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Review on Design and Analysis of Modified Agricultural Sprayer Machine

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Abstract -

Solar Operated Pesticide Sprayer is an electromechanical pump that is generated by photovoltaic panels or thermal energy obtained from collected sunlight as opposed to grid electricity or diesel-powered water pumps. The performance of solar-powered pumps is extremely costly due to the low operating and maintenance costs and has a small environmental impact than internal fuel engine (ICE) pumps. Solar pumps are useful where grid electricity is not available and some sources (especially wind) do not provide enough power. Solar panels make up the majority (up to 80%) of system costs. The size of a PV-system depends directly on the size of the pump, the amount of water required (m^3 / d) and the available sunlight. Solar sprayer has many benefits. In addition to reducing the cost of spraying, there are savings on fuel / fuel. Also, the cost of transportation to purchase fuel will be saved. Maintaining a solar sprayer is easy. Vibration is small compared to the fuel pump. The farmer can do the spraying work alone without working too hard, thus increasing the efficiency of the spraying. In this project we will look at solar pesticides that spray the wheels. This type of spray is a great way to cover large areas like grass quickly and easily. Solar spray is an inexpensive solution in areas where spraying is needed.

Keywords: Agricultural Sprayers, Solar Power, pesticides, Agro-spray, Conventional energy, power sprayers, knapsack Sprayers.

1. Introduction

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. 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 non-conventional source technique. Also reduce the weight of unique solar spray jet as compare to diesel spray jet.

Fig.1. Manual Spray Pump

2. Classification of Spraying Systems

In India there are different types of sprayer can be used according to the growth of different types of crops as fallow:

1) Hand operated sprayer.
2) Engine operated sprayer/fuel operated sprayer.
3) Electric motor pump sprayer.

1) Hand operated sprayer

Hand operated sprayer is operated by hand so that the discomfort occur while spraying.

2) Engine operated sprayer/fuel operated sprayer

As we know that engine operated sprayer is working on petrol. Petrol is costly fuel so in farmer economical point of view it is not good.

3) Electric motor pump sprayer.

Electric motor pump sprayer is used electricity for charging battery. In this way the pump can drive according to battery charging, in the above sprayer there are some drawbacks.

Such as,

1) Hand operated sprayer cannot be use continually spraying. We can say that it cannot be used for long time.
2) Engine operated sprayer can be operated on petrol so it is not possible to use every farmer.
3) Here 70% of people can be live in rural areas. In rural areas there are insufficient electricity. So it is not possible to use electric motor pump for spraying.

In our country farming is done by traditional way, besides that there is large development of industrial and service sector as compared to that of agriculture. The spraying is traditionally done by labor carrying backpack type sprayer which requires more human effort. So to overcome these above two problems, we tried

to eliminate these problems and designed the equipment which will be beneficial to the farmer for the spraying operations.

3. 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.

4. Objective

In this project 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 project we have committed to do something unique and useful equipment with non-conventional source technique. Also reduce the weight of unique solar sprayer as compare to diesel sprayer.

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

- 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.

5. Literature Review

Agriculture has been the back bone of Indian economy and culture and it will be continued to remain as such for a long time in future. Parallel to this, energy security of a country is also very important and efforts have been given on renewable energy utilization since the fossil fuel based energy is depleting at a very fast rate. In agricultural fields, considerable amount of energy is used to do different field activities e.g. ploughing, irrigation through pumps, intercultural operations, spraying of agricultural chemicals for plant protection, harvesting, post-harvest processing, etc. Therefore, there is also need to replace the conventional energy source with renewable sources to operate above mentioned agricultural activities.

Approximately, 35% of the crop production is damaged if pest and diseases are not controlled at right time. Uniform spraying of liquid formulations throughout the crop field and diseases. Using sprayer, liquid pesticide formulations are generally broken down to minute droplets of effective size for uniform distribution over a large surface area. Different types of sprayers are used in agricultural field based on different requirements.

Ultra-low volume spraying: <5 L ha-1
Low volume spraying: 50-150 L ha-1
High volume spraying: 250-500 L ha-1

On the basis of energy employed to atomise and eject the spray fluid the sprayers are categorized as:

(i) Hydraulic energy sprayer,
(ii) Gaseous energy sprayer,
(iii) Centrifugal energy sprayer and
(iv) Kinetic energy sprayer. Dose of agricultural chemicals also plays a critical role since under dose may not give the desired coverage whereas overdose is expensive and may contaminate the food chain through residues. Therefore, design and development of spray equipment for uniform and effective application is essential for different type of field and crop conditions.

Considering the above requirements, several researchers have recently developed different types of sprayer e.g. high pressure sprayer, engine operated sprayer, tractor mounted sprayer etc.
For example, Joshua *et al.* (2010) developed a power sprayer with two stroke petrol engine. Since the operating cost was found high they suggested a solar operated sprayer.

- Rao *et al*. (2013) reported the performance of a multiple power supplied fertilizer sprayer, which could be able to spray 580 litre of pesticide in about 5-6 acre land using a fully charged battery.

- Khan (2014) designed a spray jet which can be operated by a DC pump run by PV panels.

- Chavan *et al.* (2015) developed a prototype solar powered agricultural pesticide sprayer using a 20 Wp PV module and a brushless DC motor (12 V, 2.2 A). Apart from these, detailed reports on few different types of solar PV powered pesticide sprayer are available in literatures (Kulkarni *et al*., 2015, Lad *et al*., 2015; Patil *et al*., 2014; Sawalakhe *et al*., 2015).

- With an aim to reduce human drudgery while spraying in field carrying conventional sprayer on user's back, few researchers have also designed and developed vehicle for carrying the sprayer (Kshirsagar *et*

al., 2016). In this study, it was aimed to design and develop a solar PV sprayer, which can be moved in field with the help of manually drawn vehicle.

- ***J P SINHA et. al. Jan 2018, Development of solar powered knapsack sprayer ,*** This paper The small and marginal farmers in India are 83% with land holding of 46.1% and contribution of 51.2% in the production. On Indian farms, knapsack sprayers are very commonly used by small and marginal farmers for pest control because of affordability and ease of operation but with lower outputs. An attempt was made to develop a solar powered sprayer which had higher output (0.3 ha/hr) with lower physiological energy consumption and discomfort. An electronic control had been embedded for protection against deep discharge and over charging of battery for longer operational life. The system could be fully charged by solar energy within two hours of irradiation and can be operated continuously for six hours. This ensures quality spray with uniform droplet size in the swath. Anti-clogging filter had also been installed before the nozzle in nozzle head for trouble free operation as well as longer service life of nozzle.

- ***Kumawat Mukesh M et. al. May 2018 , Solar operated pesticide sprayer for agriculture purpose,*** In this paper , 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 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 as compared to the petrol sprayer. The farmer can do the spraying operation by himself without engaging labour, thus increasing spraying efficiency.

- ***Ms. . Avhad Jayshri et. al. 2019, Solar Operated Spray Pump System ,*** Sprayers are mechanical devices that are specifically designed to spray liquids quickly and easily. They come in a number of different varieties. In this project we'll take a look at solar operated spray pump. A sprayer of this type is a great way to cover large areas such as lawns quickly and easily. A sprayer typically consists of a tank for carrying the liquid to be sprayed, a solar panel, a motor for pumping out this liquid, spray nozzles on automatically disperse the liquid in a downward direction over an appreciable area, ball valves, a chassis with wheels on which the sprayer is mounted, and a hose attachment for spraying. The device is mechanically pushed from behind and as the supply to the pump is switched on, the liquid is sprayed. This type of sprayers is typically used for spraying lawn chemicals such as pesticides including herbicides, insecticides and fungicides.

6. Spraying Methods

- ***Backpack type spraying***

One of the more common forms of pesticide application, especially in conventional agriculture, is the use of mechanical sprayers.

Fig 2:- Backpack type spraying

- ***Power spraying***

Power spraying consist of a flexible diaphragm made of synthetic rubber connected to the pump machine by a crankshaft mechanism, a rigid diaphragm chamber and either flat or ball-type inlet and outlet valves. These pumps typically operate between pressures of 1 and 3 bar (15-44 psi) and it is suitable for herbicide application where large droplets are required to minimize spray-drift

Fig 3:- Power spraying

- ***Fuel Operated Sprayer***

The power sprayer consists of an integrated or external spray tank; a high pressure piston pump usually powered by a petrol engine a pressure regulating valve and a hose of up to 50 m of length. Spray tanks are too big to be carried as a knapsack. The power sprayer is produced in a number of versions. Most simple and common is an engine driven pump mounted on a frame without wheels, a 200 l drum and hose and lance. Flow regulation is to be done via a pressure regulating valve and/or by restrictors (basic power sprayer) and the size of the nozzle. At the other end of sprayers mounted on wheels, equipped with pressure regulators. Technically, the power sprayer has a lot in common with the motorized knapsack-sprayer. The unit is generally set for high volume spraying, transporting the droplets with high pressure. Hallow cone nozzles are the preferred type of nozzles.

Fig 4:- Fuel Operated Sprayer

- ***Battery operated sprayer***

Battery operated sprayer requires charging of battery before operation and its application is limited were electric power is not available.

Fig 5:- Battery operated sprayer

7. Block Diagram

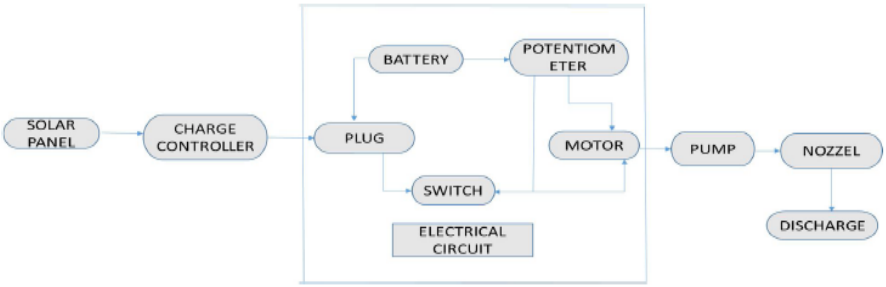

Fig 6. Block Diagram

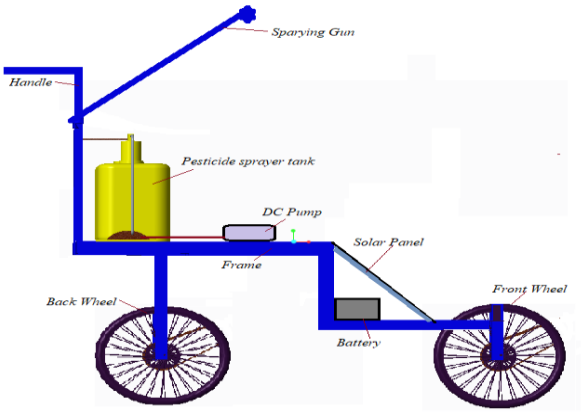

Fig 7. Basic Model of solar pesticide sprayer

8. Working Principle

It includes a solar panel, a DC pump, a battery charging kit, a pesticide tank, and spray nozzles, among other things. It is powered by solar energy. The solar panel absorbs the solar energy first. This solar energy is converted into electrical energy by the photovoltaic cell. This electricity is then used to charge the battery. After that, the battery will be used to power the DC motor. A DC motor operates a DC pump, which suctions liquid from the intake of the liquid tank. The liquid will then be sprayed from the DC motor outlet through a nozzle linked to the spray pipe**.**

9. Advantage

1) The solar sprayer has many advantages :
   - Besides reducing the cost of spraying,
   - There is a saving on fuel/petrol for spray operations etc .
   - The transportation cost for buying petrol is saved.
   - The solar sprayer maintenance is simple.
   - There is less vibration as compared to the petrol sprayer.
   - The aim of improving spraying quality and reducing physical effort for the operator.
   - The farmer can do the spraying operation by himself without engaging labour, thus increasing spraying efficiency.
   - It is multipurpose machine.
   - Easy to operate and user friendly.
   - Very less pollution on other models.
   - It is portable
   - Unit cost is very cheap one.
   - Maintenances cost is low.
   - Easy to assemble.

2) Farming is one of the oldest and important business ever done by humans but in most parts of the world it is done in traditional way. Though, farmers are adapting to changing times but there are many more things that's need to be done. SO solar spray mechanism is one of the system through which forming is easily and cost effectively done by formers.
3) At present time we use Power sprayer in two stroke petrol engine which pollutes our environment. It requires regular maintenance and filter cleaning regularly. It costs around Rs.70 / hr. As demand of energy increasing, its cost is increasing too. To deal such things solar powered spray mechanism is essential to used, it very much helpful for formers.
4) The solar power system in the sprayer facilitates lighting of ‘wireless light traps’ which controls insect pests and reduces the number of insecticide sprays by fifty percent cutting the cost of cultivation.
5) This also reduces pesticide residues in the agriculture, horticulture and animal products, improving the quality of the products. The light traps control effectively the mosquitoes too.

10. Disadvantages

1) Each formers cannot offered the solar spray system because the cost, if government helps to formers to reach such equipment to formers then it is helpful for them.
2) How to use ? is questions for formers. Formers must be trained about such mechanism before used.
3) Adjust solar panel to spray mechanism accurately otherwise panel may damage.
4) It only works when sunlight is there or in clouded season it can’t work properly.

11. Merits

The pesticide sprayer operates with minimal pollution.

- Low power consumption.
- The solar energy stored in the battery bank is 8Ah.
- Low maintenance cost and low operating cost.

12. Conclusions

It is observed that, this model of solar sprayer pump for agriculture 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 conventional sprayer. We have given the best option to farmer who economically challenged and facing electrical problem like load shading now days. As India is a developing country, this product can be become more popular in rural areas.

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