SELF POWERED PESTO–SPRAYER

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ABSTRACT

India has a large and diverse agricultural sector which requires quite effective methods for spraying pesticides at a high rate, in minimal time. In our country India, uttermost agricultural operations are performed manually by farm workers utilizing hand tools and equipments. The economic upswing and scientifically advancements have lead to greater demand and blooming of machines and devices used in industrial settings. With these changes, there has also been greater synergy between man and machines. Hence, it is important to modify the present hand tools using ergonomic principles for optimizing of operation, safety and comfort of user.

We have proposed self powered pesticide sprayer. It is a portable device which does not need any fuel to operate it. Also, its facile to move. It sprays the pesticide just by using the power developed while moving the wheels. This power developed during movement of wheels is utilized in pumping the pesticides. In this self powered equipment, the reciprocating piston itself is a pressure chamber which creates necessary pressure for spraying action.

The proposed equipment serves as an effective tool for pest management which not only minimizes the risk to user but also protects the environment. The drawbacks in the conventional sprayers are over comed to great measure in the project “Self Powered Pesto-Sprayer”
1. INTRODUCTION

Agriculture plays a vital role in India’s economy. Nearly 65% of population in the state depends on agriculture. Although its helping hand to GDP is about 1/6 th, it provides bread and butter to around 56% of Indian work force. So, any improvements in the productivity related to this field will help to increase Indian farmer’s status and economy. At present, the sprayers in use have lot of limitations and require more energy to operate them. [1]

A pesticide sprayer has to be portable with high capacity tank and it should result in reduction of cost and spraying time. In order to reduce the cost and spraying time, numbers of sprayers have been introduced in the market. But, these devices do not satisfy all the demands of the farmers.

A manually operated pesto-sprayer uses human power and mechanical advantage to spray pesticides/fluids over the crops. It is very effective method for spraying pesticides at home, gardens, and irrigation.

Objectives of the study

- Decrease the operational cost by using new mechanism.
- Work reliably under different operating conditions.
- To reduce the price of machine.
- To reduce the labour cost by advancing the spraying method.
- Machine should operate in small farming land also.

So considering points relevant to spraying and weeding, efforts are taken to design and counterfeit such gadget which will be able to perform both the operations more efficiently and also will result in low cost.

Table I Percentage variation of farm holding and working area for various farmers

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Marginal</td>
<td>39.4</td>
<td>45.9</td>
<td>57</td>
<td>62.7</td>
</tr>
<tr>
<td>Minor</td>
<td>22.2</td>
<td>22.5</td>
<td>19.4</td>
<td>17.7</td>
</tr>
<tr>
<td>Small &amp; Marginal</td>
<td>61.8</td>
<td>68.3</td>
<td>75.4</td>
<td>80.4</td>
</tr>
<tr>
<td>Semi – Moderate</td>
<td>19.7</td>
<td>17.8</td>
<td>14.3</td>
<td>13</td>
</tr>
<tr>
<td>Moderate</td>
<td>13</td>
<td>11.2</td>
<td>8.5</td>
<td>6.5</td>
</tr>
<tr>
<td>Large</td>
<td>4.6</td>
<td>3.5</td>
<td>1.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

The percentage distribution of farm holding land for marginal farmers is 39.4 percentage, for small farmers 22.2 percentage, for small and marginal farmers 61.8 percentage, for semi-medium farmers 19.7 percentage, for medium farmers 13 percentage and for large farmers 4.6 percentage in year 1960-61. Table 1 clearly explain that the maximum percentage of farm distribution belonged to small and marginal category.
2. DRAWBACKS IN EXISTING SPRAYER PUMPS

The Indian farmers generally use lever operated backpack sprayer. But it has certain limitations associated with it.

1. The backpack sprayer tank capacity is about 18 liters which is not enough and covers less area of land. Also it becomes a time consuming process.
2. Constant pumping is required to operate this which results in muscular disorder. Also, developing enough pressure is tough and time consuming.
3. The backpack sprayer cannot maintain desired pressure resulting in an unsteady stream of pesticides. This results in inadequate spraying over the crops.
4. The backpack sprayer consist of two adjustable straps for carrying the tank which may result in back pain arising during middle age due to carrying of 10-20 liter tank on back.
5. Presently farmers are using backpack sprayer for spraying pesticides on crops in their farms which costs for Rs 2500-5000/. This sprayer has wide limitations and thus farmers can use another sprayer wiz. Bullock driven spray pump and tractor loaded sprayer. Cost of bullock driven is about Rs 25000/-. But though this sprayer has high advantages but are not affordable by farmers of developing nation.²

3. CONSTRUCTION

The various components we used to complete our project are as follows:

3.1 CHAIN DRIVE: Chain drive is a method of conveying mechanical power from one point to other. It is often used to convey power to the wheels of a vehicle, mainly cycles and motorcycles. Sometimes the power is obtained by simply rotating the chain, which can be used to uplift or pull objects. In other conditions, a second gear is placed and the power is taken by attaching shafts or hubs to this gear. Gears that do not give power to the system or transmit it outside are generally known as idler-wheels. The both sprockets used in this model are having 18 teeth.

3.2. WHITWORTH MECHANISM: The Whitworth Quick return mechanism translates rotational motion to reciprocating motion, but the forward direction reciprocating motion takes less time than the return stroke. Due to this it is termed as quick return mechanism.

This mechanism is made of a driving crank and of a driven slider crank. In this configuration, the fixed pivot in the driven crank is near outer part of the circle on which the tip of the driving crank moves. This induces an alternated motion of the slider crank.

The angular speed of the driven crank is irregular. The time taken by the motion for its part corresponding to the arc is shorter than the one related to another arc. This is why it is named quick return mechanism, which was used in crank shapers, with the slow part / stroke being used for the productive time of the tool and the quicker part for the non-productive time.
4. WORKING

A tank has been installed first with piston and cylinder inside it and this piston is connected to sprayer through pipe and mounted on the frame which is connected between shafts by means of chain.

When we push the main body, the wheel rotates and thus shaft above it also rotates by means of a chain drive. The same shaft consists of the disc with a pin which is engaged with slotted bar. Using Whitworth mechanism, the rotary motion of shaft is converted into oscillatory motion which is transmitted to the piston with the help of connecting rod.

This makes the piston moves upward due to which vacuum is developed and sucks fluid from the tank and get stored in the pressure chamber and further sprayed through sprayer. Also a separate arrangement is provided which helps in spraying fluid even in the rest/stable position of vehicle.
5. CALIBRATION OF SPRAY PUMP

The methodology is thus:

1. **Assess walking speed** – The average walking speed while pushing the sprayer is calculated about 4 kmph.
2. Measure the output of the sprayer – When the piston in tank creates a desired pressure, release the button and hold the nozzle into a metric calibrated vessel like a jug and time for 1 minute. The amount of liquid collected in the jug is the measure of output which is found to be 0.8 liters per min for a single nozzle.

3. The swath width – For a single nozzle swath width is about 60”. Thus considering four nozzles the total swath width is about 3.2 meter.[4]
4. The formula for evaluating the overall output of the sprayer per Hectare =

   \[
   \text{Output per Hectare} = \frac{600 \times \text{output of nozzle}}{\text{Walking speed} \times \text{swath width}}
   \]

Where,

600 is a constant figures like the ‘360’ in the speed formula
Output of nozzle = 0.8 \times \text{number of nozzle} = 0.8 \times 5 = 4 \text{ liters per minute}
Walking speed = 4 \text{ kmph}
Swath width = 3.2 \text{ m}
Self Powered Pesto-Sprayer

Output of the sprayer per Hectare = $600 \times 4 \times 3.2$

$= 187.5 \text{ lit / hectare} = 75 \text{ lit / acre}$

For knapsack sprayer total output of sprayer is measured as 74.8 lit / acre and it has a tank capacity is 18 litres. Hence it will require 4 to 5 trips to complete spraying.

Now for self powered pesto sprayer output of sprayer is 75 lit / acre and the tank capacity is 35 litres. Hence it will require 2 to 3 trips to complete spraying.

Comparing the above two outputs it is concluded that using self powered pesto sprayer time required for completing the spray is less than that of the knapsack sprayer. [3]

6. DESIGN CALCULATIONS

To find diameter of shaft which is under twisting and bending moment

![Figure 4.1 Bending moment diagram](image)

**Given data:**

- Speed = 40rpm
- Weight of sprocket = 350gm
  $= 350 \times 10^{-3} \text{ Kg}$
  $= (350 \times 10^{-3}) \times 9.81$
  $= 3.43 \text{ N}$
- $P = 500 \text{ W}$
- From data book:-
  - $\sigma_{yt} = 320 \text{ N/(mm)}^2$
  - $\sigma_{ys} = 160 \text{ N/(mm)}^2$
  - FOS = 4

**Solution:**

- $\sigma_t = \sigma_{yt} / \text{FOS}$
  $= 320/4$
  $= 80 \text{ N/(mm)}^2$
- $\sigma_s = \sigma_{ys} / \text{FOS}$
  $= 160/4$
  $= 40 \text{ N/(mm)}^2$

\[P=2\pi NT/60\]
\[T=500*60 / 2\pi*40\]
Bending Moment,
\[ M = \frac{W \times a \times b}{L} \]
\[ M = \frac{3.43 \times 80 \times 60}{140} \]

Equivalent Twisting Moment,
\[ T_e = \sqrt{M^2 + T^2} \]
\[ T_e = 119.36 \times 10^3 \text{ N-mm} \]

Equivalent Bending Moment,
\[ M_e = 0.5 \times (M + T_e) \]
\[ M_e = 59.73 \times 10^3 \text{ N-mm} \]

By torsional equation,
\[ T_e = \left( \frac{\pi}{16} \right) \tau d^3 \]
\[ 119.36 \times 10^3 = \left( \frac{\pi}{16} \right) \times 40 \times d^3 \]
\[ d = 27.56 \text{ mm} \]

By bending equation,
\[ M_e = \left( \frac{\pi}{32} \right) \sigma b d^3 \]
\[ d^3 = \frac{(59.73 \times 10^3 \times 32)}{\pi \times 80} \]
\[ d = 19.66 \text{ mm} \]

Selecting larger value of diameter of shaft,
So, \[ d = 27.56 \text{ mm} \]
Say, \[ d = 30 \text{ mm} \]

7. CONCLUSION

- Our study was intended to develop a concept of push operated spray pump with the motivation of saving space and precluding exertion by the operator.
- As this is the era of automation there is less scope of manually operated project. But they are also somewhere important for energy consumption.
- There must be a change in wheels so that they can be operated in all the areas as well as provide caster wheels so as to change the direction of motion.

REFERENCES