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Design and Fabrication of Multipurpose Wheel Spayer Machine

Ashutosh Shimpi Ruchir Shinde Sarang Kulkarni Vaibhavi Todkar
UG Student
Department of Mechanical Engineering JSPM's RSCOE Pune India.

Abstract— *Indian farmers use the traditional method, there is a large scope for development in the agricultural sector. The fertilizing and pesticides spraying process are done manually which become costly for farmers having small farming land, its time consuming and requires separate setup. Various crops such as tomato, beans, ground nut require constant monitoring and application of pesticides and fertilizer. In large scale fields, big sized sprayers will be used. While most of the medium and small-scale farmers' use the knapsack sprayers for spraying, this is tedious to carry it around the entire field as it requires both the hands to be in constant motion for the sprayer action to take place. Pesticide sprayer and fertilizer dispenser comprises of wheeled storage and sprayer system which will reduce overall workload on the cultivator.*
Key words: *Pesticide Sprayer & Fertilizer Dispenser*

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I. INTRODUCTION

Farming is the backbone of Indian economy. In this agriculture sector, there is a lot of field work, such as weeding, reaping, sowing etc. Apart from these operations, spraying is also an important operation to be performed by the farmer to protect the cultivated crops from insects, pests, funguses and diseases for which various insecticides, pesticides, fungicides and nutrients are sprayed on crops for protection. Farming has undergone a great evolution in last 50 years. Out of the various reasons involved for this evolution is control of various diseases on crops [1].

In the modern agriculture, the usage of pesticides is still increasing moreover the 90% of these pesticides are being applied in the form of spraying which will maintain environment friendly approach. The argument for using existing conventional equipment is that farmers will face economic difficulties in case of chemical and electrical powered pumps as well as they will face health issues in case of hand operated pumps [2].

Pesticides are the chemicals used to control the various diseases in crops. Farmers use various types of sprayers for pesticide spraying. Types of sprayers depend on the spraying methods. Basically, there are four types of sprayers; Backpack (Knapsack) Sprayer, Machine mounted sprayer, Motorcycle Driven sprayer and aerial sprayer. Recently there are many research works are going on sprayer pumps for the welfare of the farmers. Wheel driven sprayers have been developed in present scenario which aids human comfort while working. Multi - purpose spraying pumps are added advantages in this regard, which will run on mechanical power and consume less time when compared with hand operated pumps. The difficulties are minimized by modifying the two stroke petrol engines. Direct current motor is operated by the electric energy by utilizing battery power. The pumping efficiency is increased by selecting the suitable type of nozzle spray patterns [3].

A fertilizer is any material, organic or inorganic, natural or synthetic, that supplies plants with the necessary nutrients for plant growth and optimum yield. Organic fertilizers are natural materials of either plant or animal origin, including livestock manure, green manures, crop residues, household waste, compost, and woodland litter. Inorganic (or mineral) fertilizers are fertilizers mined from mineral deposits with little processing (e.g., lime, potash, or phosphate rock), or industrially manufactured through chemical processes (e.g., urea).Mined inorganic fertilizers have been used for many centuries, whereas chemically synthesized inorganic fertilizers were only widely developed during the industrial revolution. Inorganic fertilizer use has also significantly supported global population growth - it is estimated that almost five percent of the people on the Earth are currently fed because of synthetic nitrogen fertilizer use [4].

Pesticides are substances that are meant to control pests or weeds. The term pesticide includes all of the following: herbicide, insecticide, insect growth regulator, nematicide, termiticide, molluscicide, piscicide, avicide, rodenticide, predacide, bactericide, insect repellent, animal repellent, antimicrobial, fungicide, disinfectant (antimicrobial), and sanitizer. The most common of these are herbicides which account for approximately 80% of all pesticide use. Most pesticides are intended to serve as plant protection products (also

known as crop protection products), which in general, protect plants from weeds, fungi, or insects [5].
The pattern of pesticide usage in India is different from that for the world in general. As can be seen in Figure 1, in India 76% of the pesticide used is insecticide, as against 44% globally. The use of herbicides and fungicides is correspondingly less heavy. The main use of pesticides in India is for cotton crops (45%), followed by paddy and wheat [5].

One way to overcome this problem is to use the equipment developed for application of the pesticides using mechanical power. In selecting a pump for furnishing a supply of pesticides for farm use, or for spraying insecticides, herbicides or fungicides, we must be sure it is designed for the job to be done. The unit should have sufficient capacity to supply the needed amount of water and spray material in the allowable time.

II. OBJECTIVES

The objective of this paper is to present the status ofthe current trends and implementation of Agriculturaland outline the potential forfuture applications.

Our aim is to fabricate a Prototype or model which can perform thefollowing functions:

- To remove the weight carried by the farmer on the back while spraying pesticides.
- Increase the efficiency of the sprayer by introducing a second nozzle for the same input pressure.
- To increase the region covered per unit time.
- To reduce the effort and time taken for spraying the whole field.
- To introduce a mechanism to dispense fertilizers.
- To be able to spray pesticides as well as dispense fertilizers simultaneously if necessary.
- To be used for multiple types of crops.
- Economically available for small-scale farmers and cultivators.

III. METHODOLOGY

The basic aim of this project is to develop a machine, which is used for spraying pesticide and fertilize the land with least changes in accessories with minimum cost. This whole system of the vehicle works with the least amount of human power.

1) This machine uses a method of dispensing fertilizers using a slotted disc.
2) The machine also utilises a crank and lever mechanism to operate the sprayer pump handle which is connected to the piston through the link [3].
3) When the farmer is supposed to spray pesticides, he fills the tank with pesticide and pushes the machine to certain distance the sprayer reaches the pressure required and then it sprays the out through the nozzles [5].
4) If the farmer uses the machine to put out fertilisers on the field, he will fill the fertiliser tank with the required fertilizer, and then when the machine is pushed fertilizer flows through the pipe and then falls into the dispenser disc.
5) This disc allows the fertilizer to fall in lesser amounts to the ground at a distance.

There were two shafts for the separate operation which was reduced to one, based on the calculations and testing done on the vehicle, 3D and 2D of model fig1 and fig2.

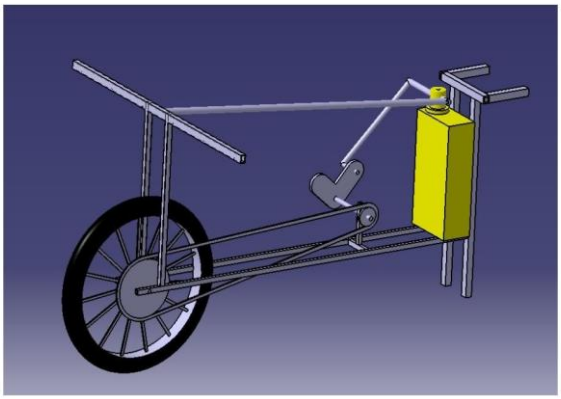

Fig. CATIA Model

Fig. 1: Final 3D Model

Drafting of model:-

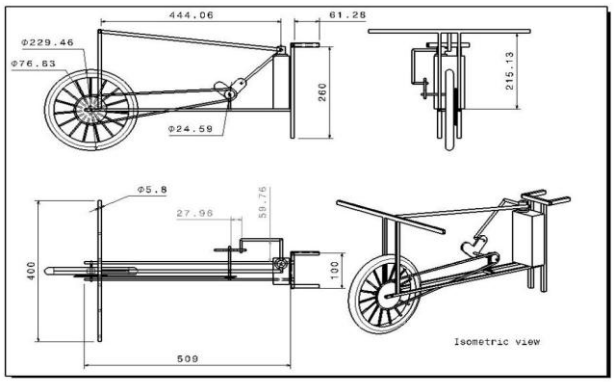

Fig. 2: Final 2D Drafting of the Model

IV. DESIGN CALCULATIONS

1) Distance covered by one rotation of wheel =
=1256.6mm
2) Time required for 1 ft distance = 4.1/3= 1.37 sec
3) No. of nozzles = 2
4) Pressure = 1 to 3 bar (14.5-43.5 psi)
5) Area covered by each nozzle approximate 1.5 m^2
6) Total Tractive Force = 6.67+0+1.6=8.2 N
7) Force required to drive the system = 8.3 N
8) Torque = FR* distance = 9*.2 = 1.8Nm
9) Pressure = 2 bar
10) Force =565.4 N
11) Capacity of the tank = 8kg
12) Mass of fertilizer inn each slot = 8 g

Given data

OD = 89.17 mm
ID = 79.17 mm
N = 18 (both gears)
C to C = 590 mm

Design of sprocket:
Used chain no.06B
For Z=18
Pitch, P = 9.525 mm
Width between inner plates, b1= 5.72 mm
Roller diameter, d1= 6.35 mm
Transverse pitch p_t =10.24 mm

1. Pitch circle diameter

$D_1=\frac{p}{sin\,(180/z1)}$ $D_2=\frac{p}{sin\,(180/z2)}$

$=\frac{9.525}{sin\,(180/18)}$ $=\frac{9.525}{sin\,(180/18)}$

D_1 = 54.85 mm D_2 = 54.85 mm

2. Roller seating radius (r_i)

$r_{imax} = 0.505d_1 + 0.069* (d_1)^{1/3}$

r_{imax} = 3.33mm

$r_{imin} = 0.505\ d_1$ = 3.2mm

3. Tooth Flank Radius (r_e)

$r_{emax} = 0.008(z^2+180)$ =16.928mm

$r_{emin} = 0.12*d_1(z+2)$ = 15.24mm

4. Root Diameter (D_f)
$D_f = D – 2* r_i = 88.47mm$
5. Tooth height above pitch polygon (h_a)
$h_{amax} = 0.625*p – 0.5*d_1 +0.8*p/z = 2.9513mm$
$h_{amin} = 0.5(p-d_1) = 1.5875mm$
6. Tooth Width (b_f)
$b_f = 0.93 *b_1 = 5.3196mm$
7. Tooth Side Relief (b_a) $b_a = 0.1p$ to $0.15p = 1.1907mm$

PUMP Calculation:
PUMP:
Power spent directly on transmission of pumped fluid energy is calculated by the formula:
$N_П = ρ·g·Q·H$
$N_П$ – useful power, W
ρ – density of the pumped medium, kg/m^3
g – gravity acceleration, m/s^2
Q – flow rate, m^3/s
H – total head, m
$N_П = ρ·g·Q·H =$
Q= Area X Velocity
Velocity = $2\pi N / 60$
= 2 X 3.142 X 100 / 60
= 10.47 m/s
$A = \pi r2 - \pi r2$
= 2.8274E-5 m^2
Q= 2.8274E-5 X 10.47 = 0.00029603 m^3/s
Nn = 1000 X 9.81 X 0.00029603 X 0.1 = 0.290 Watt.

1) Discharge per rev. = Area of piston * Stroke length =
$2.26*10^5 m$ m^3/rev
2) Number of revolutions/second =N/60 = 0.833
3) Discharge/second =ALN/60= $1.88*10^5$ mm^3/s
4) Number of nozzles =2
5) Discharge through each nozzle=$9.42*10^4$ mm^3/s Dispenser (cylindrical slots)
1) Diameter of the dispenser = 100 mm
2) Diameter of the slot = 20 mm
3) Length of the slot = 20 mm
4) Vol. of slot = area of slot * length= 628 3.18 mm^3
5) Number of slots provided = 4
6) Mass of fertilizer inn each slot = 8 g
7) Distance between the slots = 120 mm
8) Capacity of the hopper = 8kg
9) Distance covered by 8kg = 12000 mm

Sl. No.	Name of component	Material used	Specifications
1.	Frame	M.S.	300*1050*800 mm
2.	Pesticide Tank	Plastic	400*300*150 mm Capacity=16Lts
3.	Wheel	Steel	Diameter 400mm
4.	Driven sprocket	Steel	Diameter =70mm Teeth =18
5.	Sprocket	Steel	Diameter =180mm Teeth=45
6.	Shaft	M.S.	Diameter =20mm Length=40mm
7.	Crank	Mild steel	Diameter=100mm Thickness=10mm

V. OPERATIONS

A. Spraying Operation

1) Crank and Lever Mechanism for pumping action.
2) The crank is connected on the main shaft as the driven sprocket.
3) The rotation of the crank is regulated by the speed of the shaft in turn the wheel.

As the wheel rotates the driver sprocket mounted on the wheel axle will rotate, and drive the sprocket on a shaft which holds the crank to operate the pump handle Fig 3.

Fig. 3: Spraying operation

B. Fertilizing Dispensing Operation

– A tank is made in the shape of a hopper to store the fertilizers.
– The tank has a locking mechanism which can be operated to control the flow or amount of fertilizer falling in the disc.
– The fertilizer falls into the slots in the dispensing disc and then onto the ground.
– The distance between each dropping is set to an optimum so that it could be used for multiple crops fig.4.
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VI. CONCLUSION

1) Effort of lifting the sprayer tank on the back is removed.
2) Carrying of fertilizer bags on the field to put out fertilizer on the land is also removed.
3) Using of such a vehicle can be done when a crop is of different height and row spacing with respect to pesticide spraying.
4) Simultaneous use of both spraying and dispensing can also be done as the mechanism for both the components uses the same shaft.
5) To be affordable to most small scale farmers.

FUTURE SCOPE OF THE PROJECT

- Design has many variables that could be altered to enhance the utility of the vehicle.
- Increasing Tank Capacity by addition of another tank with a pump.
- The frame can be made of Aluminum alloy with a thicker gauge, which is light in weight and durable.

Addition of more nozzles can be done to increases the area covered by the machine at any given time. In order to maintain the same pressure in all nozzles, an external pump may be required.

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