

“ Design and Fabrication of Solar Operated Pesticide sprayer”

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Date of Submission: 15-09-2020

Date of Acceptance: 26-09-2020

ABSTRACT: In India, about 65% of people are involved in agriculture and farming. Indian farmers face a lot of difficulties in agriculture, one of the major problems they face is a failure of crops due to pests and insects. Insects are responsible for the destruction of crops and to prevent them we use Insecticides/pesticides are sprayed on crops using devices known as the pesticides sprayer. There are many types of sprayers used by farmers, most commonly used sprayer is backpack sprayer. It has many limitations like low pesticides carrying capacity, inefficient spraying, prolong use of backpack sprayer will lead to back problems of the person using it. The main aim of our project is to do fabricate mechanical pest sprayer, which can overcome the limitations of a backpack sprayer. We have designed a model running without any fuel and it is easy to operate.

I. INTRODUCTION

Most of the increase in the area of irrigated land in the world has been through the increasing use of engine-driven pumps. However, the increasing price of oil-based fuel has reduced the margin to be gained by farmers from irrigation, since food prices have generally been prevented from rising in line with energy costs. Despite present short-term fluctuations in oil prices, conventional oil-based engine-driven power sources and mains electricity are expected to continue to increase in the longer term. If we are to decrease our dependence on imported oil, we have to find methods for energizing irrigation pumps that are independent of imported oil or centralized electricity.

Solar radiation as a source of energy is of course, the epitome of the clean. Sustainable

energy technology except for residues possibly arising out of the manufacture of solar component (e.g. semiconductors), solar technology have very low environmental impacts. The environmental impacts of solar system in operation are very low and the source is, for us inexhaustible. Insects are largely responsible for the crop destruction. Insecticides or pesticides, a man made or natural preparation are used to kill insects or otherwise control their reproduction. These herbicides, pesticides, and fertilizers are applied to agricultural crops with the help of a special device known as a "Sprayer," sprayer provides optimum performance with minimum efforts. The invention of a sprayer, pesticides, fertilizers, bring revolution in the agriculture or horticulture sector especially by the invention of sprayers, enable farmers to obtain maximum agricultural output.

1. SPRAYING METHODS

The most common forms of pesticides application, especially in conventional agriculture is the use of mechanical sprayers. The pesticides are generally mixed with water or any other liquid chemical carrier, such as fertilizer. The formulation is sprayed in the form of droplets, the droplets may be large or tiny. The droplets size can be varied by using different nozzles or by varying the pressure under which it's been forced out. Large droplets are good because they show less spray drift, but they need more water per unit area of land covered.

a. Backpack Sprayer

The principle behind the backpack sprayer is the pressure difference created by hand operated lever. It generally has a single nozzle through which liquid pesticides is forced out in fine droplet

form. The Capacity of backpack sprayer is less than 20 liters. The components of backpack sprayer are the tank, piston pump, hose, spraying handle and a nozzle. Sprayers convert the pesticides into small droplets which can be varied by changing the pressure & size of perforation on the nozzle. Large size droplets have less spray drift while spraying, but there is a lot of wastage of pesticides in this method. The smaller size droplet sprays more evenly.

b. Hydraulic Sprayer

In hydraulic sprayer, pesticides are mixed with water or any other liquid-carrying chemicals like fertilizers and sprayed through a hydraulic nozzle of one sort of another. There is enormous variation in the scale, the way pumping is achieved and the configuration of an atomizer, at this more than hundred years old technology, is still considered as the best method by most the farmers and other spray operators.

c. Tractor mounted Sprayer

In this, the motorized technique of spraying the pesticides is employed. Light-Tractor is a European company which manufactures these 4 wheels spraying tractors for crops. These tractors have chassis, which are designed in such a way that they have a light footprint, for minimal soil compression. It has a stainless steel tank which can store around 8000 liters of pesticides for spraying hence frequently refilling is not required. The drawback of this tractor mounted sprayer is, it's highly costly, which can be afforded by rich farmers only, small and medium scale farmers cannot afford it.

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 CO₂ gases, rainfall and drought that enhance disease, pests and weeds. Better knowledge and understanding of pest behaviour 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.

1. Objective

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

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

III. WORKING

This works on solar energy. The concoction is accomplished by the use of solar panel, a centrifugal pump which runs and dc supply is attached to the solar panel the solar panel generates the power, that power is dc power and its positive and negative poles are connected to a battery in order to save the power and use it when the sun rays are not present by using this device. We can spray pesticide to the herbs and plants and any agriculture spraying it is economical as compared to the other means used like petrol/diesel pesticides sprayers. There is no much maintenance cost and no operating cost as it is using solar energy it is free of cost and there is no pollution. Its working principal is very simple and it is economical for the farmers, which has one more advantage that it can also generate power that power is saved in the battery and it can be used for both for spraying and well as to light in the house when there is no current supply. In rainy season

when the sun rays are not available that time we can charge the battery and use it to spray pesticides to the herbs and plants as compared to petrol/ diesel sprayer.

This project operates on solar energy. The concoction is accomplished by the use of solar panel, a centrifugal pump which runs on dc supply is attached to the solar panel the solar panel generates the power that power is dc power its positive and negative charges are connected to a batter in order to save the power and use it when the sun raise are not present by using this device we can spray pest ices to the herbs and plants and any agriculture spraying it is economical as compared to the other means used like petrol/diesel pesticides sprayers.

IV. COSTRUCTION

In this project an aluminium frame is constructed using aluminium bars to keep the weight of the frame low. In this frame a retractable link is fixed to the top end of which a solar photovoltaic panel is fixed that converts solar power into electricity. This electricity is then provided to battery via a charging circuit and is used for charging the battery. Electric power from this battery is given to an electric motor via control switches. By continuously feeding the insecticide to the blower pipe the same is spread or sprinkled where we wished. Liquid insecticide is sprayed on the crops using spray pipe which receives liquid from a reservoir with the help of a pump. This pump is driven by another DC motor that receives power from the same battery. Thus, insecticide in liquid form is sprayed where we wished.

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the battery and use it to spray pesticides to the herbs and plants as compared to petrol/ diesel it is economical no efforts to human just he must carry the device the device is light in weight so it is much feasible.

The main components used to fabricate the model are:

- Solar panel
- Pump
- DC motor
- Battery
- Tank
- Nozzle

V. COMPONENTS

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 photovoltaic (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 20w.



Figure 1.1 Solar Panel

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. 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.



Figure 1.2 Battery

Wheels: - Wheels are used to carry the sprayer, the trolley is mounted on the wheels. Specifications of the wheels are as follows: Radius- 280mm Wheel material- Rubber (Tyre) and Steel (Rim)

Nozzle: - Nozzle is one of the main components of the project, as the output of the projects depends on the nozzle. How much area is covered by sprayer, is decided by the type of nozzle used. Following are the nozzle spray pattern. Following are nozzle specifications:

- Nozzle type- Brass Nozzle
- Nozzle Angle- 90 degree
- Nozzle radius- 1mm



Figure 1.2 Nozzle

Piston pump: - The Piston pump is used to pump the pesticide formulation. It is actuated by a connecting rod, which connects it to the crank in the wheel. The specifications of piston pump as follows:

- Pressure- 6 bar (90 PSI)
- Flow Rate- 2.8 LPM



Figure 1.3 Piston & Cylinder

DC motor Pump: - DC motor Pump is used to pump the mixture of water and pesticides, out of the tank to the delivery nozzle. Following are the DC motor Pump specification.

- Pressure- 5.5 bar (80 PSI)
- Voltage- 12 V
- Flow Rate- 3.1 LPM



Figure 1.4 DC Water Pump

Tank: - Tank is the unit where the mixture of water and pesticides are stored. The tank is made of plastic, this prevents the tank from corrosion and gives long life to the tank.

Tank capacity- 40 liters

Frame: - Frame is a structure which acts as a chassis for a machine or vehicle. The remaining components are assembled or fitted to the frame. The frame is made of Mild Steel, to withstand heavy weight.

- Length- 91cm
- Width- 75cm
- Height- 70cm

Pipe: - Pipe is used to carry pesticide formulation from Piston pump and DC motor pump to the nozzles. To reduce weight on the trolley and to reduce corrosion, the pipes are made of plastic.

Plastic pipe length- 10 feet

T-joint: - T-joint consist of 3-way joints, it accepts the liquid in one direction and transfers it to other two directions.

- T-joint Material- Plastic
- T-joint Diameter- 10mm

Flow Control Valve: - Flow control Valve consists of a valve, which is used to vary the flow rate of the liquid passing through it. The specifications of the flow control valve are as follows:

- Valve diameter- 9 mm
- Valve material- Plastic

VI. METHODOLOGY

Design and fabrication of solar powered pesticide sprayer has following steps, Selection of components. The selection of component has been done according to the requirements. 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. Preventing overcharging and protecting against over voltage. It employs the Pulse Width Modulation (PWM) technique which gradually stops charging the battery, the main advantage of PWM is that the power loss in the switching device is very low. The output from the charge controller is given to the battery by a 3-pin socket through an electrical network.

VII. CALCULATION

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

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

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

Flow rate of Nozzle:

$$Q_n = 28.9 \cdot D^2 \cdot (86.73)^{1/2}$$

Where, Q_n = Flow rate of water from nozzle (gpm)

D = Nozzle diameter (inch)

P = Pressure at nozzle (psi)

$$Q_n = 28.9 \cdot (0.039)^2 \cdot (86.73)^{1/2}$$

$$= 0.4093 \text{ gpm}$$

$$= 1.86 \text{ lpm}$$

Backup time of sprayer:

P = (Power store in battery/power consumed by motor and pump)

$$= (V \cdot I) / (I \cdot V)$$

$$= (8 \cdot 12) / (2.2 \cdot 12)$$

$$P = 3.33 \text{ hrs}$$

ADVANTAGE

- The prepared solar operated sprayer is environment friendly and cost efficient
- It does not create air pollution and noise.
- It can use in municipality for killing insects and mosquitoes.
- It is maintenance free device.
- It is easy to operate and portable.
- It does not require fuel hence it is a zero fuel operated equipment.

COST ESTIMATION

SN	Particulars	cost
1	Frame	1500/-
2	Wheel	800/-
3	Charger Stand	1000/-
4	Battery	2400/-
5	Solar Panel	9000/-
6	Motor	3500/-
7	Motor Driver	1500/-
8	Brass Nozzle	800/-
9	Lead Screw	1200/-
10	Axle	700/-
11	BT Module	1150/-
12	Water Pump	900/-
13	Circuit Board	750/-
14	Controller	1000/-
15	Tank	1000/-
16	Attachment	1200/-
17	Accessories	-
18	Total	28400/-

VIII. CONCLUSION

It is observed that, this model of solar powered pesticide sprayer is more cost effective and gives the effective results in spraying operation. As it runs on the non conventional energy source i.e. solar energy, it is widely available at free of cost. In now days where world is moving towards the finding the new ways for the energy requirement, it can be a better option for the convention sprayer. As India is a developing country, this product can be become more popular in rural areas.

IX. FUTURE SCOPE

- Future scope of this type sprayer are very bright because it is very useful in agriculture and reduce the workload.
- Battery capacity can be increased in the future depending upon the requirements
- It reduced the time consumed in spraying the pesticides liquid and work very effectively.

DECLARATION

WE certify that

- a. The work contained in this project has been done by us under the guidance of my supervisor(s).
- b. The work has not been submitted to any other Institute for any degree or diploma.
- c. We have followed the guidelines provided by the Institute in preparing the project report.
- d. We have conformed to the norms and guidelines given in the Ethical Code of Conduct of the Institute.
- e. Whenever we have used materials (data, theoretical analysis, figures, and text) from other sources, I have given due credit to them by citing them in the text of the report and giving their details in the references. Further, I have taken permission from the copyright owners of the sources, whenever necessary.

Signature of the Students

- S1 Aman A.Rai
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- S3 Akash P.Jaiswar
- S4 Sujeet K.Singh
- S5 Shubham P.Yengalwar
- S6 sharukh M.Raheman

CERTIFICATE

This is to certify that the project entitled “Solar operated Pesticide Sprayer” is the bonafied work and framed out by, Aman Rai, Rajat Gakare, Shubham Yengalwar, Sujeet Singh, Akash Jaiswar, Sharukh Rehemman, the full time student DBACER, Nagpur during the academic session 2019-20. This project is a partial fulfilment of the requirement for Degree in Mechanical Engineering and has not been made for the award of any associate ship, fellowship or any other similar desire.

ACKNOWLEDGEMENT

We have a great pleasure in presenting this project report on “Solar Operated Pesticide Sprayer” and to express our deep regard towards those who have offered their valuable time and guidance in my hour need.

Firstly we express our sincere thanks to mentor, the guide of the project who carefully and patiently lent his valuable time and effort to give direction as well as to correct various document with attention and care. It is a great honor to do this project in this esteemed institution, and we would extend our thanks to Prof. S.A.Bobde Sir of the Mechanical Dept, who has shared their vast knowledge and experience during our stay.

We do also like to appreciate the considering of the project coordinator, our faculties and colleagues, which enable us to balance our work along with this project. It was their attitude that inspired us to do such an efficient work.

We wish to avail this opportunity to express a sense of gratitude and love to our entire friend and our families for their unwavering support, strength, help and in short for everything they have done during the crucial times of the progress of our project.

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