Solar Operated Maize Separator

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Abstract

The objective of this work is to construct a simple and affordable maize shelling machine that is powered by solar energy. The method adopted involves the selection of a direct current (DC) operated motor which consumes less power and is locally available. Based on the available motor, the mechanical part is fabricated to work with the motor. Chain drive power transmission method is adopted between the motor and the mechanical tool. he improvement in this work is the introduction of a sustainable and affordable powering method. Design calculation has suggested the use of a 20-watt solar panel. A battery of 18Ah capacity is used as storage. Test carried out on the maize separator machine shows that it has the ability to shell 24 kg of kernel in one hour. It has also been shown that the developed device has an efficiency of 97.56%. The total production cost of this sheller (together with the solar power system) is approximately eight thousand rupees (8000rs.).

Keywords—*Motor, Mechanical Tool, Solar Panel, Maize, Chain Drive, etc.*

I. INTRODUCTION

Corn is cultivated globally, being one of the most important cereal crops worldwide. It is, after wheat and rice, the most important cereal grain in the world, providing nutrients for humans and animals and serving as a basic raw material for the production of starch, oil and protein, alcoholic beverages, food sweeteners and more recently, fuel. In ancient days, people processed maize by hand to tear the skins of corn and take off the kernel by simple tools even by hand. Many farmers grow maize but could not afford the cost of acquiring some of the imported threshing machines because of their cost. Such people resort to manual means of threshing which results into low efficiency, high level of wastage and exerting of much labor. Corn threshing machine was constructed to shell maize and separate the cob from the grains. Large scale shelling for commercial purposes is not possible due to fatigue. Traditional shelling methods do not support large-scale shelling of maize. Hand shelling takes a lot of time, even with some hand operated simple tools. There are many machines which can shell maize, but these are usually unaffordable for rural farmers.

The hand shelling method usually involves using conventional finger–palm method for the removal of kernels by pressing it between thumb and palm. Some simple hand-held device has also been developed. These methods are tedious, painful and time consuming as it takes a lot of time before farmers complete the shelling of their maize. Beating by stick method usually result to damage to the kernel which reduces its commercial value. In order to reduce the efforts and time needed by the farmers in shelling, engine or electric motor driven maize sheller has been developed. Many of these shellers are expensive and as a result of this, are out of reach of the local farmers. Also, these shellers are usually powered either by combustible engines or alternating current (AC) driven electric motor. The combustible engine needs fuel (petrol or diesel) while the electric motor requires the presence of national electric grid or generator. These two sources of powering the shellers are usually not available or affordable to the local farmers. As a result of the aforementioned problems, farmers have continued to shell maize by hand not minding the disadvantages involved, thus, the need to develop a simple and affordable motorized sheller that is powered by solar energy system. It is important to state that solar systems can also be used to power AC motor with the help of an inverter. However, the introduction of inverter increases the cost of production and reduces the reliability of the developed sheller.

Solar power is the largest source of energy available today. The energy from sun cannot be exhausted, so, it far exceeds any foreseeable future need. The photovoltaic (PV) solar cells which are used to convert the energy from sunlight into electrical energy. The method adopted in this work is the usage of PV systems. Figure 1 shows the block diagram that describes the connection of a PV solar power systems. The solar panel converts the sun's energy into electrical energy in form of DC. The DC from the panel is used to charge the battery through the charge controller. The charge controller is used to regulate the charging of the battery. The charge controller also has terminals to connect DC loads. In case the solar system is to supply an AC load, an inverter is needed to convert the DC from the battery to AC. This work modifies a simple maize sheller by to accommodate DC powered motor. It should be noted that, with the DC motor, the inclusion of inverter has been eliminated in the solar power systems, which increases the affordability and reliability of the developed device. Since the

source of power to this device is sun, which is available anywhere, this device is useful to farmers irrespective of presence of electricity grid or availability of fuel. The main purpose of this study was to design and develop a solar s operated maize seed separator machine for efficient de-seeding of corn in small scale production using solar energy.

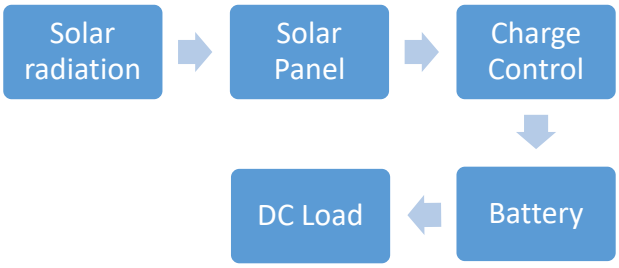

Figure 1. Connection for a solar powered system.

II. MATERIALS AND METHOD

In a bid to develop an affordable and sustainable maize sheller, the first consideration is the availability of materials. Materials for this work are locally sourced. The following materials have been used in this work:

i. For the machine: DC motor, mild steel cylindrical pipe, galvanized steel pipe, roller chain & sprocket wheel.
ii. For the stand: mild steel angle iron, 1 by 1 square pipe.
iii. For electric power supply: solar panel, charge controller, cables, battery & switch.

A. Selection of DC Motor

In order to reduce the cost of production, a DC motor has been considered as against a Solar Panel Charge Controller Inverter Battery AC Load DC Load Solar Radiation 49 AC motor. The reason for this is that, an AC motor will further require an inverter to convert the DC supply (from the panel and(or) battery) to AC supply. Considering inverter for this sheller will not only increase the cost of production, but reduces the reliability of the sheller. At the conception stage of this project, the first major challenge was how to get a DC motor that will be rugged, affordable, readily available and consumes low power. The motor that was considered to meet the mentioned requirements is the DC motor attached to the car radiator fan blade. This is shown in Figure 2. The motor is powered from a 12V DC power supply.

Figure 2: 12V DC motor detached from car wiper.

B. Cutting tool.

The shelling teeth are fabricated with a galvanized steel sheets to accommodate the shelling of an average sized corn. The teeth are made in such a way as to allow easy shelling with little or no damage to the kernel shelled.

Cutting tool have four sheets that have one side 5 teeth's, these sheets are connected to each other with rivet joint to form octagonal shape. And teeth's of sheets are angled towards the center of the octagon. By the four sheets, the number of the teeth's are 5*4=20 teeth's.

Figure 3: Cutting Tool.

Figure 4: Cutting Tool with Sprocket.

C. The Supporting stand. The supporting stand is made of mild steel plate, angle iron and 1 by 1 square pipe. This is to give support to the Components used in the sheller.
Dc motor, cutting tool, sprocket wheel, chain drive all components are mounted on the supporting stand. To make one device.

Figure 5: Supporting stand.

D. Coupling all Parts together.

The first component to be coupled to the frame is the motor. The small sprocket wheel is connected to the motor shaft and then the maize seed separator cutter having big sprocket wheel is mounted on the frame. Then these both sprocket wheels are connected with roller chain drive.

Then the solar panel is mounted on the two L-angle channels. & all the electrical connections are connected.

E. Chain Drive.

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles.

In this project we use roller chain drive for transmitting power form dc motor to the maize separator cutter. For these two sprocket wheels are used the smaller diameter sprocket wheel is connected to the drive shaft of the dc motor.

And the bigger diameter sprocket wheel is connected to the maize seed separator cutting tool, & the roller chain drive is connected to both sprocket wheels as shown in figure. this way when the dc motor is started the torque from the motor is transmitted to the maize seed separator cutting tool. This gets rotary motion to the cutting tool.

Figure 6: Chain Drive & Sprocket.

III. COSTING

Sr. No.	MATERIAL	COST (rs.)
1	DC Motor	750
2	Solar Panel	850
3	Battery	1400
4	Charge Control	665
5	Fabrication of Metal Parts	3000
6	Chain Drive & Sprocket Wheel	450
7	Cutting Tool	650
8	Total	7765

IV. SELECTION OF SOLAR POWER COMPONENTS.

DC power supply was used to power it. Not until when the power supply was set at 12V, 2A, the sheller didn't shell effectively. With these two values, the components of the solar systems are selected based on the following calculations:

$P = IV$

where P is the power required by the sheller, I is the supply current and V is the terminal voltage. So,

$P\ 2\times 12=24W$

If the sheller is to work for a 7-hour period, it will require 168 Wh. (i.e., 24W × 7h) worth of energy. The size of solar panel that can deliver this amount of energy during the 5-hour sun period with an assumption of 85% efficiency is 39.52W (i.e., 168Wh ÷ (5h × 0.85)).

The closest available solar panel to this value is rated as 20W.

Figure 7: Solar Panel Specification

For a 7-hour period of usage of the sheller, the implication is that the usage of 2-hour needs to be stored in the battery. Since the current requirement for the sheller is 4A, a 2- hour usage requires 8Ah storage (i.e. 4A × 2h). If 8Ah represents a 60% depth of discharge (DOD) of a battery, the battery capacity needed is 13.33AH (i.e. 8Ah ÷ 0.60). The next available battery capacity is the 14Ah.

V. RESULT & DISCUSSION.

The performance evaluation and limitation of the developed maize separator is discussed in this section.

A. Performance Evaluation of the Sheller

The completed sheller has been tested with 3 cobs of maize for 1 minute and the following observations have been discovered about its performance:

I. The sheller only performed optimally with cobs that are approximately equal to or above 15 cm in length.

II. The sheller was able to shell 400 gm of maize seeds during 1-minute period of time. This means that, it has the ability to shell up to 24 kg in one hour. However, there were some unshelled maize seeds due to the short length of maize cobs (i.e., less than 12cm), these maize seeds were removed and discovered to be 10gm.

- Maize seed separated in 1 minute from normal sized cob =400gm.
- Unshelled maize due short length of cob in 1 minute of time=10gm
- Maize seed separated in 1 hour approx.=24 kg.

$$shelling\ efficuency = \frac{mass\ of\ shelled\ maize}{mass\ of\ shelled\ maize + mass\ of\ unshelled\ maize} \times 100$$

$$shelling\ efficiency = \frac{400}{(400 + 10)} \times 100 = 97.56\%$$

B. Limitation to the Work.

Shelling requires some effort of the operator. So, the operator will be the one to insert the dry corn into the shelling cylinder and as well apply some force on the corn for shelling. Also, Cobs with short length and large diameter cannot be shelled. Lastly, the sheller can only effectively shell well dried maize.

VI. CONCLUSION

A maize separator powered by solar energy system has been developed in this work. All the parts have been fabricated using mild and galvanized steel. The motor attached to the car wiper has been selected to provide the required rotary motion. The choice of the motor is as a result of its affordability and availability. An 20W solar panel and an 14AH battery have been used to power the sheller. The performance evaluation of the sheller shows that it can shell 24 kg of maize seeds in one hour. The

sheller has also been shown to have an efficiency of 97.56 %. Though, there is need to improve the sheller to increase its performance, the major advantages of the constructed sheller are:
(1) the source of power (i.e., sun) to this sheller is naturally available everywhere. So, farmers don't need to bother with the presence of grid energy or availability of fuel to operate the sheller.
(2) the materials used are locally, affordably and abundantly available.
(3) when the farmer is not shelling, the power source to the sheller can also be used to power some household electrical or electronic devices.

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