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Development of A Manually Operated Sprinkler Machine

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Abstract- This project focuses on the development of a manually operated sprinkler machine for pesticide spraying in agricultural fields. The aim is to improve productivity, reduce costs, manpower, and minimize environmental impact. The project report begins by discussing the background of farming and the importance of effective disease and pest control. Various types of sprinklers used in agriculture are examined, along with the use of fertilizers and pesticides. The limitations of current farming machinery are identified, including high costs, complex designs, transportation difficulties, and inefficiencies in pesticide application. The objectives of the study are to select the materials and to design and fabricate the sprinkler machine. The working principle of the machine involves converting rotary motion from the chain drive to reciprocating motion with the help of a connecting rod that is attached to the pump and the driven or rear sprocket thereby allowing the pump to pressurise the pesticide in the container and discharge it through the nozzles. The methodology discusses the systematic approach to design and fabrication, considering factors such as farm requirements, crop types, and safety standards. The results and observations demonstrate the machine's ability to provide a stable flow of pesticide, achieve an even spray pattern, maintain hose connectivity, and ensure smooth wheel and chain drive operation. The discharge rate and coverage area meet the necessary specifications, and the machine proves to be user-friendly and easy to operate.

Keywords - Agriculture, reciprocating motion, rotary motion, manually operated sprinkler machine, pest management.

I. INTRODUCTION

Background of Study

Over the past 50 years, farming has seen a significant transformation. Control of various crop diseases is one of the many factors contributing to this progress. In the beginning, people would only hand spray. Then gradually came the invention of numerous techniques for dispersing chemicals and dusts. Although these gadgets were extremely efficient, there must be some modifications.

For the management of disease, insects, and weeds in the crops, chemicals are frequently utilized. When used in time, they can protect a crop from pest infestation. They need to be sprayed, dusted, or misted onto soil and plants. Equipment for uniform and successful application is crucial because the chemicals are expensive. Chemical application often involves the use of dusters and sprayers. Pesticide usage are one of the most common methods employed in agriculture to prevent crops from diseases and pest (Achutha et al., 2016).

There are numerous types of sprinklers used in agriculture used to apply weed killers, pest- control agents and fertilizers products on crops in a farm. Some of these sprinklers includes hand sprinklers, knapsack sprinklers, and high-pressure sprinklers etc. Fertilizers are anything, inorganic or organic, man-made or not, which gives nutrients to plants for effective output and growth.

Natural substances of either plant or animal origin, such as compost, green manures, crop leftovers, domestic trash, and woods litter, are considered organic fertilizers. Fertilizers known as inorganic (or mineral) fertilizers are either industrially produced via chemical processes or mined from mineral deposits with minor processing (such as lime, potash, or phosphate rock) (e.g., urea). While chemically produced inorganic fertilizers were only widely established during the industrial revolution, mined

inorganic fertilizers have been utilized for many millennia.

The usage of inorganic fertilizer has also considerably aided in the growth of the world's population. Pesticides are compounds used to eradicate plants or pests. Around Eighty percent of all pesticides are utilized as herbicides, which makes up the majority of pesticide use. The majority of pesticides are designed to act as crop protection agents, or plant protection chemicals, which often guard against weeds, fungi, or insects (Shimpi et al., 2022).

The use of pesticides in modern agriculture is still rising, and 90% of these pesticides are sprayed as liquids. primarily by employing the pressure created by direct energy sources such as chemical and electrical energy. Growing public concern over the possible harm caused by electrical and chemical inputs into agricultural spraying systems has pushed the industry to create innovative and efficient spraying techniques while maintaining an environmentally responsible approach (Achutha et al., 2016).

Problems in the agriculture sector include limited capacity, declining income, a labor shortage, and rising consumer demands. These problems are made worse by the widespread use of conventional agricultural machinery. Additionally, the majority of farmers are desperately looking for new approaches to raise equipment quality while lowering direct overhead expenses (personnel) and capital. Understanding the effects of a pesticide sprayer in an agricultural field is thus a key opportunity. A portable pesticide sprinkler that covers a wider area and has a larger tank capacity is required.

It should also result in lower costs, less labor, and shorter spraying time compared to heavy and costly machineries used to discharge pesticides or herbicides. Numerous sprayers have been launched to the market in an effort to lessen these issues, but these tools fall short of farmer’s expectations or the aforementioned issues. In order to create the pressure necessary to spray, the typical sprayer requires a lot of effort to move the organ up and down.

The necessity to buy fuel, which raises the sprayer's operating costs, is another challenge with petrol sprinklers. in order to get through these obstacles. A wheel-driven sprinkler that is portable can be used, runs on no fuel and sprays the pesticide by turning the wheel. The reciprocating pump and attached nozzles at the front of the spraying apparatus make up the mechanics of this sprayer (Shamali et al., 2018).

Statement of Problem

- The current cultivating heavy machinery has undergone numerous improvements, but the cost is too high. It is not within the means of all farmers.
- Most of the machinery used in a farm has complex designs and is difficult to operate by rural farmers.
- It takes a lot of work to complete the machines transportation costs from one location to another because it is not small in size and their weight is an important consideration for handling purposes.
- An adjustable tank with a 10 to 20-liter capacity makes up a backpack sprinkler. This requires excess time consumption and constant pumping which leads to muscular dysfunction. Additionally, the backpack sprinkler's inability to sustain pressure causes drifts and dribbling. Creating sufficient pressure takes effort and time. Additionally, just a tiny area is covered when spraying. hence, a lengthy process (Ghadge et al., 2021).

Objectives of the Study

The objectives of this study are to:

- Select materials needed in the fabrication and design of a sprinkler machine;
- design and fabricate the sprinkler machine;

II. LITERATURE REVIEW

Review of Related Works

In order to aid farmers, Machines were made that required less manpower and worked more swiftly. An electric source of power is not needed to run the mechanically operated pesticide sprayer pump that is mounted on a frame with a wheel. The development of this idea terminates the defect in the standard pump. Farmers fail to take proper measures since one hand is constantly occupied working the handle, which causes severe infections brought on by direct contact with the chemicals. Different materials like nozzles, a knapsack tank, steel, and a flexible pipe were used to carry out the fabrication. A limitation of the development of this machine is that it can only be used over a limited area (Parmeshwar et al., 2021).

Lightweight and economical pesticide sprayers and seed-sowing apparatus are being established in agriculture as part of the initiative to expand equipment quality and lower overhead costs. Farmer's demands are not being met by the products now on the market since they require a lot of manpower or fuel to function. A wheel-driven sprayer and seed- sowing machinery have been provided as solutions to these issues. It is efficient, portable, and fuel-free, which lowers operating costs. The system uses a chain and sprocket for seed sowing, a reciprocating pump, and nozzles for discharging pesticides (Bhagat, 2017).

The main objective of the project was to fabricate a machine that can discharge pesticides and fertilize the soil with the minimum component changes and little possible cost. This machine uses a way of discharging fertilizers using a slotted disc, which needs the smallest amount of manpower to operate as a whole. The sprayer pump handle, which is connected to the piston by a connecting rod, is also operated by the machine's crank and lever mechanism. (Shimpi et al., 2022).

For greater benefit, multiple pesticide sprayer pumps are a blend of both battery and knapsack-powered pumps. With the help of this trolley-operated system, we may discharge pesticides with minimum use of manpower and in any direction or region close to the crops, regardless of their height. This is used for plugging, weeding, etc. The model of the manually driven multi-nozzle pesticide sprayer pump proposed their research will carry out spraying at the maximum rate in the smallest quantity of time (Thorat et al., 2018).

India is mostly an agricultural nation, with 75% of the population working in farming in one way or another. Spraying is an essential procedure for safeguarding crops against insects, pests, fungi, and diseases. Agriculture, which uses a lot of energy, uses different spraying systems and numerous energy sources. When discharging pesticides, farmers experience issues like a small tank capacity, high cost, and time consumption. A portable, wheel-driven sprayer that is mechanically controlled and easy to transport has been created to meet these problems. Using a crank mechanism and a piston pump, the farmer uses less time and attains uniform nozzle pressure.

Based on research in the literature and market analysis, an economical mechanical sprayer pump has been designed for middle-scale farmers in India. The ideal input setting for acquiring the lowest circularity and lowest taper angle was recognized using grey relational analysis, and the ideal machining parameters were found to be water pressure of 3800 bar, standoff distance of 2 mm, and abrasive flow rate of 400 mg/min. Experimental run 2 produced the least circularity of 0.977 mm, whereas experimental run 15 produced the lowest taper angle of 1.3748°. Future research will also include employing SEM to analyze topography (Thakre et al., 2019).

In order to reduce labor necessity and boost crop productivity Muruganantham et al merged the plowing, seed planting, pesticide spraying, and harvesting tasks into one machine. The machine uses electrical power, which was supplied by solar panels, making usage of it simpler and more affordable. The project aims to help farmers overcome challenges brought on by a lack of workforce and labor-intensive traditional mediums. The machine reduces

the time and total expense of placing fertilizer and sowing seeds.

The ultimate aim of the project was to create a low-cost, simple-to-use device that can aid small-scale farmers in improving planting precision and efficiency. The machine though has some drawbacks, such as increased maintenance and costs because non-conventional sources were used, cost concerns for small farmers with constrained crop fields, and decreased weeding mechanism effectiveness in dry soil (Muruganatham et al., 2021).

A cheap, versatile agricultural machine is needed, according to a project work carried out by Dilip et al to help India's small farmers improve production and reduce labor costs. It draws awareness to the disadvantages of conventional agricultural techniques, such as their lack of mechanization, extravagant time commitment, and labor-intensive nature. The article goes on to propose a solution: a multipurpose agricultural machine that combines all of the many farming tools, such as a plow, a seed-sowing machine, and a sprinkler, into a single piece of machinery.

The project's objectives are to reduce expenses, save time and labor, and increase the living standards of Indian farmers. The multipurpose agricultural machine works by connecting different components to it and starting the engine to carry out the required work. For instance, when plow equipment is mounted to a machine and the machine is accelerated, the plow will remove sand and complete the plowing duty. Similar to spraying, sprinkling involves discharging water on the ground. Water under pressure is forced through a small orifice or nozzle to create the spray, which evenly dispenses water over the area the equipment is used to clean. One of the limitations of the machine is that it might not be suitable for larger farms or commercial farming functions where more compound and extensive equipment is needed.

For small and marginal farmers in rural areas who cannot afford expensive agricultural equipment, the multipurpose machine is made to be cheap and efficient. Another drawback is that not all soil types or crops may be acceptable for the machine. The machine may not be appropriate for different types of crops or soils because it was built and tested for a particular crop type and set of soil conditions (Dilip et al., 2021).

The goal of the project carried out by Madhu et al (2020), was to design and fabricate an economical and effective alternative to the labor-intensive backpack sprinkler that is currently used for agricultural spraying. It was proposed that solar panels be used to harness the abundant solar energy obtainable and fabricate a fertilizer sprayer with several power sources that can rapidly cover a large area. Additionally, to make awareness about renewable energy sources, annihilate environmental pollution by using natural energy sources, use both renewable energy and manual energy for small and large regions of agricultural spraying, reduce the cost of labor, minimize discomfort to farmers during spraying, and expand the efficiency of the process.

The method employed involved the fabrication of the machine using solar panels, steel for the frame, nozzle, sprayer tank, etc., and assessing its effectiveness at spraying crops. The limitation of the project is that it just addresses the spraying process and excludes the thought of another agricultural task. The solar-powered agricultural sprayer relies on the weather, which may demand other available sources and the need to refill the pesticide tank once it has finished. Additionally, it cannot be used for all crops and is ineffective for wetlands (Madhu et al., 2020).

An adjustable multipurpose sprinkler for work in agriculture was developed according to a project report written by (Patil et al., 2012). In their opinion, the present-day sprinkler system has the drawback of wasting water, so it is required to reduce water loss, keep costs down, and improve farmer's protection. The old method for discharging water and pesticides, such as the bamboo method and pump method, are dangerous and may give rise to accidents, and soil erosion is increasing every day. The literature study details the effects of pesticides on farmers and the importance of using safe equipment for farmers.

The sprinkler produced for their project reduces the need for human interaction with pesticides while minimizing fertilizer and water loss. The sprinkler is made to be reliable, easy to purchase, and beneficial for farmers. The adjustable multipurpose sprinkler is a farming-based equipment that adjusts and makes the irrigation process simple by spraying water and pesticides. During the sprinkler's development, PVC pipes, a motor, a dimmer, gears, nozzles, a pump, and tanks were all used.

The motor, which is placed on the bottom plate, and a pinion mounted on the motor shaft make up the sprinkler's operating mechanism. Through the use of a rack and pinion system, the sprinkler's height can be altered and it can extend to a certain height. The sprinkler was made using hand drilling, welding, and grinding techniques.

Numerous setbacks could prevent the sprinkler irrigation system from being widely used and effective in agriculture. One of the project's drawbacks is that it may be costlier to acquire the machine than it is to use conventional irrigation techniques, making it challenging for small-scale farmers or people with tight budgets to embrace it. Additionally, the sprinkler might need to be maintained regularly, by cleaning the nozzles and replacing broken parts.

The sprinkler's dependence on a motor and pump, which needs a stable power source, is another drawback. This can be difficult in places with poor electricity access. Finally, even though the sprinkler can be used to apply pesticides, it is important to take the necessary precautions when doing so because of possible worries about the pesticide's effects on the environment and potential health risks for farmers (Patil et al., 2021).

In order to increase production and reduce labour expenses for farmers in rural areas and small farms in India, Mishra et al proposed a new technique for agricultural mechanization and equipment design. They produced a multi-purpose agricultural machine that could cut crops, carry out seed feeding, spray pesticides and fertilizers, and carry out other tasks while being powered by solar energy, which makes it accessible and easy to operate. The article also evaluates different seed-sowing tools, highlighting the potential for innovation and development. Using PRO-E software, they altered a multipurpose sowing machine, reducing its size and cost.

The fabrication of a solar-powered cutter machine and the design and development of a power-operated rotary weedier for wetland paddy are also highlighted in the article. In order to expand agricultural output and lower labor costs for farmers, the article also presents numerous approaches that were used in the context of agricultural mechanization and equipment design. The solar panels used for power generation are weather dependent, which means that their efficiency and capacity to produce electricity will differ depending on weather conditions. This poses a limitation to the project's work (Mishra et al., 2007).

The aim of the project carried out by Kendre et al was to fabricate a machine that would do different tasks for farmers while requiring little manpower. The machine had a fertilizer spreader and a pesticide sprayer pump mounted on its frame with a wheel that is both mechanically powered by internal energy. The machine was designed to reduce the amount of effort that is required to do these tasks and to reduce the amount of chemical pollution that results from their use.

The existing cultivating equipment, according to Kendre et al is costly and not lightweight, making it difficult for small farmers to use. The major component of the machine included an engine, a chain drive, a sprocket, a plough, wheels, and a sprayer. To make the machine more accessible, easy to maintain, and efficient in performance these parts were carefully chosen. The proposed machine has multiple nozzles, suitable adjustment facilities, and was made to be cheap and low maintenance. Additionally, it was simple to exchange, making it easy for farmers to switch between several tasks. The machine was superior to existing ones in that it cost less than half as much and prevented the muscular difficulties brought on by human labor.

The suggested machine had numerous benefits, but it also had drawbacks that needed to be resolved. One drawback is that the machine might not be compact and might be quite heavy due to its size and weight, making it challenging to manage and carry. Farmers working in small or crowded fields, where maneuverability is important, may find this to be a serious difficulty. Furthermore, because the device relies on an engine for power, fuel may not always be easily accessible in rural areas, especially during emergencies. Due to the machine's need on fuel, it may also be expensive to run, making it an undesirable choice for small-scale farmers who cannot afford such expenses. Although the machine is less expensive than other machines, small-scale farmers may still not be able to afford it, which would limit its application and effects on agriculture (Kendre et al., 2021).

III. METHODOLOGY

The development of a manually operated sprinkler machine for sprinkling pesticides in a farm calls for the application of several materials and methods to make certain that the eventual outcome is good, efficient, and convenient. The procedure requires carefully choosing the materials needed and a systematic approach to the design and fabrication phase. The necessity of the farm, as well as the size and structure of the field of farm to be sprinkled, the type of crops farmed, the kinds of pesticide to be used, and the target pests are strictly examined in order to design and fabricate the sprinkler machine. Together with these factors, the design also takes the project's budget, safety standards, and convenience of use into account.

Once the design is complete, the fabrication phase starts, which requires the choosing of the suitable materials and methods to be implemented. The materials used in the making of the sprinkler machine are normally lightweight, long-lasting and corrosion-resistant. The sprinkler machine also needs a spraying operation, which often has a nozzle or series of nozzles to attain a regular or steady dispersion of the pesticide over the field or farm. The spraying mechanism must be carefully made. In order to achieve this objective, consideration must be given to the size, form and orientation of the nozzle. Finally, the sprinkler machine requires a manual operating system. The operating system must be designed to provide the required pressure and flow rate to the spraying mechanism. It must also be easy to operate, with minimal effort required from the operator This chapter, therefore, discussed the materials, calculations and methods used for the design and fabrication of a manually operated sprinkler machine used in a farm. Also, its working principle and various maintenance needed.

Working Principle

The basic working principle of a manually operated sprinkler machine is quite simple. The machine is composed of several key components, such as nozzles, sprockets, chain, pump, a container for holding the pesticides etc. To operate the machine, the farmer will first fill the container with the desired amount of pesticides. Then he simply gives motion to the machine by pushing the handle of the machine. As the machine is being pushed, the wheel is rotated. The wheel is attached to the chain and sprocket which transfer rotary motion to the front sprocket.

The rotary motion of the front sprocket is then transmitted to the rear sprocket. This mechanism acts like a single slider crank mechanism. While the rear sprocket is being rotated, a connecting rod attached to both the rear sprocket and piston of the pump converts the rotary motion to reciprocating motion. The pump then moves in an up and down direction. When the piston rises, the liquid from the pump is sucked up, and when it descends, the flexible hose that is connected to the pump discharges the highly pressurized liquid toward the nozzle which then releases the pesticides on the farm.

Materials

Mild Steel

Mild steel was used in the designing and fabrication of the manually operated sprinkler machine used to spray pesticides in a farm. This is because mild steel is of low cost compared to other metals and versatile

metal that provides a good stability of solidity and durability. Mild steel is used in various parts of the sprinkler machine majorly the frame which provides support and strength to the machine.

The frame is composed of mild steel that are welded together to form a tough and stiff structure. Mild steel is also used in the fabrication of other components. Another important use of mild steel in the sprinkler machine is in the fabrication of the handle. Mild steel was also used to create the spraying arms, which hold the nozzles and distribute the pesticide across the field. Mild steel is also used in the fabrication of the nozzle brackets, which hold the nozzles in place and provide the required angle and orientation for effective spraying. Figure 3.1 shows an image of mild steels.

Nozzles

Nozzles played an important role in the designing and fabrication of the manually operated sprinkler machine used to spray pesticides in a farm. Figure 3.2 shows various types of nozzles that can be used on manually operated sprinkler machine. The main function of the nozzles is to distribute the pesticide solution evenly over the crops. Some of the importance of nozzles in a pesticide spraying is discussed below:

- Regulate the flow rate: Nozzles are made to regulate the pesticide solution's flow rate. The flow rate of the nozzle determines how much insecticide is
- applied to the crop. The operator can regulate how much pesticide is applied to the crop by adjusting the nozzle.
- Spray pattern: Nozzles are designed to create a specific spray pattern. The spray pattern determines the coverage area of the pesticide solution. The nozzle can be altered to form a design in form of a fan, a cone-shaped design, or a firm stream design.
- Droplet size: Nozzles can be used to control the size of droplets of pesticides.
- The coverage and penetration of the pesticide are influenced by the size of the droplets. While providing higher coverage, smaller droplets may also disperse more in the wind. Bigger droplets may not cover as much ground but are less likely to drift.
- Durability: Nozzles must be durable to endure the demanding conditions of pesticide application. They should last enough to resist wear and tear, corrosion, and blockage.

Overall, the efficient and successful application of pesticides on a farm is greatly aided by the use of nozzles. To guarantee that the pesticide is applied uniformly and effectively to protect crops from pests and diseases, the proper nozzle selection and upkeep are important.

Plate 3.1: An image of mild steels

Figure 3.1: Various types of nozzles (Manzoor et al., 2020)

Hose

The hose is essential for the connection of the pump to the nozzles. It should be long-lasting and flexible enough to resist the chemicals in the pesticide and the force of the fluid. It should also be easy to install. The use of a flexible hose in the development of a manually operated sprinkler machine used to discharge pesticides in a farm helps to make certain efficient and successful disposition of pesticides while lowering the time and cost involved in the operation. A flexible hose is shown in Figure 3.3.

Chain

Chain is a series of connected links which are typically made of metal. A chain may consist of two or more links. A chain works together with the

sprockets When the chain is placed all over the sprockets and one of the sprockets is rotated, the teeth on the sprocket drags the chain onwards with it. This causes the chain to go on every side the sprocket and in turn, turns the other sprocket. Thus, the rotary motion conveys from one shaft to another.

The size of the sprockets and sum total of teeth on them can influence the speed, moment and force of the system. A larger sprocket will revolve more slowly but provide more moment and force. On the other hand, a smaller sprocket will revolve more swiftly but supply a lesser torque. Figure 3.4 shows an image of a chain drive.

Plate 3.2: A flexible hose

Plate 3.3: Chain drive

Sprocket

A sprocket or sprocket-wheel is a profiled wheel with teeth, cogs, or even sprockets that mesh with a chain, track or other perforated or indented material. The name 'sprocket' applies generally to any wheel upon which radial projections engage a chain passing over it. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth etc. Sprockets are used in bicycles, cars, motorcycles and other machinery either to transmit rotary motion between two shafts where gears are unsuitable or to impact linear motion to a track, tape etc. The machine is composed of a front sprocket and a rear sprocket which are both used to create rotary motion. Figure 3.5 shows the image of sprockets that was used in sprinkler machine.

Wheel

In the design and construction of the manually operated sprinkler machine used to spray pesticides on farms, the wheel is plays crucial role. A wheel may be helpful in the following situations:

- Mobility: The wheel allows the sprinkler machine to move around the farm, making it easier to cover a larger area without having to carry the machine.
- Stability: When the machine is in use, the wheel gives it stability. This is crucial when the machine is being pushed across unlevelled ground.
- Durability: The wheel is made of strong materials that can resist the rigors of farm thereby, making sure that the machine lasts for a long time.
- In conclusion, the wheel is a crucial part of the design and construction of a manually controlled sprinkler machine used to spray pesticides on farms because it gives the machine mobility, stability, maneuverability, and longevity. Figure 3.6 shows an image of a wheel.

Plate 3.4: Sprocket

Plate 3.5: Wheel

Sprinkler Container and Pump

The sprinkler container is simply used to house the pesticide. The sprinkler container is a container which holds the fluid to be dispends and a piston pump. The piston pump pressurizes the fluid and deliver it through the pipes to the nozzles. Figure 3.7 shows a sprinkler container with a pump.

Plate 3.6: Sprinkler container with pump

Calculations

To design the frame of the manually operated sprinkler machine, it is required to first draw the frame on paper or using a CAD software to design the frame. Figure 3.8 shows the design of the frame of a manually operated sprinkler machine.

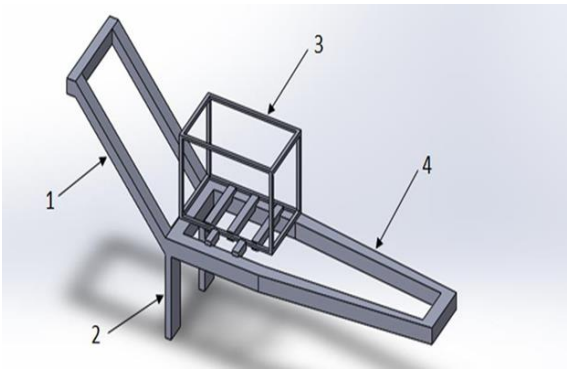

Plate 3.7: Computer aided design of the frame of the sprinkler machine

Table 3.1: Nomenclature of Various Parts of the Frame

Serial number	Name
1	Handle
2	Stand
3	Container compartment
4	Base

Area of Handle for the Frame

$14\ inches \times 24\ inches = 336\ square\ inches = 0.217m^2$

Area of Stand for the Frame

$10\ inches \times 3\ inches = 30\ square\ inches = 0.0193548m^2$

Area of Compartment for the Sprinkler container

$$16\ inches \times 9\frac{1}{2}$$

$inches = 152\ square\ inches = 0.0980643m^2$

Area of Base for the Frame

$$Area\ of\ base\ for\ the\ frame$$

$$= area\ of\ rectangular\ base\ - area\ of\ both\ sides\ of\ traingular\ base.$$

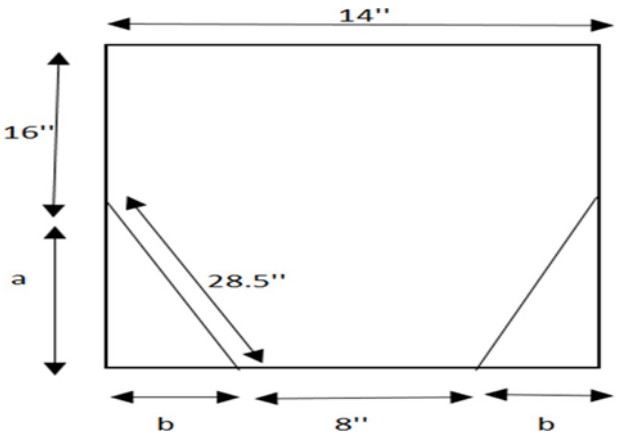

Plate 3.8: Illustration of the unknown base and height of base

$$\overline{8\ inches} + 2\ inches \times (b) = 14\ inches$$

(3.5)

$$\overline{2\ inches} \times (b) = 14\ inches - 8\ inches$$

(3.6)

$$2\ inches \times (b) = 6\ inches$$

(3.7)

$b = 3\ inches.$

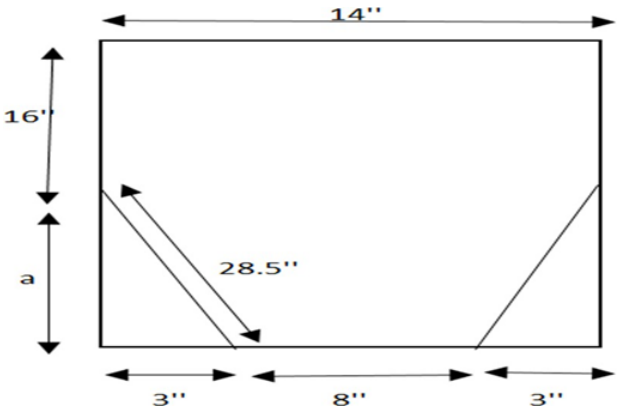

Plate 3.9: Illustration of the unknown height of base

$$Using\ Pythagoras\ theorem$$

$$c^2 = a^2 + b^2$$

(3.9)

$$Where\ C = 28.5\ inches$$

(3.10)

$$b = 3\ inches$$

$$a = ?$$

(3.12)

$$c^2 = a^2 + b^2$$

$$a^2 = c^2 - b^2$$

(3.14)

$$a = \sqrt{c^2 - b^2}$$

$$a = \sqrt{(28.5)^2 - 3^2}$$

(3.16)

$$a = \sqrt{(812.25) - 9}$$

$$a = \sqrt{803.25}$$

(3.18)

$$a = 28.3\ inches$$

$$area\ of\ rectangular\ base = 14 \times (16 + a)$$

(3.20)

$where\ a = 28.3\ inches$

$14 \times (16 + 28.3) = 620.2\ square\ inches$

$area\ of\ both\ sides\ of\ the\ triangular\ base =$

$2 \times \frac{1}{2} (3 \times 28.3) = 2 \times 42.45 = 84.9\ square\ inches \therefore\ area\ of\ base\ for\ the\ frame$

$620.2 - 84.9 = 535.5\ square\ inches = 0.34548318 m^2$

(3.24)

Distance Covered by One Rotation of Wheel

$Using\ the\ Formula:$

$2\pi r$

(3.25)

$Where\ \pi = 3.142$

$r = Radius$

$Radius = \frac{Diameter}{2} = D$

$Diameter\ of\ wheel = 622mm$

(3.28)

$Radius = \frac{D}{2} = \frac{622mm}{2} = 311mm$

$\therefore\ 2\pi r = 2 \times \pi \times 311 = 1954.07mm$

Gear Ratio

$Gear\ ratio = \frac{Number\ of\ teeth\ on\ driven\ sprocket}{Number\ of\ teeth\ on\ driver\ sprocker} = \frac{28}{48} = 0.6$

(3.32)

Number of Stroke of Pump

$Number\ of\ Stroke = \frac{Number\ of\ rotations\ of\ the\ driver\ sprocket}{Number\ of\ rotations\ of\ the\ driver\ sprocket} \times Gear\ ratio$

(3.33)

$Number\ of\ rotations\ of\ the\ driver\ sprocket = 1$

$Number\ of\ rotations\ of\ driven\ sprocket\ per\ pump\ stroke = 0.7$

(3.35)

$From\ equation\ 3.32, Gear\ ratio = 0.6$

$\therefore\ \frac{1}{0.6} \times 0.7 = 1.17$

$\therefore Number\ of\ stroke\ of\ Pump\ for\ one\ rotation\ of\ the\ driver\ sprocket = 1.17$

IV. METHODS

Designing

METHODS

DESIGNING

The initial stage carried out in fabricating of the manually operated spraying device is designing. It entailed making decisions about the machine's dimensions and materials that would be best for the intended use. This could be done on paper or by drawing using (CAD) software.

Selection of Materials

During the selection phase, various factors were considered such as the cost, availability, and the durability of the materials. Mild steel was chosen for its availability and versatility. The container and the pump were selected based on their capacity and compatibility with the spraying mechanism.

The sprockets and chain drive were chosen based on their strength and durability to ensure efficient transmission of rotary motion from the wheel to the pump. The nozzles were selected based on their spray pattern and ability to deliver the required amount of pesticides. Overall, the selection phase aimed to ensure that the chosen materials were of high quality and capable of meeting the functional requirements of the spraying device.

Cutting

Cutting

After mild steel has been chosen and other essential materials for the fabrication of the manually operated sprinkling machine, the next phase was to cut the mild steel into the required measurement and configuration. This was an essential stage in the fabrication process as

the precision of the cuts would influence the general form and service of the machine. Several cutting equipment's such as saws, lathe machines, and grinders can be used to cut the mild steel to the appropriate dimensions and form.

A grinder was used for the cutting process. The cutting process needed accuracy and awareness to detail to make sure that the parts are in conjunction with each other during the assembly process. After completing the cutting phase, the mild steel parts were ready to be assembled together by welding process.

Welding

Welding
After cutting the mild steel into the proper size and shape, the next step in fabricating the manually operated spraying device was welding them together to create the frame. This was done using a welding machine, which required skill and precision to ensure that the frame was strong and durable. Welding involves joining other parts such as brackets, clamps, and fittings to the frame. After welding was finished, the frame was examined for any deficiency that could compromise its structure. Certain mending was made before moving to the next phase of fabrication.

Drilling

Drilling
Drilling was a critical phase in the fabrication process, as it was required to produce holes of the required size and position for connecting the different constituent of the machine. This was done using a drilling machine, which allowed precise control over the position and depth of each hole. The holes are for fastening the wheel and sprockets to the frame. Drilling with great accuracy was needed to ensure proper alignment and smooth operation of the chain drive mechanism. The size of each holes also had to be correctly selected to accommodate the size of the bolts and nuts that would be used to link the parts together. Overall, drilling was an important step in ensuring the functionality and durability of the manually operated spraying device.

Assembly

Assembly
The next phase was to put together the several components of the machine. This involved careful placement and alignment of the different components Firstly, the chain had to be perfectly set to the sprockets to make certain that it does not slack during operation. Then, the container and pump were set perfectly on the frame, with the pump being tightly attached to the container. The nozzles were then positioned onto the frame, and the pipes were attached to the pump and nozzle to permit for the flow of liquid.

Finally, the connecting rod was attached between the rear sprocket and pump, with the help of a cotter pin and nut to ensure simple operation of the machine. All of these components had to be set up with precision to make sure that the machine works effectively and efficiently.

Painting

Painting
The machine was then painted to prevent it from rust and corrosion, and also to make the appearance better and make it more visibly attractive. Also, painting could help to make it simple to recognize and fix any damage or wear and tear that could happen over time.

Testing

Testing
The machine was put through testing after fabrication was done to make sure it operated properly. In order to do this, the tank was filled with water and the machine's spray pattern and pressure were observed.

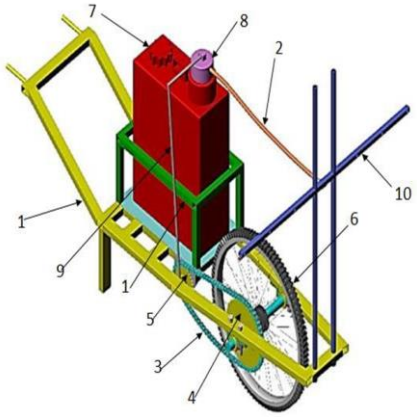

Figure 3.2: Labelled CAD diagram of the manually operated sprinkler machine

Table 3.2: Part List

Serial Number	Name of parts	Materials	Quantity/Size

1	Rectangular and Square tube	Milled steel	02/0.34548318m^2
2	Flexible hose	Rubber	01/1.2m
3	Roller chain	Steel	01/2.4mm
4	Driver sprocket	Steel	01/48 teeth
5	Driven sprocket	Steel	01/28 teeth
6	Wheel	Standard	01/24 inch
7	Pesticide container	Plastic	01/16 litres
8 9	Pump Connecting rod	Plastic Steel	01 01/600mm
10	Nozzle	Plastic	02

(3.34)

V. RESULTS AND DISCUSSION

Testing

The goal of the test was to evaluate the functionality and efficacy of the manually operated sprinkler machine that is used to sprinkle pesticides on a farm. All of the machine's important parts, such as the nozzle, pump, hose, wheel, chain drive, and other parts, were carefully put in place. Each part of the machine was carefully assembled ensuring that each component was accurately installed and adequately connected. An appropriate pesticide was used for testing in order to check the machine's performance and functionality. To provide a typical setting for assessing the machine's abilities a designated area was selected as the test site. Several parameters such as the discharge rate, coverage area, consistency of pesticide dispensation, and overall functionality were observed.

Analysis of Result

A stable flow of pesticide to the nozzle was made possible because of the pump's consistent flow rate and adequate pressure. The pump provided the necessary volume of pesticide throughout the process, enabling accurate application in the area that was sprayed. The nozzle could disperse the pesticide evenly and effectively across the area while the pump maintained constant pressure. The successful application of pesticides was largely due to the pump's constant and consistent flow rate, which provided a reliable and efficient way to convey the pesticide to the appropriate areas.

The spray pattern and droplet size were obtained by the nozzle, resulting in effective pesticide coverage and dispersal. It effectively covered all intended surfaces with a steady, well-defined spray pattern. With its good performance, the nozzle facilitated thorough coverage of the area. It applied uniformly throughout the surface and

got to even the hardest- to-reach places. The pesticide's efficiency was intensified by reducing drift and making sure that it stuck to the necessary surfaces due to the regulated droplet size.

The hose maintained the connection between the pump and the nozzle reliable and stable. No major leaks or damages were found after the test, making sure the pesticide kept on flowing without any problem. Its proper fittings provided an airtight fit that stopped any possible leaks or inefficiencies. The hose was firmly connected to the pump and nozzle during the test, effectively delivering the pesticide without detaching. The hose worked as a reliable and strong connection in the pesticide application system. This safe connection allowed the pesticide to move smoothly and consistently, ensuring a proper supply of pesticide to the nozzle.

The sprinkler machine moved and functioned across the test area with ease due to the smooth functioning of the wheel and chain drive. The wheel rotated smoothly, providing stability and grip on different surfaces. The pump's movement was effectively conveyed to it through the chain drive, ensuring continuous and smooth motion. Their coordinated movement enabled efficient navigation around contours and obstructions. Overall, the driving systems for the wheels and chain worked well allowing smooth movement throughout the test region.

The discharge rate of the pesticide was within the required specification, ensuring the effective application of pesticides. In a one-square-meter area, 0.2 litres of pesticide is discharged. Consequently, with the total volume of 16 litres, which fills the entire pesticide container, the area covered would be 80 square meters.

The even spread of pesticides in the area of coverage showed the sprinkler system's effective operation. There were no obvious variations or gaps in the pesticide solution's application across the target area. This even distribution showed that the device could successfully reach all specified surfaces, maximizing the pesticide application's effectiveness.

For efficient and successful pesticide application, the sprinkler machine's steady discharge rate and uniform coverage area were necessary. The machine provided the pesticide precisely, avoiding over- or under-application, by meeting the necessary requirements. The even distribution made provided that every area received appropriate treatment, preventing pests from escaping.

The sprinkler machine was found to have a user-friendly design and to be simple to operate during the test, allowing users to move around the test area quickly and conveniently. The machine's controls are simple and easy to understand, making it possible to use it with ease. The sprinkler machine also performed properly. Without any serious operating problems or malfunctions, it effectively sprayed the pesticide. The machine's systems and parts worked well, enabling reliable and smooth operation throughout the test. Figure 4.1 shows an image of the manually operated sprinkler machine.

Plate 5.1: Manually operated sprinkler machine

VI. CONCLUSION AND RECOMMENDATION

Conclusion

The development and application of the manually operated sprinkler machine for pesticide spraying in farms has shown a successful and functional solution for controlling pests in a farm. This project report has provided a full description of the design and construction.

This project's main aim was to develop a low-cost, simple-to-use pesticide spraying system for small and medium-sized farms that don't have access to costly, complicated automated heavy machinery used in a farm. A manually operated sprinkler machine that efficiently fills this need was developed through a design procedure. Farmers with limited resources can readily use the machine because it is made to be simple, dependable, and economical.

In the fabrication stage, high-quality materials had to be used and good fabrication methods had to be employed.

The ergonomic design of the machine permits comfortable handling and ease of use by farmers, reducing tiredness during prolonged spraying sessions. The distribution and coverage of pesticides using the equipment were outstanding. The machine's manual operation provides farmers better control over the spraying process, allowing them to target specific areas.

Despite its many advantages, the manually operated sprinkler machine does have some limitations. The manual process requires the operator to put forth physical effort, which could hinder it from being used in large-

scale farming operations. Additionally, the machine relies on the strength and endurance of the operator, which could affect the consistency of pesticide application if fatigue sets in during long spraying sessions.

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