and Yamaha. Pumps. Performance evaluation test was carried out on Honda pump which discharges an average of $6.67x10^{-3}$ m^3/s when pump was operating at maximum speed of 3500rpm, water horse power was computed to be 0.87kw at a total head of 20m, while Yamaha pump discharges an average of $5.88x10^{-3}m^3$ /s at maximum speed of 3500rpm, water horse power was computed to be 0.60kw at a total head of 20m, Maritza pump discharges an average of $4.6x10^{-3}$ m^3/s at maximum speed of 3500rpm, water horse power was computed to be 0.56kw at a total head of 20m. Honda pumps were found to be used because of its efficiency, discharge capacity, spare parts availability, running cost and maintenance.

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CHAPTER ONE

1.0 INTRODUCTION

Irrigation water is supplied to supplement the water available from rainfall and the contribution to soil moisture from ground water. In many areas of the world, the amount and timing of rainfall are not adequate to meet the moisture requirement of crops and irrigation is essential to raise crops necessary to meet the needs of food and fiber. Irrigation is an age old art, as old as civilization; the increasing need for crop production for the growing population is causing rapid expansion of irrigation throughout the world. Water being a limited resource, its efficient use is basic to the survival of the ever increasing population of the world. (Michael, 2004) In the comprehensive strategy needed for the conservation and development of our 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, climatic conditions, and nature of the soil, competing demands and socio-conditions. In dealing with each of these, every effort must be made to make the best use of water, so as to make possible a high level of continuous production (Dennis, 2004). Our aim today is to increase agricultural production per unit volume of water, per unit area of cropped land, per unit time. Scientific management of irrigation water provides the best insurance against weather induced fluctuations in total food production. This is the only way in which we can make our agriculture competitive and profitable. Lift irrigation requires that water from its sources to be field surface. Whatever the source of water in a lift irrigation project, the efficiency of the system depends on the application of sound principles in the design and construction of the utilization structure, usually the well, and characteristics of the water lifting device in relation to the source of water (Andrew, 2000). Devices for irrigation water lifting range from age old indigenous water lifts to highly efficient pumps. Pumps operated by electric motors or engines have come into prominence in all large scale lift irrigation schemes. This is because high output and efficiency levels can be more easily attained and controlled, using mechanically powered water lifts. Basically, there are four principles involved in pumping water; these are atmospheric pressure, positive displacement, centrifugal force and movement of columns of water caused by the difference in specific gravity. Water is one of 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 adequate water supply. Irrigation agriculture plays an important role in the world food production. Man has extracted water from rivers, lakes, canals for centuries to supplement the available rainfall water for crop production. Irrigation water must be applied to maintain the soil moisture for satisfactory crop growth. (Olu, 2005).

The heart of most irrigation systems is a pump. To make an irrigation system as efficient as possible, the pump must be selected to match the requirement of the water sources, the water piping system and the irrigation equipment (Olu, 2005).

1.1 Background to the study

The proper selection of pump is an integral part of irrigated schemes. Pumps are often used in drainage, irrigation and other areas such as industries where they are used mainly to transport fluid. Pumps are generally required to add hydraulic energy to be transported. The basic hydraulic concept of pump will be outlined to provide sufficient understanding of their design selection, operation and maintenance. Pumps are required where 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 irrigation farming. The three main classes of pumps are the centrifugal, rotary and reciprocating pumps. These classes can complete inventory of the conditions under which the pump operates must take place. The inventory must include; the source of water (well, river, pond), the required pumping flow rate, the total suction head, the total dynamic head. Centrifugal pumps are used to pump from reservoirs, lakes, streams and shallow wells. They are also used as booster pumps in irrigation pipe lines. All centrifugal pumps must be completely filled with water or 'primed' before they can operate. The suction line as well as the pump has to be filled with water and free of air. Air tight joints and connections are extremely important on the suction pipe. Priming a pump can be done by hand operated vacuum pumps, internal combustion engine vacuum, motor powered vacuum pumps or small water pumps that fill the pump and suction pipe with water.(Mazumber, 2004)

1.2 Statement of the Problem

Evaluation test of the irrigation pumps are aimed at setting the specifications for optimal 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, the urgency for agricultural mechanization and to meet the country's goals in food security, food production has to be increased.

1.3 Objectives of the study

1. Make a careful analysis of selected pumps, the problems encountered in operation.
2. Make recommendations based on their performance characteristics on the field of operation.

1.4 Justification of the study

The study is necessary to enhance the selection of irrigation pumps by carefully analysis of their performance characteristics. Based on the outcome of this research, the selected pumps should be able to meet the present day irrigation requirement.

1.5 Scope of the study

This project intends to evaluate the performance of irrigation pumps in irrigation farms at Agaie, Paikoro, Bida, Mokwa, Chanchanga local government areas of Niger state. Questionnaires were used in the collection, collation and analysis of the data obtained with regards to pump specification, type of pump selected and problems encountered on the field of operation.

CHAPTER TWO

2.0 LITERATURE REVIEW

Irrigated land represents about 18% of all land under cultivation but often produces over twice the yield of non irrigated field, about three quarters of the earth surface suffer from inadequate moisture for successful crop production, half of the irrigated areas lie in the developing countries. The total estimated land mass of Nigeria is 98.3 million hectares out of which 70.8 million hectares are adjudged arable. i.e. about 72% of total area. Only about 24.78 million hectares is under cultivation is under cultivation in 1999, while in 2004 only 6.3722 million hectares were cultivated and put into agricultural use. Presently only about 101,600 hectares is under irrigation in Nigeria. (http://www.fao.org/irrigatedagricultureinnigeria/htm,2009)

Motorized pumps (centrifugal pumps) are devices used to raise, transfer or compress liquids. They 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 performance as claimed by their manufacturers have not been given adequate attention (http://www.cheresource.com/centrifugalpumps.htm,2009). Most of the pumps are used for irrigation do not have sufficient information about their performance characteristics. Centrifugal pumps are designed for either horizontal or vertical operation. The horizontal centrifugal has a vertical impeller connected to a horizontal drive shaft. Horizontal centrifugal pumps are the most common in irrigation systems. They are generally less costly, require less maintenance, easy to install and more accessible for inspection and maintenance than the vertical centrifugal pumps. There are self priming horizontal centrifugal pumps, but they are special purposed pumps and not normally used with irrigation systems. Vertical centrifugal pumps may be mounted so that the impeller is under water at all times. This makes priming unnecessary and the vertical centrifugal desirable for floating applications. Also, a self priming feature is very desirable in areas where there are frequent electrical power outages or off-peak electrical price reductions are available (Schivab et al., 2004) A pump is a contrivance which provides energy to a fluid in a fluid system; it assists to increase the pressure energy or kinetic energy, or both of the fluid by converting the mechanical energy. (Rajput, 2004). Components of a centrifugal pump consist of; impeller, casing, suction pump, delivery pipe. Impeller: An impeller is a wheel (or rotor). It is mounted on a shaft which is usually coupled to an electric motor. The impellers are of following three types: Shrouded or closed impeller: In this type of impeller vanes are provides better guidance for the liquid and has a high efficiency. It is employed with the liquid to be pumped is pure and relatively free from debris. Semi-open impeller: a semi-open impeller is one in which vanes have only the base plate and no crown plate. This impeller can be used even if the liquids contain some debris. Open impeller such an impeller, the vanes have neither the crown plate nor the bare plate i.e. the vanes are open on both sides. Such impellers are employed for pumping liquids which contain suspended solid matter such as sewage, paper pulp, and water containing sand or grit. Casing is an airtight chamber surrounding the pump impeller. It contains suction and discharge arrangements, supporting for bearings, and facilities to house the rotor assembly. It has provision to fix stuffing box and house packing materials which prevent external leakage. The essential purposes of the casing are to guide water to and from the impeller and to partially convert the kinetic energy into pressure energy. There are types of casing commonly used; these are volute casing, vortex casing and casing with guide blades. Suction pipe, the pipe which connects the centre/eye of the impeller to sump from which liquid is to be lifted is known as suction pipe. In order to check the formation of air pockets the pipe is laid air tight. To prevent the entry of solid particles, debris into the pump the suction pipe is provided with strainers at its lower end. The lower end of the pipe is also fitted with a non-return foot value which does not permit the liquid to drain out of the suction pipe when pump is not working, this also help in priming. Delivery pipe, is the pipe which in connected at its lower end to the outlet of the pump and it delivers the liquid to the required height is known as delivery pipe to regulate the supply of water. The following points, regarding impellers are worth noting, these are: Where it is required to pump clear and fresh water, the impeller is cast as a single piece and made of cast iron. The cast iron impeller is cheaper. (Rajput, 2004). Where corrosion due to salt water or chemical is expected the impellers are made of material such as gun metal, stainless steel (Rajput, 2004). Machines (pumps) that handle hot water having temperatures above 150^0c have to be made of cast steel impellers with special types of packing (Rajput, 2004). Centrifugal pumps work on the principle that when a certain man of fluid is rotated by an external source, it is thrown away from the central axis of rotation and a centrifugal head is impressed which enable it to rise to a higher level. The operation of filling the suction pipe, casing of the pump and a portion of the delivery pipe completely from outside source with the liquid to be raised, before starting the pump, to remove any air, gas or vapour from these parts of the pump is called priming of a centrifugal pump. If a centrifugal pump is not primed before starting, air pockets inside the impeller may give rise to vortices and cause discontinuity of flow. Further, dry running of the pump may result in rubbing and seizing of the wearing rings and cause serious damage. Small pumps are usually primed by pouring liquid into the funnel provided for the purpose while doing priming, the air-vent value provided in the pump casing is opened; the air escapes through the value. The priming is continued till all air from the suction pipe, impeller and casing has been removed. Large pumps are primed by evacuating the casing and the suction pipe from the sump and the pump is filled with liquid. The internal construction of some pumps is such that special arrangement containing a supply of liquid are provided in the suction pipe due to which automotive priming of the pump occurs; such pumps are known as self pumps.

2.1 Selection of Pumps

The main criteria of the selection of the type of pump are values of discharge (Q), head (H) and speed (N). From these values the specific of the pump is calculated and subsequently the type of the pump can decided when the specific speed is low and it is possible to increase the pump speed, it is better to use multi-stage pump, the number of stages are decided on the basis of the head and type of the pump to be used. (Michael, 2004)

2.2 Operational Difficulties in Centrifugal Pumps

The type of operational difficulties commonly experienced in centrifugal pumps and their remedies are given below Pump fails to start pumping Pump may not be properly primed – (Reprime the pump) Total head against which the pump is working may be much higher than that of which the pump is designed – (check the head with accurate gauges; reduce the head or change the pump) Low speed – (increases the speed) Impeller may be clogged- (clean the impeller) Pump stops working Presence of air in suction line – (Remove the air by priming and plug the entry of air) High suction lift – (Reduce the suction lift) Pump has very low efficiency. Speed may be too high (Reduce the speed). Pump may be operating in wrong direction (correct the direction of rotation of impeller). Shaft may be bent, impeller may be touching the casing, stuffing boxes may be too high, wearing rings may be worm – (Repair the affected parts). (http://www.howstuffswork.com/pumps/operation.htm,2009)

2.3 Specific Speed of Pumps

The selection of 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 respectively small elevation from the canal or river on 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. Simplify things the discharge head and speed at optimum performance of various pumps are consolidated into one name 'specific speed'. The specific speed Ns of a pump is computed from;

$$Ns = \frac{N \times \sqrt{Q}}{H^{\frac{3}{4}}} \qquad 2.0$$

(Michael, 2004)

Where Ns= the specific speed, unitless

N= pump rotational speed, in rpm (revolution per minute)

Q= flow rate or pump discharge in m^3s^{-1}

H= total head, m

Specific speed Ns is a non dimensional number used to classify pump impellers as to their type and proportions. Specific speed should be thought of only as index used to predict pump characteristics such as the general shape of impeller. As the specific speed increase, the ratio of the impeller outlet diameter to the inlet diameter decreases. (Michael, 2004)

2.4 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 the discharge pipes must be included. Other losses such as foot valve, elbow valves are ignored. The pump size is expressed by 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 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 right pump for use and also establish the power required. 'Head' is a common term used with pumps. Head refers to the height of a vertical column of water. Pressure and head are interchangeable concepts in irrigation. The total head of a pump is composed of several types of head that help to define the pump's operating characteristics. (Schivab et al., 2004)

2.4.1 Total Dynamic Head

Total dynamic head of a pump is the sum of the total static head, the pressure head, the friction head, and the velocity head. (Michael, 2004)

2.4.2 Total Static Head

The total static head is the vertical distance the pump must lift water. When priming from a well, it would be the distance from the pumping level in the well to the ground surface plus the vertical distance. The water is lifted from the ground surface to the discharge point when pumping from an open water surface; it would be the total vertical distance from the water surface to the discharge point. (Michael, 2004)

2.4.3 Pressure Head

Pump systems require certain pressure at the pivot point to distribute the water properly. This is suction or against which the pump discharges. It is expressed mathematically as

$$H_p = \frac{p}{w} \qquad 2.1$$

(Michael, 2004)

H_p- Pressure head, m

P-pressure inside vessel, kgm^{-2}

W-Specific weight of water, kgm^{-3}

2.4.4 Friction Head

Friction head is the energy loss or pressure due to friction when water flows through pipe networks. The velocity of the water has a significant effect on friction loss. Loss of head due to friction occurs when water flows through straight pipe sections, fittings, valves, around corners and where pipe increase or decrease in size. The friction head for piping system is the sum of all the friction losses. (Douglas et al, 2004)

2.4.5 Velocity Head

Velocity head is the energy of the water due to velocity. This is a very small amount of energy and is usually negligible when computing losses in an irrigation system. It also refers to the energy of a liquid as a result of its motion at some velocity 'v'. It can also be the head necessary to accelerate water. (Douglas et al, 2004)

2.4.6 Capacity

This is volume of water pumped per unit time, expressed in liters per second. Small capacities, however, it may be stated in liters per minute or liters per hour and large quantities in cubic meters per second. (Douglas et al, 2004)

2.5 Suction Head

A pump operating above a water surface is working with a suction head. The suction head includes not only the vertical suction lift, but also the friction losses through the pipe, elbows, foot valves, and other fittings on the suction side of the pump. There is an allowable limit to the suction head of a pump and net positive suction head (NPSH) of a pump sets that limit. To minimize the suction pipeline friction losses, the suction pipe should have a larger diameter than the discharge pipe. Operating a pump with suction lift greater than it was designed for, or under conditions with excessive vacuum at some point in the impeller, may cause cavitation. Cavitation is the implosion of bubbles of air and water vapour and makes a very distinct noise like gravel in pump. The burst of numerous bubbles will corrode the impeller and it eventually will be filled with holes. (http://www.engineersedge.com/pumps/preventingcavitation.htm,2009)

2.5.1 Allowable Suction Head

The allowable suction head 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. the pump is required to deliver a factor of proportionality, called cavitation parameter. This is determined by the manufacturer. The net positive suction head available (NPSHA) combines the effect of atmospheric pressure, water temperature, supply elevation and the dynamics of suction piping. The net positive suction head required (NPSHR) is the suction pressure necessary to ensure proper operation it is purely a function of pump design, and although it can be calculated, it is more accurately determined by testing. Therefore, all pump systems must maintain a position suction pressure that is sufficient to overcome this pressure drop. (http://www.pump-zone.com/pumps/centrifugal-pumps/npsrandnpsh.htm,2009).

If the pressure is not sufficient, some of the water will change state (liquid to vapour) and cavitation initiated. Like NPSHA, NPSHR is also a dynamic quantity and increases substantially with pump flow. Therefore, to avoid cavitation the NPSHR is always greater than NPSHA which is measured by the pump manufacturer. (Olu, 2005)

2.5.2 Power Requirement for Pumping

Work is defined as the force multiplied by distance. Power is defined as work per unit time or the rate of doing work. Work is required to lift water out of a well and the amount of water delivered per unit time can be related to power and this is referred to, in unit of horsepower. Power requirement for pumping are proportional to the total pumping head, including velocity head, frictional losses, static head. The power required to drive the pump is determined by dividing the output power by the pump efficiency. It is determined by this formula;

Power required for pumping

$$Kw = \frac{9.8qh}{E_p} \qquad 2.2$$

(Michael, 2004)

Kw- Input power delivered to pump

Q- Discharge rate in $m^3\ s^{-1}$

H- Total head in m

Ep- pump efficiency in decimal.

2.6 Efficiency of a Pump

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

$$E_p = \frac{output}{input} \times 100 \qquad 2.3$$

(Michael, 2004)

$$= \frac{WHP}{BHP} \times 100 \qquad 2.4$$

(Michael, 2004)

WHP- Water horsepower, expressed as

$$= \frac{Q \times H}{3960} \qquad 2.5$$

(Michael, 2004)

Q- Flow rate, M^3s^{-1}

H- Total Head, m

BHP- Brake horsepower, express as

$$= \frac{100QH}{3960n} \qquad 2.6$$

(Michael, 2004)

Q- Flow rate/ discharge, m^3s^{-1}

H- Total Head, m

N- Pump Efficiency, %

Efficiency of a pump is obtained based on field and experimental conditions. The economic implication of operating a pump at a low efficiency is considerable power cost and more time will be required to apply the needed irrigation water. (Michael, 2004)

2.7 Pump Selection and Alteration

Affinity Laws

The performance of a pump varies with the speed and the diameter at which the impeller rotates. Theoretically, varying pump speed and diameter will result in changes in flow rate, head and brake horsepower. Pump selection and alteration means changing the pump performance characteristics and certain basic laws are valid for centrifugal pumps, which is affected by a change in speed or diameter of the impeller. These basic laws are known as affinity laws.

A. Changing the impeller diameter D in the pump results in the changes of discharge Q, Total Head H, and brake horsepower (BHP) according to the following relationships;

$$\frac{Q_2}{Q_1} = \frac{D_2}{D_1} \qquad 2.7$$

(Michael, 2004)

$$\frac{H_2}{H_1} = \left(\frac{D_2}{D_1}\right)^2 \qquad 2.8$$

(Michael, 2004)

$$\frac{BHP_2}{BHP_1} = \left(\frac{D_2}{D_1}\right)^3 \qquad 2.9$$

(Michael, 2004)

B. Changing the motor speed of a pump, the resultant changed follow these relationships

$$\frac{Q_2}{Q_1} = \frac{N_2}{N_1} \qquad 2.10$$

(Michael, 2004)

$$\frac{H_2}{H_1} = \left(\frac{N_2}{N_1}\right)^2 \qquad 2.11$$

(Michael, 2004)

$$\frac{BHP_2}{BHP_1} = \left(\frac{N_2}{N_1}\right)^3 \qquad 2.12$$

(Michael, 2004)

2.8 Trouble Shooting 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. Trouble may arise from improper design, poor operation or installation and from poor maintenance. Centrifugal pumps are ultimate in simplicity. In general, there are two basic requirements that have to be met at all times for a trouble free operation and longer service life of centrifugal pumps. The first requirement is that no cavitation of the pump occurs throughout the broad operating range and the second requirement is that a certain minimum continous flow is always maintained during operation. The consequences of prolonged conditions of cavitation and low flow operation can be disastrous for both the pump and the process. Such failures can result in loss of machines and poor production. Thus, such situation should be avoided at all cost whether involving modifications in the pump and its piping or altering the operating conditions. Proper selection and sizing of pump and its associated piping can not only eliminate chances of cavitation and low flow operation but also significantly decrease their harmful effects. (Olu, 2005)

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 MATERIALS

The material used in the project was questionnaire for the collection of the data obtained. The respondents were accorded an opportunity to comment on several issues relating to pump specification, type of pump, and problems encountered on the field of operation. The data used for the case study was obtained from the various farms in local government areas where irrigation is practiced in Niger state. The local government areas used were; Agaie, Mokwa,Chanchanga, Bida, and Paikoro. Sample of the questionnaire is shown in appendix A with all relevant information that is required to access the performance of the irrigation pumps in Niger state.

3.1.1 Study Area.

The study area were farms in five different local government area of the state, these are Agaie, Mokwa, Chanchanga, Bida, and Paikoro all in Niger state, Nigeria. Niger state is situated in the north central part of Nigeria, it lies in the northern guinea savannah and zones of the tropics between latitudes 8^0 10 N and 11^0 30 N. Longitude30^0 30E and 7^0 30 E. Its climate is influenced by mainly the rain bearing south west monsoon winds from there are mainly the raining and dry seasons. The raining season begins in April and ends in October and the dry season starts in November and ends in March. (Ibrahim, 2006)

3.2 METHOD

A survey was conducted to obtain some data which were not available on the performance evaluation of these pumps. The parameters observed during the investigation includes; measure the discharge (flow rate) of pumps in l/s and computed in m^3/s at same suction head (m), pump speed in revolution per minute (r.p.m), power output in kilowatts (Kw) by computation.

3.2.1 Experiment layout.

The pump discharge for Honda WX 30S, Honda W10BT, Yamaha Y10BE and Maritza were determined on the field using a stopwatch and a bucket of 10 liters capacity. 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 three times at the same head and corresponding interval was recorded at the maximum speed of 3500pm.

Pump specification: Honda WX 30S

Total head: 20m

Capacity: 400l/mm= 6.6×10^{-3} m^3/s

RPM: 3500

Impeller diameter: 30mm = 0.3m

Power hated = 3.0hp =4.02 km

$$\text{Discharge in liter per second} = \frac{volume\ of\ container}{Time\ taken} \qquad 3.0$$

(Andrew, 2000)

$$\text{Average discharge} = \frac{\text{1st discharge} + \text{2nd discharge} + \text{3rd discharge............nth discharge}}{\text{No of time of Experiment}} \quad 3.1$$

(Andrew, 2000).

The analysis of the pump capacity shows that at same pump speed of 3500pm, same delivery head of 20m.the analysis of the pump capacity shows that:

Discharge QA = 400L/min= 6.6 x 10^{-3} m^3/ sec (Honda WX 30S), (Honda W10BT)

Discharge QB = 300L/min= 5.88 x 10^{-3} m^3/ sec (Yamaha Y10BE)

Discharge QC = 250L/min= 4.6 x 10^{-3} m^3/ sec (Maritza)

Volume of water discharge in pump A = 5092m^3 (Honda WX 30S), (Honda W10BT)

Volume of water discharge in pump B = 3650 m^3 (Yamaha Y10BE)

Volume of water discharge in pump C = 2150 m^3 (Maritza)

Pump specification: (Honda W10BT)

Total head: 20m

Capacity: 400l/mm= 6.6 x 10^{-3} m^3/s

RPM: 3 500

Impeller diameter: 30mm = 0.33m

Power Rated = 3.0hp = 4.02 km

Pump Specification: (Honda Y10BE)

Total head: 20m

Capacity: 300l/mm= 5.88 x 10^{-3} m^3/s

RPM: 3 500

Impeller diameter: 30mm = 0.3m

Power Rated = 2.5hp = 3.35 km

Pump Specification: (Maritza)

Total head: 20m

Capacity: 250l/mm= 4.6 x 10^{-3} m^3/s

RPM: 3 500

Impeller diameter: 30mm = 0.3m

Power Rated = 2.5hp = 3.35 km

CHAPTER FOUR

4.0 RESULT AND DISCUSSION

4.1 Results.

Based on the survey carried out on some farms in Niger state. The three major types of motorized pumps that were in use are Honda, Yamaha, and Maritza. The analysis of the performance characteristics of the pump are based on the performance evaluation carried out on the field operation and practical test to know the volume discharge per time.

4.2 Pumps and Brand Types

This shows the popularity 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 respondents on the pump brands. This implies that because of the efficiency of Honda pumps, its operating capacity, discharge capacity, running cost and maintenance the Honda brand is preferred than other pumps.

Table 4.2: Brands of Pump and Percentage of Respondents

S/N	Brand Of Pump	% Of Respondents
1	Honda	50
2	Yamaha	30
3	Maritza	20

4.3 Pump Specification

This contains information on the total head of the pump, capacity, diameter and horse power (hp). It is the major determinant in the choice and selection of pumps.

Table4.3 Pump Specification.

Make and model No.	Rate of power (hp)	Total head (m)	Capacity(m^3/sec x 10^{-3})	Speed	Impeller diameter(mm)
Honda WX30S	3.0	20	6.60	3500	30
Honda W10BT	3.0	20	6.60	3500	30
Yamaha Y10BE	2.5	20	5.88	3500	25
Maritza	2.5	20	4.66	3500	25

4.4 Pumps Installation, Running Cost and Maintenance.

In some of the farms in local government areas such as Chanchanga, Mokwa ,Agaie. Partial installation methods were used, this was due to damage caused by rainfall to the pipe and fear of it being stolen prevented full installation. The Maritza and Yamaha pumps uses one drum of diesel per week and working hours are between 8am to 5pm while under pumps used 25 liters of diesel per day for the same working hours with maximum discharge. The effective use of pumps like other farm machinery considerably depends on quality of maintenance. Maintenance depends, usage, size and age of machine. A newly bought machine needs lesser maintenance, maintenance increases with the age of the machine. Maintenance could be preventive or need-base. From the survey, it could be seen that most farms in Niger State practice the need-base maintenance which is not recommended for machines, because it reduces the over all period of the machine. In highly mechanized agriculture, preventive or routine maintenance is best recommended, to avoid dead period of machines during intensive field work.

Appendix B indicates that 70% of the farmer used preventive maintenance while 30% use need base maintenance. The effective use of farming machinery is dependent on quality of maintenance and repairs.

4.5 Spare Parts and Material Availability

Appendix C indicates that 70% of the respondents get their spare parts ready, while 30% of the farmers hardly get their spare parts and materials for their machines ready. 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 70% of the respondents have moderately available spare parts while 30% of the respondents hardly get spare parts. The farms in local government areas that use Yamaha and Maritza spare parts availability are scarce while the Honda pumps are relatively available.

4.6 Result of Experiment Carried Out on Honda, Yamaha, and Maritza Pumps.

These tables show the maximum total head of various pumps operating at same speed 3500rpm. It shows suction head (m), delivery head (m), friction head (m), total head (m), volume (litres), time (s), Discharge (l/s), water horse power (kw).

Table 4.6(a): Maximum Total Head at 3500rpm (Honda Pump).

Suction Head(m)	**Delivery Head(m)**	**Friction Head(m)**	**Total head(m)**	**Volume (lit)**	**Time (s)**	**Discharge ($m^3/sX10^{-3}$)**	**WHP (KW)**
3	10	5	15	10	1.46	6.84	0.46
3	12	5	17	10	1.48	6.76	0.54
3	15	5	20	10	1.50	6.66	0.87

Table 4.6(b): Maximum Total Head at 3500rpm (Yamaha Pump).

Suction Head(m)	**Delivery Head(m)**	**Friction Head(m)**	**Total head(m)**	**Volume (lit)**	**Time (s)**	**Discharge ($m^3/sX10^{-3}$)**	**WHP (KW)**
3	10	5	15	10	1.46	5.62	0.40
3	12	5	17	10	1.48	5.95	0.42
3	15	5	20	10	1.50	5.88	0.60

Table 4.6(c): Maximum Total Head at 3500rpm (Maritza Pump).

Suction Head(m)	**Delivery Head(m)**	**Friction Head(m)**	**Total head(m)**	**Volume (lit)**	**Time (s)**	**Discharge ($m^3/sX10^{-3}$)**	**WHP (KW)**
3	10	5	15	10	1.46	4.44	0.46
3	12	5	17	10	1.48	4.52	0.54
3	15	5	20	10	1.50	4.66	0.56

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

It can be concluded from the study carried out that;

1. Three major types of motorized pumps used are Honda, Yamaha and Maritza.

2. Honda pumps were found to be mostly used.

3. Lack of preventive maintenance has led to the failure of most of the irrigation pumps, farmers in some of the local government areas such as Agaie, Mokwa and Paikoro practiced need base maintenance due to lack of capital to fund the routine/ preventive maintenance.

4. The efficiency of the pump (Honda) reduces as the total head increases.

5.2 Recommendations

In order to use modern pumps most profitable to obtain irrigation water;

1. It is essential to select pumps that are well adapted to a particular field of operation and to obtain a relatively high efficiency. Low efficiency results when the quantity of water pump is appreciably less than the quantity or which the pump is designed, this result in excessive head. Likewise, a pump may deliver more than it is designed to deliver at a lower than the normal head, this also results in low efficiency.

2. It strongly recommended that the manufacturer's manuals are strictly followed in order to achieve maximum productivity in pump operations.

3. Preventive or routine maintenance is also recommended to avoid dead period of machines during intensive field work.

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APPENDIX A

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

DEPARTMENT OF AGRICULTURAL AND BIO-RESOURCES ENGINEERING

QUESTIONNAIRE ON THE SURVEY OF IRRIGATION PUMPS OF FARMS IN AGAIE, BIDA, PAIKORO, CHANCHANGA AND MOKWA LOCAL GOVERNMENT AREAS OF NIGER STATE.

1. Name of organization/farm. ______________________________

2. Name of farm manager/Qualification. ______________________________

3. Total number of employees. ______________________________

4. Source of finance

   Government ☐ private ☐ both ☐

5. Total number of hectares used. ______________________________

6. Source of water supply.

   ☐ Deep well ☐ River ☐ Lakes

7. Source of electricity (power supply)

   ☐ Solar ☐ PHCN ☐ Generating sets

8. Type of irrigation system practiced

   ☐ Surface ☐ sub surface ☐ sprinkler

9. Average annual income per annum ______________________________

10. Cost of establishment ______________________________

11. Amount of running and maintenance cost ______________________________

12. Type of crops grown

    ☐ Food crop ☐ cash crops ☐ vegetable

13. State the specification of the pump.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

14. Problems encountered when using pump.____

____

____

15. How many times do you irrigate?

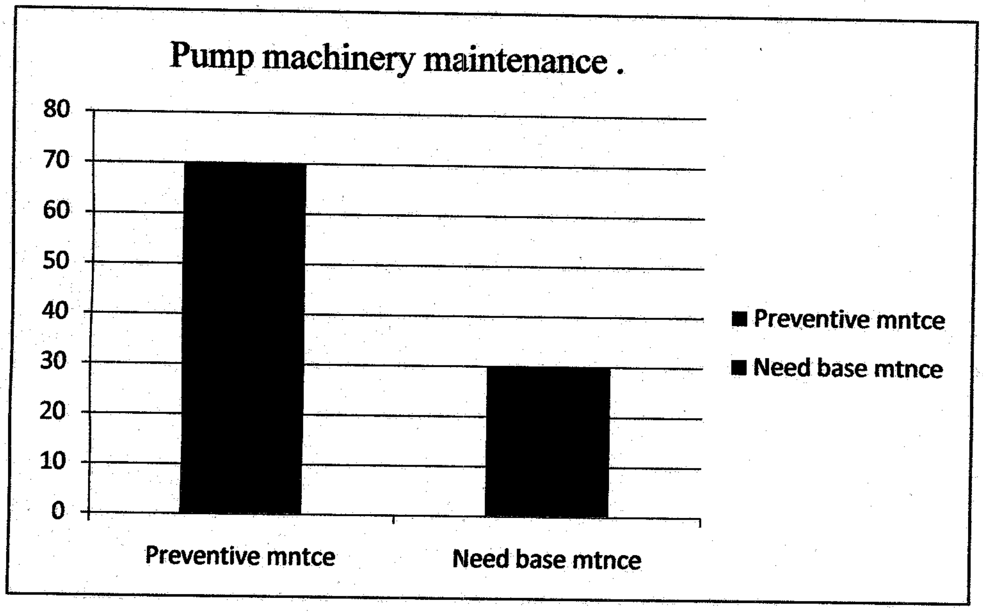
☐ Daily ☐ weekly ☐ monthly

16. How long those it take to irrigate your farm at a time.

17. Type of pump in use.

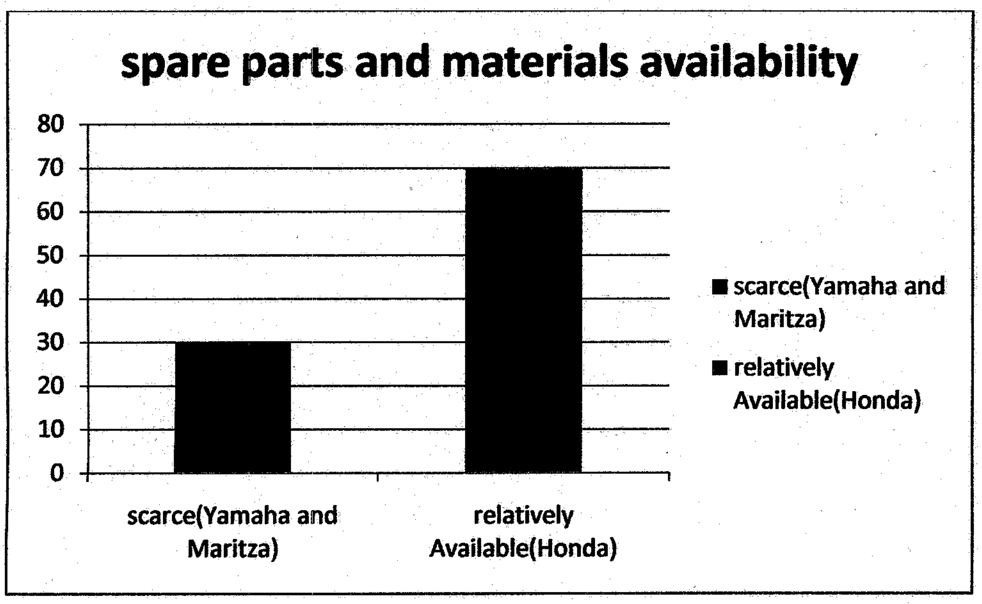
☐ Centrifugal pump ☐ rotary pumps ☐ reciprocating pump

APPENDIX B



Pump machinery maintenance .
80
70
60
50
40
30
20
10
0
Preventive mntce
Need base mntce
Preventive mntce
Need base mntce

APPENDIX C


spare parts and materials availability
80
70
60
50
40
30
20
10
0
scarce(Yamaha and Maritza)
relatively Available(Honda)
scarce(Yamaha and Maritza)
relatively Available(Honda)