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A Modified Design Approach of Solar Powered Fertilizer Sprayer Machine for Agriculture Application

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Abstract— *Sprayers are mechanical devices that are specifically designed to spray liquids quickly and easily. In this project we'll take a look at solar operated mechanical sprayers. A sprayer of this type is a great way to use solar energy. Solar based fertilizer sprayer pump is one of the improved version of petrol engine fertilizer sprayer pump. It is vastly used in the agriculture field & also used for many purposes. This is having more advantages over petrol engine sprayer pump. It uses the solar power to run the motor. So it is a pollution free pump compared to petrol engine sprayer pump. In this charged battery can also use for home appliances like glowing of CFL bulbs, mobile charging etc.*

The solar panels make up most (up to 80%) of the systems cost. The size of the PV-system is directly dependent on the size of the pump, the amount of water that is required (m^3/d) and the solar irradiance available. The solar sprayer has many advantages. Besides reducing the cost of spraying, there is a saving on fuel/petrol. Also, the transportation cost for buying petrol is saved. The solar sprayer maintenance is simple.

There is less vibration the operation of solar powered pumps is more economical mainly due to the lower operation and maintenance costs. Solar pumps are useful where grid electricity is unavailable and alternative sources. The farmer can do the spraying operation by himself without engaging labour, thus increasing spraying efficiency.

Keywords— Solar, Sprayer pump, fertilizer, PV system, CFL pulbs etc.,

I. INTRODUCTION

Day by day the population of india is increasing and to fulfill the need of food modernization of agricultural sectors are important. Spraying of fertilizer/pesticides is an important task in agriculture For protecting the crops from insects and growth of crops. Farmers mainly use Hand operated or fuel operated spray pump for this task. This conventional sprayer causes user fatigue due to excessive bulky and heavy construction. This motivated us to design and fabricate a model that is basically solar sprayer In our design, here we can eliminate the back mounting of Sprayer ergonomically it is not good for farmer's health point of view during spraying. in this way here we can reduce the users fatigue level. There will be elimination of engine of fuel operated spray pump by which there will be reduction in vibrations and noise. The elimination of fuel will make our spraying system eco-friendly. So with this background, we are trying to design and construct a solar powered spray pump system.

Now days there are Non-conventional energy sources are Widely used. The energy which is available from the sun is in Nature at free of cost. In India solar Energy is available around 8 months in year .so it can be used in spraying operation. Solar pesticide sprayer can give less tariff or price in effective spraying. Solar energy is absorbed by the solar Panel which contains photovoltaic cells. The conversion of the solar energy into electrical energy is done by these cells.

This converted energy utilizes to store the voltage in the DC Battery and that battery further used for driving the spray Pump. Solar spray are the ultimate cost effective solution at the locations where spraying is required. This solar-powered spray pump system uses solar energy as source. Solar energy is first used to charge a storage battery. The solar energy stored in the battery is utilized to operate motor which functions as pump. As the name of the paper suggests, it deals with the constant discharge of pesticide, compress air control system, solar power, battery charging, monitoring as well as timer and non-conventional power controlling techniques. As far as controlling is concerned, it include the parameters such as pressure, pesticide level, battery voltage, current, solar cell and discharge condition.

In this paper we are trying to make unique equipment for cultivation users. Mostly in the forming process pesticide spray is taking a critical role due to poison properties of chemical. So, in this paper we have committed to do something unique and useful equipment with nonconventional source technique. Also reduce the weight of unique solar spray jet as compare to diesel spray jet.

II. LITERATURE REVIEW

Many researches were conducted in the field of solar sprayer for increasing the efficiency and their uses, various papers were presented and any many of these were written in the field of development of solar pesticide sprayer. Some of the literatures are listed in support of development solar pesticide sprayer.

Virendra Patil, Prashant Patil, Pravin Patil published the paper on the 'Solar Pesticide Sprayer' on 2015 from this paper

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we get the knowledge of dc water pump. The operation of solar powered pumps is more economical mainly due to the lower operation and maintenance costs and has less environmental impact than pumps powered by an internal combustion engine(ICE).Solar pumps are useful where grid electricity is unavailable and alternative sources (in particular wind) do not provides sufficient energy. The solar panels make up most (up to 80%) of the systems cost. The size of the PV-system is directly dependent on the size of the pump, the amount of water that is required (m^3/d) and the solar irradiance available.

Mr. Arunkumar, Mr. Kiran, Mr. Rangaswamy, Mr. Udedararavigouda published the paper on the 'Solar Pesticide Sprayer' on 2015, from this paper we get the knowledge on the discharge rate of the sprayer. The hand operated sprayer gives a discharge of about 0.8 to 1.5 lit/min it needs the operator to operate the sprayer till the pesticides are deposited by a sufficient amount. However the fuel operated sprayer gives a discharge about 6 to 8 lit/min which leads to wastage of pesticides. These problems are eliminated in the proposed sprayer system.

Madurai Kamarajar University, Mohmad Sathak Polytechnic College published the paper on the 'Solar Pesticide Sprayer' on 2015, from this paper we get the knowledge on the power conversion efficiency. The solar cell Power Conversion Efficiency can be calculated by using the relation,

P = Incident Solar radiation x Area of the Solar Cell The output power (P) = V * I out.

F.Pezzi,V.Rondelli ,The performance of a sprayer fitted with two vertical adjustable air outlets has been studied in vineyards investigating the effects of changing speeds(1400 ,2000&2500 rpm) and the direction of the air- jet (90 &120 backward angle of the outlet side deflectors in relation to the treated row).

Burrell J, Brooke T and Beckwith.R, his tells about Using ethnographic research methods, the authors studied the structure of the needs and priorities of people working in a vineyard to gain a better understanding of the potential for sensor networks in agriculture. The study's larger purpose is to find new directions and new topics that pervasive computing and sensor networks might address in designing technologies to support a broader range of users and activities.

A. Ruckelshausen and E. Wunder, The scientists are working in the fields of unmanned or remote controlled autonomous field robots, navigation, image-based sensors fusion as well as agricultural applications. The authors have developed a 3D simulation environment which allows the virtual test of the robot platform prior to its application.

III. PROBLEM IDENTIFICATION

In India, 73% of population is directly or indirectly dependent upon the farming. Hence India is now an agricultural based company. But till now farmers face numerous problems.

A. Pests:

Farmer's productivity is threatened by pests. Pests are a major threat to food production. Climate change produces warmer temperatures and increases CO2 gases, rainfall and drought that enhance disease, pests and weeds. Better knowledge and understanding of pest behavior under different projected scenarios is required to adopt and develop new technologies to respond to threats resulting from climate change.

B. Lack of Mechanization:

In spite of the large-scale mechanization of agriculture in some parts of the country, most of the agricultural operations in larger parts are carried on by human hand using simple and conventional tools and implements like wooden plough, sickle, etc. This is specially the case with small and marginal farmers. Due to poor mechanization and crude agricultural techniques the farmers don't get a good value for their produce. Strenuous efforts are being made to encourage the farmers to adopt technically advanced agricultural equipment.

C. Short supply of electricity:

Rural areas face serious problems with the reliability of power supply. In a country like India most of the people in rural areas depend on agriculture. They also face a problem of erratic and random electricity supply in villages. Because of this, farmers have to make multiple visits to the farms at odd timings just to turn on the pumps.

D. Existing methods - Ergonomically imperfect:

Most of the existing spraying techniques are either very heavy to use or incompletely mechanized which results in problem relating to their health and economic condition. Demanding efforts are being made to reduce the stress and fatigue caused during farming activities in order to carry out farm operations timely and to economize the agricultural production process.

IV. OBJECTIVES

The main objective is to utilize the inherently available solar energy in spraying operations.

- To cut down the cost employed for spraying machines.
- Decreasing the operational cost by further introducing new mechanisms.
- To decrease labor costs by advancing the spraying methods.
- To consume zero electricity.
- Uninterrupted spraying operation at the field throughout the year.

Design

V.LAYOUT OF THE SYSTEM

The first unit of proposed system is energy conversion unit. Solar energy obtained by the sun is converted into electrical energy using solar panel by photovoltaic effect. The output of the energy conversion is given to charge a deep cycle lead acid

battery through a charge controller. The charge controller limits the rate at which electric current is added to the battery.

There by, preventing overcharging and protecting against over voltage. It employs the Pulse Width Modulation (PWM) technique which gradually stops charging the battery, when it exceeds a set high voltage level and gradually re- enables the charging, when the battery voltage drops back below the safe level. The main advantage of PWM is that the power loss in the switching device is very low. This circuit is designed to control the RPM of the motor by controlling the

amount of resistance between the motor and the battery while simultaneously providing a charging supply for the batter.

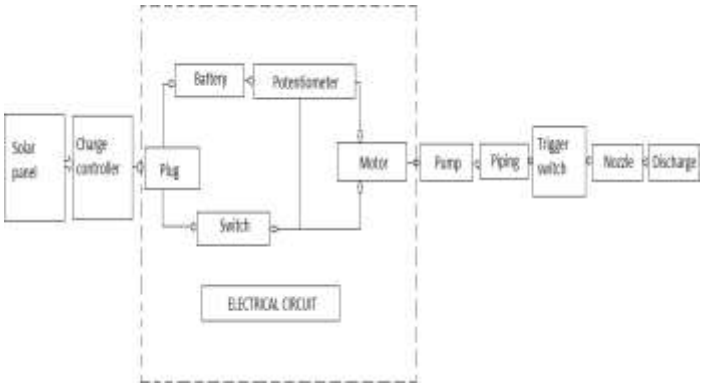

Fig. 7.1 Block Diagram of Spraying System.

VI. WORKING PRINCIPLE

When the sunrays are falling on the solar panel electricity will be generated through the solar cells and stored in the battery. By the electric power in the battery the pump operates and therefore fertilizers from the tank is sprayed out through the sprayers.

The photovoltaic cells in solar panel will store the energy and convert into electricity and stored in dc battery. Lead acid 12v battery is used to store the current. It gives input to various components dc motor, pump which used to spray purpose. The electricity stored in the battery will give input to the dc motor where with the help of this the trolley is used to move.

The pump used is centrifugal pump. Its power is about 3.5volt and its speed is about 3600rpm. And its discharge is about 2.9 liter per minute. This pump is used for spraying the fertilizer to the field.

The power of solar panel is about 20w. and its weight is about 2kg. this will store the energy form the sunrays and produce electricity with the help of photo voltaic cells to different components. Its operating current is 1.176A and open circuit voltage is 21.6V and its short circuit voltage is 1.176A

A buck converter is used to steps down its voltage from its input to output. It is a power converter used to improve the output power of solar panel along with fertilizers by adding new sensors and valves.

Arduino boards are used to activate motors and remote control. It can able to read inputs light on a sensor or finger and turn it into an output activating a motor. It is a smart farm application fertilizer system to control fertilizer.

Hand spreading has some problems like uneven spreading of fertilizer, more time consuming, high human effort, so a trolley mounted fertilizer spreader reduces these problems. These farmers can avoid carrying heavy bags. A large area of field can be covered in short time. Maintenance required for this is very less.

A remote control is used with the help of Arduino and it can be able to handle the trolley around 2 metre. It can be easily control the spraying machine trolley.

VII. DESIGN OF THE SYSTEM

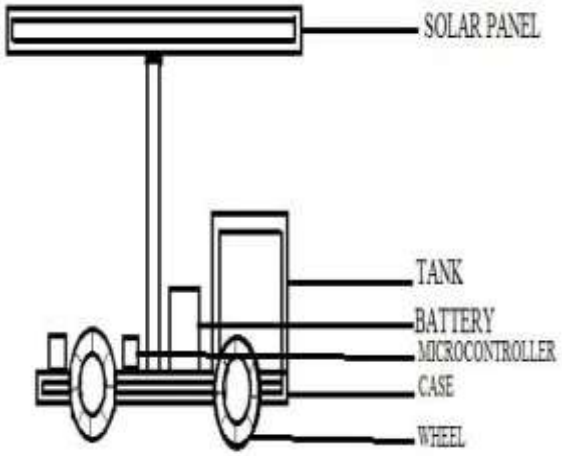

Figure 1. 2D Diagram

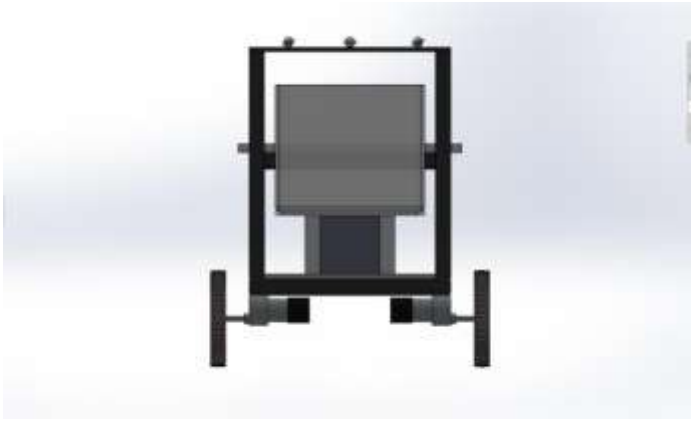

Figure 2. 3D Diagram - Back view

Figure 3. 3D Diagram - Right side view

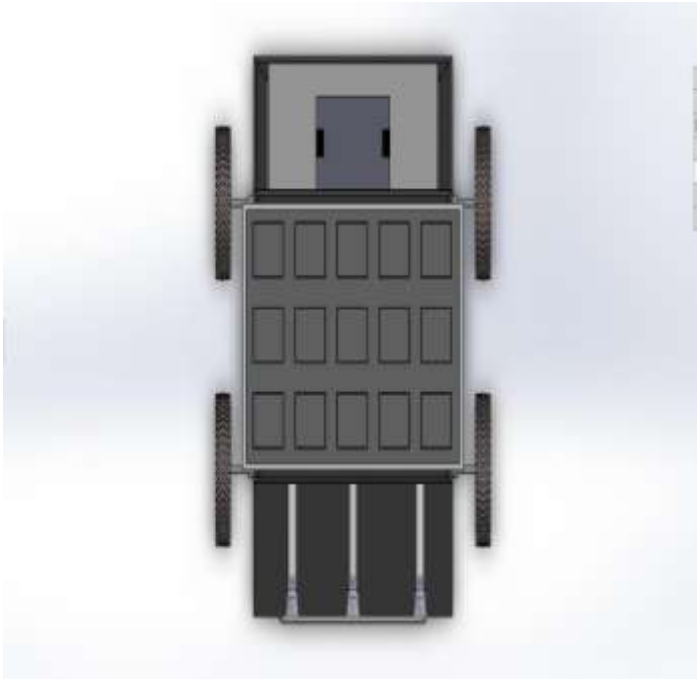

Figure 4. Diagram -Top view

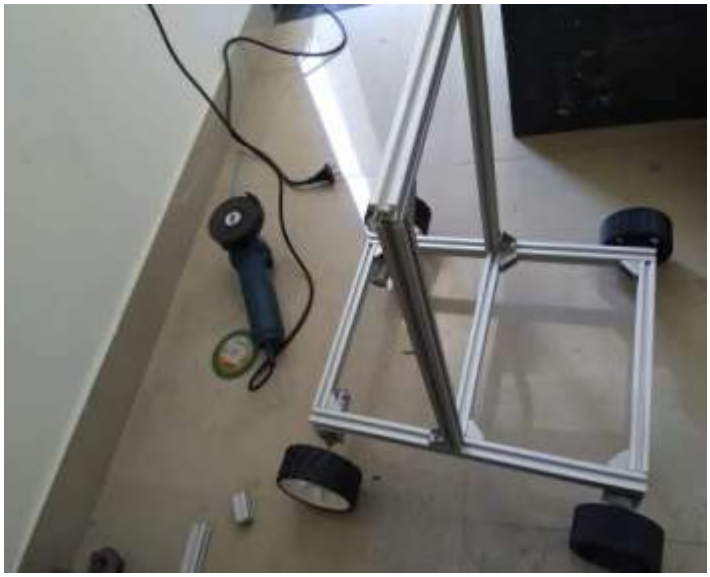

Figure 5.. Trolley

Hand spreading has some problems like uneven spreading of fertilizer, more time consuming, high human effort. So a trolley mounted fertilizer spreader reduces these problems. The trolley mounted fertilizer is economic and can reduce the time consumption, human effort and it will provide, even spreading of fertilizer.

As it is compact and economic design, it is affordable for small scale farmers. These farmers can avoid carrying heavy bags. A large area of field is covered in short time. maintenance required for this is very less.

A modest and reliable trolley mounted fertilizer is designed and fabricated. After using it, a uniformity in fertilizer spreading is obtained.

A trolley is an object with wheels that you use to transport heavy things such as shopping or luggage. A trolley is a small table on wheels which is used for serving drinks or foods.

Figure 6.. Plastic tubes

A. PLASTIC TUBES

Plastic tube is lightweight and versatile, used commonly as flow lines for fluids and gases in pneumatic, hydraulic, medical and many other applications.

Plastic tubes can be made of a mixture of different polyethylene grades including HDPE, LDPE and LLDPE and can be single – layered or multi- layered. Read on for an explanation of the different material characteristics.

Polyurethane tubing is very durable with outstanding memory, making it a good choice for coiled, portable, or self-storing pneumatic hose applications.

B. STORAGE TANK

Storage tanks are containers that hold liquids, mediums used for the short- or long-term storage of heat or cold. the term can be used for reservoirs, and for manufactured containers.

Fig.ure 7. .STORAGE TANK

VIII.DESIGN CALCULATION

A. Selection of Spray Pump

According to spraying capacity, the spray pump is selected.

Type: Centrifugal Pump. Liquid Discharge = 2.9 lit/min. Speed= 3600 rpm. Power=3.5 W

B. Selection of Battery

According to pump operating power, battery is selected. Type: Lead acid battery.

Voltage=12 V Current=8 A

When the circuit is short then, Voltage =12 V, Current = 2.4 A Power = Voltage x Current = 12 x 2.4= 28.8 W

C. Selection of solar panel

According to battery output power, solar panel is selected.

Power = 20 W Dimensions: 500 mm x 22 mm x 340 mm Weight =2.0 kg Open Circuit Voltage =21.6 V Short Circuit Current =1.318 A

Operating Current =1.176 A

D. Current produced by panel and charging time of the battery

(i) The current produced by the solar panel (I) was calculated by knowing the maximum power (P) of the solar panel and the voltage rating (V) of the battery that is given by I = P/V Therefore, I = 20/12 = 1.66 A

(ii). Charging time (T) was computed by taking the ratio rating of battery in ampere hour (Ah) to the total current supplied by the solar panel. T = (battery rating in ampere hour) / (total current consumed by the solar panel) Therefore,

T = 8 / 1.66 = 4.79 hr

IX. RESULTS AND CONCLUSION

Based on the experimentation, it is found in this project that the Solar panel provides 17V, 1A during day time between 9.30 AM to 4.30 PM. Since the pesticide sprayers are used in this duration, testing is as carried out in this time. The 12V, 8Ah battery can be charged fully in 4 hours during this time at 1.3A.Hence this module can be operated to spray continuously 3 to 4 hour which is not possible with electrical fertilizer sprayer. Hence the proposed model is cost effective and compatible with other models available commercially.

Main objective of the project was to utilize inherently available solar energy in spraying operations thus achieving zero electricity.Proposed model made it possible using simple and effective principle of storing sun energy in battery through constant supply of voltage from solar charge controller and then with the use of selected pump and nozzle, spraying operation can be carried out. Fatigue and Stress that usually generates during working condition for the farmers has been reduced considerably after adopting ergonomic techniques during designing. Hence analyzing the function v/s cost with the presently available equipment in market, solar sprayer equipment is more efficient with comparatively lesser cost. Battery capacity can be increased in the future depending upon the requirements.

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A. Annexure

1) PHOTOGRAPH OF THE MODEL