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Design and Fabrication of Agricultural Sprayer, Weeder with Cutter

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Abstract

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, equipment for uniform and effective application is essential. Dusters and sprayers are generally used for applying chemicals. Dusting, the simpler method of applying chemical, is best suited to portable machinery and it usually requires simple equipment. But it is less efficient than spraying, because of the low retention of the dust. In this work we have proposed an equipment that is wheel and pedal operated sprayer, it is a portable device and no need of any fuel to operate, which is easy to move and sprays the pesticide by moving the wheel and also peddling the equipment. In this equipment using reciprocating pump and there is a accumulator provided for the continuous flows of liquid to create necessary pressure for the spraying action. This wheel operated pesticide spray equipment consumes less time and avoids the pesticide from coming from front of the nozzles which will in contact of the person who sprays pesticides. Weed management is one of the tedious operations in crop production. Because of labor costs, time and fully manual weeding is unfavorable. Hence effort is made to design and develop efficient Farm equipment to perform weeding without using electric power.

Index Terms- *Mechanization, Weeding, Cutting and Spraying.*

1. INTRODUCTION

Insects are largely responsible for the crop destruction. Insecticides or pesticides, a man made or natural preparation are used to kill insects or otherwise control their reproduction. These herbicides, pesticides, and fertilizers are applied to agricultural crops with the help of a special device known as a "Sprayer," sprayer provides optimum performance with minimum efforts. The invention of a sprayer, pesticides, fertilizers, bring revolution in the agriculture or horticulture sector especially by the invention of sprayers, enable farmers to obtain maximum agricultural output. They are used for garden spraying, weed and pest control, liquid fertilizing and plant leaf polishing. There are many advantage of using sprayers such as easy to operate, maintain and handle, it facilitates uniform spread of the chemicals, capable of throwing chemicals at the desired level, precision made nozzle tip for adjustable stream and doing capable of throwing foggy spray, light or heavy spray, depending on requirement. Agriculture sector is facing problems with capacity issues, shrinking revenues, and labour shortages and increasing consumer demands. The prevalence of traditional agriculture equipment intensifies these issues. In addition, most formers are desperately seeking different ways to improve the equipment quality while reducing the direct overhead costs (labour) and capital. Thus, a significant opportunity rests with understanding the impact of a pesticide sprayer in an agriculture field. A pesticide sprayer has to be portable and with an increased tank capacity as well as should result in cost reduction, labour and spraying time. In order to reduce these problems, there are number of sprayer introduced in the market but these devices do not meet the above problems or demands of the farmers. The conventional sprayer having the difficulties such as it needs lot of effort to push the liver up and down in order to create the pressure to spray. Another difficulty of petrol sprayer is to need to purchase the fuel which increases the running cost of the sprayer. In order to overcome these difficulties. We have proposed a wheel driven sprayer, it is a portable device and no need of any fuel to operate, which is easy to move and sprays the pesticide by moving the wheel. The mechanism

involved in this sprayer is reciprocating pump, and nozzles which were connected at the front end of the spraying equipment,[1].

2.LITERATURE REVIEW

The common disadvantage was that the engine runs down easily and the cost of production was high for an average individual to purchase. Rotary movers were not developed until engines were small enough and powerful enough to run the blades at a high speed. Many people experimented with rotary blades in the late 1920s and early 1930s, and Power Specialties Ltd. introduced a gasoline powered rotary mover. The story of one experiment in the design of rotary moving equipment is that of C Stacy, a farmer in the Midwest region of the United States. His concept was the use of a toothed circular saw blade mounted horizontally on a vertical shaft, which would be suspended at a height of approximately 2 inches (50 mm) and moved across a lawn to cut grass and other lawn vegetation at a uniform height. The power for his experimental mower was an electric motor,[2].

2.1 Backpack (knapsack) sprayer

One type of backpack sprayer is a compressed air sprayer with a harness that allows it to be carried on the operator's back. Another type of backpack sprayer has a hand-operated hydraulic pump that forces liquid pesticide through a hose and one or more nozzles. The pump is usually activated by moving a lever. A mechanical agitator plate may be attached to the pump plunger. Some of these sprayers can generate pressures of 100 pounds per square inch (psi) or more. Capacity of both these types of backpack sprayers is usually 5 gallons or less Hydraulic sprayers consist of a tank, a pump, a lance (for single nozzles) or boom, and a nozzle (or multiple nozzles). Sprayers convert a pesticide formulation, often containing a mixture of water (or another liquid chemical carrier, such as fertilizer) and chemical.

Fig.1: Backpack Type Spraying

into droplets, which can be large rain-type drops or tiny almost-invisible particles. This conversion is accomplished by forcing the spray mixture through a spray nozzle under pressure. The size of droplets can be altered through the use of different nozzle sizes, or by altering the pressure under which it is forced, or a combination of both. In order to increases the rate of spraying with permeable time.

2.2 Lite-Trac

Lite-Trac is a trading name of Holme Farm Supplies Ltd, a manufacturer of agricultural machinery registered in England and based in Peterborough.The Lite-Trac name comes from "lite tractor", due to the patented chassis design enabling the inherently very heavy machines manufactured by the company to have a light footprint for minimum soil compaction.

Fig. 2: Lite-Trac Spraying

Holme Farm Supplies Ltd agricultural products, sold under the Lite-Trac name, include tool carriers, self-propelled lime and fertilizer spreaders, sprayers, granular applicators and tank masters. Lite-Trac is currently the manufacturer of Europe's largest four-wheeled self-propelled crop sprayers. The company's products are identifiable by the combination of unpainted stainless steel tanks.

2.3 Spraying Techniques

The liquid formulations of pesticide either diluted (with water, oil) or directly are applied in small drops to the crop by different types of sprayers. Usually the EC formulations, wet able powder formulations are diluted suitably with water which is a common carrier of pesticides. In some cases however, oil is used as diluent or carrier of pesticides. The important factors for spray volume consideration are: The volume of spray liquid required for certain area depends upon the spray type and coverage, total target area, size of spray droplet and number of spray droplets. It is obvious that if the spray droplets are coarse-size then the spray volume required will be larger than the small size spray droplets. Also if the thorough coverage (eg. both the sides of leaves) is necessary then the spray volume requirement has to be more.

3. OVERVIEW OF MACHINE

Bright yellow cabs and detailing. A Lite-Trac crop sprayer, or liquid fertilizer applicator, mounts onto the SS2400 Tool Carrier centrally between both axles to maintain equal weight distribution on all four wheels and a low centre of gravity whether empty or full. The stainless steel tanks are manufactured in capacities of up to 8,000 liters, whilst Pommier aluminum booms of up to 48 meters can be fitted, making these Europe's largest four-wheeled self-propelled sprayers,[3].

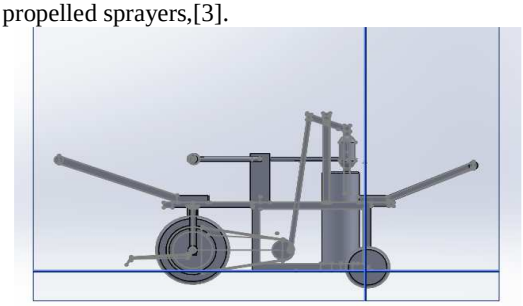

Fig.3: 2D CAD Model

3.1 Motorcycle driven multi-purpose farming device (Bullet Santi)

In 1994, Mansukhbhai Jagani, developed an attachment for a motorbike to get a multi-purpose tool bar. It which addresses the twin problems of farmers in Saurashtra namely paucity of laborers and shortage of bullocks. This motor cycle driven plough (Bullet Santi) can be used to carry out various farming operations like furrow opening, sowing, inter-culturing and spraying operations. Mansukhbhai's intermediate-technology contraption proved,[7].

3.2 Weeding or Weed control

Weed control is the botanical component of pest control, using physical and chemical methods to stop weeds from reaching a mature stage of growth when they could be harmful to domesticated plants and livestock. In order to reduce weed growth, many "weed control" strategies have been developed in order to contain the growth and spread of weeds,[6].

In world the usage of agriculture equipment is increasing. In the usage ofagriculture. Equipment's, India contributes only 10% as Conducted survey in year2012.two types of harvesting methods generally available in India are 1.Manual method2. Mechanized type of harvesting In Manual Harvesting to cut one acre of crop 15-16 labors are required they take 3 days to cut one acre and involves harvesting of 60-70 tons per acre with labors being paid 500-550 Rupees per ton of harvest hence total cost of harvesting per acre comes up to 30,000-35,000 Rupees. In mechanization now by using large scale harvesting machine takes about 6-7 hours for harvesting one acre averaging about 60-70tons with labor costing around 3,500 4,000Rupees per hour, [4].

4. PARTS OF MACHINE AND ITS SPECIFICATIONS

4.1 Power head

Includes the wheel known as the source of transmitting power, go to the sprocket makes the rotations take place & further it drown into the spraying systems.

4.2 Gear Box mechanism

Basically the purpose of the gear box is to increasing or decreasing the speed of the machine, generally we can used the chain sprocket arrangement with the bevel gear arrangement

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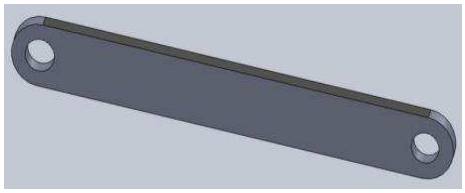

Fig 4: Connecting Link

4.3 Crank mechanism to the reciprocating pump

Generally the crank is attached to the one of the rotating wheel & other end is attached to the reciprocating pump i.e. the pump is under working. The inlet & outlet is connected to the pump through inlet sucked the water & discharge through the nozzles for spraying purpose .

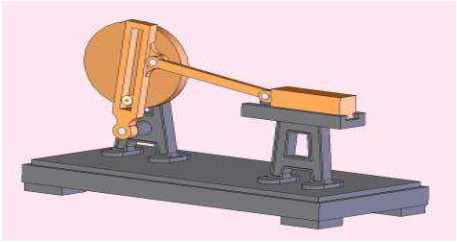

Fig. 5: Slider Crank Chain Mechanism

4.4 Nozzles system

Nozzle mounted on the front of the frame generally we can adjusted the nozzle in any desirable directions. The flooded type of the nozzles used

Fig 6: Nozzle

4.5 Cutter

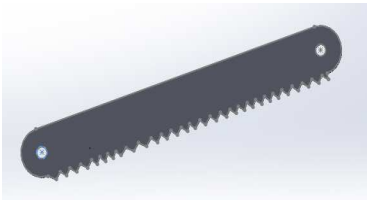

Fig.7 Cutter

5 Sample calculation

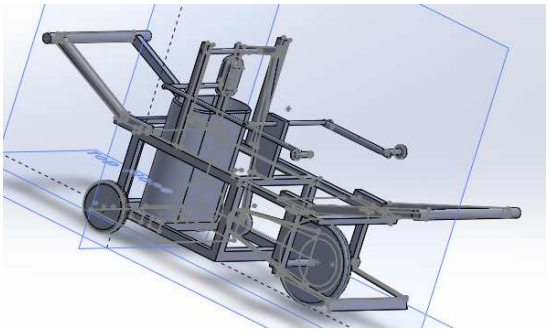

Fig. 8: 3D CAD Model

Speed of the main wheel N_1 = 25 rpm
Speed of the sprockets $N_B = N_A$ = 60 rpm
Length of the connecting rod is = 440 mm
Distance between the wheel and the smaller sprockets = 500 mm
Distance between the sprockets and the reciprocating pump=46cm
Length of the crank=16cm
Stroke length of the reciprocating pump=18cm
Discharge through the nozzle per rotation of pump=6.38ml/stroke
Pump stroke per rotation of wheel= 3 stroke
In ideal condition rate of discharge through the pump= 1.58 lit/min
In working condition rate of discharge through the pump=0.166 lit/min
Rotation of wheel per minute N_1 =22 rpm
Delivery of pesticide per stroke of the pump = 6.29=7ml
Delivery of pesticide per rotation =12ml
Delivery of pesticide from 2 nozzles = 7ml/stroke
Delivery of pesticide from 1 nozzle =2.68 ml/stroke
Speed of the wheel N_A = 25 rpm
Speed of the sprockets N_B=60rpm
Length of the connecting rod is L = 440 mm

6. SELECTION OF RECIPROCATING PUMP

Speed of Crank N=122 rpm
Required Discharge (with one nozzle)
Q = 3 Lit/min = 0.0166 m^3/sec
Assuming Ratio,
Length/Diameter= 2.769

Q = ALN/60……. for single acting
Q = 2ALN/60……... for double acting

Where, A = Area of piston = 331830.72 mm
L = Length of stroke=180 mm
D=diameter of piston = 650 mm
Speed of piston or RPM of crank= 122 rpm

Q = 2ALN/60
Q = $2*18*10^{-2}*(\pi/4)*(65*10^{-2})*122/60$
Q = 2*1.39 m^3/sec
For…… Q = 1 Lit = 3000 cm^2
Q = 2*1.39*60 = 166.84 m^3/min
Q = 0.166.8 lit/min
L= 180mm
D= 65mm

So, pump having the diameter 18 cm and length 65 cm is chosen

CONCLUSION

The equipment is purposely design for the farmers having small farming land say 5-6 acre. It is suitable for spraying as well as weeding at minimum cost for the farmer so that he can afford it. The equipment will results more beneficial when it is subjected to moist soil for weeding purpose, due to moist soil the weed cutter can easily penetrate and dig out the soil and hence will easily accomplished the weeding process.

The performance of the equipment will increase when it is operates on the smooth surface or less uneven surface and also it will be more effective when it is used on the crops having nearly similar height and having the less space between two crops.

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