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Design Considerations of a Cycle Mounted Agricultural Sprayer

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***Abstract*—Farming in India is a traditional affair, involving sticking to the same old equipment and techniques. This paper attempts to design a smart technology that reduces farming efforts in spraying, and it aims to provide this at a cost affordable to a small-scale Indian farmer. The presented design considerations are for the cycle mounted spray pump assembly.**

Keywords—design; farming; spraying; mechanical; agro-mech;

I. INTRODUCTION

India is a land of agriculture; most of the population in India is dependent on farming for its livelihood. The economic conditionsof average Indian farmers are poor and hence they cannot afford large automatic effortless mechanization for their farms. Spraying is an essential component of farming as it is important to spray the pesticides to improve the efficiency of yields and meet the growing food requirements of India. The average Indian farmer is using conventional methods for spraying of crops, these methods includes the knapsack sprayer which has to be mounted on back and requires the lever to be operated manually in order to spray .Continuous weight on back of farmer leads to back pain and manual pumping leads to wastage of efforts of the farmers. There is need to reduce this efforts, and speed up the spraying application in the field. The study of practices of farming in India is important for the effective design of a new kind of sprayer. These include practices followed by the farmers for seeding in different conditions with different kind of crops; this will give the design considerations for size of the sprayer and height of boom to be reached.Bicycle is commonly available means for transportation in villages. It is cheap and portable. Hence, we have used bicycle to carry and drive the proposed spray pump assembly effectively. One can either walk with the bicycle assembly on the side or ride it, depending on convenience.

II. LITERATURE SURVEY

A. *KNAPSACK* *[1]*

Knapsack is the most commonly used type of sprayer. The problems associated with which include-

- Back pain and exertion of the user due to its heavy weight and manual pumping.
- When the pressure inside the spay cylinder increases, the width of spray increases, thereby causing the wastage of pesticides.
- When Pressure in the tank fluctuates, it causes the flow to become turbulent which is highly undesirable.
- Herbicide/Pesticide gets into the eye of the user causing irritation.

B. *POWER SPRAYER*

CROP	**COTTON**	**JOWAR**	**PULSES**	**MAIZE**
Recommended package of Practices R*P-P (cm*cm)	**90*90 120*60**	**60*30**	**90*60**	**60*30**
Maximum Height of Plant Growth	**4-6ft**	**4-5 ft.**	**3.5-4 ft.**	**5-6ft**

Power Sprayers uses an engine instead of manual operation. The drawbacks include-

- The heavy weight distorts the natural curves in the middle and lower backs of the user, causing muscle strain and irritation to the spine joints and the rib cage.
- The heavy weight also causes the person to lean forward, reducing balance and making it easier to fall.
- Vibration of the engine can cause fatigue, insomnia, stomach problems and headache shortly after or during exposure. This could result in a number of health disorders.

C. TRAILED CROP SPRAYER/SELF PROPELLED SPRAYER

These tractor-mounted sprayers, while efficient, do not find a place in small holdings.

- They are very expensive, and not affordable by the average Indian farmer.
- They take up a large amount of space and cannot be used for all types of crops.

III. DESIGN CONSIDERATIONS

Before designing the sprayer the spraying conditions of the farms should be known.

The designed sprayer should not interfere between the crops. Therefore, the growth of different crops and the available distances for the movement of bicycle are taken into account.

India has different soil and weather conditions. As a result, various types of farming conditions exist, which results in a variety of crops optimal for different conditions.

For the design considerations of the sprayer we havetaken into account four major crops of India into account viz. Cotton, Jowar, Pulses (Red gram,Green gram, Bengal gram etc.) and Maize.

Recommended package of practices for these crops are given in the table below.

TABLE 1.RECOMMENDED PRACTICES FOR CROPS[2][3][4]

The R*P-P is the spacing distance between crops it is Row by Plant- Plant distance between two crops and the maximum height of the crop so that the boom to be reached to that height.

From above we can consider width of the sprayer should not exceed 60cm.

And height of the boom to be reached should be 6 ft.

From general practices the amount of spray solution needed to spray 1 acre of land is 60 liters which can be refilled again.

Considering the bicycle mounted agricultural sprayer, we take the capacity of spray tank to be 40liters.This is done to reduce the weight of the sprayer to increase portability.

IV. DESIGN

Calculations for pump capacity

Formula used-

$$gpm = \frac{gpa \times mph \times w}{5940} \quad [5]$$

gpm = gallons per minute, the nozzle flow rate.

gpa = gallons per acre, a decision made based on label recommendations, field conditions, spray equipment and water supply.

mph = the ground speed you select, miles per hour.

w = band width or spacing between nozzles in inches.

5940 = A constant to convert gallons per minute, miles per hour, and nozzle spacing in inches to gallons per acre.

Pump Capacity=(Boom requirement)*(1.2)

Boom requirement=Nozzle flow rate(gpm)

1.2=factor to provide agitation and offset pump wear

(20% greater capacity).

For 1 acre of land we require 60lit. solution

(as a rule of thumb)

Gpa =gallons per acre

=15.50

(3.875 lit = 1 gallon)

The average walking speed of man is 5km/hr. = 3.1 miles/hr.

Therefore, Mph (miles per hour) =velocity of vehicle

=3.1mph

W= band width (spacing of nozzles)

= 120 cm = 47.2 inches

Therefore,

Boom requirement (gpm) = (gpa*mph*w)/5940

gpm= (15.50*3.1*47.2)/5940

gpm=0.38

Pump Capacity= (Boom requirement)*(1.2)

Pump capacity (Q) = 0.38*1.2

=0.456 gpm

=1.764 lit/min

=1764 cm3/min

V. CONCLUSION

1. The suggested model has removed the problem of back pain, since there is no need to carry the tank (pesticides tank) on the back.
2. The suggested model has more capacity than knapsack ,hence it reduces the need to refill.
3. Design considerations have been appropriately chosen from agricultural practices, layout of farm and dimensions of crops.
4. Flow rate of the sprayer has been calculated.

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