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Development and Performance Evaluation of a Lab-Scale Solar Grass Cutter

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Abstract **–** This study aims development a lab-scale solar grass cutter and to evaluate the performance of the developed machinery for field efficiency. In this regard due to the continuous increase in the cost of fuel and the effect of harmful gases from the burnt fuel into the atmosphere, this necessitated the use of renewable solar energy from the sun as a source of energy to drive a solar grass cutter. Solar grass also saves energy and reduces workers' fatigue. In this project, we have to decide to develop a solar grass cutter. The main component of a solar grass cutter is a direct current (D.C) motor, a rechargeable battery (12v), a solar panel, a stainless-steel blade, and a control switch. Performance evaluation of the developed machine was carried out with different thicknesses of cutting blades. The solar grass cutter is light in weight and easy to handle. The detailed design of the solar grass cutter component was giving the result of field efficiency is 85% with 2 mm and 6 mm blade thickness which demonstrated the ease of use as well as better grass cutting. Cutting blade height is adjustable for different heights of cutting grass. The battery, which takes about 2 hours to charge, is capable of cutting grass an in area of 300 square meters.

Keywords – Solar grass cutter; farm machinery; energy efficiency; performance.

I. Introduction and Background

This grass cutter machine is of great importance in this era of technology. The most machine is used for grass cutting and lawn furniture. The part of the grass cutter is a battery, solar panel, a direct current motor, and a cutting blade. All the parts of the grass cutter are placed in an iron structure. The motor used in this grass cutter machine is about 3000 r.p.m and is connected to the battery through a wire. Its r.p.m is increased with help of a battery and a switch is used for on/off the motor. The stainless-steel blades are connected to the shaft of the motor [1]. The raw materials used in the grass cutter are the motor, wheel, square pipe, and other assembling objects like nuts, etc. The machines required for assembling the solar grass cutter include a welding machine, grinding machines, and drilling [2]. The principal operation of a grass cutter is to give maximum energy to its blade. the edges of the blade should be sharp which makes it easy to cut the grass. The blade of a grass cutter gets kinetic while using electricity. Additionally, an electric grass cutter is difficult to use on the domestic lawn as compared to field grass. if you want to enhance the beauty of gardens, then we have to make the grass cutter with modern technology. in the step with the world power article, we get around 95% of our energy from conventional fossil fuels like electricity, oil, and coil [3].

The past research on the manufacturing of solar grass cutters consists basically of a direct current (D.C) motor, a rechargeable battery, a solar panel, a stainless-steel blade, and a control switch. It was reported that solar panels were mounted in such a way that they can receive solar radiation with high concentration easily from the sun. These arranged solar panels converted solar energy into electrical energy [4]. This electrical energy was stored in batteries through the solar charger. The motor was connected to the batteries through two mechanical circuit breaker switches, which aided the ON and OFF of the motor. The rotary power from the motor

was transmitted to the blade, which resulted in the cutting of grasses [5].

Manual grass cutting is the cheapest and most common method. solar powered grass cutter is environmentally friendly, it saves the environment from noise pollution [6].

The purpose of this research work is to design and develop and evaluate the performance of a solar grass cutter using SolidWorks Expert software the design of the grass cutter is shown in Fig. 1. And the implantation of the design is done with different processes and different machine are used to assemble the solar grass cutter.

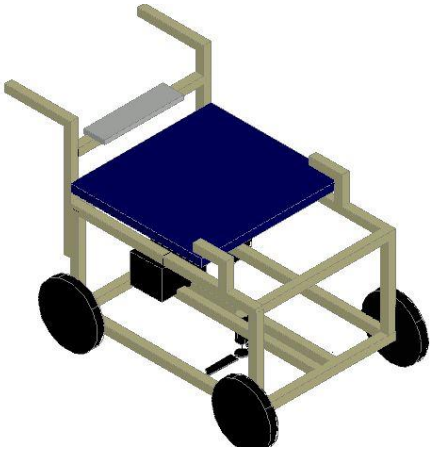

Fig. 1 3D model

II. Review of Conventional Grass Cutter

Landscaping and lawn maintenance remains important constraints to keeping the good looking and clean the gardens. The conventional method of grass cutting involves cutting grass with a manual source like a hand cutter, etc. Therefore, the need of fabricating a Manal grass cutter. The object of past studies is to design and develop the locally fabricated non-engine powered grass cutter [7].

A cylinder mower or reel mower incorporates a hard and fast, horizontal reducing blade at the favored top of reduce. Over that is a quick-spinning reel of blades that force the grass beyond the reducing bar. Every blade within the blade cylinder paperwork [8]. A helix around the reel axis, and the set of spinning blades describes a cylinder. Of all of the mowers, a properly adjusted cylinder mower makes the cleanest reduction of the grass and this permits the grass to heal extra fast [9].

In this paper, the study is about to handhold a petrol-powered grass cutter that works on the principles of a blade that is turned fast enough and is held out from its housing very rigidly by centrifugal force [10]. The handy grass cutter is powered by an internal combustion engine which is located on the differing end of the shaft from the cutting head [8].

Fig. 2 Hand-hold grass cutter [8]

III. Materials and Method

A. *Design and development of solar grass cutter*

The design of a solar grass cutter is simple which is to optimize the material used in this machine. The overall dimensions of a solar grass cutter depend upon our requirements. The is used to rotate the cutting blade. First, we start the design of solar grass with a rough design by hand, and then the prototype is designed by using SolidWorks. The design dimensions are very important and need to be correct and exact for safety factors enhancement [11].

To design the solar grass cutter, different parameters need to be considered like components used in this project, the installation position of the component, the main frame size, safety factor, and advantages and disadvantages.

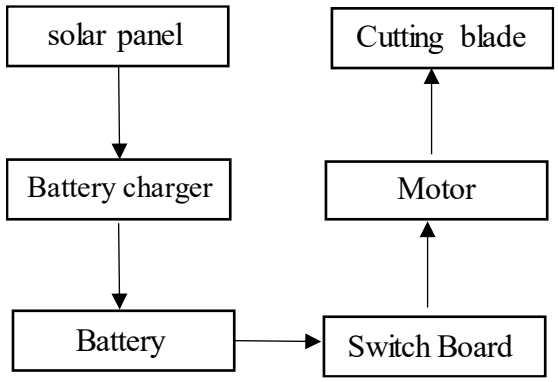

Fig. 3 Block Diagram of working principle of solar grass cutter

B. *Experimental parameters*

In this section, we discuss the parameter used in this paper like T.F.C, E.F.C, and F.E.

The T.F.C is the rate at which a solar grass cutter would cut grass without interruptions, clogging, turning, or slowing. The T.F.C is expressed in terms of Acer per hour.

$$\mathrm{T.F.C} = \mathrm{width(ft)} * \mathrm{speed(miph)}/8.25$$

The E.F.C is the average rate at which the solar grass cutter moves. If, for example, at the end of 1 hour the solar grass cutter cut the grass from 100 square meters or 0.0241 acres. Hence, the effective field capacity is 0.0241 acres per hour. The E.F.C is expressed in the term of Acer per hour.

$$coveredE.F. = \text{Area (acr)}/\text{Operating time(h)}$$

The ratio of effective field capacity (E.F.C) to theoretical field capacity (T.F.C) is known as Field efficiency. It is term as a percentage (%).

$$F.E = (E.F.C)/(T.F.C) * 100$$

The Martials of solar grass cutter and their specifications are listed in the table given below.

Table 1. Specification of Materials

Material	Specification
D.C motor	12 v, 3000 r.p.m
Solar panel	30 watts
Cutting blade	2mm,3mm,6mm
Battery	12 v, 5 Ah
Push Handle	1.5 feet
Solar battery charger	12 volts

IV. RESULTS AND DISCUSSION

Fig.4 Shows that the variation in voltage w.r.t different energy sources like when we used only a Solar plate as an energy source to drive the motor of the grass cutter then the rotates at the speed of 2500 R.P.M and the voltage used by the motor is varying between 12.1 to 13.9 volts, when I used only battery as an energy source the to drive the motor of grass cutter then it rotates at the speed of 2800 R.P.M and the voltage used by motor is 13.1 to 14 volt and when we used combine Source (Battery + Solar plate) as the energy source the motor of solar grass cutter rotates at the speed of 3200 R.P.M and the voltage used by motor is 13.4 to 14 volt. we have concluded that if we operate the grass cutter machine with a combine (battery + Solar plate) as the energy source then the motor of solar grass cutter speed is high than the conventional grass cutter.

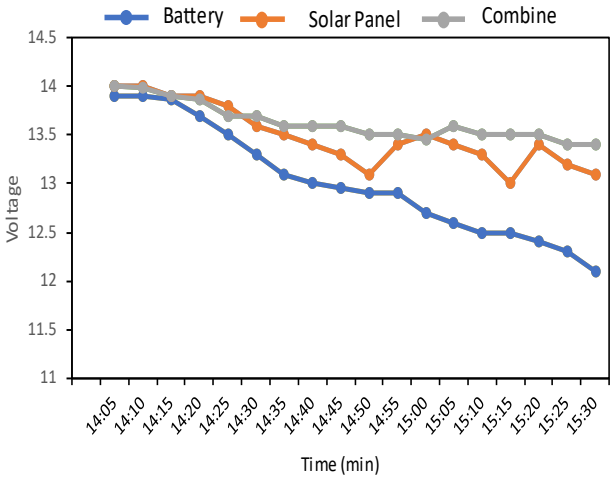

Fig. 4 Variation in voltage w.r.t energy source

Fig.5 shows that the result of the solar grass cutter was carried out with a different height of cutting grass and different thickness of the blade. The maximum field efficiency of the grass cutter was found 78-85% with 2mm and 6mm thickness of blade and height of cutting grass is 50.8mm.

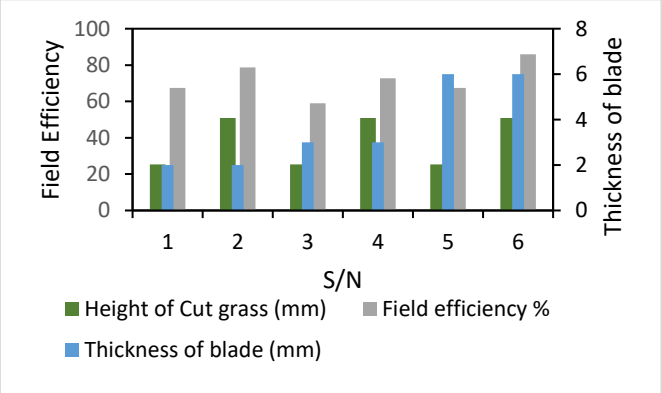

Fig. 5 Effect of blade thickness on Field efficiency

V. CONCLUSION

In conclusion, the operational performance of the solar grass cutter was satisfactory during cutting grass in the field. A solar grass cutter can be successfully used for domestic lawn grasses. The solar grass cutter takes a little more time for covering an area because of its less working width. The solar grass cutter gives a fairly uniform cutting height of grass The performance of the solar grass cutter was also satisfactory from an economical point of view.

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