Fabrication of Multipurpose Pest Sprayer

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***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 pesticides and insecticides. 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.**

***Keywords*- Agriculture, Mechanical pest sprayer, fabrication, carrying capacity, muscle problems.**

I. INTRODUCTION

India is a land known for its Culture and Tradition. Agriculture is also the backbone of India, India stands second in terms of having Agricultural Land, as per 2011 study. India has a total agriculture land of 394.6million acres, out of which 215.6million acres of land is used for irrigation. There are many problems related to agriculture faced by farmers, the attack of Pest and Insects is the major issue. Chemicals are widely used for controlling disease, insects, and weeds in the crops. They are able to save a crop from pest attack only when applied in time. The chemicals are costly. Therefore, for uniform and effective application, it is essential. Dusters and sprayers are used for spraying chemicals. The invention of a sprayer brings revolution in the agriculture or horticulture sector, this enables farmers to obtain the maximum agricultural output. There are many sprayers which are easy to operate, maintain and handle, it facilitates the uniform spread of the chemicals.

The agriculture sector is facing problems with capacity issues, shrinking revenues, and labor shortages and increasing consumer demands. The prevalence of traditional agriculture equipment intensifies these issues. In addition, out of the 215.6million acres of irrigated land, around 44% is used for Herbs, 24% is used for Trees and 13% is used for Shrubs, 14% for Climbers and others 5%. The pest sprayers which are on the market can be used for any one of these sectors. Our project focuses on all these sectors. Most farmers are seeking different ways to improve the equipment quality while reducing the direct overhead costs (labor) and capital. Pesticide sprayer must be portable, an increased tank capacity and it should be of less cost, labor and spraying time.

II. 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. The main drawback of backpack sprayer is that the labor has to carry nearly 18-19 liters capacity tank on his back which causes severe back pain and fatigue to labor.

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 short 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.

d. Motorized Mist Blowers

Motorized mist blowers are originally developed for spraying pests to tall trees, such as cocoa capsids. Motorized mist blower usually depends on air – shear atomization, but they may be supplied with a rotary atomizer. Mist blowers are used to improve horizontal throw and penetration into crops. Here, a kioritz DM9 is being used to apply a fungicide against rice sheath blight in Vietnam.

2.1 Shortcoming in Existing Sprayer Pumps:

The normally used pest sprayer by Indian farmers (small, marginal or medium) is the backpack sprayer. The main limitation of it is that it has small tank capacity for storing pesticides, it must be carried on back, while spraying, this will cause back pain and continuous lever movement for pressure generation, while spraying will lead to muscular disorder. Developing adequate pressure is a tedious and time-consuming process. It takes a longer time to spray the entire land due to frequent refilling it because it has a small tank capacity of 10-15 liter.

III. LITERATURE REVIEW

The experiments and studies done by others show that the projects which they have done focus on spraying pests to either crops or trees. But they haven't focused on both crops as well as trees. The tank capacity is less than 20 liters, they have used only single operating mechanism. The ground clearance of the model is less than 1 feet. The existing models and projects cannot spray more than 5 feet in height, hence cannot be used. Our project overcomes all these problems. Some projects have used solar panels to generate electricity, with which the sprayer operates, this has some drawbacks too, the solar intensity is not same throughout the day, hence there is variation in the amount of electricity produced, which affects the efficient spraying of pesticides. Our model works on mechanical energy and as well as electrical energy, hence it's more efficient.

IV. WORKING

Figure 4.1: CAD model of multipurpose pest sprayer

Figure 4.2: Actual model of multipurpose pest sprayer

There are three mechanisms working in one single system according to the farmer requirement. In this model, we have used slider crank mechanism which is mounted to the wheel. A connecting rod connects the crank and piston pump which is attached to the spraying tank. The outlet of the piston pump is connected to the nozzles. As the trolley moves, the wheel rotates which in turn rotates the crank, thus actuating the piston pump. The piston pump pumps pesticides out of the tank to the nozzles through the hoses. This is helpful for spraying crops/plants up to 1.5 to 2 feet in height. Slider crank mechanism is used only when the farmer spraying ground level crops (groundnut, wheat, beans, vegetables, etc). A rechargeable battery is provided which is connected to the motor pump which in turn connected to the nozzle to hose. This mechanism is used for spraying trees up to 8 to 10 feet in height. A hand operated lever mechanism can also be used by connecting to the piston pump. To increase the pressure or flow rate, the levering action should be increased. This is used when the battery is down or if you want to increase the flow rate.

V. COMPONENTS

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 are 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 5.1: 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 5.2: Piston and 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 5.3: DC 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- 10 mm

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. CALCULATION

Flow rate of Nozzle

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

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

D = Nozzle diameter (inch)

P = Pressure at nozzle (psi)

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

= **0.4093 gpm**

= **1.86 lpm**

Backup time of sprayer

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

= (V*I)/ (I*V)

= (8*12)/ (2.2*12)

P = **3.33 hrs**

VII. COST ESTIMATION

TABLE I
SELECTION OF MATERIALS ALONG WITH COST

Sl. No.	Particulars	Quantity	Cost
01	Backpack sprayer 2 in 1 kit. (with Battery, Piston pump, DC motor Pump and Tank)	01	3800
02	Plastic pipe 12.5mm.	01	100
03	Nozzle	04	165
04	Flow control valve	03	30
05	Collar 0.5 inch.	02	20
06	Socket 0.5 inch	02	20
07	PVC tank nipple 0.5 inch.	02	50
08	Connector 8mm.	02	06
09	Connector 12mm.	02	08
10	Tee joint 10mm.	03	15
11	Teflon Tape	01	25
12	Plastic Tag	10	30
13	Frame	01	1106
14	Shaft	01	225
15	Plumber Block	02	600
16	Cycle wheels	02	500
17	Tank 25 liters	01	250
18	Connecting Rod	01	45
19	Crank wheel	01	120
Total			Rs. = 7115/-

VIII. RESULTS TABLE

TABLE II
SPRAYING CAPACIY

crops		Trees	
Type	Height of spray	Type	Height of Spray
Sugar cane	3-4 ft.	Mango	10-12 ft.
Groundnut	1-1.5 ft.	Chikku	10-12 ft.
Corn	1-2 ft.	Pomegranate	10-12 ft.
Wheat	1-2 ft.	Apple	10-12 ft.
Gran	1-1.5 ft.	Guava	10-12 ft.
Soya bean	1-1.5 ft.	Cashew	10-12 ft.
Cotton	1 ft.		
Pigeon pea	1 ft.		

IX. CONCLUSION

The Mechanically Operated Multipurpose Pest sprayer using the Slider-Crank Mechanism is much better as compared to the other different type of options available. It works on both ‘Mechanical Power’ and also 'Electrical Power' sources which will be employed in its operation. Moreover, various materials selected for the entire mechanism will be easily available at a considerably affordable price. The main problem being faced by the farmer was to carry the entire load of the pests on his shoulder and this problem can be solved by adopting this method. Also, very fewer efforts are needed to be applied for its working on the real-situation fields. In addition to that, no special skills or training is required for the farmer (operator) to operate it.

Thus the DC motor pump also giving very effective spray for the height crops up to 10-12 feet. In this way, multipurpose pest sprayer is going to be a very convenient and feasible product for the farmers. The suggested model has more number of nozzles which is used for spraying crops, the sprayer will cover maximum area of spraying in minimum time & at a maximum rate. Proper adjustment facility in the model with respect to crop helps to avoid excessive use of pesticides which result in less pollution. Muscular problems are removed and there is no need to operate the lever. This pump alone can be used for multiple crops.

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