ENHANCEMENT OF IRRIGATION PRACTICE IN BIRNIWA – TASHA VILLAGE OF JIGAWA STATE

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ABSTRACT
Agriculture is a fulcrum of any nation economic and technological development. Development of any country in an absence of agriculture with particular reference to irrigation system is very slim. Irrigation can be made possible, simple, efficient and effective in the Sudan savanna especially in an area where the static water level is not more than twenty five (25) meters; Most of the water pumps available in the Nigerian mark et have total head of twenty five (25) meters with maximum suction head of 8.5 meters. Going by the data available the researcher have fabricated a device that can be use to lift water from depth that is greater than eight and half meters (8.5m) but less than twenty five (25m) meters for irrigation with this available pump. The device is fabricated in segments, each segment is one meter long, it is constructed in this manner to suit different depths of static water level. The number of segments to be used is determined by the depth of the static water level of the borehole. The device is tested in a borehole of twelve (12m) depth and found to be efficient and effective for irrigation in an area where the static water rest level is more than 8.5 meters depth.
KEYWORDS: Sudan Savanna, Suction Head, Total Head, Lift Head, Borehole and Water rest level

INTRODUCTION

Agriculture is the main occupation of Jigawa state people, but most of them only farm in rainy season, due to non availability of adequate water for irrigation. This is as a result of static water level depth of the drilled wells in the Sudan savanna particularly Birniwa – Tasha village, are more than 8.5 meters. Most drilled wells within Birniwa Local Government of the state are between thirty six (36m) to forty six (46m) meters depth above the sea level, which means the normal water pump, cannot be used to draw water from this distance for effective, efficient and reliable irrigation system. Hadejia – Jama'are River Basin Development Agency (Nigerian Government Agency) assisted Birniwa – Tasha village with one hundred (100) washbore wells and gasoline water pumps for irrigation system, but they cannot be properly utilized for the purpose as a result of the wells static water level been measured to be twelve (12m) meters deep.

A borehole was drilled as a substitute for the washbore and a 2m x 1m x 4m (length x breadth x deep) rectangular hole was excavated. Centrifugal pump is put four (4m) deep and gasoline engine is placed at ground level, the two were connected together by mean of power transmitted device, which transmit power from the engine to the pump. The specification data on available centrifugal

water pump in Nigerian market shows that, the pump can only draw water (suction head) from a distance not more than 8.5 meters and discharge water (delivery head) to a distance not exceeding 16.5 meters. By implication it means the pump cannot be used in an area where the static water level of the well exceeded 8.5 meters. This fabrication made it possible, simple, efficient and effective to use the pump even if the static water level of the well exceeded 8.5 meters but less than 25 meters total head. The pump when assembled with fabricated power transmission device can be use in lifting water of vertical height (suction head) above 8.5 meters below the pump and less than 16.5 meters above the pump for irrigation system in Birniwa – Tasha village of Birniwa Local Government, Jigawa State, Nigeria. The device is constructed to suit different static water level of the borehole for irrigation system and other usages in the State and its neighboring localities. Therefore boreholes could be constructed in this area for the purpose of using the fabricated device to find a solution to the existing problem, which will make irrigation possible, effective and reliable in the Sudan savanna particularly in Birniwa local government of Jigawa State.

The fabricated device is so flexible that it can be connected to different devices of power e.g solar, gasoline engine or electric motor depending on which system best suit the user's choice, but for this fabrication the solar power system was adopted. The fabricated equipment can be used to boost irrigation system in an area where the borehole static water level is not more than twenty five (25m) meters deep, thereby creating employment and reduce poverty for the people of the state and irrigation would now be all year round. The main objective of this research is to fabricate a power transmission device that can enable the available water pump in Nigerian market be used for irrigation system in Birniwa – Tasha of Birniwa Local Government in Jigawa state.

IRRIGATION SYSTEM

Irrigation is a system of supplying a piece of land with water by means of artificial canals, ditches, etc, for the purpose of promoting the growth of food crops. When water supplies are adequate, irrigation can increase crop yield dramatically. Different irrigation systems are suited to different soils, climates, crops and resources. There are three main types of irrigation systems: surface, overhead and drip. In this research work surface irrigation is used, irrigation refers to systems that deliver water to crops using a gravity-fed, overland flow of water (Benjamin, 2019)

The heart of most irrigation systems is the pump. To make an irrigation system as efficient as possible, the pump must be selected to match the requirements of the water source, the water distribution system and the irrigation equipment. There are many types of water pumps used in irrigation systems; such as floating, booster and turbine, submersible, centrifugal and displacement pumps. In this work the centrifugal pump is used as a means of drawing water from the well and delivers it to the channels for irrigation. (Staff Reporter, 2018)

SUDAN SAVANNA

The Sudan *Savanna* is a broad belt of tropical *savanna* that runs east and west across the African continent, from the Atlantic Ocean in the west to the western lowlands in the east. Nigerian Sudan Savanna Zone is situated between latitudes 9°3' and 12°31' N and longitudes 4° and 14°3' E which covers about 22.8 million hectares representing about one quarter of Nigeria's geographical area (Wikipedia 2019). The Sudan's mean annual rainfall varies between 10 inches (250 mm) in the north and 60 inches (1,500 mm) in the south, with the hottest months usually from June to September and with a pronounced, and often very prolonged, dry season. Temperatures are generally high throughout the year. Vegetation ranges from semi desert steppe and thorn scrub near the Sahara through vast grass plains, loosely termed savannas, to parkland country where low trees grow among tall grasses, and savanna forest that merges ultimately into equatorial rain forest (Daniel, 1983)

During dry season; the trees shed their leaves all the largest rivers run dry, and brush fires that burn up the grass are common. The rainfall might be adequate for cultivation where it is not for the very high rate of evaporation, which makes irrigation essential in many areas. The drawing below shows the sudan savannah region in the African continent.

Figure 1. The Sudan Savanna region. Source: Based on White 1983.

BOREHOLE CONSTRUCTION

The borehole was constructed using the jigging method, the depth of the well is thirty (3m) meters and the diameter is four (4 inch) meters. Six (6) PVC casings were used and four (4) PVC screens were used at the bottom of the well, the last bottom screen was sealed at the lowest end to prevent back filling of the borehole as the area is more of sandy soil. This is shown in the figure 2.

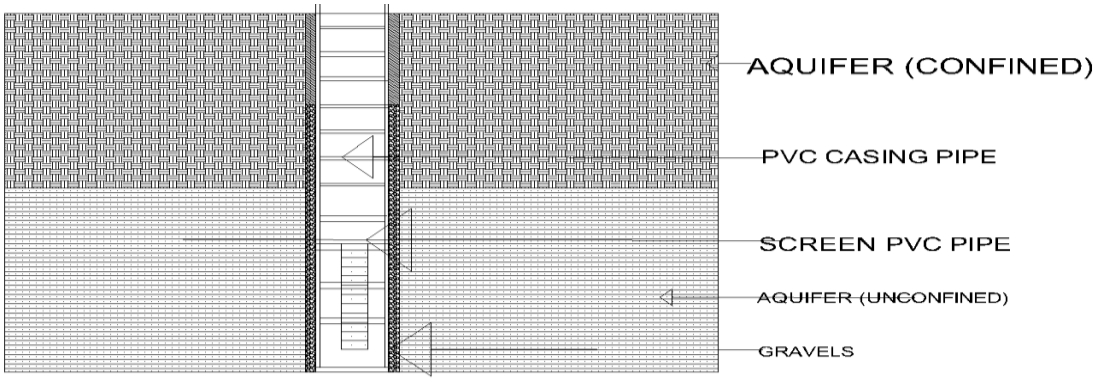

Figure 2: Drilled Borehole. Source: Author

DESIGN AND CONSTRUCTION OF PUMPING UNIT

To provide a means by which the assisted equipment from Hadejia – Jama'are River Basin Development Authority (H – J. R. B. D. A.) can properly and effectively be used for irrigation in Birniwa – Tasha village and its neighboring localities, the researcher designed and fabricated the pumping unit for the purpose of addressing the problem of static water level of the constructed borehole so that the equipment can be utilized to burst irrigation and create job, thereby reduce or eradicate poverty in the village. The construction process is in stages, which include:

Solar Power System

The fabricated pumping equipment is intended to be used only in the day time, which means only four solar array panels of 300watts as shown in figure 3 below, each were needed to power the D. C. motor. The power is controlled by the use of an automatic switch.

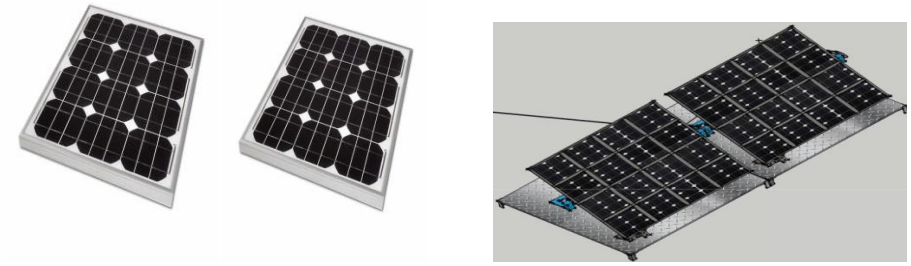

Figure 3: Solar Array Panels. Source: Author

Direct Current (D. C.) Motor

The direct current motor is the source of mechanical power that rotates the pump. It uses direct current energy produced by the solar array panels to rotate the armature which in turn rotate the spindle. The spindle is connected to the pulleys and transmits power to centrifugal pump through belts. The pump capacity needed for the pumping is 24V 1000W.

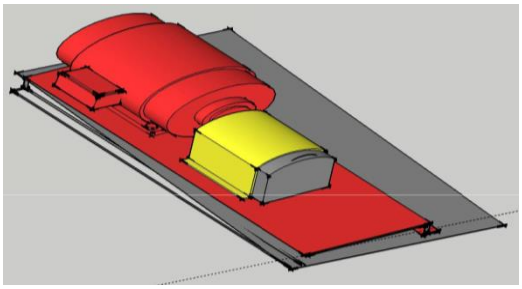

Figure 4: Direct Current (D. C.) Motor **b) D.C. Motor connected to pulley**
Source https://www.alibaba.com/showroom/1-hp-12v-dc-motor.html

The Centrifugal Pump

The centrifugal pump (Fig. 5) is the unit where pressure is created for the purpose of drawing water from a distance that is below the pump (suction head) and lift it above the pump discharge/delivery head. Total of these quantities is referred as total head (maximum head). The suction head is the maximum vertical distance the pump can lift water from below (8.5m). Discharge head is the vertical distance the pump can push water above it (16.5m) while the total head is the vertical distance the pump can lift water below plus above (25m). The available pump in the market is WP20X and is what the fabricator intends to use for the work. Figure 5 indicates how the speed and torque can be altered by changing the diameter of the pulleys to suit the purpose, from this arrangement a speed decrease is attained at the second drive system, this because the driver pulley diameter is smaller than the driven pulley diameter.

Figure 5. Centrifugal water pump

Source:https://www.pentair.com/en-us/products/business-industry/agricultural-products/agricultural-irrigation/berkeley-b-series-frame-mount-centrifugal-pumps.html

Power Transmission Device

Solar and wind source of energy are among the alternative way from which a mechanical motion can be obtained to drive a centrifugal pump for constant water supply for human consumption and for irrigation purposes. The power transmission device is a fabricated segment of transmission unit (fig. 6 and 7) that enable power to be transmitted from one segment to the other by sets of pulleys and belts, which finally make it possible to transmit power from the power unit (D.C. motor) to the pump and achieved delivery of water to the required place. It is also through this means that water can be drawn (Suction head) from a borehole and discharge it (lift head) for irrigation. With the absence of fabricated equipment irrigation cannot be possible due to the water static level of the area. The number of transmission unit segment to be used for each system depends on the static water level of the borehole for irrigation. The exploded view of the fabricated transmission unit is shown below.

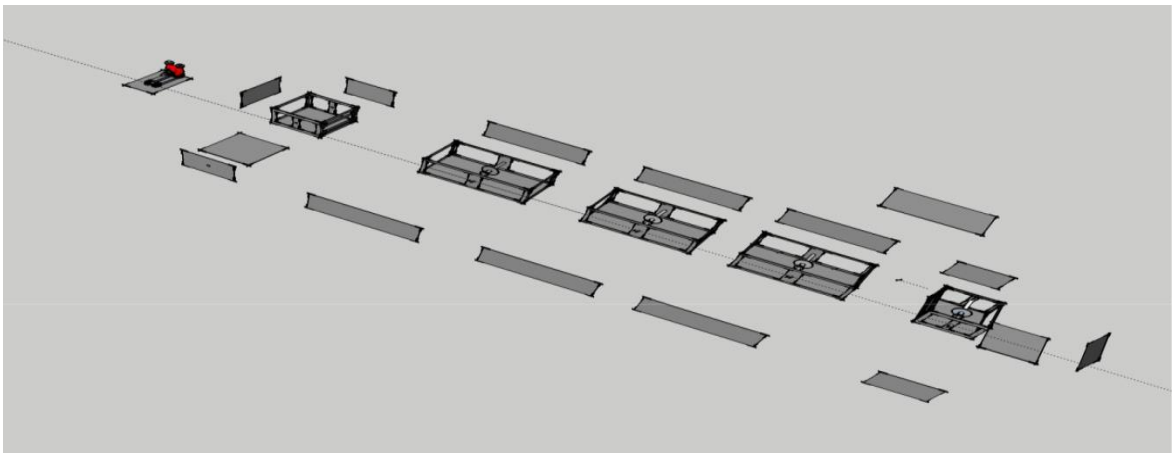

Figure 6: Exploded view of Power Transmission Unit. Source: Author

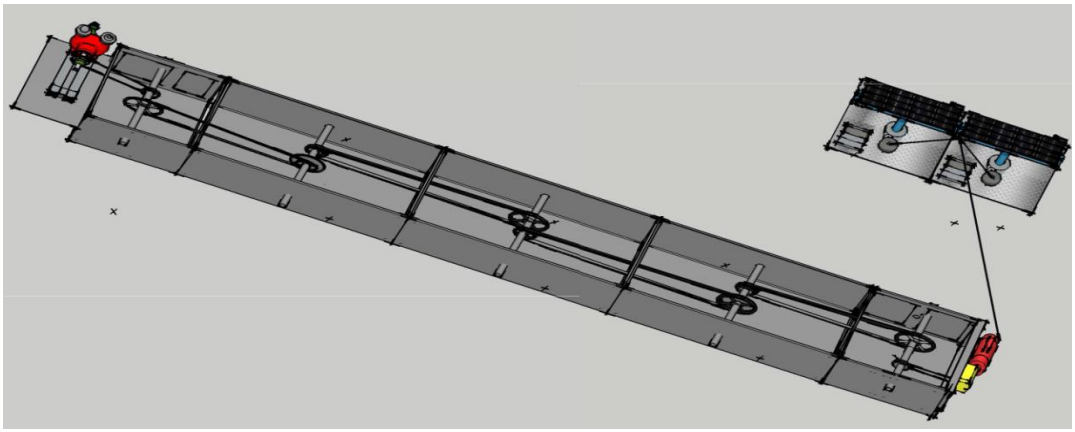

Figure 7: Assembled pumping equipment. Source: Author

Drive System

The power is transmitted from one shaft to the other by means of belts, chains and gears. The belts and ropes are flexible members which are used where distance between the two shafts is large. In this type of fabrication a stepped cone belt drive device was used, the number of steps to be is dependent on the speed and torque variation required. The belt drive is adopted because of the following advantages it possesses:

- Belt drives are cost-effective. New belt drive efficiency can be up to 95-98 percent
- They are simple to use
- Belt drives do not require parallel shaft
- They have low maintenance cost
- They come with overload and jam protection
- Different speeds can be obtained by means of step or tapered pulleys
- When the distance between shafts is very large, belt drives are the most economical options
- Damp out noise and vibration
- Load fluctuations are shock-absorbed, increasing the machinery life
- Clutch action can be activated by releasing belt tension

The fabricated device was purposely designed to be used for irrigation in an area where the suction head exceeded 8.5 meters but not greater than 25 meters which is the maximum total head of a normal available water pump in the market. Going by the above stated advantages of the belt drive arrangement, the researcher adopted this type of power transmission drive as shown in figures 8 and 9.

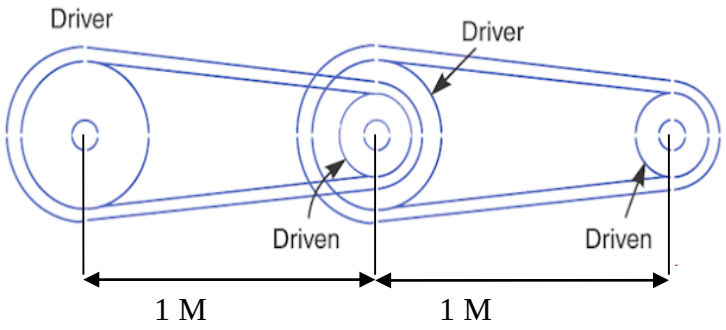

Figure 8: Double stepped pulley belt drive.

Source: https://www.engineeringchoice.com/what-is-belt-drive/

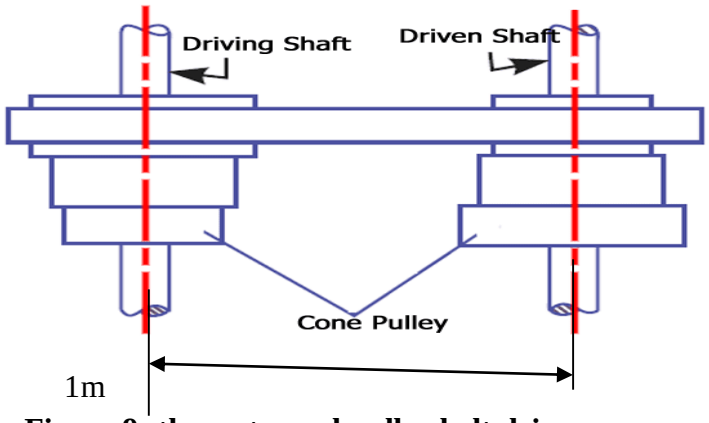

Figure 9: three stepped pulley belt drive

Source: https://www.engineeringchoice.com/what-is-belt-drive/

The volume of water drawn and delivered depends on the speed and torque at which the pump is rotated. Therefore a means by which the speed and torque can be altered must to be provided. It is a known law that speed is inversely proportional to the torque, which means the higher the speed the lower the torque. Three stepped pulleys in both the driver and driven are used: if a higher speed is required the larger diameter pulley in the driver will rotate the smaller pulley in the driven stepped arrangement. The opposite is employed if higher torque is needed. To obtain a drive ratio of 1:1, middle pulley in the driver will rotate a middle pulley in the driven stepped arrangement. At this power transmission processes no changes in both speed and torque occurred because the pulleys are of the same diameter as explained in figure 10.

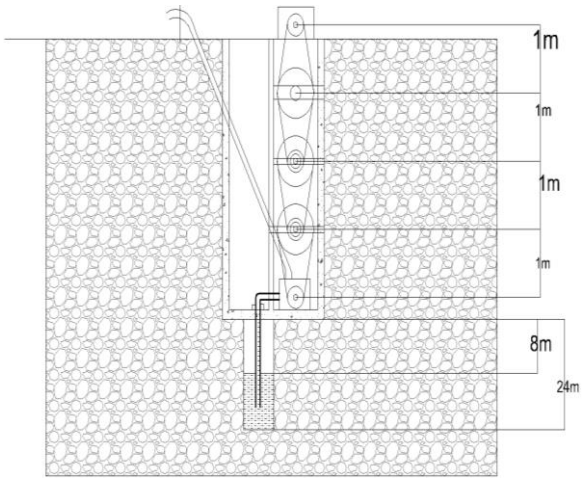

Figure 8: excavated borehole and assembled pumping unit. Source: Author

The static water level of Birniwa – Tasha village is measured to be twelve (12) meters depth while the available water pump can only draw (suction) water from a maximum distance of 8.5 meters

depth. Therefore to use the pump for irrigation four (4) meters depth has been excavated and power transmission device of this length was used. The pump and the power unit were connected using belt and pulleys; the distance between them is measured to be four (4) meters apart. The power unit is mounted at the upper part and centrifugal pump at the lower part of the power transmission device. They are connected by belts and pulleys, the torque and speed variations were achieved by changing the position of the belts, The D. C. motor and the pump speed have already been calculated and rated to be operated at a speed of 3600rpm. Going by this rating, alteration or change of speed and torque are required to a minimal.

RESULT

The assembled fabricated device in the modified/ excavated borehole is tested and found to be efficient, effective and reliable for irrigation and other usages, the discharge rate is measured to fill 25 liters of container in 9 seconds. Therefore aquifer discharge rate of the borehole is;
Aquifer discharge rate in liter/per second, a = 25 liters / 9 seconds **= 2.78 l/s**

The result indicates that the discharge of 2.78 liters of water per second with 2 inches pumping generator is adequate for irrigation in Birniwa – Tasha village of Jigawa State, Nigeria.

BENEFIT OF FABRICATING THE SOLAR POWERED PUMPING EQUIPMENT

Technical and economic benefit of fabricating the Proposed Solar Powered Pumping Equipment Includes:

1. Addressing the water shortage Problem in Birniwa – Tasha Village
2. It helps in bursting irrigation system in Jigawa and its neighboring States
3. It create job for Birniwa – Tasha indigenes and neighboring localities
4. It reduces/eradicate poverty and unemployment rate

CONCLUSION

Irrigation system in Birniwa – Tasha village of Birniwa Local Government of Jigawa State is very difficult due to water rest level of the drilled boreholes in the area. This is because the depth of the water rest level is between 12 to 15 meters depending on the location. The available water pumps in the markets can only draw water from a depth not greater than 8.5 meters, which is the maximum suction head of the pump. The research conducted reveals that , with this fabricated transmission unit it is possible to draw water at a distance between 12 to 15 meters depth of the static water level of a borehole using a pump of maximum suction head of 8.5 meters.

The fabricated pumping system is very flexible on the type of power sources to be used. Solar, A/C motor or gasoline engine can be use depending on which best suit the purpose. The system has assisted in boosting irrigation in the locality by making it all round and it reduce poverty level in Birniwa – Tasha.

RECOMMENDATIONS

The following recommendation/suggestion will be useful in creating employment and making farmers in this area to become self reliant:-

1. Jigawa State and Birniwa Local Government should encourage mass production of this system.
2. Training should be given to farmers in the state and Local Government Areas on operation, repair and maintenance of the system.
3. State in collaboration with Local Government should purchase the fabricated device and give it to farmers at subsidized price.

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