MULTI NOZZLE MANUALY OPERATED SPRAYER

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Abstract :As on today the whole world is facing a problem of energycrisis. If we want to continue for prolonged use of energy then we must try tosave it as much as we can whether it is on large scale or small scale. Today weuse various spraying and seed sowing technologies involving use of electricalenergy, chemical energy of fuels. This fact makes us know that how largecontent of energy is getting used at such a places where mechanical energy canbe used instead of direct energy sources. This is a reason why we haveimplemented mechanical sprayer getting powered by human effort. Althoughthese are serving the purpose, their range of working is not enough. They takeconsiderably larger time for spraying. Thus what we have aimed is to designsuch a technology which will run on mechanical power but requiring less timefor spraying than those which are hand operated. Thus considering today'sdemand, we have come up with mechanically operated spray pump and seedsowing which is purely mechanical. This device is having the advantage oftaking less time for spraying and seed sowing once it starts. In addition to allthis we are implementing soil coulter along with spray pump so we can havedouble advantage.Mechanical energy can be used instead of direct energy sources.This is a reason why we have implemented some mechanical sprayers and seedsowing equipment getting powered by human effort. Although these are servingthe purpose, their range of working is not enough. They take considerably largertime for spraying and seed sowing. Thus what we have aimed is to design sucha technology which will run on mechanical power but requiring less time forspraying and seed sowing than those which are hand operated.

IndexTerms–Spray,Multipurpose Sprayer, Agriculture,

I. INTRODUCTION

As on today the whole world is facing a problem of energy crisis. If we want to continue for prolonged use of energy then we must try to save it as much as we can whether it is on large scale or small scale. Today we use various spraying and seed sowing technologies involving use of electrical energy, chemical energy of fuels. This fact makes us know that how large content of energy is getting used at such a places where mechanical energy can be used instead of direct energy sources.

This is a reason why we have implemented mechanical sprayer and seed sowing getting powered by human effort. Although these are serving the purpose, their range of working is not enough. They take considerably larger time for spraying and seed sowing. Thus what we have aimed is to design such a technology which will run on mechanical power but requiring less time for spraying and seed sowing than those which are hand operated. Thus considering today's demand, we have come up with mechanically operated spray pump which is purely mechanical. This device is having the advantage of taking less time for spraying and seed sowing once it starts. If we want to decrease the spraying time further we just need to increase size of our piston and no. of nozzles with relative change in effort.

In addition to all this we are implementing soil coulter along with spray pump and seed sowing so we can have double advantage. Mechanical energy can be used instead of direct energy sources. This is a reason why we have implemented some mechanical sprayers and seed sowing equipment getting powered by human effort. They take considerably larger time for spraying and seed sowing. Thus what we have aimed is to design such a technology which will run on mechanical power but requiring less time for spraying than those which are hand operated.India is land of agriculture which compromises small, marginal, medium and rich farmers. Small scale farmers are very interested in backpack type sprayer because of its price, versatility, cost and design. But this sprayer has certain limitations like it cannot maintain required pressure; it leads to problems of back and solder pain. However this equipment can also leads to misapplication of chemicals and ineffective control of target paste which leads to loss of pesticides due to dribbling or drift during application. This phenomenon not only adds to cost of production but also cause environmental pollution and natural imbalance in echo system. The manually operated spray pump and seed sowing equipment which will perform maximum rate in minimum time. Constant flow valves can be applied at nozzle to have uniform nozzle pressure. In the modern agriculture, the usage of pesticides is still increasing, moreover the 90% of these pesticides are being applied in the form of liquid spray and mostly by using the pressure gained from direct energy sources like electrical energy, chemical energy. Increasing public concern about the potential damage of chemical and electrical inputs in agricultural spraying systems has challenged industry to develop new and effective methods of spraying which will maintain environment friendly approach.

The current backpack sprayer has lot of limitation and it required more energy to operate. The percentage distribution of farm holding land for marginal farmers is 39.1 percentage, for small farmers 22.6 percentage, for small and marginal farmers 61.7 percentage, for semi-medium farmers 19.8 percentage, for medium farmers 14 percentage

and for large farmers 4.5 percentage in year 1960-61.Table 1 clearly explain that the maximum percentage of farm distribution belonged to small and marginal category.

Table I: Percentage distribution of farm holding and operated area for various farmers

	Percentage distribution of farm holding				Percentage distribution of Operated Area			
Land Class	1960-61	1981-82	1991-92	2002-03	1960-61	1981-82	1991-92	2002-03
Marginal	39.1	45.8	56	62.8	6.9	11.5	15.6	22.6
Small	22.6	22.4	19.3	17.8	12.3	16.6	18.7	20.9
Small & Marginal	61.7	68.2	75.3	80.6	19.2	28.1	34.3	43.5
Semi-medium	19.8	17.7	14.2	12	20.7	23.6	24.1	22.5
Medium	14	11.1	8.6	6.1	31.2	30.1	26.4	22.2
Large	4.5	3.1	1.9	1.3	29	18.2	15.2	11.8
Total	100	100	100	100	100	100	100	100

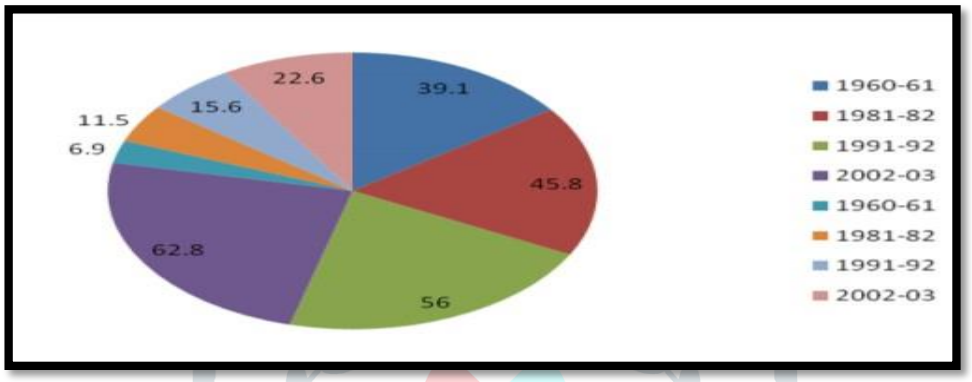

Figure 1: Percentage-wise Land distribution from 1960 to 2003

Fig 1 shows that percentage of the marginal, small and semi medium farmers is about 92.15 %, which states that growth of these farmers require advanced equipment which will work faster than existing one.

II. RESEARCH METHODOLOGY

The sprayer machine is pulled manually leaving behind the spraying effect, since the pesticide is hazardous to health, the person is moving ahead and behind him is the spray. Here the wheel driving the spur drives gear which drives the driven gear to rotate. Here the wheel is of 500mm diameter and the drive gear is of 45number of teeth which drives the driven gear with15 numbers of teeth which gives us the ratio of 1:3. here the wheel covering the distance of 500mm x 3.142 = 1571mm during which the pumping is done for 3 times so, each stroke is effective at a distance of 1571/3= 524mm travel distance. Next we are having the pump piston of 50mm and the stroke length as 100mm, cranking provided at the crank is 50mm. the tank held on the tank holder which is fixed on the frame, the driven gear driving the crank which pushes and pulls the cranking of the tank pump arm which effects in building the pressure generated into the accumulator which dispenses the pressure through the outlet port and through the valve provided which is connected through the four way splitters to the four jets which are fixed on the adjustable boom, the adjustment given to adjust for height and also for the rows as required. We are providing four number of jets which are fixed to the polyurethane connectors with 8mm pipe insertion into it which are held on the plates welded to the guide bushes held on the rods on the boom as required.

III. WORKING PRINCIPAL

- Motion transmission by chain and sprockets arrangement.
- Slider crank mechanism.
- Rotary motion converted into reciprocating motion.

3.1 Working

Following Figure 2 shows the assembly of the agricultural reciprocating multi sprayer. The operator grabs the handle and pushes the cycle forward as cycle moves forward, the wheel rotate. When the wheel rotates then the gear sprocket mounted on wheel is also rotate at same speed. The chain drive transfers the motion of gear sprocket to pinion sprocket. The pinion sprocket and crank is mounted on either side of same shaft, the rotary motion of shaft is converted into the reciprocating motion with the help of crank and connecting rod mechanism. The connecting rod is also connected with lever and then the lever oscillates at fulcrum.

The piston connected at fulcrum produce reciprocating motion in cylinder and the required pressure is achieved. The pesticide from tank sucks in cylinder and piston forced the pesticide to nozzle through the pipe; the numbers of nozzles are connected to spray the pesticide. We can adjust the pressure, which is required for spraying with the help of special arrangement is to change the length of crank by providing slot on crank.

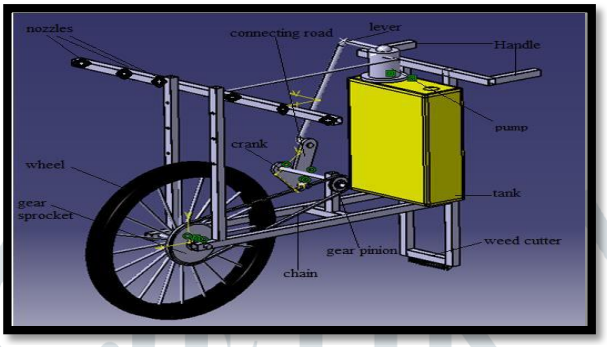

Figure 2:Agricultural Reciprocating Multi-Sprayer

By providing some adjustment at joint of connecting rod and lever free rotation of crank or neutral position can be achieved. Using these adjustments pumping is stop and the wheel rotate freely when you need not spray pesticide. Height, position and angle of the nozzle can be adjustable.

The difference of the sprocket and pinion helps in the proving the speed. The crank shaft arrangement placed on the same shaft the pinion place, the pinion gives his rotation to that crank shaft. Here the rotary motion is converted into reciprocating with the help of piston having 150mm stroke, Ø100mm. Just on the piston the pump is placed having non-return valve which helps to create pressure in the tank nearly 13.5 psi pressure can be created in the small tank having the capacity of 3lit. Piston pumps having the two outputs and one input. The input is attached to the larger tank contain solution of pesticide and two outputs are help to cover the larger area in the less time.
models which are being used to forward the study from data towards inferences. The detail of methodology is given as follows.

. In future it can be used to generate electricity by connecting dynamometer at rear wheel of bicycle. This mechanism can also be used for winnowing. Power transmission to other sources, which can transfer manual work to machine work. Use of positive drive utilizes total power consumption for various farming functions in different types of equipment. Multi-operational Machine can designed using such concept of mechanism.

The gear ratio we have used in this project is 1:3 which can be varied according to the need and design in order to obtain variety of performances in the sprayer. More number of nozzles can be utilized. Higher capacity bag pack sprayer can be used.

IV. DESIGN SELECTION

4.1 Selection of Wheel

Distance between two plants = 1.25 feet = 38 cm.

Line covered by one rotation of wheel = 4

$38 * 4 = 152$ cm

$152 = 2\pi r$

$r = 152/2\pi$

$r = 25$ cm

The diameter of wheel = 50 cm

4.2 Selection of Pinion

Minimum no. of teeth available on pinion = 18

Outer dia. Of pinion = 8 cm = 80 mm

Inner dia. Of pinion = 6.5 cm = 65 mm

Pitch circle dia.(Dp) $= \frac{Do-Di}{2} + Di$

$$= \frac{80 - 65}{2} + 65$$

Dp = 72.5 mm

Gear Ratio = 1:3

On rotation of gear sprocket gives three rotation of pinion sprocket, we required three strokes to generate adequate amount of pressure.

3.3 Selection of Gear Sprocket

$$\frac{1}{3} = \frac{Tp}{Tg}$$

$$\frac{1}{3} = \frac{18}{Tg}$$

Tg = 18*3

Tg = 54

$$\frac{Dg}{Dp} = \frac{Tp}{Tg}$$

$$\frac{Dg}{72.5} = \frac{3}{1}$$

Dg = 218 mm

$$\text{Pitch} = \frac{\text{Number of teeth on pinion}}{\text{Pitch circle diameter of pinion}}$$

$$= \frac{18}{72.5}$$

= 0.25 mm

4.4 Selection of Chain

Chain type roller chain.

ISO Chain no. 05B

pitch = 0.25 mm

Length of chain , L = K.P

No. of chain ,

$$K = \frac{T1 + T2}{2} + \frac{2X}{P} + \frac{T2 - T1}{2\pi} * \frac{P}{X}$$

$$K = \frac{54 + 18}{2} + \frac{2 * 478}{0.25} + \frac{54 - 18}{2\pi} * \frac{0.25}{479}$$

K= 3860mm

L= K*P

L= 3860*0.25

L= 965 mm

L= 96.50 cm

4.5 Design of Crank and Connecting Rod by Using Synthesis of Mechanism (Three Position Method)

Crank, AB = 5.1 cm

Connecting Rod, BC1 = 10.8 cm

4.6 Nozzle Selection

Diameter of wheel =50 cm

Let's consider farm of 1 Acre,

Therefore, 1 acre = 4046.86 m^2

$L= \sqrt{4046.86} = 64$ m

Number of plants in 64 meters, NP $=\frac{64}{0.68} = 38$

From survey earlier when hand backpack spray pump used then 60 ltr. of pesticide are used for 1 acre farm. Consider 60 ltr. of pesticide is required for 1 acre farm so how much amount of pesticide is required for one plant .

Total number of plants in 1 acre, 168*168 = 28224

60 ltr.for 1 acre, $\frac{60}{28224} = 2.1258 * 10^{-3}$ltr/plant.

Consider time required for 1 acre farm to spray a pesticide is 3 hrs.= 180 minute

=180/28224 =6.3775 * 10^{-3} min/plant

=1/6.3775 * 10^{-3} = 156.8 plant/min.

Discharge = (2.1258 * 10^{-3}) * (156.8)

Discharge = 0.3333 ltr./min.

Find the pressure drop,

$(Q1|Q2)^2 = \frac{P2}{P1}$

$P_2 = P_1 * (Q1|Q2)^2$

$= 2 * (0.3333|0.4166)^2$

P_2 = 11.279 bar

Pressure drop = 0.72 bar

4.7 Design of Manifold and Pipe Selection

When we carry out small survey we come to know that various pump are use by different farmers but the most probably use pump is having capacity 16 Ltr. with pressure of 2-4 bars.

Pump Pressure = 2-4 bars

Spray Pipe Material = Plastic

Pump discharge = 2 ltr./min = 3.33310^{-5}m3/sec.

$$Q = A*V$$

$$V = 3.33 * 10^{-5} / \frac{\pi}{4} * d^2$$

$$= 4.244 * 10^{-5} / d^2 \text{ m/sec}$$

Major Losses,

Take a Friction Factor, f = 0.09

$$h_{fm} = \frac{4flv^2}{2gd} = \frac{1.123*10^{-10}}{d^5}$$

Loss at Entry,

$$h_{fo} = \frac{0.5v^2}{2g} = \frac{4.590*10^{-11}}{d^4}$$

Loss at Out,

$$h_{fO} = \frac{v^2}{2g} = \frac{9.180*10^{-11}}{d^4}$$

Loss at T Section

Take, Bending Coefficient, k = 0.54 for 90°

$$h_{ft} = \frac{kv^2}{2g} = \frac{4.9573*10^{-11}}{d^4}$$

Total Losses,

$$h = h_{fm} + h_{fE} + h_{fO} + h_{ft}$$

$$h = \frac{1.123*10^{-10}}{d^5} \mp \frac{4.590*10^{-11}}{d^4} \mp \frac{9.180*10^{-11}}{d^4} \mp \frac{4.9573*10^{-11}}{d^4}$$

Required Pressure at nozzle is 2 bar,

Therefore, pressure, P = 2 bar = 2*105 N/m^2

$$P = \rho gh$$

$$2 * 10^5 = 1000 * 9.81 * h$$

h = 20.38 m of water

Therefore,

$$20.38 = \frac{1.123*10^{-10}}{d^5} \mp \frac{4.590*10^{-11}}{d^4} \mp \frac{9.180*10^{-11}}{d^4} \mp \frac{4.9573*10^{-11}}{d^4}$$

$$d = 5.611*10^{-3} \text{ m}$$

d = 5.61 mm = 0.6 cm

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. As suggested model has more number of nozzles which will cover maximum area of spraying in minimum time & at maximum rate.
3. The c.f. valves can also be applied which help in reducing the change of pressure fluctuation and c.f. Valves helps to maintain pressure.
4. Proper adjustment facility in the model with respect to crop helps to avoid excessive use of pesticides which result into less pollution.
5. Imported hollow cone nozzles should be used in the field for better performance.
6. Muscular problems are removed and there is no need to operate the lever.
7. It is upgraded design of manually operated sprayer which will be helpful for small land farmers. It consumes less time and saves money as compared with conventional spraying.
8. This machine does not require any fuel or power so maintenance is less. This model removes vibrations and noise.
9. This alone pump can used for multiple crops.

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