

Design And Development Trolley Operated of Agricultural Multi-nozzle Spray Pump

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Abstract— In Agricultural production insects are a major arisign in crop cultivation. Different types of chemical as well as organic fertilizers are sprayed over the crops to solve this problem. The sprayingv methods are majorly classified into two categories i.e. manual and power operated. Both the methods are having their own advantages and disadvantages. Knapsack sprayer is the most commonly used spraying technique by the farmers. Which is aslo causing some health related problems like back pain which also lead to various serious ailments. It is also not a very efficient method as compared to power operated methods but the power operated methods are not economical for the marginal farmers. To address this problem the following solution is provided titled “Design And Development of Trolley Operated Agricultural Multi-nozzle Spray Pump”.

Keywords—Back pain, constant flow valve, Multi-nozzle spray pump, farming, pesticides, farm equipment, Spraying equipment, etc.

Introduction

As of now, India has 2nd highest crop output in the world. A report released by the Ministry of Agriculture and Farmer Welfare, Govt. Of India & a study by National Statistical Office (NSO) and Ministry of Statistics and Program implementation (issued on 31st May 2021) suggests that the contribution of agriculture and it’s associated sectors in Indian economy is 20.2% which is greater as compared to past two financial years. Which was 18.4% in 2019-20 as well as 17.6% in 2019-18.

The farming practiced in India is majorly divided into following 9 categories :

1. Shifting Agriculture
2. Subsistence Agriculture:
3. Intensive Farming

4. Extensive Farming:
5. Plantation Agriculture
6. Commercial Agriculture
7. Dry Land Farming
8. Wet Land Farming
 - (i) Kharif
 - (ii) Rabi
 - (iii) Zaid
9. Terrace Agriculture

Although farmers are classified on the basis of land size as follows:

Sr No.	Category	Size-Class
1.	Marginal	Below 1.00 hectare
2.	Small	1.00-2.00 hectare
3.	Semi- Medium	2.00-4.00 hectare
4.	Medium	4.00-10.00 hectare
5.	Large	10.00 hectare and above

According to the results (provisional) of latest Agriculture census 2015-16, the State-wise average size of operational holdings in the country is less than 2 hectares except some states which indicates that majority of the farmers in India have 1.08 hectares of land for farming.

Therefore, the market of farm related equipments and products (Fertilizers, Insecticides, Pesticides,etc.) has been increasing continiously.

These pesticides are sprayed all over the farm by conventional methods like using a hand operated (manual) sprayer or motor (semi-autoatic) sprayer,etc.

On an average the time required to spray pesticide over a single plant is approximately 8-20 seconds depending upon the size of plant. And a farmer has to cover over 100 plants a day. Which is causes back pain eventually leading to some other health complication to the farmers due to constant exposure to the pesticides for long time. Also the time required to cover a certain area as well as cost of labour increases. Some efforts by some individuals are being made in this case but most of them either are not feasible for all farmers or are beyond the farmer's reach.

Along with the improvements and innovations in the technologies spraying drones have been proposed as a solution but, they need high initial setup & operation cost which isn't economical for majority of the farmers. Also highly skilled operator is needed to make them work. So, currently it doesn't seem to be a solution.

Here we have tried to propose a solution by using our knowledge that we have gained from our course.

LITERATURE REVIEW

1. Dr. R. D. Dhete' s research paper on types of spraying mechanisms describes various types of mechanisms that are being used in the industry for spraying of chemicals and they can be useful.
2. Different types of Spraying mechanisms were also referred from a research work published by Massey University New Zealand.
3. The methodology for calculation of design work were studied and analysed from a paper on "Manually operated Multi-nozzle sprayer" by Rushikesh Ghadge, Savitribai Phule Pune University & Sandeep H. Poratkar, from Tulsiramji Gaikwad Patil College of Engg & Technology titled "Development of Multinozzle Pesticides Sprayer Pump"

CONSTRUCTION

1. Design Factors :

According to the data obtained by our team from a local village and some research works we concluded on some that our design must be based on following factors and should have these characteristics :

1. The Farme should have better durability as it should be workable in soil conditions of the field.
2. It should be light in weight and comfortable to transport over a distance of upto 3-4kms .
3. The machine must be less space consuming as it may be required to be transported in a mini truck.
4. The height for the sprayer end should be adjustable according to different crops.
5. The manufacturing cost of the machine should be affordable to marginal farmer.

2. Materials used :

Depending upon this design & manufacturing criteria the suitable materials and processes were selected.

• **Mild Steel (MS) :** Mild steel was selected for fabrication of the frame and other assembly body parts as it possesses properties like high ductility, weldability, high impact strength characteristics and is cost effective at the same time.

• **Stainless Steel (SS) :** The major impact is going to come on the wheel of the machine as it is going to have direct contact with the ground and also has to sustain the weight of the machine.

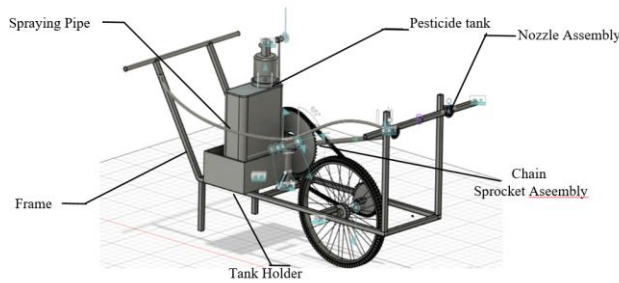
• **Plastic :** Plastic tank and sprayer nozzles are preferred to reduce the weight and its anticorrosive nature. Plastic is also cheap as compared to other materials and durable also.

• **Rubber :** Rubber is utilised for the pipes as it is elastic in nature and fits as well as detaches easily and can be easily replaced as it is available in most of the villages.

• **Brass :** The connectors used in joining the pipes are made of brass. Due to its high corrosion resistance it has been selected for this purpose.

CAD DESIGN

The CAD Design for this model is made according to the above characteristics mentioned above. CAD Software used for making this 3D CAD model and simulation is **Autodesk's Fusion 360.**



(CAD Design of frame and mechanism of machine)



Agricultural Multi-nozzle Spray Pump

Working

The operation starts by pushing the machine in front direction; the mechanism doesn't work if force is applied in the reverse direction as per the arrangement of the sprocket assembly.

1. As the trolley moves forward, the wheel starts rotating in an anti-clockwise direction.
2. The sprocket mounted on the same shaft as the wheel also rotates in the same direction & the motion gets transferred to the crank via a chain drive.
3. The driven sprocket then converts rotary motion into reciprocating motion by a slider attached to the driven sprocket.
4. This slider rod transfers the reciprocating motion to the piston rod
5. Now as the piston comes under motion it starts generating a pressure.
6. As the piston moves upward (expansion) of the connecting rod the pesticide is drawn into the pump and as the piston moves downward (compression) of connecting rod the pesticide is pushed to the delivery valve, the delivery valve is connected to the rubber pipe connected to a nozzles on an adjustable bar.
7. The operator needs the hand operated lever to be pressed so that the mechanism to start the spraying according to the requirement.

Sr. No.	NAME OF COMPONENT	DIMENSIONS	MATERIAL
1.	FRAME	609.60 MM X 1176.43 MM X 368.15 MM	MILD STEEL
2.	WHEEL	D = 650 MM	STAINLESS STEEL
3.	TANK	500 MM X 20 MM X 160 MM	PLASTIC
4.	TANK HOLDER	500 MM X 265 MM X 160 MM	TIN
5.	ADJUSTIBLE BAR	930 MM	MILD STEEL
6.	PIPES	1200 MM	RUBBER
7.	NOZZLE	OD = 32.5MM	PLASTIC & RUBBER
8.	SPROCKET 1 (DRIVER)	T1 = 18	AISI 304
9.	SPROCKET 2 (DRIVEN)	T2 = 43	STAINLESS STEEL
10.	CHAIN	875 MM	AISI 304
11.	SLIDER ROD	800 MM	MILD STEEL
12.	CONNECTING ROD	480 MM	MILD STEEL

9. The height and the angle of spraying can be adjusted according to the requirement.

ADVANTAGES

- Being light in weight it can be transported and lifted easily
- As it is a manually driven solution no external power source is required
- The human effort as well as time is saved and the spraying is done efficiently
- Design, manufacturing and maintenance cost is lower.
- Multiple nozzles which cover maximum area of spraying in minimum time and at maximum rate.
- Only one machine can be used for different types of plants.
- There is no requirement of buying any Specially fabricated Pump (Hand operated pump can be directly used here).

LIMITATIONS

- In irregular area of land, it could be difficult to operate sometimes.
- On rainy day in a muddy environment it is difficult to operate.
- For irregular crops this pump is difficult to work. The flow is not uniform, so we have to fit a bottle at both ends.

Note :- These Limitations can be removed by doing some minor changes

CONCLUSION

1. This is comparatively better solution to what is being currently used and other methods in terms of efficiency.
2. This is completely eco-friendly & a pocket friendly solution that is feasible and effective.

3. The main problem faced by the farmer is to carry the entire load of the pesticide tank on his shoulder which was causing backpain is solved by this machine.

4. The operator requires very less efforts as compared to the manual knapsack method. No specific training is required by the farmer (operator) to operate it.

5. The farmer can cover a large area without any external power driven equipment.

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