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DESIGN OF SOLAR HYBRID PESTICIDE SPRAY SYSTEM

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Abstract- The demand for energy is emergent day by day in the whole world special in developing country like India (four highest in the world). India is the seventh largest country in the world and more than 1.27 billion people accounting for more than 17% of world's population. India government facing energy issues that are why India takes various measurement and initiative to promote "make India Energy from Non-conventional source". As India is agriculture based country and 70% people do farming and related work. More than 60% Indian economy depends on agriculture so we need to raise the production in the agriculture field. In order to meet the food requirements of growing population, modernization of agriculture has become a necessity. In agriculture, spraying of pesticides is an important task to protect the crops from insects for obtaining the high yield. Farmers mainly use engine operated or hand operated spray pump for this task. Conventional spray method is more costly and tiredness for the farmers. To overcome this problem hybrid pesticide spraying comes in a picture which uses solar energy to run the hybrid pesticide sprayer. This model will perform spraying at the maximum rate in minimum time at low running costs.
Keywords- Productivity in agriculture, Efficient sprays system, User-friendly, Low running cast, Solar energy

1. INTRODUCTION

Spraying of pesticides is an important task in agriculture for protecting the crops from insects. Farmers mainly use hand operated or engine operated spray pump for this task. Traditional sprayer causes user tiredness due to excessive massive and heavy construction. Now day's non-renewable energy sources mainly solar energy is widely used in agriculture for different applications. Solar energy availability is free of cost. In India solar energy is available around 8 months in year (7 to 8 hours per day) so, it can be used in spraying operation. In this paper, we are trying to construct and design a solar powered spray pump system. Thus, we will design and fabricate a model that utilizes solar energy for spraying pesticides.

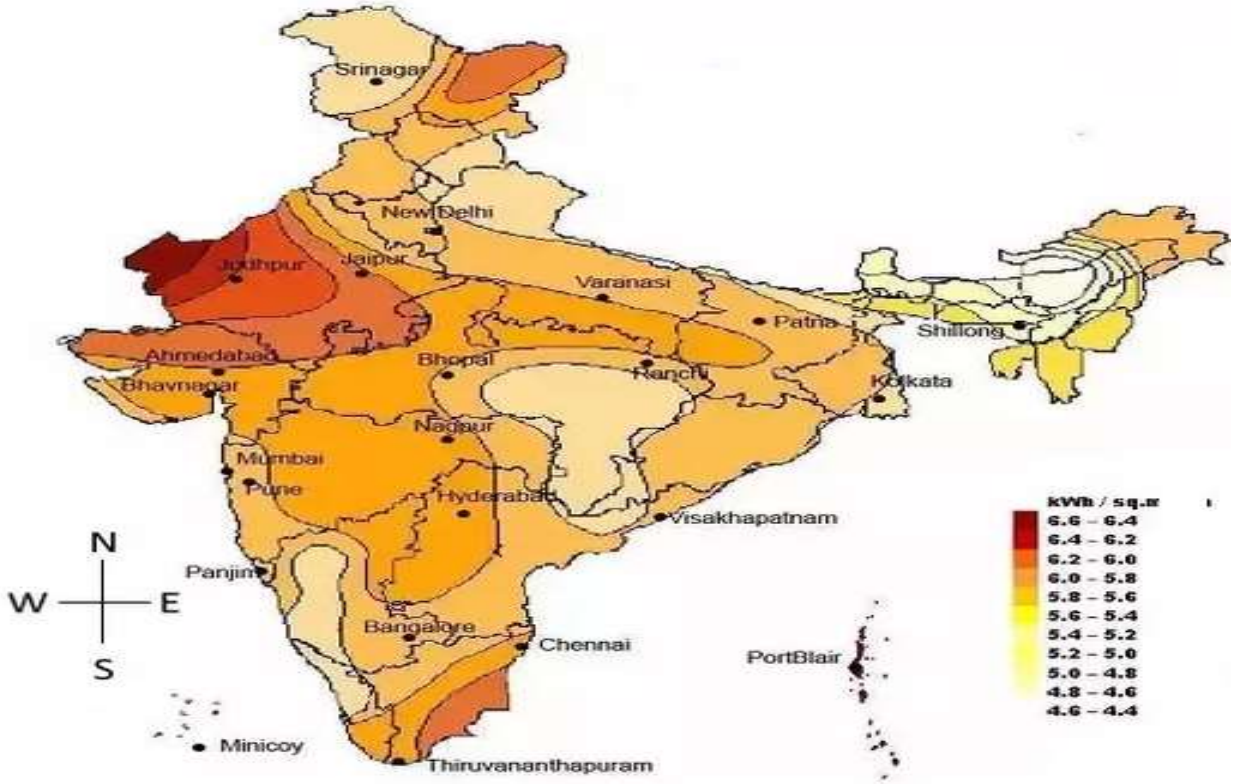

Fig. 1.1 Solar Energy Availability in India

In this model, the hand lever will be eliminated to reduce the user's fatigue level. There will be elimination of engine operated spray pump by which there will be reduction in vibrations, noise and make our spraying system eco-friendly. Solar energy is availability in day time in India as shown in figure 1.1 [1-9].

2. CONSUMPTION OF AGROCHEMICAL WORLDWIDE AND INDIA

The advancement and use of insecticides have produced huge benefits as they kill undesirable pests by disruption of their vital processes through chemical action. Thus, they are the main contributors for the boost in agricultural yield over the past three decades. The use has resulted in foodstuffs of the utmost quality and also has saved millions of lives through obliteration of disease-carrying insects. In the developed countries, the use of crop protecting chemicals has played a main role in efficient production of food. At current, the developed countries are using more pesticides to control wide varieties of pests compared to the developing countries (As shown figure 2.1) [11-15].

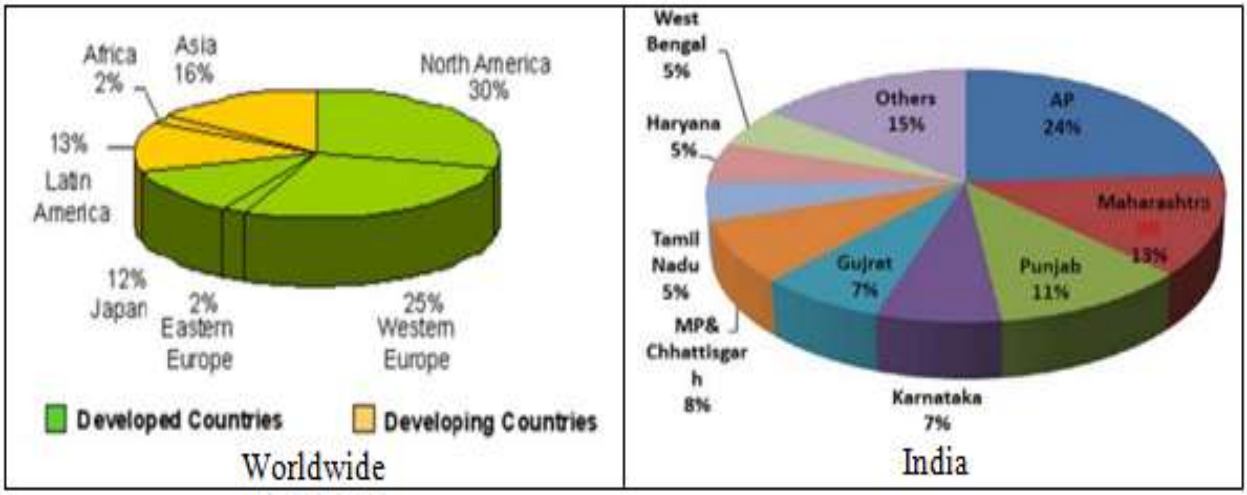

Fig. 2.1 Worldwide and Indian State Wise Agrochemical Consumption [17]

All over India average consumption of peats increased from 69.84 kg/ha in 1991-92 to 128.08 kg/ha in 2014-15. The feeding of pesticides in India is amongst the lowest most in the world and presently stands at 0.6 kg/ha against 5-7 kg/ha in the UK and at almost 20 to 30 times appx. 13 kg/ha in China. Crop wise agrochemical and fertilizer consumption in India as shown in figure 2.2 [7, 16].

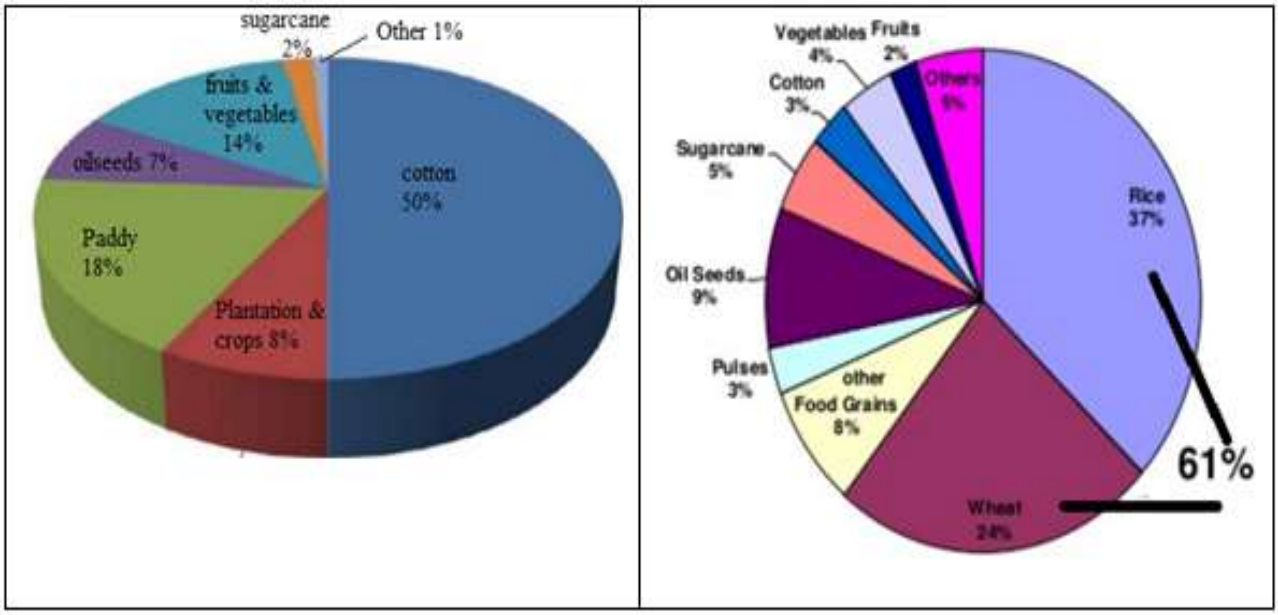

Fig. 2.2 Crop Wise Agrochemical and Fertilizer Consumption in India [17-18]

2.1 Types of pesticide spray system using in India

There are different type of sprayer is used:

2.1.1 Hand Operated Sprayer

Hand operated pump sprayer is operated by hand which causes discomfort & fatigue while spraying to the user. So, Hand operated sprayer cannot be used continuously for spraying.

2.1.2 Electric Motor Pump Sprayer

Electric motor pump sprayer uses electricity for charging battery. The supply from battery is given to pump for spraying pesticides. The electrical motor pump sprayer is eco-friendly and easy to handle than hand operated & engine operated sprayer but as most of the people lives in rural areas where they are facing problem of electricity.

2.1.3 Engine/Fuel Operated Sprayer

The engine operated sprayer is working on petrol. The use of conventional energy i.e. petrol produces many pollutants which are harmful to environment.

2.1.4 Solar Operated Sprayer

The solar based agro spray pump is one of the most improved and modern version. It can be most often used at various locations such as gardens, farms. It uses solar power to run sprayer so its operational cost is low also it is pollution free agro pump as compare to engine/fuel operated sprayer. The advantage of this spray pump is that, it can be useful for appliances like unique DC mobile charger and emergency LED; also it can be used as home lighting system as its battery can be used at night too [15-20].

3. DESIGN AND OPERATING PRINCIPLE HYBRID PESTICIDE SPRAY SYSTEM

To compete with the existing product in the market, we have limited the budget of our system. We had modified the design of the existing conventional spraying setup to meet the standard quality requirements. The principle of REVERSE ENGINEERING was adopted for the design of our solar powered spray pump system. Hybrid pesticide sprayed system shown in figure 3.1. Sunlight falls on the solar panel few part of the light is absorb on it and it is converted into the electrical energy. Charge controller does control electrical voltage. This Solar Panel supply power to 12V dry battery for storing the electrical energy. A 12V DC motor was connected to battery to convert the electrical energy into mechanical energy. Motor provides the required head which is used in spraying the pesticides or fertilizer.

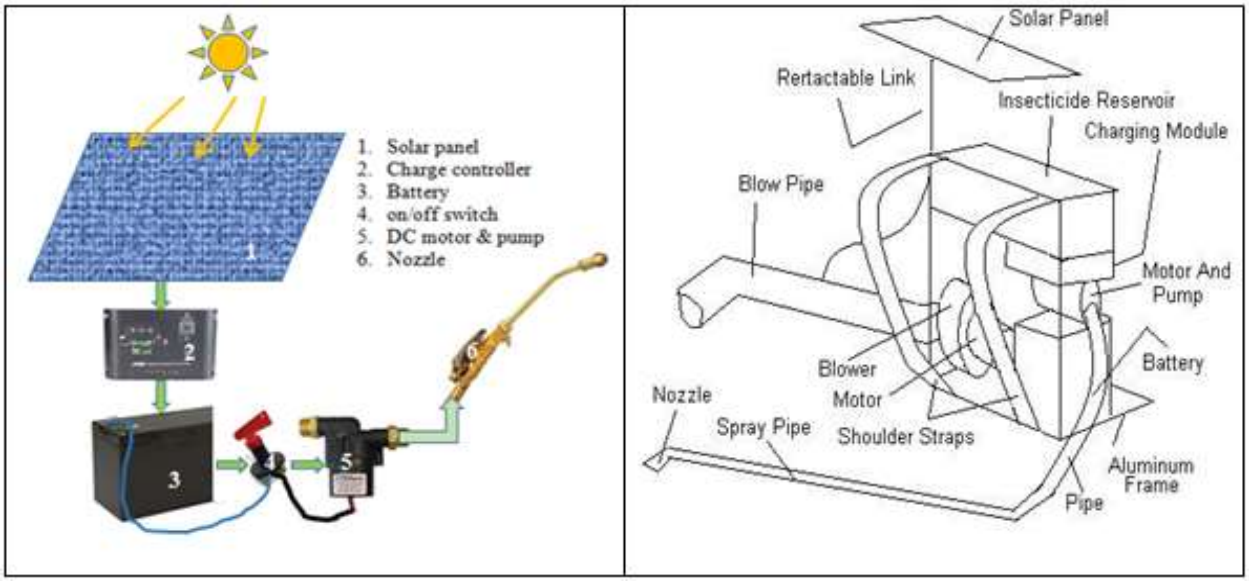

Fig. 3.1 Schematic Diagram of Solar Sprayer

4. MATHMATICAL MODLLING

4.1 Assumptions

- The height of the delivery pipe containing nozzle is in the range of 0.50 to 0.80 m above the ground and it is held horizontally.
- The coverage area is in the form of sector of a circle whose path is controlled by operator.
- The clearance angle of the sector covered during spraying is 6° on both the sides.

- Actual area is lesser than the calculated area by 15%.
- Cross section of nozzle is circular.
- The portion of pipe containing the nozzle is held horizontal to the ground.
- The discharge out of the nozzle is in the form of finely atomized particles performing projectile motion.

4.2 Solar Panel

Material: silicon semiconductor
Type: dark blue
Panel size: 45cm * 28cm
Maximum power: 15W

4.3 Battery

Weight of the battery: 1.5 kg
Operating voltage: 12V
Rated current: 8 Ah

4.4 DC Motor and Pump

Operating voltage: 12V
Current: 2.1 amps
Speed: 90 rpm
Torque: 115 N- m
Operating voltage: 12V
Operating current: 0.5A
Liquid discharge: 1.2 litre per minute

4.5 Nozzle

The discharge of the system is Q lit/min. Here, v_1 and v_2 indicates inlet and outlet velocity of the nozzle. The diameter of the pipe is d_1.

$Q = A_1V_1$

$V_1 = 4Q/ (\pi d_1^2)$

4.6 Power Conversion Efficiency

The Solar cell Power Conversion Efficiency can be calculated by using the relation,

Efficiency of power Conversion= (P_{out} /P_{in})

P_{in} = Incident solar power x solar panel area = I.P x A watt

P_{out} = V x I

$\therefore P_{in}$= 500 x 10-3 W/cm^{2}x 45cm x 28cm = **630 watt**

$\therefore P_{out}$ = V x I = 12 x 7.5 = **90 watt**

Efficiency of power Conversion= (P_{out} /P_{in}) = (90/630) = **14.285 %**

Fig. 4.1 Fabricated Model of Solar Hybrid Spray System

The developed Hybrid pesticide sprayer can be used for spraying the fertilizer, fungicides. The same technique and technology can also be extended for all types of power sprayers. This model can be also used as mosquito repellent. Solar hybrid sprayed system as shown in figure 4.1.

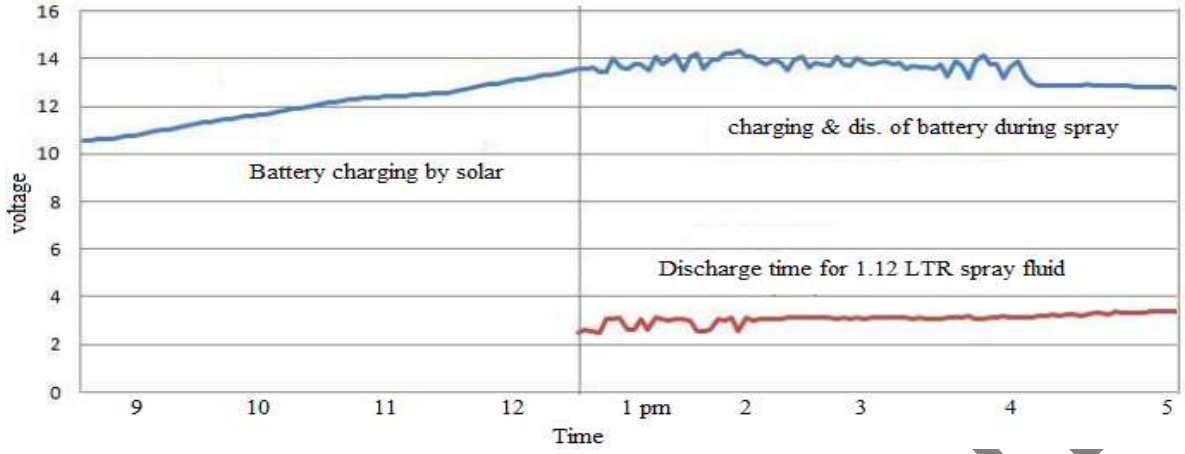

Fig. 4.2 Battery Voltage and Discharge of Pesticide

Nomenclature:

Q = Discharge through pipe (m^3/s)
P_{out} = Output power (watt)
P_{input} = Input power (watt)
A = Area of solar panel (m^2)
A_1 = Area of discharge pipe (m^2)
V_1= Inlet velocity of nozzle (m/s)
V_2= Out velocity of nozzle (m/s)
d_1 = Diameter of discharge pipe (m)

CONCLUSION

Asian countries face profound sustainability challenges that will influence their ability to achieve lasting environmental objectives. When pesticides used in greater amounts than desired, it become contaminated to food and environment. As we know 60% of economy depends on agriculture. The prominent aim of the hybrid pesticide sprayer is to make cheaper spraying by using solar energy. The fabricated hybrid sprayer is most suitable for small and medium scale farmers and remote areas like island, forest where fuel is not available easily. They can perform their work efficiently as well as save fuel at large scale. At the same time they reduce environmental pollution by fuel burning. Public awareness can be increased by more appropriate farmer programs based on solar Hybrid Pesticide Spray system should be initiated at national level.

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