Semi-automatic wheel driven Agricultural Sprayer

Project Report 2022-2023

submitted

in partial fulfilment

for the award of the Degree of

Bachelor of Technology

in Department of Mechanical Engineering

Supervisor

Dr. Sanjay Kumar Gupta

Assistant Professor

Submitted By:

Ali Affan
Anupam Singh

Enrolment No.: MUIT0119017001
Enrollment No.: MUIT0120018009

School of Engineering &Technology

Maharishi University of Information Technology, Lucknow

Utter Pradesh, INDIA

May, 2023

DECLARATION

I hereby declare that the work, which is being presented in the Project, entitled "**Semi-Automatic Wheel Driven Agricultural Sprayer"** in partial fulfilment for the award of Degree of "**Bachelor of Technology**" in Department of **Mechanical Engineering**, School of Engineering &Technology, Maharishi University of Information Technology, Lucknow is carried under the Guidance of Dr. **Sanjay Kumar Gupta** Department of Mechanical Engineering, Maharishi University of Information Technology, Lucknow.

I have not submitted the matter presented in this project anywhere for the award of any other Degree.

Ali Affan
Enrollment no.: MUIT0119017001
Anupam Singh
Enrollment No.: MUIT0120018009
B. Tech Mechanical Engineering
Maharishi University of Information Technology
Lucknow, Utter Pradesh, India

CERTIFICATE

This is certified that Project Report entitled "**Semi-Automatic Wheel Driven Agricultural Sprayer**" in partial fulfilment of the requirements for the award of the B.Tech. (Mechanical Engineering) of Maharishi University of Information Technology, Lucknow is a record of the student's own work carried out under my supervision and guidance. The project report embodied do not from the basis for the award of my any other B. Tech or degree to the candidate or to anybody else.

Ali Affan - MUIT0119017001
Anupam Singh - MUIT0120018009
B. Tech Mechanical Engineering
Maharishi University of Information Technology
Lucknow, Utter Pradesh, India

Counter Signed by

Dr. Sanjay Kumar Gupta

Dr. Shobhit Srivastava

Approved by

Dean Engineering, SOET

Dr. Kalyan Acharjya

ACKNOWLEDGEMENT

I am highly grateful to my supervisor Dr. Sanjay Kumar Gupta, Department Mechanical Engineering, Maharishi University of Information Technology, Lucknow to provide me this opportunity to carry out the project work under their guidance, whose kind inspiration invaluable guidance and encouragement from time to time had kept me going inspired of the adversities confronted and has culminated in the successful completion of this project.

I would like to make a special reference to **Dr. Kalyan Acharjya**, Dean Engineering, SOET, Maharishi University of Information Technology and **Dr. Shobhit Srivastava**, Co-Ordinator, Mechanical Engineering, Maharishi University of Information Technology, Lucknow for the invaluable support and providing necessary resource for completion of dissertation.

I would like to express my sincere thanks to my classmates and friends throughout the entire course of study who helped me in many ways to proceed in to steps of my life.

I would also like to thank all the members of my family for their tremendous support and love all through. I thank the Almighty God for all that I have achieved thus far.

Ali Affan

Anupam Singh

TABLE Of CONTENT

ABSTRACT

Semi-Automatic wheel driven Agricultural Sprayer design to accommodate a hand driven Agricultural Sprayer on a cart which is having three wheels two small wheels and a big wheel used to drive chain and sprocket system which further drive a shaft in up and down movement which increases the air pressure mechanically. The pressure inside the container further pumps the water with other solvent out of the container through a pipe equipped with a nozzle in form of fine droplets of liquid.

The design Is completely fabricated using mild steel square cross section pipe made into chassis of the cart.

This report is based on the work undertaken to complete and test the wheel driven pump is practical or not. This mechanical pump is designed mainly for use in garden and crops grown on height and small plants.

In the completion of the design, the major factor to consider was to design using the minimum weight and complexity of the machine.

The project was hence done in the following manner.

- Making the design of cart and whole systems on paper.
- Completing of the fabrication.
- Research on ways of enhance the practicality.
- Making the design cost efficient and pocket friendly
- Testing of the model/design in real life scenario and real field work.
- To reduce the workload on farmer or gardener when is praying medicines on to the crop or plants while carrying the heavyweight on their back which contains the water and other solvent.

OBJECTIVE STATEMENT

- The aim of this project was to make a cart driven water sprayer pump which is able to spray the liquid on to the crops and plants without use of electrical energy or other type of fuels.
- As the gardening and farming is mostly done in remote location where electricity is not available the spraying machine is not useful.
- The spraying machines equipped with the engine which uses liquid Petroleum fuels (Petrol, Kerosene, Diesel) to spray the liquid (Water with dissolved pesticides/insecticide) on to the crops create a lot of noise because of Internal Combustion and also the air pollution as they don't have pollution norms or are not eco friendly.
- They are heavy for the farmers/gardeners to carry them on their back and are not portable or walk through out the area with carrying them
- Some research was done and the spraying machine was designed and fabricated though not to Completion. It was nevertheless tested specifically to determine its working effectively.
- However critical factors such as the use in different types of surfaces were taken into consideration. The small wheels on which all the weight of the frame and liquid container rest were use as to carry the machine when not in use. The larger wheel which drives the chain and sprocket system is equipped with a tire as to increase the friction and the contact area so that the wheels do not slip and loose the power in the slippery surface.
- The whole frame of the cart is made up of mild steel square cross section pipe to ensure the strength of the cart when fully loaded with the liquid. As the liquid container mounted on the frame is having 16 Liters of capacity. Therefore, the chassis would have been stronger and rigid enough to support whole system.
- The chain and sprocket system ratio are synchronized in such a way that the spray remains continuous while pushing the cart in forward direction at the normal walking speed or below walking speed. The rotating arm which moves the handle of pump in up and down movement which further moves the reciprocating pump to build air pressure inside the pumping chamber of the container to pump the liquid out.

1. INTRODUCTION -

Agricultural crop sprayers play a significant role in the management and health of crops, with various types available and numerous uses that serve different purposes.

(1.1) Agricultural Sprayer-

They are the equipment used for applying liquid substances to plants or crops. These substances could be fertilizers, herbicides, or pesticides – all of which are important for the maintenance of crop health during the crop growth cycle. The sprayers come in various sizes and types – from hand-held backpack sprayers to trailed sprayers that are connected to tractors.

(1.2) Application of an agricultural sprayer -

An agricultural sprayer does not serve just one purpose, instead, it has numerous uses that will benefit the overall health and management of the crops:

- **Liquid fertilizer application:** The sprayer is loaded with liquid fertilizer to efficiently distribute the fertilizer to the crops. The main purpose is to supply the crops with nutrients, and it is extremely effective due to its ability to target specific crops without losing liquid to evaporation or weather conditions such as wind.

  Liquid fertilizer application is a suitable method used in various areas prone to cause soil erosion and in drylands. Here, the sprayer comes equipped with liquid fertilizer to increase the efficiency of the process.

  Liquid fertilizer targets a specific group of crops without any risk related to loss because of evaporation or liquid to winds. These sprayers used in agriculture benefits crop establishment and promote its early rooting. Other than supplying essential nutrients, liquid fertilizer application provides irrigation.

- **Spraying water:** A water sprayer is used to spray water on plants and crops with the goal to hydrate them. They are high-pressure sprayers that are used over small areas for irrigation. Likewise, before crops are harvested, they are sprayed with fresh water to clean any chemicals away that may have been left behind.

  Sprayers can easily control unwanted vegetation. For this, they combine herbicide with water in a sprayer. Later, the farmer sprays it on unwanted vegetation that dries automatically a few days later. With technology innovation, scientists have come up with many new chemicals, which may select and eliminate only unwanted crops in a piece of land. Farmers may administer such selective herbicides by applying sprayers as well.

- **Spraying herbicides or fungicides:** These are mixed with water and sprayed onto crops to control any fungi from developing or unwanted vegetation from growing.

  Hand sprayers used in agriculture to control mildews, rusts, blights, and fungi. These are the worst enemies of plants, as they reduce the production of crops.

  Parasitic fungi cause adverse effects to animals as well. However, when you use a hand sprayer, you may easily control them. In most cases, fungicides are available in liquid form and possess 90 percent of sulfur. Sprayers are effective to control

fungi, as they keep the leaves unaffected.

- **Pest control:** A sprayer is extremely effective in controlling pests, and pesticides are mixed with water and sprayed on the affected areas of crops to eliminate infestation.

  Farmers have to apply sprayers after every two weeks. You may even spray pesticides on livestock for killing ticks and many other dangerous pests, which intend to lower production.

- **Irrigation and Hydration:** Many times, high-pressure sprayers used in agriculture on small irrigation areas. Besides, farmers spray freshwater before they harvest any crop to clean any leftover deposits. Sprayers are useful in all-weather. These may also be used to cool insects and livestock kept to meet various agricultural purposes.

- **Application of plant growth, Flowering & Fruiting:** Method of application plays an important role in the efficiency of plant growth. Spraying of Plant growth regulators quicker the effect on flowering & fruiting as well as flower yield of flowering crops. One of the most advantages of this application is that it will take less time to treat the plant and environment friendly.

2. CLASSIFICATION OF SPRAYERS

(2.1) Various types of sprayers-

1. **Knapsack/Back Pack Sprayer**
2. **Portable Power Sprayer**
3. **Knapsack/Back Pack Power Sprayer**
4. **Mist Dust Sprayer**
5. **HTP Sprayers**
6. **Orchard Sprayers**

1. **Knapsack sprayer:** It is convenient for spraying through hand-held nozzles that is connected to tank carried on operators back. There are three types of Knapsack sprayers i.e., battery, manual and battery cum manual sprayer.

2. **Portable power sprayers:** They are operated by electric and petrol engine with the help of hose pipe. This type of sprayer doesn't have chemical tank, which is used for applying pesticides, insecticides or liquid type chemicals at extensive land coverage.

3. **Knapsack power sprayer:** It has motor engine operated by using petrol engine i.e., 2 stroke and 4stroke engine type. It has the separate chemical tank and also has hand held nozzles.

4. **Mist dust sprayer:** It is a kind of knapsack power sprayer which is used to spray liquid chemical in mist form and urea in granule form. Ideal for quick spraying operations in orchards, tea, coffee estates & other crops. It can spray dust powder form pesticides also.

5. **HTP sprayer:** It is a horizontal triple piston pump with brass head, mainly used for uniform spraying with high pressure all over the operation land, it is used for multipurpose like commercial usage and agricultural usage. Its main benefit is having long operation life and power efficiency. In this type of sprayer also we can find battery, manual and battery cum manual operated sprayers.

6. **<u>Orchard Sprayers</u>:** They are used to apply pesticides, plant growth regulators and foliar nutrients to orchard trees. It is a tractor mounted equipment suitable for large area lands.

<u>Use of a water/liquid Spraying machine</u> -

The liquid Spraying machines are widely used in agricultural purposes to spray insecticide and pesticides on the crops or plant to keep them safe from any kind of insects or diseases.

Which helps in increasing the production of crop or the life of plants.

(2.2) Different types of knapsack/backpack sprayers

There are many types of earlier design in the market designed differently. Which use different types of operating mechanism depending on the availability of fuels electricity and environment they are supposed to be used by the farmers/gardeners. The earlier designs are categorized on the basis of three different types of mechanism: -

1. **Manual Hand operated**
2. **Battery operated**
3. **Engine operated**

1. **Manually Hand driven –** This type of spraying machine is loaded on the back of farmers/gardeners and is having a tank in which water is stored along with the dissolved insecticide/pesticides in them. It has a reciprocating air pump which increases the air pressure inside the pumping unit of the machine and the increased air pressure forces the liquid out through a valve which is further connected to a hose and attached nozzle which sprays a fine mist of liquid onto the crop.

2. **Battery Operated** – This type of spraying machine is also loaded on the back of farmers/gardeners and is having a tank in which water is stored along with the dissolved insecticide/pesticides in them. Just the difference in this one is that it has a Battery and a high flow(pressure) DC Pump equipped into the container tank. It requires a regular charging as it has limitations of the usage timings due to discharging of battery

3. **Engine operated** – This type of spraying machine is also loaded on the back of farmers/gardeners and is having a tank in which water is stored along with the dissolved insecticide/pesticides in them. It is different than the previous ones as it contains a small displacement Internal Combustion Engine which runs on the petroleum-based fuels

(2.3) Working of Manual Agricultural Sprayer -

You pump the trigger up and down, forcing air (initially) from the nozzle. The air inside the top of the bottle is at higher pressure than the air in the tube, so it pushes down on the liquid. The liquid is forced up the tube toward the pump mechanism. The liquid leaves as a fine mist of aerosol spray.

Agricultural sprayers have components like spray nozzle, liquid tank, sprayer pump, pressure regulator, valves and fluid plumbing and some sprayers have spray gun. This agriculture sprayers comes in various size, design and performance specifications. There are small sprayers to very large sprayers in size that helps to cover small area of land to extensive land.

There are number of sprayers which are designed for different spraying applications like gardening, crops, trees, fruit, livestock needs, and weed control.

3. LIST OF ITEMS USED

(3.1) Table:

Sl. No.	Name of components	Materials used	Quantity	Material specification	Cost ₹(INR)
1.	Frame Pipe	Mild Steel	Wt. - 8Kg Length- 3.65M	Best material for making durable Ans cost efficient frames	₹80/kg × 8 =₹640
2.	Knapsack sprayer tank	PVC plastic	1	Light weight, durable & cheap	₹1100
3.	Sprayer nozzle	Plastic	1	Traditional sprayer nozzle	**
4.	8-inch wheels	Plastic	2	Durable to support the max. weight	₹120/unit ×2 = ₹240
5.	14-inch driving wheel	Mixed	1	Light weight MS Rim + tubed tire	₹220
6.	Cycle pedal Sprocket	MS	30 Teeth's	Front sprocket	₹100
7.	Custom made rotating arm	MS	1	Used to move the sprayer handle up and down	**
8.	Cycle chain	MS	50 links	To use in the drive train	₹80
9.	Cycle rear chain sprocket	MS	20 Teeth's	Used to transfer wheel power	₹60
10.	Axle and handle pipe(cylindrical)	MS	5.5 ft	Used to make axle for small wheels and Handle to push the cart forward	₹240

(3.2) Description of Items

1. **Frame pipe** – The whole structure of the frame is made using mild steel hollow pipe with square cross-section 1×1 inch. We have used approximately 8 Kgs of weight which accounts to total of 3.65 Meters in length. We have used square cross-section pipe because of the strength of the structure and the application we are using in. The welded joints are stronger in square cross section pipe. The mild steel pipe can accommodate a hued amount of weight when drawn in the structure of a frame and is widely used in every section of the manufacturing. It is easily available in the metal market and is cheap to decrease the initial cost of the machine.

2. **Knapsack sprayer** – The knapsack sprayer/Backpack Sprayer we used is 16 Liters of capacity Manually operated via handle and push rod. Made up of ABS plastics which accounts of total of 1.8 Kgs of dry weight. We used this sprayer as our concern was to take a tank which can take large quantity of water as we do not have any issues with carrying the weight at the back and we don't want refilling the tank all the time when empty. The pump of the Sprayer is reciprocating pump which increases the air pressure inside the pump unit and the increased air pressure results in the flow of liquid through a nozzle equipped with a pipe all through the high-pressure pipe and further to the Sprayer Nozzle

3. **Sprayer Nozzle** – Sprayer Nozzles are available on the basis of direction of spray, Density of Spray (amount of water discharge) & the flowing distance. We got the standard sprayer nozzle along with the knapsack sprayer as an attachment with the High-pressure hose and nozzle stick to open and close the valve.

4. **Small wheels** – We used the small wheels of 8-inch diameter to give support to our cart and move it freely without hustle over the uneven ground. The wheels were sourced from the same as use in diesel-electric generator. They can handle a good amount of weight onto it. The wheels can take a large amount of weight as they are use in heavy diesel engine to move it. They are fitted on an axle made from cylindrical pipe welded with washers which are not removable as they don't need maintenance because they don't have bearing inside them. The weight of these wheels is 240 gems/wheel which means 0.48 Kgs in Total.

5. **14 Inch driving wheel** – The wheel we used to drive whole machine and pump the handle is a 14 Inch cycle spoked wheel as per our calculation the 14-inch wheel would work well so we sourced it from a cycle along with the tire and tube as tire will enhance the grip of the wheel to ensure the constant power is delivered to the pump mechanism and a rear free wheel sprocket is also present on the wheel

as to allow free movement when moving the machine in backward direction.

6. **Cycle pedal sprocket** – The power is transferred to the larger sprocket from the smaller sprocket on the wheel via chain and the larger wheel is equipped with a pedal arm which acts as a rotating arm and moves the pump handle up and down via slide crank mechanism.

7. **Cycle Chain** – The chain is used to transfer the power from smaller driver sprocket to the larger driven sprocket. This chain is sourced from a cycle and has 48 links and the length of total of 1 meter. The material of the chain is Mild Steel. The total weight of the chain is 100 gems. The chain needs lubrication every time used as the working environment will be humid and containing moisture as to avoid the same it should be lubricated to avoid rusting.

8. **Cycle Rear Sprocket** – The sprocket is having 20 teeths on it and weights around 60 grams the material of the sprocket is mild steel. This is a special sprocket which acts as one way drive and one way freely to stop rotating or transferring power in the opposite direction. It is used to Transfer power from the driver wheel to the Rotating arm via chain and sprocket system equipped with a driven sprocket having 30 teeths. It is used mostly in the cycle. It has very low maintenance except the lubrication of the inbuilt ball bearing

9. **<u>Cylindrical Hollow Pipe</u>** – This pipe was used to make the axle for the small wheels which were having pre drilled hole into it with diameter of 1 Inch and the pipe used for making the axle was also of 1 inch diameter to make it free we bored the hole to increase the diameter by 2mm via a fixed tower drill machine and then fixed the wheel onto the axle by putting a washer on each side of the wheel to stop it from moving.

   The same pipe is used to make the grab handle of the machine in order to push it forward and backwards effectively. The handle of machine is 2.5 ft wider and is at the height of 1.20 meter on the basis of average height of human being to push it comfortably without bending down or being upright for a long duration.

(3.3) List of Equipment's/Tools used in making of the Machine -

- Electric arc Welding Machine with welding electrode rods
- Electric angle grinder with cutting and grinding blades
- Hammer, pliers, compatible wrenches, etc.
- Grease & lubricating oils
- Fixed pillar drilling machine with compatible drill bits.

4. CONSTRUCTION

(4.1) Designing

In this concept of sprayer, we have used a regular Knapsack Manually operated Sprayer and mounted it on a cart. The Frame of the card is made from Mild steel pipe of square cross section So that the bends and joint remain intact and to strengthen up the whole design as the container of knapsack sprayer we used is of Sixteen Liters and the dry weight of the Sprayer is 2.2 Kgs

(4.2) Making of frame

- We had designed frame in such a way to accommodate a knapsack/Backpack manually driven sprayer tank with wet weight of 19 Kgs.
- The frame is totally welded made up of Mild Steel one-inch square cross section pipe so that the corners and joint stay affirm without use of any nuts and bolts in the whole frame to make it durable
- The frame is designed in form of diamond rail chassis as the rear portion will be used to mount the Sprayer tank so it is wide and narrowing the front of the frame which will be occupying a 14-inch cycle wheel to power the whole system.
- To fit the cycle wheels, we have welded 3-inch piece of L shape channel with the removed portion in order to maintain the wheels rear sprocket and chain if needed.
- The rear end of the frame is welded with cylindrical hollow pipe to make the axles of the smaller supporting wheels which is wider than the chassis itself in order to prevent the chassis from roll over situations when using or operating onto uneven surface area as of gardens and fields
- The straight vertical support rods are also fitted onto the chassis to mount the Spraying tank onto it so that it doesn't moves while operating
- The further upward extended support rods are also welded to a round hollow pipe to make handle to push and move the cart forward and backwards
- The ground clearance of Chassis is 7 inches

(4.3) Making of the drive Train

1. The driving wheel is fitted in the front direction and the smaller wheels in the rear towards the handle
2. When pushed forward the rotating bigger wheel rotates the small sprocket fitted onto it which is further pulling the cycle chain as in the chain and sprocket system of the cycle.
3. The chain further rotates the bigger sprocket which has attached Rotating pedal arm which rotates with the bigger sprocket
4. The rotating Arm moves the rod slide mechanism attached to the handle of the Sprayer tank pump which moves up and down and pumps the air into the tank. Which results in increasing of the pressure and pumps the liquid out of the tank at High pressure though a pipe attached to the outlet
5. The rotating arm moves the handle similarly as the piston moves along with the connecting rod and crankshaft
6. The chain sprocket ratio is done in order to decrease the Rotation speed of the rotating arm and gain enough torque to move the pump handle up and down without locking the front driving wheel or making it slip on the working surface
7. The selection of the sprocket ratio was also a challenge as if ratio is reduced extensively it can lead to insufficient amount of pressure inside the pump when pumping slowly which will not properly work
8. The rotating speed of the wheels will depend on the speed of pushing cart which will be naturally set to the average walking speed of the human being.

(4.4) Calculations of drive train

1. Wheel size (Diameter) = 14 Inches = 304.5 mm
2. Driving sprocket = 20 teeth's
3. Driven sprocket = 30 teeth's

Circumference of Driver wheel = $\pi \times$ D (Diameter)

$= (22/7) \times 304.5$ mm

$= 957.55$ mm

Gear Ratio = No. of teeth on (Driven Sprocket / Driving sprocket)

$= 30 / 20$

$= 3:2$

Therefore,

(One complete rotation of Wheel) = (One complete rotation of driving wheel & driving sprocket)

(Three complete rotation of driving = (Two complete rotation of driven sprocket)

sprocket)

(One complete rotation of driven = 2 strokes of rotating arm one whole

Wheel). cycle the water pump)

Hence,

The driving wheel will rotate 1½ times, it will complete one whole 2 stroke cycle of the water pump. The circumference of driving wheel is 957.55 mm. One rotation of driving wheel will cover 957.55 mm or 0.95 m. In order to get one complete cycle of the pump we need to rotate the driving wheel 1½ times which mean it will cover 1½ times total length of its circumference, which is 1436.32 mm or 1.43 m.

Result: -

In order to get one complete cycle (Two strokes of the handle once moving upwards and once moving downwards) of the pump we need to push the cart 1.436 m in the forward direction. We can get a continuous spray of 5 seconds From one cycle of the driven wheel

5. EXECUTION

(5.1) Application

- Its major use in agriculture to spray fertilizer.
- In city and urban area, it can use for spraying water on lawn. It may be exercising device at morning during utilize in lawn. Use from spray chemical Pesticide.
- It is use for spray painting in industry
- It is use for spray water in garden on the plants.
- It is use for transfer water from one place to its nearer place.
- For the insecticides application to control insect pests on crops and instore, houses, kitchen, poultry farm burns etc.

(5.2) Advantages

- It does not require any kind of non-renewable energy is mechanical, electrical energy.
- It reduces the fatigue of operator during the operation.
- It increases the efficiency of operator
- It can cover more area of land during spray.
- It can adjust the height of spray by using adjustable
- Its cost is less than electrically and solar operated pump.

(5.3) Disadvantages

- In irregular area of land, it can difficult to operate.
- In rainy days in 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.
- The flow is very less & can't be used for high flow operation.

(5.4) Conclusion

No design is ever perfect for all the time; design needs to be changed as per the needs and wants of users. Inputs for new product development and or design improvements are obtained from the user's feedback and product evaluation with respect to user requirements. The major outcome from this effort of new product development is concluded below: Working prototype of the mobile pesticide sprayer was designed and developed. The pesticide sprayer reduces back ache and shoulder pain while using the product. The cost of the product can be brought down if mass production can be considered. The product can spray pesticide over multiple rows of plants in one pass there by reducing manual effort.

6. PRECAUTIONS:

- Read the operator's manual and observe all safety precautions for all equipment.
- Protect yourself from electric shock. ...
- Keep all guards and shields in place.
- Give the task your full attention.
- Let each tool work at its own speed; do not force it.
- Always wear appropriate personal protective clothing

7. REFERENCES –

- https://elibrary.asabe.org/abstract.asp?aid=13221
- https://elibrary.asabe.org/abstract.asp?aid=13221
- https://elibrary.asabe.org/abstract.asp?aid=23622
- https://en.wikipedia.org/wiki/Sprayer
- https://inpressco.com/wp-content/uploads/2016/03/Paper83405-408.pdf