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Design and Development of Multipurpose ATV for Agriculture

Deshmukh G. A[1]., Randhe P. V.[2] , Choramale D.Y[3]., Patekar A. G.[4], Vilhekar R. R.[5]
UG Student, Department of Mechanical Engineering, Arutvahini college of engineering Sangamner. Maharashtra, India -422605[1 2 3 4]
Assistance Professor, Department of Mechanical Engineering, Arutvahini college of engineering Sangamner. Maharashtra, India -422605[5]

***Abstract*— Day by day the population of India is increasing and to fulfill the need of food modernization of agricultural sectors are important. Due to chemical fertilizers the fertility of soil is decreasing. Hence farmers are attracted towards organic farming. By mechanization in spraying devices fertilizers and pesticides are distributed equally on the farm and reduce the quantity of waste, which results in prevention of losses and wastage of input applied to farm. It will reduce the cost of production. It will reduce the cost of production. Small scale farmers are very interested in manually lever operated knapsack sprayer because of its versatility, cost and design. But this sprayer has certain limitations like it cannot maintain required pressure; it lead to problem of back pain. However this equipment can also lead to misapplication of chemicals and ineffective control of target pest which leads to loss of pesticides due to dribbling or drift during application. By using diesel operated vehicle are able to work for material handling and spray a Pesticides. It is suitable for small farmer which is not able to take a tractor for spray and material handling.**

***Index Terms*—spray, ATV, Agriculture equipment, pesticide.**

I INTRODUCTION

Agriculture is an important sector of the Indian economy, accounting for 14 % of the nation's GDP. India is set to be an agricultural based country approximately 70 % of population of India is dependent on agriculture directly or indirectly. Our farmers are using the same methods and equipment for the ages. Generally mechanization of small forms are very difficult and non-affordable but Japanese make it happens. One of the most common forms of pesticides application, especially in conventional agriculture, is the use of mechanical sprayers. 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, of one containing a mixture of water (or another liquid chemical carrier, such as fertilizer) and chemical, 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. Large droplets have the advantage of being less susceptible to spray drift, but require more water per unit of land covered. Due to static electricity, small droplets are able to maximize contact with a target organism, but very still conditions are required. The project aim is to remove the backpack and foot spraying techniques, eliminate the human efforts, to decrease labor cost by advancing the spraying method and constant flow of droplets and using non-conventional sources for charging the batteries. [2]

II NEED FOR PROJECT

The objective of building this machine is to eliminate the physical fatigue and the health hazards caused by pesticides. Following drawbacks of various spraying techniques shows the need of our project.

In the backpack spraying / solar operated sprayer the labor has to carry all the weight of the pesticides filled tank which causes fatigue to labor and hence reduces the human capacity.

The engine operated spraying equipment needs fuel for its running and proper operation which increase its operational cost and also its gives the back pain due to vibration problem. In the aerial spraying wastage of fertilizer and some crops are not totally covered and also not suitable for small farms. During spraying after sometime hand muscles starts to pain and thus proper pressure is not maintained. So, it affects the droplet pressure.

When using fuel operated vehicles the exhaust gases liberated from the Silencer or muffler produces a harmful effort over the crops. There is requirement for India is a land of agriculture which comprises of small, marginal, medium and rich farmers. Small scale farmers are very interested in manually lever operated knapsack sprayer because of its versatility, cost and design. But this sprayer has certain limitations like it cannot maintain required pressure; it lead to problem of back pain. However this equipment can also lead to misapplication of chemicals and ineffective control of target pest which leads to loss of pesticides due to dribbling or drift during application.

Objectives

1. To design multi-purpose agriculture machine for spray and material handling.
2. To design and add steering assembly in vehicle and add clutch and brake in vehicle
3. To add suspension system to increase durability and stability of vehicle.
4. To Increase Load caring capacity of vehicle.
5. To reduce a weight and make a vehicle compact.
6. Manufacture a Compact size which is able to spray small plant also.

III LITERATURE REVIEW

L.nandhini, et. Al. involves the usage of structure which can be automatically moved over particular area. The length of the nozzle used for spraying and the force of the pesticide through the nozzle can also be adjusted according to the user demand which makes this automatic agro sprayer much more efficient one.

Shaileshmalond, et. Al. He works on solar based spray fertilizer machine design. This model carries multi nozzle pesticides sprayer pump which will perform spraying at maximum rate in minimum time.

Prof.N.Rr.Jadhao1, et. Al. He is developed which will be beneficial to the farmer for the spraying and weeding operation along with the seed sowing application. A multifunction device will come in handy that can be put to use in different stages of farmig as per requirement.

Sandeep h. Poratkar, et. Al. He work on model of manually operated multi nozzle pesticides sprayer pump which will perform spraying at maximum rate in minimum time. Constant flow valves can be applied at nozzle to have uniform nozzle pressure.

Nitish das, et. Al. He is design and mechanization in spraying devices fertilizers and pesticides are distributed equally on the farm and reduce the quantity of waste, which results in prevention of losses and wastage of input applied to farm. It will reduce the cost of production.

Kamleshkishor, et. Al. This paper suggests a model of manually operated multi nozzle pesticides sprayer. This will perform spraying at maximum rate in minimum time and optimum utilization of organic pesticides and evenly distributing it.

Siddharthkshirsagar, et. Al. It is electronically operated by a wireless remote which runs on power source as a dc battery. One vertical arm is attached at centre of vehicle and one horizontal arm at top of the vertical arm. As more no of nozzle are there hence spraying is done rapidly and time and money is saved.

IV METHODOLOGY

The way we Precedes Basically, by doing the observation of the worker which are actually working in agriculture farm and discussing with them about problems related with farming and try to establish certain method which with guide also.

To achieve the project objective, we decided to adopt such tool which is very effective.

It is commonly used by 'Japanese' companies like Honda etc. and many other organizations to find solution on any complicated problem. That tool is named as 'SIX SIGMA QUALITY TOOL'.

V PROJECT METHODOLOGY FLOW CHART

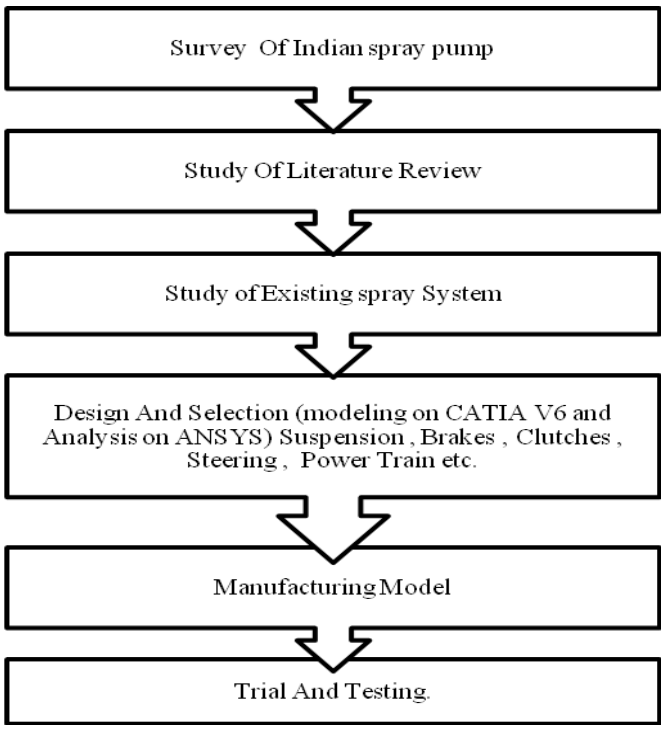

Figure 1- Project Methodology Flow chart

Design Calculation

Design Calculation

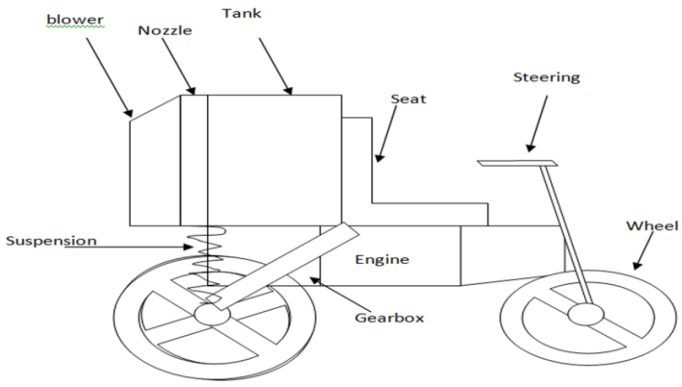

Figure 2. Concept Drawing of Projects

Nozzle Design -

As per Thumb Rule 3 Piston pump are used to spray a Pump

Total Discharge through nozzle –200 liter in 30 min

i.e 6.66 liter/min =6.66 $*10^{-3}$ m^3/min

total no. of Nozzle = 8

Discharge of single Nozzle=6.66 *10^{-3}/ 8 = 0.0008325 m^3/min

The wide-angle, full-cone nozzles produce large droplets. Full-cone nozzles, which are recommended for soil-incorporated herbicides, operate at pressures between 15 psi and 40 psi. Optimum uniformity is achieved by angling the nozzles 30 degrees and overlapping the spray coverage by 100 percent. [11]

Nozzle Materials –

Nozzles are made from several materials. The most common are brass, nylon, stainless steel, hardened stainless steel, tungsten carbide, thermoplastic, and ceramic. Ceramic and tungsten-carbide nozzles are very longwearing and extremely corrosion-resistant. Stainless-steel nozzles last longer than brass or nylon and generally produce a uniform pattern over an extended time period. Nylon nozzles with stainless steel or hardened stainless-steel inserts offer an alternative to solid stainless-steel nozzles at a reduced cost. Thermoplastic nozzles have good abrasion resistance, but swelling can occur with some chemicals, and they are easily damaged when cleaned. Nozzles made from hard materials cost more initially, but in the end they pay for themselves because of their long-lasting properties.

Nozzle Influence on Droplet Size Spray-drop size is one of the most important factors affecting drift. Because of the unusually small size of the target, good coverage is essential for those insecticides and fungicides that must come into contact with the pest insect or disease-causing organism. Similarly, in the case of protectant fungicides and no systemic stomach poison insecticides, thorough coverage is essential, because untreated surfaces allow infection or crop damage to continue from feeding insects without exposing them to the applied control. “Fine-” to “medium-” size droplets are desirable when applying insecticides and fungicides, because they usually provide better coverage. “Fine” droplets, however, are difficult to deposit on the target, so they may remain airborne and drift long distances because of their small, lightweight size. Spray-droplet diameters are measured in micrometers. A micrometer is approximately 1/25,000 of an inch and is usually referred to as a “micron.” For reference, the thickness of a human hair is approximately 100 microns. Drops smaller than 150 microns in diameter (smaller than the diameter of a sewing thread) usually pose the most serious drift hazard. Drift is far less likely to be a problem when droplets are 200 microns and larger in size. A study indicated that spray particles less than 50 microns in diameter remain suspended in the air indefinitely or until they evaporate. This should be avoided because there is no way to control deposition of very small droplets. [11]

Selection of Tank –

Tanks that hold liquids or gases under pressure are apart always cylindrical or spherical because these shapes react to the stresses caused by internal pressures much more favorably. Because fluid pressure acts in all directions a round wall shape will see even distribution of pressure, whereas any shape with corners will see concentrations of load due to pressure acting on either side of the corner pushing the two sides apart.

As per Market survey, we select a 200 lit. Tank are selected for 1 Acer area

Calculate a weight of Vehicle –

Table no: 1 weight of vehicle

Sr. No.	List of component	Weight	No. of component	Total Weight
1	Tank with Water	210 kg	1	210kg
2	Blower assembly	10 kg	1	10kg
3	Gear box	10 kg	1	10kg
4	Tier	5 kg	3	15kg
5	Suspension	3 kg	2	6 kg
6	Brakes	2 kg	1	2kg
7	Steering	8 kg	1	1 kg
8	Power train assembly	20 kg	1	20 kg
9	Piston pump	10 kg	1	10 kg
10	Chassis	40 Kg	1	40 kg
10	Engine	20 kg	1	20 kg
11	Other	20 kg	1	20 kg
12	Driver	100 kg	1	100 kg
Total				470 kg

Selection of Engine –

For horizontal moment =

$$horsepower = weight \times \left(\frac{velocity}{234}\right)^3$$

We take a weight = 470 kg

Velocity = 60 Km/hr

Horsepower (hp) = 4.012419 horsepower

Assume Factor of Safely = 2

Engine HP = 8 hp [19]

SUSPENSION -

Rear Suspension Designing**:-**

The information that is required before we start the designing of suspension are:-

a. Knuckle height and its distance of lower and upper ball joint from centre line of tire.

b. Distance acquired by rim and brake assembly from centre of tire.
c. Track width of vehicle.

1.Assumptions to be made:-
   A. ground clearance
   B. kingpin inclination

2.Find out the mounting points of suspension arms on chassis.

3. Find out the distance of lower ball joint from centre of rim i.e. centre of the tire. This distance includes the distance of brake assembly hub, knuckle assembly and clearance. (note:- the clearance to be provided for ball joint is approximately 30-40 mm)

4.Take the distance of lower ball joint from centre line. Similarly for upper ball joint from centre line.

5.Then from the half of the track width of the vehicle subtract the distance so obtained from point no. 3.

6. Now you get the lower ball joint of the suspension. Use the kingpin inclination axis and with the help of distance between lower and upper ball joint find out the upper ball joint.

7.Now find out the distance of control arms. This distance would be the distance from ball joint to the mounting point on chassis.[17]

Rear suspension geometry:-

Table no. 2 Values of various suspension related parameters [17]

Parameter name	Value
King pin inclination angle	7 deg
Castor	0 deg
Camber	0 deg
Toe in	0 mm
Roll centre height	290.57 mm (above ground as per 15 January 2014)

Spring design

1. We have mean coil diameter, wire diameter and free length according to assembly of spring mounting.
2. Now we need to find natural frequency and accordingly stiffness.
3. Then we need to find out ride frequency for rear from following formula.(ride frequency for rear should come a little higher)

Formulas are:-

$F= (1/2Pi) (sort (k/m))$

$K=4pi^2Fr^2 (Ms) (MR)^2$

Note:-the steps 1 and 2 are simultaneously carried out

F=natural frequency
Pi=3.14
K=spring stiffness in N/m
Ms=sprung mass
MR=motion ratio
Fr=ride frequency

8. Find the stiffness of spring and using it find out number of turns.
9. Now we have solid length and free length you get maximum compression.
10. Now design accordingly and order the spring to star springs.[17]

Table no3Parameter [17]

Parameters	Values
Stiffness	23.2N/mm
Ride frequency	2.25Hz
N	7
N	9
Free length	230
Motion ratio	0.98
Damper compressed length	500-190=310mm

Brakes

Stopping Distance Calculation

Braking Distance in meter,

$$\mathbf{D = V^2 / [2 \times g \times (\mu + s) \times 3.6^2]}$$

V=Speed in Km/hr =40km/hr
g=acceleration due to gravity 9.8 m/s^2
μ=mean coefficient of friction =0.6
S=Roadway grade (it is 0.05 for flat-road)
$D = 45^2/(2\times9.81\times(0.6+0.05)\times3.6^2 = 7.23$ m

Deceleration:

Deceleration = $V^2/stopping\ distance$
$=12.5^2/(2\times12.25)$ $=6.37\ m/sec^2$. [18]

TIRE

For calculating the diameter of tire for satisfying the condition of engine RPM, gear ratio and MPH of vehicle. We came to know the formula for calculating the dia. of tire from the internet.

$$\text{Tire Diameter} = \frac{\text{MPH* gear ratio * 336}}{\text{RPM}}$$

$$= \frac{32* 7.46* 336}{3800}$$

= 21.107 inch

But the tire diameter calculated from the formula is not available in market. Hence, we have to round off the tire diameter to the nearest available diameter of tire i.e. 21 inch.

Calculation of rim diameter, width and height of tire

For 21 diameter of tire 10 inch rim is the most appropriate rim diameter for ATV.

Rim diameter for tire= tire diameter – 2*sectional height
10 = 21 -2* sectional height
Sectional height= 5.5 inch
Aspect ratio = sectional height /Sectional width

= 5.5/7

=0.7857

For the tire having diameter 24 inch the most appropriate tire specification is

Tire width=177.8mm

Rim diameter=254mm

Tire sectional height=1524mm

The reason behind selecting the low aspect ratio is the following advantages-

A tire with a lower aspect ratio responds to lateral force more effectively than a tire with a higher aspect ratio. The aspect ratio affects steering stability. Generally, the shorter the sidewall, or the lower the aspect ratio, the less time it takes to transmit the steering input from the wheel to the tread. The result is quicker steering response. =0.8125

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TRACTIVE EFFORT CALCULATION

The tractive effort can be calculated by the formula

$$TE = \frac{Me^* GR^* \text{transmission efficiency}}{\text{Radius of wheel}}$$

Assuming the$_{1st}$ transmission efficiency as 90% (from book "Automobile transmission" by Springer Publication)

$$= \frac{19.6591*0.9*27.66}{0.28575}$$

$$= 1712.67N$$

== 1712.67N

Cad Drawing of Vehicle –

In this stage, the engineering drawing of the chassis frame is produced using CATIA V5R16. In the process of developing the chassis frame, a proper design method is employed. The conceptual design is first developed using sketches. Then, Computer Aided Design software that is CATIA V5 is utilized to help the process of the design. It is important that the results of the analysis satisfy the technical requirement of the vehicle. Necessary modifications to the design need to be undergone if the analysis yields negative results.

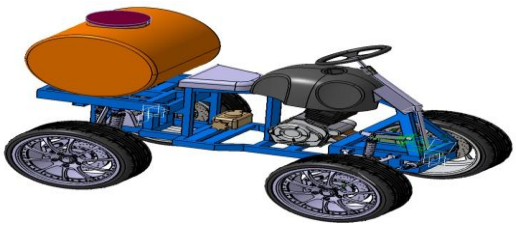

Figure 3 CAD Model of Multipurpose Agri. Vehicle

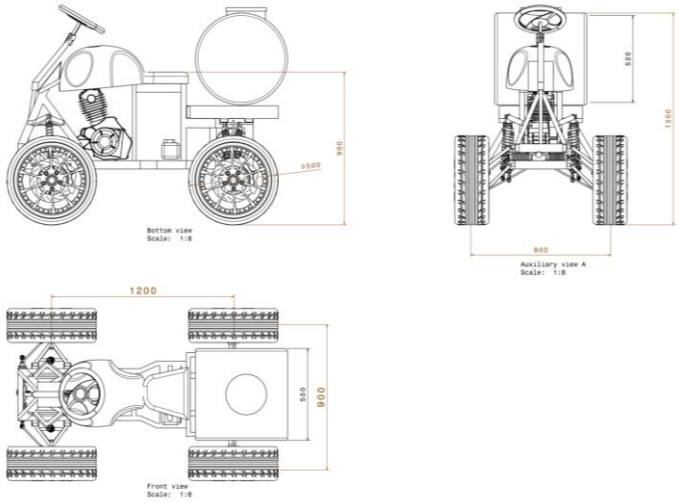

Figure 4. CAD DRAWING OF Multipurpose Agri. Vehicle

V CONCLUSION

The objective of design a off-road vehicle for agriculture used include pesticides spray and transport with high safety and low production costs seems to be accomplished. The first concept design based on practical personal experiences and intuition. Then engineering principles are used to optimization of performance, safety, manufacturability, and human ergonomics. The design process included using CATIA software. after testing it seen that design will successfully work.

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