DESIGN AND FABRICATION OF A MOBILE WATER SUPPLY SYSTEM FOR DRIP IRRIGATION

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17 /A/BME/0538/G/F

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AN INDIVIDUAL PROJECT REPORT SUBMITTED TO THE FACULTY OF ENGINEERING, TECHNOLOGY, APPLIED DESIGN, AND FINE ART, KABALE UNIVERSITY (KAB) IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF MECHANICAL ENGINEERING IN THE DEPARTMENT OF MECHANICAL ENGINEERING.

APRIL, 2022

DECLARATION

I hereby declare to the best of my knowledge that this piece of work is my own and has never been submitted to any higher institution of learning for the award of a Degree or any other academic qualification and thus describes my involvement as a student of Bachelor of Mechanical Engineering.

SIGNATURE~ Date:24/04/2022

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APPROVAL

This is to certify that this work was carried out under strict supervision and has been approved for submission to the Faculty of Engineering, Technology, Applied Design, and Fine Art, Department of Mechanical Engineering of Kabale University in partial fulfillment of the requirement of the award of a Bachelor of Mechanical Engineering.

SIGNATURE.. DATE 25th/04/2022.............................

Mr. NDA WULA ISAAC

SUPERVISOR

ABSTRACT

In this study, a design and fabrication of a mobile water supply system for drip irrigation was undertaken thus the major aim of this project is to eliminate the existing out fashioned drip irrigation methods such as the use of water bottles and stationary water supply system for drip irrigation to improve on the Agricultural yield from the crops.

A survey was undertaken to establish the day-to-day methods stil1 in existence for drip irrigation, thus this was to give an overview of the need to have a cheaper design that *is* simple and cost-effective. This involved collection of resources from different sources to obtain important data for the project and having a guideline on the steps involved in the design.

The specific objectives will entail the determination of pertinent parameters for the conceptual design and coming up with the system layout generated from 3D modeling software (DS SOLID WORKS), selecting material, sizing the components that are necessary for the machine, and fabricating the prototype. Thus, the design and fabrication of a mobile water supply system for drip irrigation will be done, stating design specifications, developing conceptual designs, sizing of the solar components, and details of the design of the selected concept with its working drawings.

Therefore, various sources of the data (references) given in this report are also provided at the end of the document.

ACKNOWLEDGEMENT.

I wish to acknowledge and thank God Almighty for giving me the strength and ability to undertake and complete this research project. I am grateful to my supervisor **Mr. Ndawula Isaac** for his patience and before ringing out the best in me during this. May God Almighty bless him.

Heartfelt thanks to my dad, **Mr. Walyaula Samuel Baker** who loves me, prays for me, and always encourages me as well as valuable insights and perspectives on finances.

My final appreciation also goes to my coursemates who have continually given me guidance on how to undergo with my project.

DEDICATION

This project work is dedicated to my father **Mr. Walyaula Samuel Baker** and all lovers of research in my field of study.

TABLE OF FIGURES

NOMENCLATURE

T = twisting moment

J = polar moment of inertia τ

= torsional shear stress

M = bending moment σ

= bending stress (Pa)

τ = working shear stress (Pa)r stress Pa

τma maximum allowable shear stress (Pa) Fos =

factor of safetysafety

σna = maximum normal stress (pa)

σ = working normal stress (pa)al stress pa θ=

angular deflection (rad)ection rad

G = modulus of rigidity (N/m)igidity N/m2 σry

= yield stress

I = moment of inertia

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INTRODUCTION

1.0 Background

Overtime there is need for a growing economy to have self sustainability and this necessitates the introduction of irrigation as a method to boost this. Irrigation is a mechanization tool that comes into play as one of the means of improving total reliability of agricultural production by managing water supply to the crop.

Irrigation has been promoted in Uganda by both government and non-government entities as a measure to maintain all-year-round food production regardless of the current state of unpredictable weather. This is because climate change has prolonged dry seasons into what were traditionally planting seasons and misaligned wet seasons into what were traditionally harvesting seasons thereby making reliance on the traditional indicator's incapable of sustaining food production. To supplement rain-fed agriculture, efforts have been made by capable and well-informed farmers to invest in irrigated agriculture. Startup costs of conventional irrigation systems, however, are too high for the majority of smallholder and medium-level farmers in Uganda to afford either upfront or under installment purchase wherein harvests clear out the balances. Additionally, the cost of continuously operating the same conventional irrigation systems is rather high due to such variable costs as fuel, manpower and water. Each of these budgets is way above the average annual incomes of small-holder farmers and therefore keeps irrigated agriculture out ofreach of over 70% of Uganda's food producers. When access to nutritious home-grown food is low some periods of the year, this is one of the key causes.

Efforts have been undertaken on a global scale to reduce both startup costs and recurring (operational) costs associated with irrigation systems to enable the inclusion of sub-Saharan African farmers of whom the majority are smallholder. Portable solar pumps have been designed and distributed to enable off-grid farming households to irrigate their fragmented farms without incurring any re-fueling costs. These have been very beneficial especially since the dryer seasons that often strike during flowering, a delicate stage, are the times when solar luminance is highest providing maximum power to irrigate and counter the effects of too much sunshine. This approach, however, of irrigating when the sunlight is very bright, happens when evapotranspiration rates are very high. Though intended to match maximum discharge with maximum soil dryness, sprinkling water at this time of day also leads to maximum water loss through evaporation both mid-air and on the hot soil surface and also makes the remaining **water** seep through the sun-heated soil when at a high temperature that is devastating to the render roots of the crops. The recommended time to irrigate is at dawn and/or dusk but the intermittence nature of the sun dictates that without sufficient energy storage, one cannot irrigate at dawn and dusk. Therefore, Initiatives have been taken to augment the conventional irrigation systems to make them less costly in terms of routine operations by increasing water use efficiency.

The commonest systems are the clock-driven automated irrigation systems that irrigate farms and lawns strictly at dawn and dusk when evapotranspiration rates are lowest. Although this reduces water-losses, the challenge with this approach is that irrigation will happen even when the field was submerged in an overnight rain shower should the farmer/technician fail to shut it off just before dawn or dusk. This challenge gave rise to the need to first check the water content of the soil before executing an irrigation command.

Modern agricultural techniques and equipment's are not used by small land holders since most of its equipment's are too expensive and difficult to acquire. By adopting scientific farming methods, we can get maximum yield and good quality crops which can save a farmer from going bankrupt but majority of farmers still uses primitive method of farming techniques due to lack of knowledge or lack of investment for utilizing modern equipment.

1.2. Problem Statement:

The continuous use of primitive methods for drip irrigation such as water bottle methods and stationary water systems have lots of drawbacks leading to a low agricultural yield.

Therefore, the aim of this project is to provide a modernized drip irrigation method to reduce on such drawbacks in order to have a high agricultural yield for the increasing population.

1.3 Objectives

Below are the objectives of this project

1.3.1 Main Objective

To design and fabricate a mobile water supply system for drip irrigation

1.3.2 Specific Objectives

(a) To conceptualize the design.
(b) To size and dimension the basic components for the machine. (c)
To fabricate a working prototype.

1.4 Project Report Outline

This project report consists ofliterature review on the available mobile platforms and available low pressurized water pumps, description of the conceptual design and mechanical design of the components of the Mobile water supply system for drip irrigation.

LITERATURE REVIEW

2.0 Introduction

The development of robotic platforms for agricultural application isn't a new idea in the Agrosector, many engineers in the past have tried to develop driverless machines though most weren't successful due to the complexity of the real world. Therefore, this project is aimed at coming up with a mobile platform that can easily be operated both manually and a little bit of automation for pimping water into the drip lines. Hence Robotics and automation can play a significant role in enhancing agricultural production needs.

2.1 Mobile Robots

In [1], developed a mobile remote controlled multipurpose robot for agriculture, which consisted of the following a seeder which is used for seeding, a gear which is used to transmit power, a chasis onto which all the components are assembled, De motors used to convert electrical energy into mechanical energy, a water tank used for storage of water used for spraying after seeding, a water pump this is used for pumping of the water out of the storage tank, Plough this consists of blades fixed on a frame and is used to create furrows in preparation for the planting of seeds.

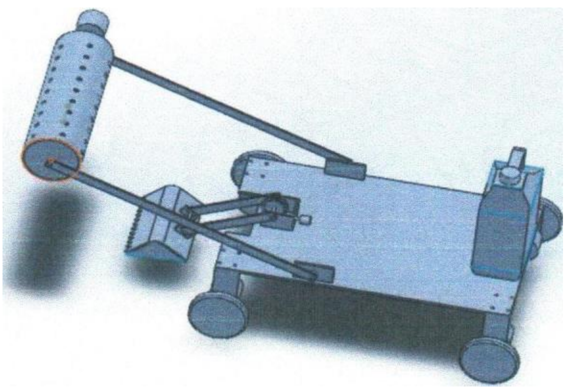


Figure 1: Design of seeder machine [JJ

In [2], a solar operated seed sowing and ploughing robot was developed to improve efficiency of crop production and it consists of the following components; a chassis onto which all parts of the machine are incorporated, Printed Circuit Board(PCB) this houses all the electronic components, battery used to power the electronic components, solar panel used to harvest solar energy, seed tray which houses a seed hopper and a seed drum and lastly four wheels used for mobility of the machine.

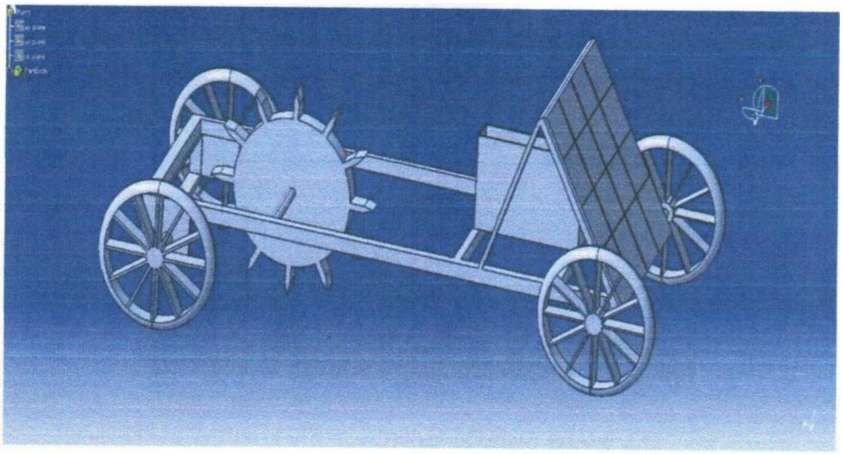


Figure 2 solar powered seed sowing and ploughing robot [2]

In [3], a hybrid Control Design for a Wheeled Mobile Robot was developed to survey an agricultural field autonomously. It consisted of the following components; a rigid frame with four identical wheels, a GPS, gyros, magnetometer and odometers that will be used for determination of exact location and also measurement of robotic tracking algorithm and lastly drive motors.

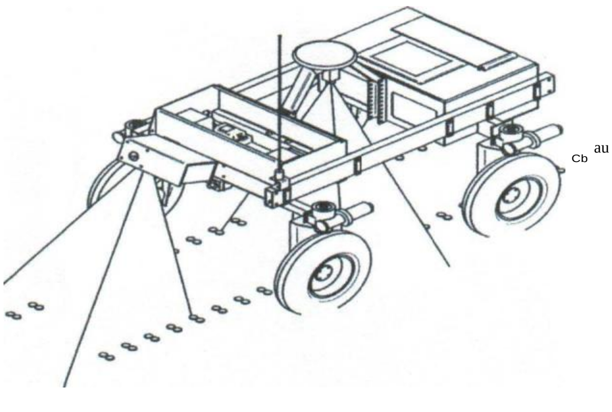


Figure 3 hybrid control design for a wheeled mobile robot [3]

In [4], an Agriculture mobile robot was developed to easy on the farming in the Brazilian Culture and it consisted of a rectangular frame onto which the wheels are attached and any other components, traction system which consists of wheels and track, its used to evenly distribute load on the soil, power supply system, motors, electronic control units, propulsion system.

Figure 4 Agricultural Mobile robot [4]

In [5], an electromechanical design of an agricultural mobile robot was developed and the the proposed project also integrates mechatronic design principles thus this project consisted of the following components cooler system; Diesel engine; fuel tank; secondary frame; hydraulic system support; front wheel module; propulsion hydraulic motor; gauge adjust system; hydraulic pumps; ladder; hydraulic fluid tank; batteries pack, four wheels with dumpers.

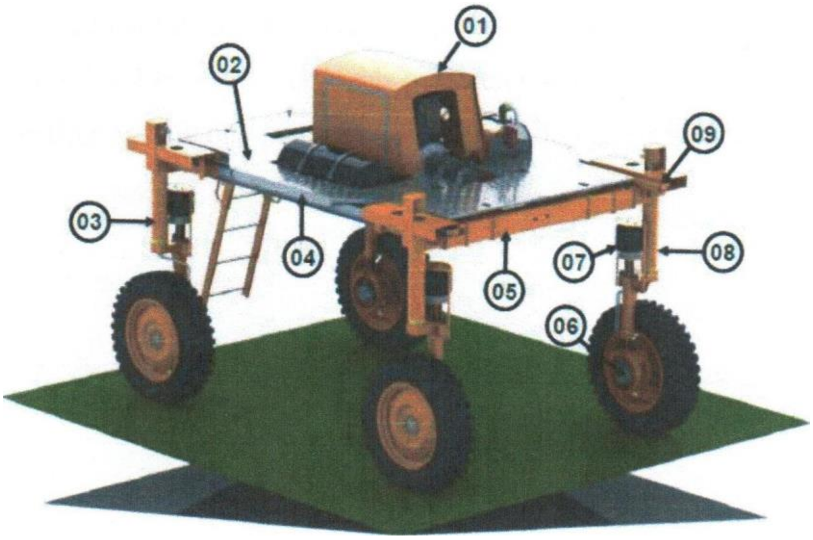


Figure 5 robotic platform [5}

In [6], developed an agricultural robot for crop seeding consisting of two parts, namely a mobile base for robot movement and a seeding mechanism attached to the mobile base for crop seeding g)

application. The mobile base has a four-wheel design for ease of movement on uneven terrains, **while** the seeding mechanism uses the concept of a crank-slider to continuously inject seedlings into the ground. The crank-slider mechanism is also attached to a seedling dispensing mechanism consisting of a circular plate with a scoop inside a seedling storage container attached to the robot.

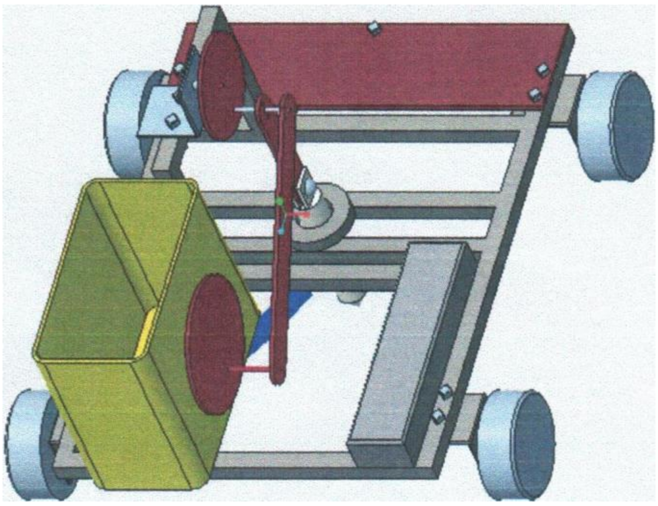


Figure 6 Agricultural robot for seeding [6]

2.2 Low Pressure Pumps

In [7], a designed and developed a pendulum operated water pump which consisted of a frame housing all the rigid links, a pendulum with suitable counter weight, main lever supported by two pedestal bearings, oscillating mechanism, reciprocating pump, piston, cylinder and spring.

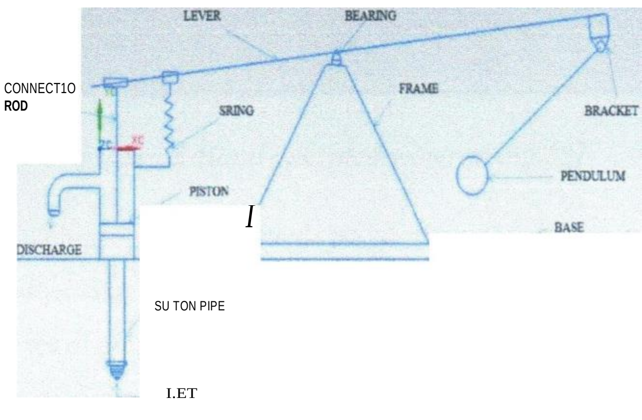


Figure 7 Pendulum operated hand pump [7]

[8]. designed and developed a hand operated water pump that consisted of a pump chamber, cylinder pipe, connecting rod, crankshaft, pulley, junction box, suction pipe, and the pump frame. The designed pump is similar to a treadle pump in terms of the working mechanism. It is designed in a way that it has check valves both at the entry and the exit with the chamber so **has** to prevent backlash.

Figure 8 Hand operated water pump [8 J

In [9], [10] Both developed an improved pedal powered water pump that included a transmission system consisting of chain drive, sprocket, pedal, gear, bicycle frame and wheel. The pump unit comprises of pump cylinder, piston, connecting rod, cylinder cap, seal, sprocket, rotating disc, shaft, bearing, bolt and nut, hub, pump frame, adjuster and column stand while the piping system consist of the inlet and the outlet valves.

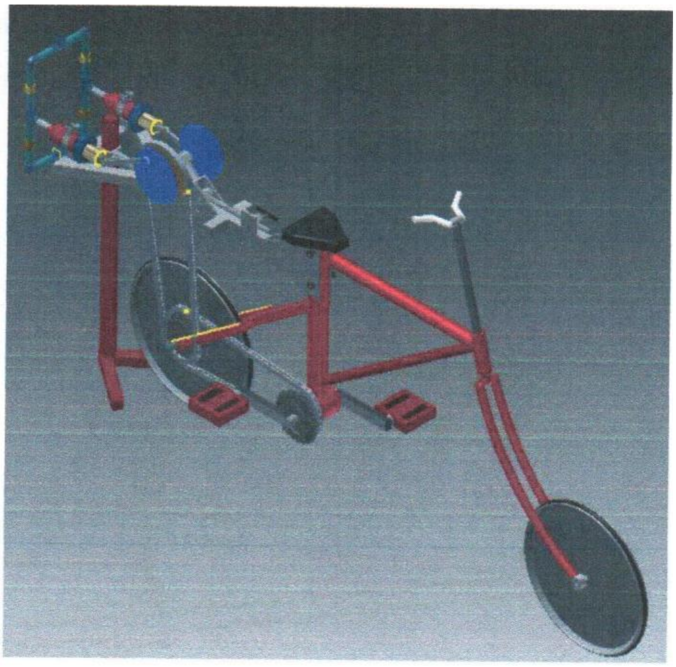


Figure 9 improved pedal powered water pump [9}

In [11], [12] developed a lightweight manual piston pump operated by human power consisting of a handle, pump chamber, piston, check valves and an end cover plate.

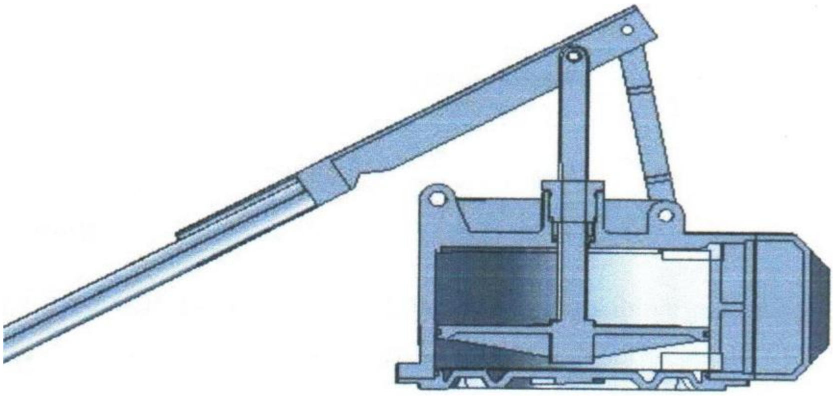


Figure 10 Manual piston pump [11}

According to Kwamie, a treadle pump is a type of foot operational pump having a single acting double cylinder pump for low lift irrigation. The design of the pump consists of two metal cylinders with pistons operated by the natural walking motion on two treadles. A treadle pump usually consists of two cylinders appropriated with one piston each and some means of reciprocating the pistons up and down inside the cylinders. Pipes connects the pump through i)

to the source of water and a check (non-return) valve is attached at the pipe end to allow entry of water into the pipe and prevent water from backward flow into the source.

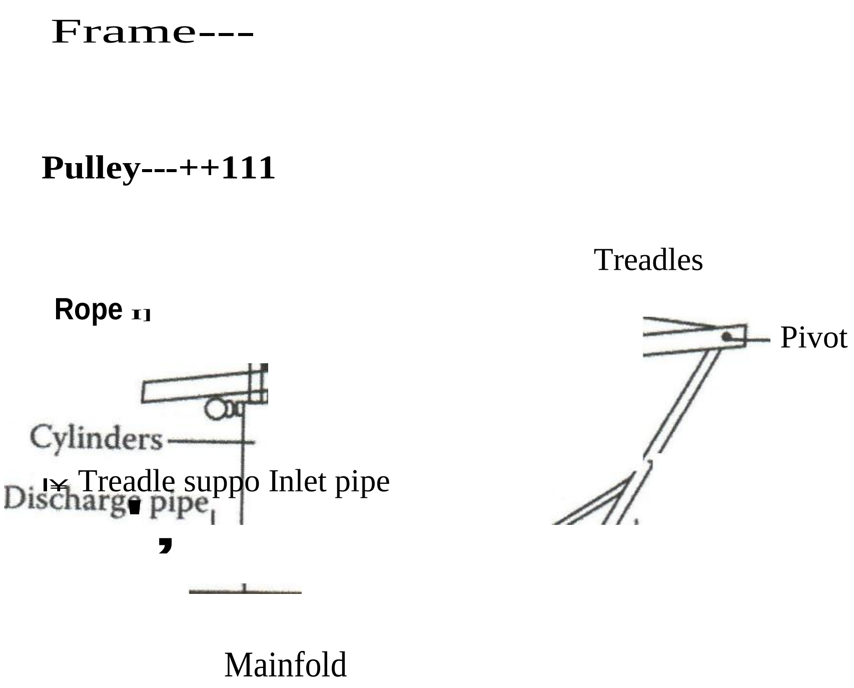
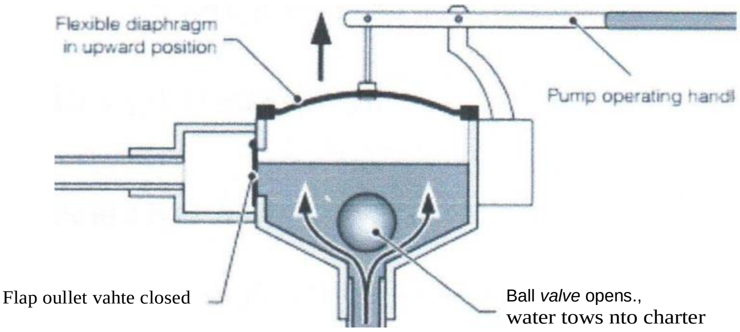


Figure 11 Design of a treadle pump

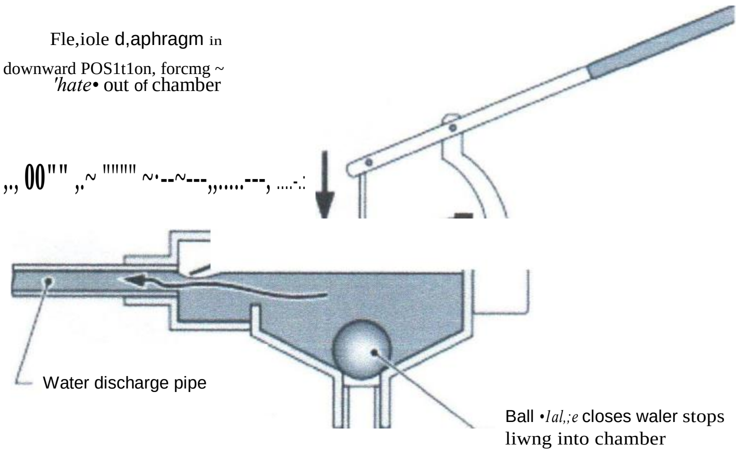
Diaphragm pump:

They operate by use of an expandable diaphragm in the submerged pump cylinder to push water up and out of the rising main when pressure is increased by means of a mechanism such as a foot pedal (Stewart, 2003). Diaphragm pumps use a flexible diaphragm to achieve pumping action. The input shaft drives an eccentric through a worm and gear. Rotation of the eccentric moves the diaphragm on the discharge stroke by means of a push rod, taking the water in through an inlet valve and forcing it out through an outlet valve.

k)



Upward movement



Downward movement

Figure 12 schematic view of a Diaphragm pump

Therefore, in the above review, there is no design that has been developed to supplement water for drip irrigation. Hence there is need to design a mobile water supply system for drip irrigation.

l)

CONCEPTUAL DESIGN

3.1 Conceptual Design Description

3.1.1 Proposed System Overview

In this design, it incorporates the use of solar energy that is used to generate electrical power for the water pump. The machine consists of four fixed wheels, four ball bearings, a water storage tank, 12V battery, solar charge controller, De water pump and the movable cart.

Therefore, the proposed conceptual design of the mobile water supply system for drip irrigation is implemented using Solid Works software as shown in Fig 13.

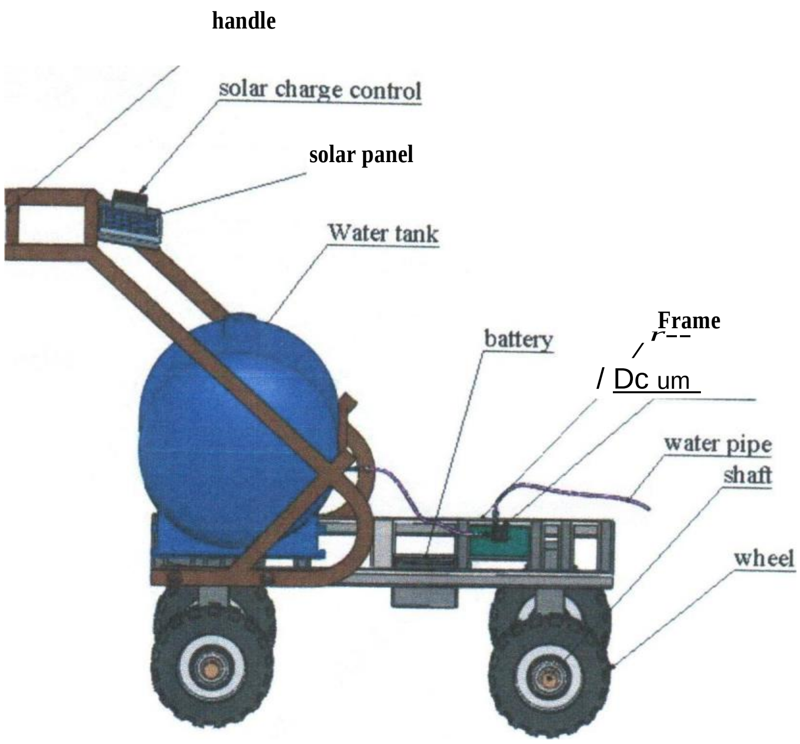


Figure 13 Mobile water supply system for drip irrigation

3.1.2 Mobile Platform

The mobile platform is the supporting structure, to which all components of the system are attached as shown in figure 14. The handle and four wheels are all mounted on to this platform. It is made using 40mm by 40mm mild steel hollow sections joined together to form a rectangle ñ)

- ~ by 600mm. The wheels use the Ackman steering mechanism to perform their operations.

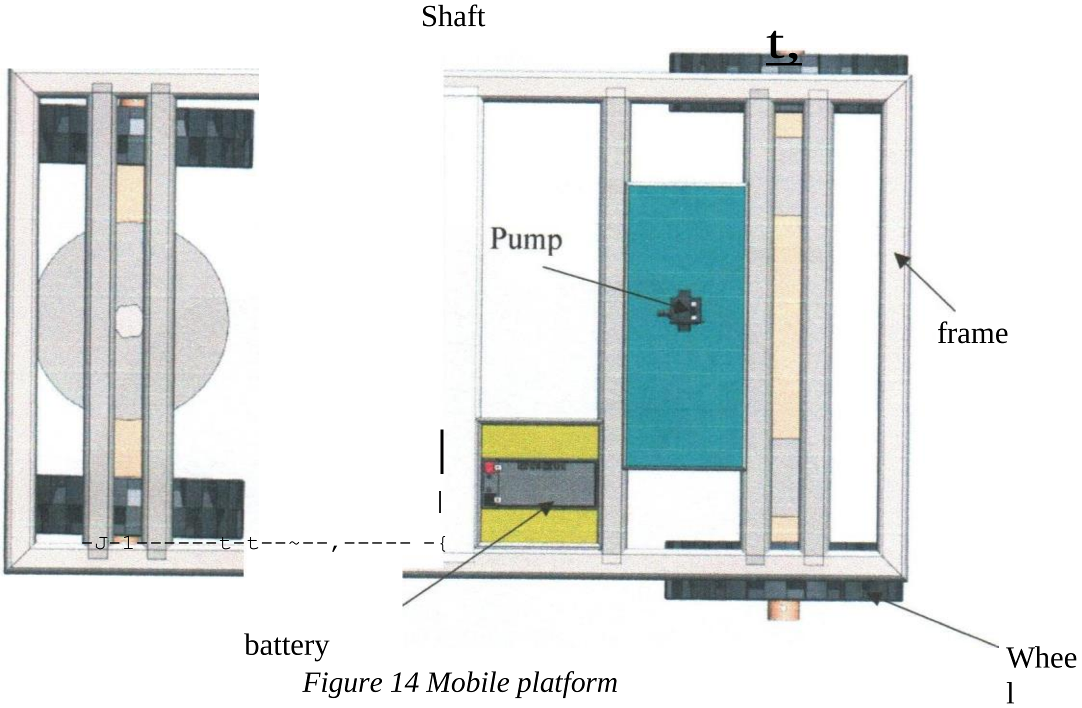


Figure 14 Mobile platform

3.1.3 The Bandle

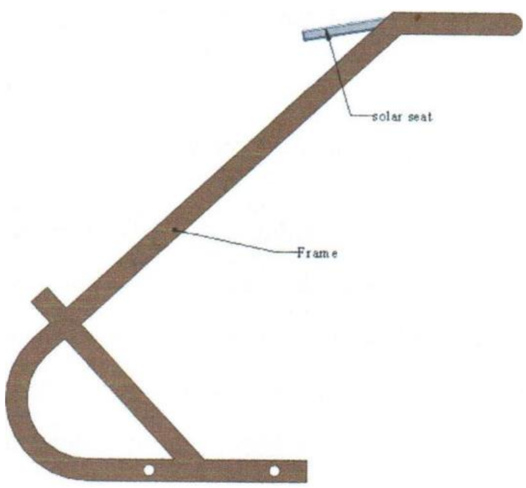


Figure 15 Handle

he figure above, it illustrates the front view for the handle used to move the mobile water supplysystem. The handle is mounted at the end of the mobile platform and its tightened using bolts to make it fixed thus providing support for movement.

3.1.4 Water Storage System

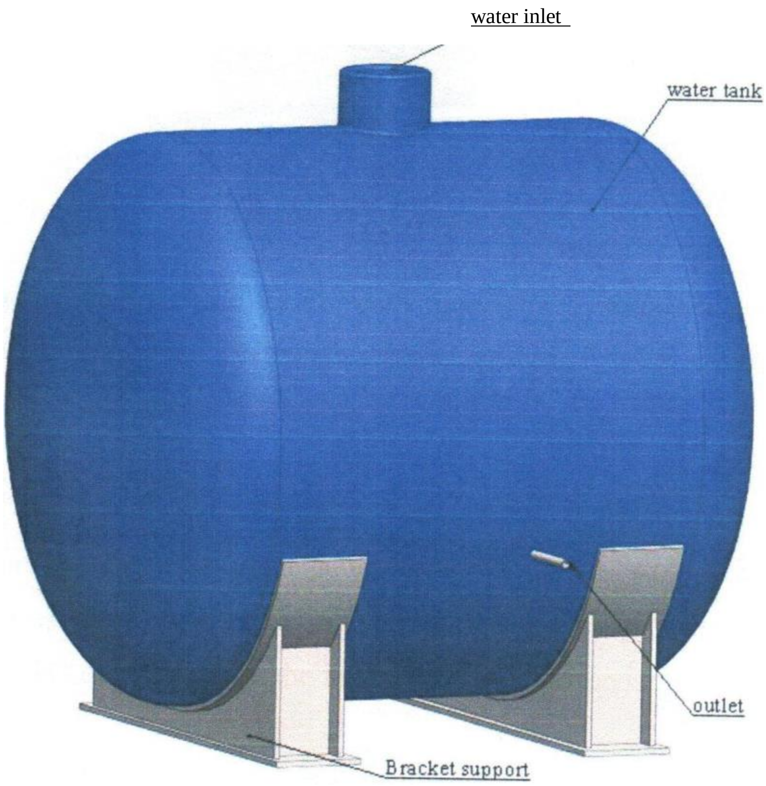


Figure I 6 Water storage tank

The water storage system consists of two components i.e., the water tank and the Bracket that provides support for the water tank. It has one outlet pipe used for refilling water into the tank and the outlet pipe that connects to the horse running to the driplines within the garden. The capacity of the designed water storage system holds about 40 litres of water since drip irrigation is a low pressurized type of irrigation.

3.1.5 Brushless De Water Pump

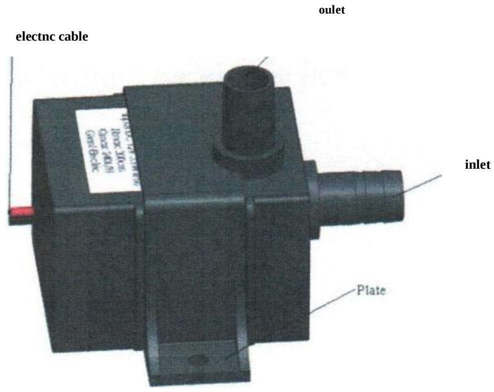


Figure 17 De Water pump

The brushless water pump is made out of plastic material and consists of a plate, an inlet and an outlet pipe as shown in Error! Reference source not found.7. It has a maximum water head of 300mm and its power rating is 3.6 watts.

3.2 Working Principle

The mobile water supply system can be moved from one place to another with the help of the four translational wheels that are driven by the help of ball bearings. The mobile water supply system is moved TO and FRO with the help of an operator since its operated manually by pushing it.

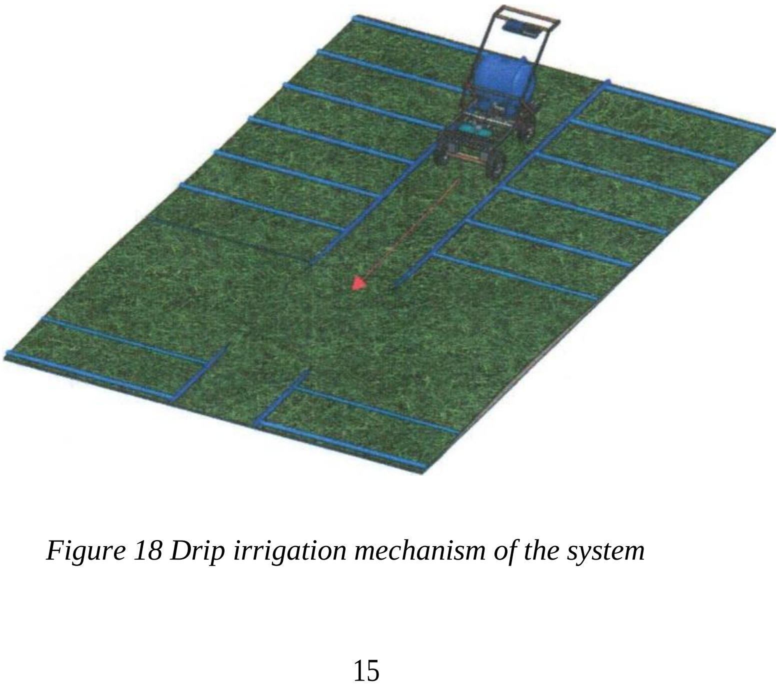


Figure 18 Drip irrigation mechanism of the system

When the movable cart is in position, the outlet pipe from the Dc water pump is connected to he driplines in the garden as shown in figure 18. The pump is connected to a solar pump that provides power for pumping the water into the driplines. Once everything is in place, the pump is turned on using a switch that controls the electric flow.

DESIGN

4.1. Design Considerations

The machine is designed and fabricated with the intentions to perform in the following capacity:

a) To delivery water to the drip lines.

b) To transport the water storage tank.

c) Required capacity of the machine; It should have high capacity and be able to reduce labour requirements compared to other methods in current use.

d) Portability and ease of operation of the machine; It should be simple in design and able to perform different functions.

e) The material used for the design of the machine; It should be fabricated from readily available materials most of which should be locally sourced; fabrication materials should possess ability to withstand corrosion, wear and tear.

o) The overall cost of the machine should be cheap and within the purchasing capacity of small-scale farmers.

4.2. Design Specifications

These specifications under-listed spell the various performance characteristics of the system. Below are the pre-design or set values:

1. Capacity of the system (volume of the storage tank): 20 Itrs (0.02m^3)
2. Size (dimensions) and power ratings:
    a) Total length and width of the system: 900mm by 600mm
    b) Diameter of tanks: 500mm
    c) Capacity of the pump: maximum flow 240L/H, maximum head 3.0m, power rating 3.8W and voltage is 12V.
    d) Solar battery ratings: 12V and 7AH/20Hr

4.3 Solar PV Sizing

4.3.1. Solar Insolation on a Surface

Solar isolation refers to the amount of energy in kilowatt received inform of a light photon on the earth's horizontal surface from the sun. The average global horizontal insolation of the world is given in kWh/year and PSH/day. According to solar radiation data on availability of direct solar radiation that reaches the earth's surface in Uganda, 5-6KWh/m radiation per day is received. This insolation is highest at the Equator, but varies up to a maximum of 20% from place to place away from the Equator. It is highest in the dryer areas (north-east) and lowest in the mountainous areas (south-west) of the country. Taking into a consideration of 7 hours for

the design; The daily insolation for 7 hours is calculated as /, = *0.857KWh/m°*

Therefore, the instantaneous insolation on the surface can be taken as 0.857 KWh/m^2

4.3.2 Size of Solar Receiver

A flat plate solar collector consists of a transparent cover and an absorber at the bottom known as photovoltaic cells[13][14]. It is positioned when it is tilted and oriented in such a way that it receives maximum solar radiation during use. Choosing a flat plate type, its area and length are obtained as follows;

Total load = **Load x no. of hours**

$$\text{Size of the panel} \quad \frac{\textit{Power generated from panel}}{\textit{Panel generation factor}}$$

4.3.3 Sizing of Charge Controller

According to standard practice, the sizing of charge controller is to take the short circuit current of PV array and then multiply by the safety factor of 1.3 In sizing the capacity of the charge controller, it is as follows;

$$\text{Size of the charge controller} = \frac{\textit{Panel rating}}{\textit{battery Voltage}} \times \textit{safety factor}$$

$$\text{Number of charge controllers} = \frac{\textit{Charge}}{\textit{Capacity of the xharge controller}}$$

4.3.4 Sizing of Battery

The battery stores energy for later use. In solar PV systems Lead-Acid batteries are recommended because they are specifically designed to be discharged to low energy levels and rapid charged to high energy levels daily for some good number of years. In sizing the capacity of the battery, it is as follows;

B tt 't *Total watt-hours per day usedxdays of autonomy* di ['IV ==
0.85x0.6xnominal battery voltage

N b · d d f b tt *load rating amp-hour* um,er o a{er1es nee(e'
Amp-hour

4.4 Design of the Shafts

A shaft is a rotating machine element used to transmit power from one place to another. The power is delivered to the shaft by some tangential force and the resultant torque (or twisting moment) set up within the shaft permits the power to be transferred to various machines linked up to the shaft. The shaft adopted to this design was a transmission shaft which has a ball bearing attached to its ends. The design of the shaft was based on the strength, rigidity and stiffness. The following stresses are induced in the shaft:

- Shear stress due to the transmission of the torque
- Bending stress due to the forces acting on the shaft (the weight of the components seated on the mobile frame)

4.4.1 Shaft Diameter

In designing the adequate shaft diameter that can withstand the stresses that acts on them, considerations would be made for the various stress conditions. The larger diameter would be chosen.

For a shaft subjected to twisting moment (or torque) only, then the diameter of the shaft may be obtained by using the torsion equation.

According to KHURMI & GUPTA, 2005,

$$\frac{T}{J} \quad \frac{\tau}{r}$$

Where;

- = *twisting moment* (or *torque) acting upon the shaft* (Nm)ent or torque acting upon the shaft

Nm

J = *polar moment of inertia of the shaft about the axis of the rotation* (m^4) of

inertia of the shaft about the axis of the rotation m4

τ = *torsional shear stress* (pa)ear stress pa

r = *distance from the neutral axis to the outer most fibre* (m)m the neutral axis to the outer most

fiber m

but $r = \frac{d}{2}$ *where, dis the diameter of the shaft* (m)

For a round solid shaft, the polar moment of inertia is given as;

$$J = \frac{\pi}{32} \times d$$

Therefore, $T = \frac{\pi}{16} \times \tau \times d^3$

For a shaft subjected to bending moment only, the maximum stress (tensile or compressive) is given

by the bending the equation below;

$M\ O\ I\ y$

Where;

M = *bending moment* (Nm)nt Nm I =

moment of inertia of cross -
sectional area of the shaft about the axis of rotation (m)ertia of cross-sectional area

of the shaft about the axis of rotation m4

σ_b = *bending stress (Pa)*

y = *distance from the neutral axis to the outer most fibre* (m)m the neutral axis to the outer most

fibre m

For a round solid shaft, the moment of inertia is given as;

$$I = \frac{\pi}{64} \times d$$

The bending moment, *M*

$$M = \frac{45}{1[} O x d°$$

For shaft subjected to combined twisting and bending moment, the maximum shear stress theorem is applicable. From this theory, the maximum shear stress in the shaft is;

The allowable or working shear stress can be given by the expression;

$$r''''' \frac{16}{Fas\ rrd^3} \sqrt{M^2 + T^2}$$

Where;

τ = *working shear stress (Pa)r* stress Pa

τ_{ma} *maximum allowable shear stress (Pa) Fos* =

factor of saf etysafety

The maximum normal stress theorem, the maximum normal stress in the shaft is,

$$er = \frac{-}{Fos} = \frac{16}{rrd^3} \frac{M + \sqrt{M^2 + T^2}}{2}$$

Where;

σ_{max} = *maximum normal stress (pa)*

er = *working normal stress* (pa)al stress pa

4.4.2 Deflection of the Shaft

For the angular deflection of the shaft,

$$\frac{0}{L} = \frac{T}{JG}$$

Where;

0 = *angular def le ct ion* (rad)ection rad

G = *modulus of rigidity* (*N*/m?)igidity N/m'2

4.4.3 Equivalent Torque and Bending moment

The equivalent torque, *Te* which the shaft is subjected to is given as;

$$T_e = \sqrt{M^2 + T^2}$$

The equivalent bending moment, *Me* was also given as,

$$M_e = \frac{1}{2}(M + T)$$

4.5 Handle Design

Diameter of the handle was obtained from bending consideration

P = ²h *rd of its length* ***(l)***

Maximum bending moment

2l M= Px 3

$$= \frac{2}{3} \times P \times l$$

Section modulus, *z*

z = xᵀxdd 32

Where;

d = *diameter of the handlethe* handle

Turning Moment;

=*a*,xz=*o*45*d*ᵀ

Where;

ab = *Permissible bending stress for the material of the handle*

Equating that resisting moment to the maximum bending moment

$$45\underline{d}^{n}==;Pl^{2}$$

a–[($OO°4 3xIxO

But, $o, = 0.66F,$

Where; $F_{,,}$ = *yield strength of the material*

Calculating for the maximum principal and shear stresses, the equations below were used to calculate the maximum principal and shear stresses.

Maximum principal stress, <lbmax

$$\sigma_{bmax} = \frac{1}{2}\left[\sigma_b + \left(\sqrt{(\sigma_b)^2 + 4\tau^2}\right)\right]$$

Maximum shear stress, *tax*

$$\tau_{max} = \frac{1}{2}\sqrt{(\sigma_b)^2 + 4\tau^2}$$

4.6 Mobile Platform

In the design of the machine, the force exerted on the machine includes all the loads due to the water storage tank, handle, solar panel, motor pump. This frame is designed for stability and strength so as to accommodate all that weight.

To determine whether the hollow sections of mild steel material selected to construct the machine frame support the weight of its content without fail, the compressive stress on each position of the frame was estimated, Therefore the compressive stress on the mobile platform

$$cry= \frac{F}{A}$$

Where F is the total force due to the load of the components supported by the mobile platform p)

IMPLEMENTATION

The machine can easily be operated by a person with little or no knowledge thus it doesn't require a user manual for instructions on how to operate the machine.

Therefore, I do recommend its usage in the Agricultural sector since its water consumption is lowest as compared to the existing technologies of drip irrigation.

Figure 19 fabricated working protype

RESULTS AND DISCUSSION

6.1 Introduction

This chapter contains the discussions and the results of the project that was carried out. It gives a detailed description and discussion of the data acquired during the research in line with the specific objectives and therefore conclusions in the next chapter were drawn accordingly.

6.2 Size of Solar Receiver

Total load = **Load x no. of hours**

= *3.6W* x *7hrs*

= **25.2W**

Power needed from panel **=Total load x Energy loss factor** =

25.2W x 1.3

= *32.76W*

S . f th l *Power generated from panel* IZ? 0] [Dane]
Panel generation factor

= 32.76/3.33 =

9.84W

Therefore, size of the panel chosen is **10 W** power rating

$$\text{Number of panels} = \frac{\text{Total watt-peak(Wp) rating of the pv modules}}{\text{module peak rating}} = \frac{10}{10} = 1 \text{ pane}$$

6.3 Sizing Of Charge Controller

According to standard practice, the sizing of charge controller is to take the short circuit current of **PV** array and then multiply by the safety factor of 1.3 In sizing the capacity of the charge controller, it is as follows;

$$\text{Size of the charge controller} = \frac{\text{Panel rating}}{\text{battery Voltage}} \times \text{safety factor}$$

$$= 10.8A$$

Therefore, size of the charge controller chosen is= 20A

Number of charge controllers= $\frac{Charge}{Capacity\ of\ the\ xharge\ controller}$

$$= 10/10$$

$$= 1\ charge\ controller.$$

6.4 Sizing of Battery

The battery stores energy for later use. In solar PV systems Lead-Acid batteries are recommended because they are specifically designed to be discharged to low energy levels and rapid charged to high energy levels daily for some good number of years. In sizing the capacity of the battery, it is as follows;

Battery capacIty= $\frac{Total\ watt\text{-}hours\ per\ day\ used \times days\ of\ autonomy}{0.85 \times 0.6 \times n0minal\ battery\ voltage}$

$$= \frac{20 \times 2}{0.85 \times 0.6 \times 12}$$

$$= 6.54AH$$

Therefore, size of the battery chosen is 7*AH* Using

a battery of 7amp-hours

Number of batteries needed = $\frac{load\ rating\ amp\text{-}hour}{Amp\text{-}hour}$

$$= \frac{7Ah}{7\ Ah} = 1\ battery$$

6.5 Discussion

The Mobile water supply system for drip irrigation study shows that it could be used for small scale rural farmers who lack proper means to carry out modernized drip irrigation, since the results obtained from the solar sizing are for a small machine set up.

CONCLUSION AND FUTURE WORK

7.1 Conclusion

The project was aimed at designing and fabricating a mobile water supply system for drip irrigation for small scale farmers and also for research purposes. The components assembled together to form the machine include the DC motor pump, solar panel, charge controller, battery, frame, wheels, ball bearings and water storage tank. As primary design requirement, the proposed machine design can automate and perform the movement and it uses solar energy to recharge the battery.

The machine is easy and safe to operate, has a low energy consumption rate and does not pollute the environment and its time efficient. Having successfully taken into consideration the different loads carried by the frame, failure modes of each component, tests for the maximum crushing stresses and the case studies considered proved that the machine was excellently packaged and it could be used in solving problems related to irrigation.

7.2 Future Work.

For future designs on the machine, I recommend the use of a De motor with a higher water head of about 30 meters.

The wheels for transportation should be incorporated with actuators for easy moving of the machine from one field to another in the future designs since these operations of each wheel are done autonomously.

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APPENDICES

Appendix A

Table 1: Budget

No.	ITEM	UNIT COST(UGX)	QUANTITY	TOTAL COST(UGX)
1.	Bearing	10,000	5 rolls	50,000
2.	Square hollow section (40 x 40)	50,000	16ft	50,000
3.	Square hollow section (25 x 25)	40,000	12ft	40,000
4.	Wooden wheels	15,000	4	60,000
5.	Nails	3000	1/4kg	3,000
6.	Rubber	5,000	4 rolls	20,000
7.	Hollow pipe (4cm diameter)	40,000	8.5 ft	40,000
8.	Hollow pipe (1 inch)	26,000	12ft	26,000
9.	Water pipe	2000	3m	6,000
10.	De motor pump	52,000	1	52,000
11.	Solar battery	35,000	**l**	35,000
12.	Charge controller	20,000	1	20,000
13.	Solar panel	35,000	1	35,000
14	wires	2000	3m	6,000
15.	Paint	20,000	500ml	20,000
16.	Travel expenses			50,000

17. Miscellaneous			200,000
Total			**713,000**