DESIGN AND CONSTRUCTION OF AUTOMATIC NOZZLE SPRAY FOR KILLING INSECTS/PEST FROM AGRICULTURE LAND

A thesis paper submitted in Partial Fulfillment of the Requirements for Award of Degree to the department of Mechanical Engineering.

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For partial fulfillment of the requirements for the degree of B.Sc in Mechanical Engineering from Sonargaon University under BME Department.

This report has been carrier our under my guidance & supervision. This definitely concept and creative activity. This thesis will give a clear over view about automatic nozzle spray for killing insects/pets from agricultural land and is a record of bona fide work carried out successfully.

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LETTER OF TRANSMITTAL

14 September 2022

To,
Md. AHTASHAMUL HAQUE KHAN SHUVO
Lecturer & Coordinator
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Subject: **Application for submission of Thesis paper.**

Dear Sir,

With due respect, we would like to inform that we are going to submit our thesis paper on **"Automatic Nozzle Spray For Killing Insects/Pest From Agricultural Land"** It has been a great pleasure to work on such an innovative topic according to **Sonargaon University** degree requirement and complying with our supervisor suggestion and guidance we have tried our best to make. This thesis success by taken information form book's Journals, Wikipedia, Internet and Laboratory is other laboratory organization work.

We believe and hope that this report will be acceptable to you against the partialfulfillment of requirements for awarding the degree of bachelor of science in mechanical engineering your sincerely .

Yours Sincerely

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ABSTRACT

Internet of Things (IOT) devices are exposed to many advanced vulnerabilities and various new inventions Bangladesh has agriculture as its primary occupation. Economy of the country highly depends on Agricultural productivity. To increase productivity controlling of Pest infestation plays an important role. Many kinds of pests can hurt plants as they grow. Sprayers are machines used for Pests removal. An automatic sprayer is one of the prominent forms of pest removal. Smaller spraying machines commonly Known as portable sprayers are solely used for Pest removal in agricultural fields, in our country, most of the farmers have small croplands and that's why they don't preferto purchase of Pesticide Sprayer. So, we in this paper design and fabricate a good efficient, low-cost Pesticide Sprayer. The special type of powered Pesticide sprayer is designed and constructed to remove the Pests. The foremost benefits of our product were, they must reduce labor cost similarly in quantity of labors, consume less time to remove the pests, Easy and Simple to operate and handling should be comfortable for farmers. It should be faster than the traditional method of removing pests.

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Chapter-1

Introduction

Agriculture is the backbone of the Bangladesh economy. In Bangladesh agriculture and agriculture-based products have received great importance in the Bangladeshi economy. The 2010 world statistics of agriculture says, Bangladesh to be the world's highest producer of several vegetables, fresh fruits, major spices, milk and also some fibrous crops. Lack of mechanization or automation is one of the major roadblocks to improving the productivity of agriculture. With agriculture facing a shortage of manpower, the need for automating the various activities in the field arises or it is becoming the need of the day. With this in mind, a simple machine has been designed and fabricated for removal of pest and unwanted plants between the rows of sugarcane plants. As the sprayer is portable, it is hangedat the shoulder and pesticides are sprayed by the farmer.

A pest is usually characterized by rapid growth and It typically replaces another more desirable disease. Some pests, such as crabgrass, are considered weeds everywhere they grow, but many plants are considered pests in some regions and no tin others. Although most pest damage cultivated plants by competing with the for sunlight, water, mineral nutrients, some pest are parasites that in fact directly on other plants and those it her weaken or kill them. Many pests are also hosts fordisease- causing organisms. For example, some of the fungi diseases that infect food crops spend part oftheir life cycle on a pest that typically grows near the crop.

In addition to harming cultivated plants, many pests, such as Canada thistle, can poison live stock if eaten. Although livestock poisoning is not a serious problem in the eastern United States, the western states, having many poisonous species, report a considerable loss each year. For example, the wild onion, although not poisonous, spoils the flavor of milk produced by cows that consume this weed. Although generally harmful or undesirable, weeds can also provide benefits for agriculture. Pests prevent Torre tardy soiled rosin in open pastures and stabilize the thin, fragile soils of tropical farmlands. They conserve water in semi-arid and Mediterranean climates by enhancing water storage, increasing shade, and breaking up the soil with their root growth. This prevents a condition called hard cap, in which rain puddles that set on sunbaked soil rapidly evaporate without ever penetrating the ground.

Some pests may provide a source of food. The tender shoots of weeds such as dock, pokeweeds, fieldmustard, and dandelion are considered as tasty and nutritious as garden greens. Archaeologists have uncovered evidence that prehistoric Native Americans cultivated weeds, such as knotweed and little barley. Alongside traditional crops such as corn, beans, and squash. In addition to their agricultural uses, many pests such as tansy, Chicory, and smartweed have medicinal properties and are used extensively inhomeopathic and naturopathic medicine.

AIM OF THE PROJECT

The overall goal of this project was to develop and evaluate the performance of a battery and pump mechanism indented for power-operated electrical spraying in sugarcane crop production. The specific objective of this project is to remove the pest by using power-operated pesticide spayed ratherthan manually operated sprayers to reduce lime find increase work effort of labor.

PROBLEM STATEMENT

From several surveys, we observe that the main reason for the lack of agricultural productivity is Pest. So we preferred to Design and Fabricate an Automatic Sprayer machine to control the weeds. Here weeds are nothing but unwanted plants that grow in Farmlands, Parks, Gardens, Lawns, etc. It also poses a great problem in non-cropped areas like industrial sites, road/rail lines, airfields, landscape plantings, water tanks, and waterways, etc. Pests are an unimportant factor in the management of allland and water resources, but its effect is greatest on agriculture. The losses caused by pests exceed the losses caused by any other category of agricultural pests.

Pests may be unwanted for a number of reasons the other important problem with the weeds is, they grow with food, fiber, croplands. If they were not controlled, it leads to loss of farm yield. Also, it disturbs growth in golf courses, playgrounds, beauty farms, decoration, and cosmetic farms in houses, etc. Similarly, they can be of concern for environmental reasons whereby introduced species out- compete for resources or space with desired plants. Pests have long been a concern, perhaps as long as humans have cultivated plants.

JUSTIFICATION

Presently in Bangladesh, spraying with simple tools like pneumatic sprayers is labor-intensive and time- consuming. Thus, there is a need for the design of an automatically operated sprayer for an intensive and commercial farming system in Bangladesh. One of the problems in crops and vegetable production is poorpest control, hence there is a need for the electrical sprayer to increase the production of these products. The cost of employing a Labor force when using pneumatic sprayer is very high in the commercial farming system. This can be reduced using an electrical sprayer. This Concept involved the developmentof electrical sprayer, after discovering that tools such as a pneumatic sprayers and petrol engine sprayers arc time consuming, high labor requirement and fuel consumption. As a solution to lo these problems. The electrical sprayer was designed and developed. The tool developed will be able to fulfill the presentrequirement for pest control. Accordingly. The present development is directed to an improved manual sprayer pest control.

Chapter-2

LITERATURE SURVEY

The Food and Agriculture Organization (FAO) has defined pesticide as: Any substance or mixture of substances intended for preventing, destroying, or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals, causing harm during or otherwise interfering with the production, processing, storage, transport, or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs, or substances that may be administered to animals for the control of insects, arachnids, or other pests in oron their bodies. The term includes substances intended for use as a plant growth regulator, defoliant, desiccant, or agent for thinning fruit or preventing the premature fall of fruit. Also used as substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport.

2.1 Spraying Methods

The objective of spraying is to deliver an effective, uniform dose of product to a target area ina safe and timely manner. The most common type of pesticide sprayers used are Mechanical Sprayers.

2.1.1 Backpack Sprayers

Manually operated, tank capacity is 15 liters, mechanical or hydraulic agitation, worked witha hand lever to maintain constant pressure, particularly used for spot treatment by small holding farmer and hand treatment. Equipped with a boom. It is good for blanket application.

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, often 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 canbe altered through the use of different nozzle sizes, or by altering the pressure under which itis 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 wind conditions are required. But, in this type of spraying, the labour has to carry all the weight of the pesticides filled tank which causes fatigue to labour and hence reduces the human capacity.

Fig.2.1.1 Backpack Sprayers

Drawbacks: These sprayers are mounted on the back of a man. One hand to lever sprays 0.4 ha/day and with a boom 0.8 ha/day. It is a high volume spray but low volume nozzles can also be fitted. Spray potential is 12 kg/ cm^2. It is sprayed at 3 to 4 kg/cm^2 to prevent spray drift.

2.1.2 Tractor Mounted Sprayers

With spray pressure of 1.4 to 2.8 kg/cm^2 and fitted with multi nozzle boom, they are very usefulin CPP application for large holding of farmers [1]. Tractor mounted sprayer fitted with booms are used to spray road side vegetation. Tractor run sprayers have,

- High uniformity of sprayers.
- High working efficiency.
- Full utilization of tractor during idle time.

Fig.2.1.2 Tractor Mounted Sprayers

2.1.3 Aerial Sprayers

Aerial application, or what was formerly referred to as crop dusting, involves spraying crops with crop protection products from an agricultural aircraft [1]. Planting certain types of seed are also included in aerial application. The specific spreading of fertilizer is also known as *aerial topdressing* in some countries. Many countries have severely limited aerial application of pesticides and other products because of environmental and public health hazards like spray drift.

Agricultural aircraft are highly specialized, purpose-built aircraft. Today's agricultural aircraft are often powered by turbine engines of up to 1500 hp and can carry as much as 800 US gallons(3,000 l) of crop protection product. Helicopters are sometimes used, and some aircraft servedouble duty as water bombers in areas prone to wildfires. (These aircraft are referred to as SEAT, "single engine air tankers").

Fig.2.1.3 Aerial Sprayers

2.1.4 Foot Operated Sprayer

Foot operated sprayers [2.1.4] are suitable for both small and large spraying operation on cropsand plantations. The sprayer has two discharge outlets and it develops sufficient pressure tooperate with two discharge line. The equipment is supplied with 8m long delivery hose and 2meter long suction hose with strainer. The sprayer is less in weight and easy to move. Its potential spray pressure is 17 to 21 kg/cm^2 output and with lance is 1 ha/ day. It can spray high volume spray and covers more area.

Insects and weeds are largely responsible for the crop destruction. In modern horticulture and agriculture, insecticides/pesticides, a man made or natural preparation are used to kill insects or otherwise control their reproduction. These herbicides, pesticides, and fertilizers are applied to agricultural crops with the help of a special device known as a "Sprayer." Sprayers are commonly used on farms to spray pesticides, herbicides, fungicides, and defoliants as a means of crop quality control. To produce more output from the farm, mechanizing the equipment is necessary. It gives more productivity in less input. Mechanization reduces the efforts of labours and helps to uniformly spray the fertilizers and pesticides all over the farm.

Fig.2.1.4 Foot Operated Sprayer

2.2 Existing pesticide sprayers

There many types of pesticide sprayers available in the market. Depending on the crops, area of the farm, type of pesticide and cost of the sprayer, the pesticide sprayers are chosen. Some of the most widely used pesticide sprayers are as follows.

2.3 Manually Operated Sprayers

2.3.1 Compression sprayer

Usually considered as the standard equipment [2] for residual spraying. It consists of a tank for holding a liquid insecticide formulation, which can be pressurized by means of a hand pump attached to it. The compressed air forces the liquid from the tank via a hose with a cut off valve,a lance and a nozzle. It consists of following main parts.

- **The tank:** It is usually made of stainless steel. Most tanks have four openings on top;a large one for filling, fitted with a removable cover and openings for the air pump, discharge system and pressure gauge.
- **The tank cover:** It consists of a rubber gasket, a handle, a PRV, operated by hand orby giving the handle a quarter turn, a chain to prevent the cover from being lost.
- **An air pressure gauge:** It is used to measure pressure in the tank.
- **The shoulder strap:** It should be wide enough to prevent it from cutting into the shoulder of the person using the sprayer.it is fastened to the tank with steel buckles. On large tanks, it is adjustable.

Fig.2.3.1 Compression sprayer

2.3.2 Knapsack sprayer

Widely used in agriculture, this is carried on the back. A frame or shield prevents contact between the tank and the back. It is a continuous type of sprayer with a fairly constant discharge rate. The person maintains pressure in the tank by pumping air with a lever with one hand and directs the spray lance with the other. If the sprayer is fitted with a spray control valve, continuous pumping may not be necessary. The knapsack sprayer can be used for spraying breeding sites with parricides but should not be used for residual wall-spraying.

Fig.2.3.2 Knapsack sprayer

2.3.3 Stirrup pumps

These are used in some vector control programmers because they are less costly than compression sprayers. The pump, mounted on a footrest or stirrup, is inserted in the spray liquid in a bucket. A hose attached to the pump leads to the spray lance. Two persons are needed, one to pump and one to direct the spray. The pressure varies with the speed of pumping, and so it is difficult to make uniform spray applications. Because of their inaccuracy and because of the risk of spilling insecticide from the open bucket inside houses, stirrup pumps are not recommended. They should not be used with hazardous pesticides.

Fig. 2.3.3 Stirrup pumps

2.3.4 Rocker Sprayer

The Rocker sprayer has a pump assembly, fixed on a wooden platform with an operating lever,a valve assembly with two ball valves a pressure chamber, a suction hose with strainer and a delivery hose with spray lance [3].

When the plunger is pulled behind, the spray fluid from the container is sucked through the strainer and pushes the bottom ball valve above and enters the pump. The movement of the lower ball valve is arrested by the upper valve seat. When the lever is pushed towards the pump, the sucked fluid is forced to enter the pressure chamber by opening the upper ball valve. The operation is continued till the entire suction pipe, ball valve assembly, delivery hose and a portion of pressure vessel is fitted with spray fluid and the pump operator finds it difficult to push the piston forward, due to the downward pressure developed by the entrapped compressed air in the pressure vessel. Thereafter, the trigger cut-off valve will be opened to allow the spray fluid to rush through the nozzle and get atomized.

Usually, 60-80 psi pressure can be built in the pressure chamber and hence can be conveniently used for tree spraying.

Fig. 2.3.4 Rocker Sprayer

2.4 Power Operated Sprayers

Various power-operated sprayers are available and range in size from small, hand-carried engine-driven pump units to large self-propelled sprayers. Some of the power operated sprayers are a follows.

2.4.1 Knapsack Power Sprayer

Knapsack Power Sprayers [4] are easy to use and highly durable. Designed in sync with the industrial standards, these sprayers are immensely used for garden spraying - weed, pest control, liquid fertilizing and plant leaf polishing. General Technical Specifications are as follows.

- Spraying capacity: 8 litres/min
- Capacity of chemical tank: 25 litres
- Capacity of fuel tank: 1.1 litres
- Net weight: 10.5 kg
- Engine type: 2 stroke
- Petrol displacement: 22 cc

However, there are certain limitations of this sprayer. They are,

- Heavy in weight
- Service life is low
- Initial cost is high
- Complicated maintenance
- Pollutes environment
- Certain parts can get corroded

Fig.2.4.1 Knapsack Power Sprayer

2.4.2 Motorized Knapsack Mist-blower cum Duster

This sprayer cum duster [4] is fitted with a 2-stroke air cooled engine of 35-70 cc capacity, connected to a centrifugal fan by a direct drive. The spray liquid is first pressurized by air generated by the blower. This air current achieves a velocity of over 275 kmph at the nozzle and sprays the chemical in fine particles that can be measured in microns. The nozzle design enables even spraying at maximum efficiency.

When dusting, the air blast enters the tank from an air inlet, which is connected to a tube with several holes on its surface. This agitates the powder, which is then thrust out by the velocity of the air coming out of the blower, through the pleated hose and out through nozzle.

Fig.2.4.2 Motorized Knapsack Mist-blower cum Duster

2.4.3 Hydraulic Sprayer

Hydraulic sprayers [5] may be engine or electric motor driven and are available with single, double and triple piston pumps. The single piston pump develops a maximum pressure of 150 psi, whereas the double and triple piston pump develops 300-400 psi. Only two discharge lines can be used with the single piston pump, whereas the double and triple piston pumps can accommodate 4 – 6 discharge lines.

The operation is by means of 1 – 2 HP electric motor or 2 – 3 HP petrol, petrol-kerosene or diesel engine. These sprayers can also be driven by a power tiller or tractor.

Fig.2.4.3 Hydraulic Sprayer

2.4.4 Boom Sprayer

These apply the spray liquid through nozzles which are normally directed downwards and mounted on a horizontal structure (boom) and are generally used to spray low-growing arable (field) crops and weeds. Some models employ air to aid downward penetration of droplets into low-growing cereals and other crops.

Fig.2.4.4 Boom Sprayer

Chapter-3

Working Principal

The sprayer machine is pulled manually leaving behind the spraying effect. Here, the driver gear drives the driven gear to rotate. The wheel is of 457.2 mm diameter and the drive gear is of 52 number of teeth which drives the driven gear with 38 number of teeth which gives us the ratio of 1:1.37. The wheel covers 1436.33 mm during which the pumping is done for 1.37 times. Thus, each stroke is effective at 1048 mm travel distance. Next, we have a pump with piston of 50 mm and the stroke length of 100 mm, with cranking provided at 50 mm. The tank is held on the tank holder which is fixed on the frame. The driven gear drives the crank which pushes and pulls the cranking of the tank pump arm which effects in building the pressure generated into the accumulator which dispenses the pressure through the outlet port and through the valve provided which is connected through the four-way splitters to the four jets which are fixed on the adjustable boom. The adjustment is given to adjust the height and for the rows as required. We have provided four number of jets which are fixed to the polyurethane connectors with 8 mm pipe, which are held on the plates welded to the guide bushes held on the rods on the boom as required.

Fig.3 Automatic Spray nozzle machine

Chapter-4

Fabrications

4.1 Parts of Sprayer Pump

4.1.1 Nozzle

A nozzle is a device designed to control the direction or characteristics of a fluid flow (especially to increase velocity) as it exits (or enters) an enclosed chamber or pipe. A nozzle is often a pipe or tube of varying cross-sectional area, and it can be used to direct or modify the flow of a fluid (liquid or gas). Nozzles are frequently used to control the rate of flow, speed, direction, mass, shape, and/or the pressure of the stream that emerges from them. In a nozzle, the velocity of fluid increases at the expense of its pressure energy.

Fig. 5.1.1 Nozzle.

4.2 Parts of Our Model

4.2.1 Main frame

This is made from MS pipe of diameter 19.05 mm, cut to a length of 1760 mm and 160 mm, all are ground to remove the cutting burr and joined by arc welding to makethe rectangular frame. This frame is then marked at the center of the length and drilledto have 10 mm hole to insert the wheel axle into it. Wheels are assembled in this holeswith the axle at both the sides as required.

Fig. 4.2.1. Main frame.

4.2.2 Wheel

These are standard bicycle tyre of diameter 650 mm with rim, spokes, spindle with hard tubeless rubber tyre. Such 1 numbers of wheels have been used.

Fig. 4.2.2. Wheel.

4.2.3 Tank Base

This is made from mild steel flat being cut from the size of 40mm x 6mm of lengths240mm--2nos, 250mm—1nos, all are hammered for flattening and then right-angle grinding is done and then joined to make the frame as per the sketch to be able to holdthe tank on this. This is then marked for the holes to hold the clamps to be able to clamp the tank at four places as per the requirement.

Fig. 4.2.3 Tank Base.

4.2.4 Pump

A Pump is an equipment that moves fluids or other slurries by mechanical action. Pumps operate by some mechanism and utilize energy to perform mechanical work by moving the liquid.

Fig: 4.2.4 Pump

4.2.5 Battery

A Battery is equipment which contains an electrochemical cell with connections affixed to it, which is mainly used for several applications. The battery here we chose is a 12v battery. When the battery is supplying electric power, its positive terminal acts as cathode whereas negative terminal acts as an anode.

Fig 4.2.5 Battery

4.2.6 Charger

A battery charger, or recharger, is a device that stores energy in a battery by running an electric current through it.

Fig. 4.2.6 Charger

4.2.7 Cable

Electrical cables work by providing a low resistance path for the current to flow through.

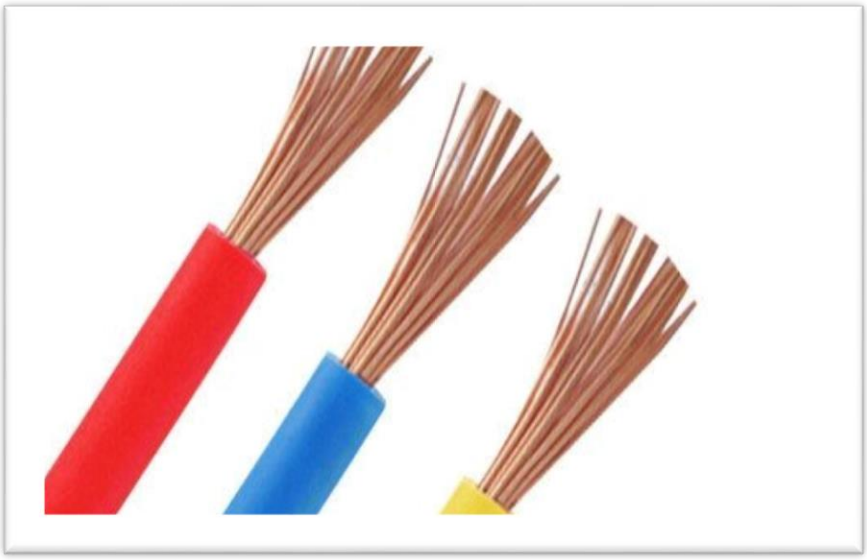

Fig. 4.2.7 Cable

4.2.8 Switch

A switch is an electric device that is used to complete or break an electric circuit. If the switch is 'ON', then a current can flow through the circuit. However, if the switch is 'OFF', then the current cannot flow through the circuit.

Fig: 4.2.8 Switch

4.2.9 Vertical Legs

This is made from MS pipe, similar to which is used in the rectangular base, being cutto a length of 270 mm and welded onto the rectangular base to support the tank base.Such 2 numbers of vertical legs have been used.

Fig. 4.2.9 Vertical Legs

4.2.10 Handle

This is made from MS box cut from the size of length 800 mm and ground to removethe cutting burr and then marked for the cutting at the distance of 600 mm from one end and slightly angle cut and then bent to make the handle as required. Such 2 numbers of pipes have been used.

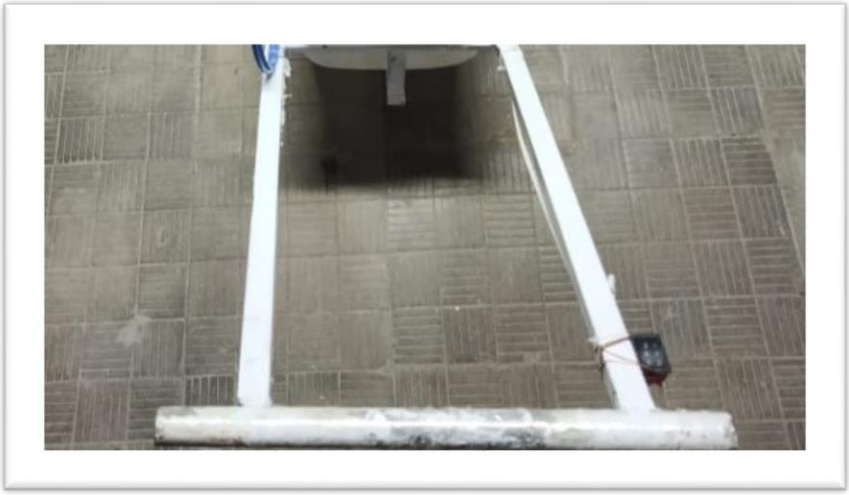

Fig. 4.2.10 Handle

Chapter-5

Parameters and Calculation

5.1 BATTERY SELECTION

Specification of Battery

- Charging time = 10 hr
- Battery Duration time = 8 hr
- Voltage Regulation = 12V – 13.8 V
- Initial Current = 9Ah max.

5.2 DESIGN OF NOZZLE

- Diameter of nozzle (For Nozzle 1) = 1.1 mm
  = 0.0433 inch
- Diameter of nozzle (For Nozzle 2) = 1.1 mm
  = 0.0433 inch
- Diameter of nozzle (For Nozzle 3) = 1.1 mm
  = 0.0433 inch
- Diameter of nozzle (For Nozzle 4) = 1.1 mm
  = 0.0433 inch

5.3 Selection of Pump

- Type of Pump = Radial Piston Pump
- Volts =12V DC
- Amps = 2.1 A
- Flow = 3 L/Min
- Pressure =4.5 Bar

5.4 Calculation

5.4.1 Spraying Done By Manual Process:

Amount paid to the labor for one day = 500 Tk. per labor

Total number of labor required in general to spray 1 Ac = 4

Total amount paid to the labour =(4*500) = 2000 Tk/ day / acre

Therefore, Total expenditure in one day is = 2000 Tk.

5.4.2 Spraying Done By Battery Machine:

Consumption of electricity (1 Times full charge) = 1.512 units

Cost of electricity per unit = 5.70 Tk.

Total cost electricity for one times = 1.512*5.7 = 8.60 ~ 9 (approx.) Tk.

Amount paid to the labor = 500 Tk. per day

Total Cost = Total cost of electricity + Amount paid to the labor

= (9 + 500) Tk.

= (509 ~510) Tk.

Amount saved by using the automatic removal machine = (2000 – 510) Tk.

= 1490 Tk. / day

Chapter-6

ADVANTAGES & DISADVANTAGES

ADVANTAGES

- The mechanism is a simple one.
- One Labor is enough for operation.
- Working is very easy compared to the primitive work method.
- Time consumption is less compared to manual weeding.
- It reduces the labor problem.
- It is portable for the farmers having small land.

DISADVANTAGES

- Can be used in only hard surfaces.
- Small tank capacity.
- Limited adjustability.

Chapter-7

Conclusion

By making a talk about the topic of agricultural technology, we can learn more and in-depth about it. This is our little effort to make comfort to our farmers, this machine is developed to reduce the time and effort required for production up to the great extent Not only that, but the making cost of our equipment is also economic affordable and cost-efficient. All the manufacturing processes are carried out with a great concentration; any wrong calculation may have resulted in the failure of the project model.

Hence by comparing Pneumatic sprayer and Battery sprayer, it has been observed that battery sprayer is more than 4. 5 times faster than another sprayer.

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