Design & Development of Automated Solar Sprayer for Agricultural Farm Purpose

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Abstract— The project titled "Design and development of automated solar pesticide sprayer for agricultural farm purpose" is an attempt for finding ample solutions to the problems faced by farmers. The goal is to reduce fatigue on farmers while spraying pesticides using the renewable source of energy to power the sprayer. In Agricultural field pesticide spraying is one of the essential tasks to upkeep the health of crop and avoiding or controlling the pests, as it affects the growth of the crops. There are various non-conventional energy sources through which the power can be generated, such as solar energy, Wind energy, Tidal energy, Biogas energy, these are the various non-conventional energy sources. In most parts of India, Solar energy is widely available in nature throughout the year, henceforth energy from sun rays can be utilized in miscellaneous application like spraying, drying and cooking etc. In agricultural areas spraying is one of the essential tasks. This project aims in designing and constructing low cost solar powered pesticide sprayer. Automated Solar pesticide sprayer would consist - solar panel, chargeable battery and motor with other necessary accessories. The equipment will have potential advantages over conventional sprayers, and would be user friendly hoping that it would be readily accepted by the farmers.

Key words: Pesticides, Renewable Energy Source, Pesticide Sprayer, Non-Conventional Energy Sources, Solar Energy, Automated Solar Sprayer

I. INTRODUCTION

India is an agricultural based country and farmer is the heart of Indian Economy. But till now farmers face numerous problems. One of them is with the pesticide sprayer. In agriculture, a sprayer is a piece of equipment that is used to apply herbicides, pesticides, and fertilizers on agricultural crops. Sprayers range in size from man-portable units to trailed

Sprayers that are connected to a tractor as shown in fig 1.1. Spraying of pesticides is an important task in agriculture for protecting the crops from insects. Farmers mainly use hand Operated or fuel operated spray pump for this task. These conventional sprayers cause user fatigue due to excessive bulky and heavy construction. Some other sprayers cause pollution while few others are difficult to maintain and all the existing sprayers require grid electricity to run the sprayer.

Fig. 1.1: Portable sprayer and Trailed sprayer

To eliminate these problems, we came up with a pesticide sprayer that has a single wheel and runs on solar energy. Nowadays, non-conventional energy sources are widely used. Solar energy is the light and radiant heat from the sun that influences earth's climate and weather and sustains life. Since ancient times, solar energy has been harnessed for human use through a range of technologies. Solar radiation along with secondary solar resources such as wind and wave power, hydroelectricity and biomass account for most of the available flow of renewable energy on Earth. Basically, sun is clean source of energy which is inexhaustible. The energy which is available from the sun is in nature at free of cost. By using solar panel, we can easily conduct electricity and do any mechanical work. In India, solar Energy is available around 8 months in year, so it can be used for spraying.

Solar Operated Pesticide Sprayer is a pump running on electricity generated by photovoltaic panels or the thermal energy available from collected sunlight. Fig 1.2 shows how the photovoltaic panels work. This converted energy is utilized to store the voltage in the DC battery and that battery is further used for driving the spray 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. From this sprayer, we can also eliminate the back mounting of sprayer ergonomically as it causes shoulder and back pain. Solar pumps are useful where grid electricity is unavailable and alternative sources (in particular wind) do not provide sufficient energy. The solar sprayer maintenance is simple. There is less vibration and noise as compared to the petrol sprayer. The elimination of fuel will make this spraying system eco-friendly. The farmer can do the spraying operation by himself without engaging labor, thus increasing spraying efficiency. Our new invention gives support by making farmer friendly solar operated sprayer.

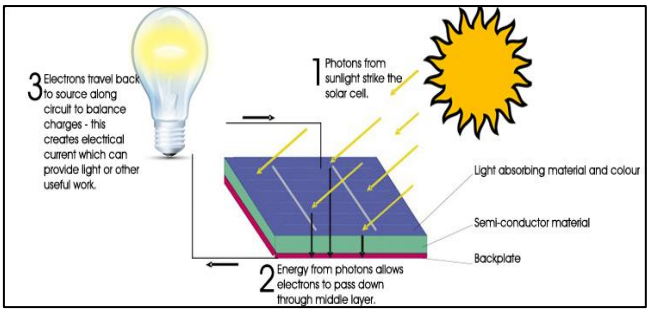

Fig. 1.2: Working of photovoltaic panels

II. 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 CO_2 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.

III. OBJECTIVES

- The main objective is to utilize the inherently available solar energy in spraying operations.
- Work reliably and ergonomically under different working conditions.
- 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.

IV. COMPONENTS

Several components and materials are required for assembling the final model.

A. Solar Panel:

Solar power is arguably the cleanest, most reliable form of renewable energy available, and it can be used in several forms to help power appliances. Solar-powered photo-voltaic (PV) panels convert the sun's rays into electricity by exciting electrons in silicon cells using the photons of light from the sun. This electricity can then be used to supply renewable energy to battery. By lowering utility bills, these panels not only pay for themselves over time, they help reduce air pollution caused by utility companies. We chose a solar panel of 40w.

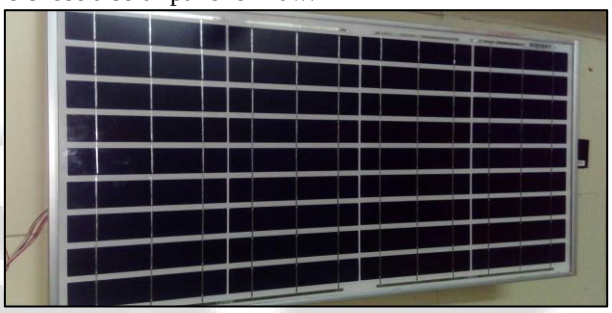

Fig. 4.1: Solar panel

B. Battery:

In the modern era, electrical energy is normally converted from mechanical energy, solar energy, and chemical energy etc. A battery is a device that converts chemical energy to electrical energy.

Fig. 4.2: Battery

This is a 12V/7.2Ah lead acid battery. 12V is one of the most diverse of all batteries. The sizes of 12 volt batteries vary widely based on the amp hours they are designed to produce. This battery is charged using solar panel to provide electrical charge when needed to run the pump.

C. Solar Charge Controller:

Fig. 4.3: Solar charge controller

A solar charge controller limits the rate at which electric current is added to or drawn from electric batteries. It converts 40w from solar panel to 21w to prevent overcharging and to protect against overvoltage, which can reduce battery performance or lifespan, and may pose a safety risk. It may also prevent completely draining (deep discharging) a battery. Some charge controllers are available with additional capabilities, like lighting and load control, but managing the power is its primary job.

D. Pump:

A pump is a device that moves fluids, by mechanical action. Pumps operate by some mechanism consume energy to perform mechanical work by moving the fluid.

Fig. 4.4: Pump

We selected a pump with the flow rate of 4.5lpm according to the calculations of pump capacity. This pump has two outlets. It develops suction when connected to a battery and lifts the pesticide from the tank via one outlet and supplies to the nozzle through the other outlet.

E. Other Components:

8 holed Nozzles are used to control the direction of the pesticides that comes out of the tank. A 30l tank is used to carry the pesticides. 80 mm hose pipe is used for connecting pesticides in the tank to nozzles through the pump. Frame is made up of mild steel and is painted to avoid corrosion. The wheel makes the transportation of the whole assembly much faster and more efficient.

V. CALCULATIONS

Where,

- Boom requirement=Nozzle flow rate(gpm)
- gpm = gallons per minute, the nozzle flow rate.
- gpa = gallons per acre, a decision made based on label recommendations, field conditions, spray equipment and water conditions
- Mph = the ground speed you select, miles per hour.
- w = band width or spacing between nozzles in inches.
- 5940 = A constant to convert gallons per minute, miles per hour, and nozzle spacing in inches to gallons per acre.
- 1.2=factor to provide agitation and offset pump wear (20% greater capacity).

For 1 acre of land, 145gallons of solution is required (as a rule of thumb)

Gallons per acre (gpa) = 145

The average walking speed of man is 3km/hr. = 1.86 miles/hr.

Therefore, Mph (miles per hour) =velocity of vehicle

=1.86mph

W= band width (spacing of nozzles)

W= 51 cm = 20 inches

Therefore,

gpm (3.875 lit = 1 gallon)

Q = 4.22 lpm

So, we chose a pump with the flow rate of 4.5lpm

Specifications of Solar Panels:

Panel Size: 26” x 19”

Weight of the Panel: 3kg.

Power = 40W

Pump specification:

Flow rate: 4.5lpm

Pressure: 7 bar

Voltage: 12V

Power Rating:

Voltage: 12V

Current: 7.2Ah

Power: 12 x 7.2 = 86.4Wh

Time required for charging the battery =

= 2.1h*

Time varies according to the intensity of sun radiation

VI. MECHANISM

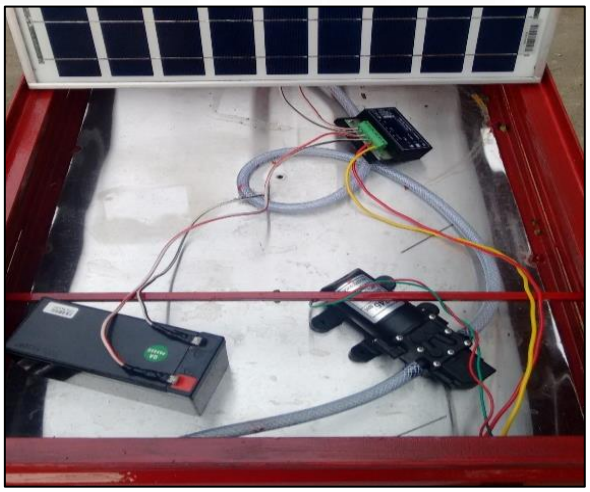

Fig. 6.1: Circuit view

When thermal radiations from the sun falls on a 40W solar panel, photo-voltaic cells present in the solar panel converts it into an electricity of around 21.6V during peak time and around 12V of current during early morning and evenings. This generated electricity from solar panel moves to the solar charge controller where it matches the output power that the pump receives with the input power available from the solar panels. It also provides low voltage protection. This increases the lifetime of the pump thus reducing the need for maintenance.

Constant 12V current passes to the battery where it starts to store the current when not in use and passes it on to the pump with 4.5lpm output rated 12V capacity. Pump has two openings, one inlet and one outlet. Pump develops the suction and lift the pesticide from the tank via connecting pipe and supplies to the nozzle. Nozzle generates the spray.

80mm hose pipe is used to obtain the suitable pressure required and 8 holed flat fan nozzles are used to match with the capacity of pump and the pressure with which the pesticide is pumped.

VII. ADVANTAGES

- Overcomes scarcity of electricity.
- Battery is rechargeable by supply available at homes.
- The arrangement of nozzles is adjustable according to the crops.
- Removes the problem of back pain, physical fatigue and health hazards to the operator.
- Low operational cost.
- Effective and efficient spraying.
- Low maintenance cost.
- Easy in operating
- Eco friendly.
- Cost of the sprayer has reduced compared with existing sprayer.

VIII. LIMITATIONS

- Difficult to convince the farmers for using a new design.
- Wobbliness of the model due to the uneven path in the field.
- Human presence in the field is likely to be necessary.
- Since the capacity of the tank is 30lts, refilling is a problem.
- There should be a pathway for spraying action.
- High initial cost that overshadow the low maintenance and lack of fuel cost.

IX. CONCLUSION

- 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.

X. FUTURE SCOPE

- Battery capacity can be increased in the future depending upon the requirements.
- Efficiency of the solar panel can be increased with the new technologies in electronics field.
- Weight of the model can be decreased further using aluminum, but would increase the cost.
- Tank capacity can be increased further depending upon the requirement providing suitable space during designing.

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