JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Solar Powered Fertilizer Sprayer Agricultural Purposes

Shrikant Dhavale[#1], Patil Ritesh [#2], Shejul Samarth [#3], Belikar Srushti [#4],
1,2,3,4. Department of Mechanical Engineering.
Modern Education Society's Wadia College of Engineering, Pune, 411001, Maharashtra, India

Abstract -

This paper provides a study of solar-powered fertilizer sprayers used in agriculture. The study reports the sprayer's design, materials, methodology, and results. The sprayer allows rural areas to limit their need for fossil fuel and human labor, improving convenience and efficiency while being more eco-friendly. Moreover, the paper mentions the components of the presented mechanical device, such as the solar panel, battery, motor, and nozzle, to list their technical definitions and areas of application. The purpose of this research is to ease the issues associated with the facial lifestyle and support modern-day challenges in farming. The statistical data represents a comparative analysis of the economic and health benefits of using the presented prototype versus the traditional fertilizer sprayers. The above study concludes that these sprayers reduce the physical strain imposed on a user, costs involved, and environmental impact rates besides enhancing productivity and profitability levels and suggests a few areas that one can opt to do future research on to enhance further improvements.

Keywords-Solar-powered fertilizer sprayer, Sustainable agriculture, Renewable energy, Environmental impact, Rural Development, Crop spraying, Eco-friendly, Efficiency, Cost comparison, Health benefits, Agricultural innovation, Productivity Profitability

INTRODUCTION

Solar-powered fertilizer sprayers are an economical replacement for sprayers in the agriculture sector. These models use solar energy to power the sprayer. It reduces the dependence on fossil fuels and labor. Critical areas include zone coverage, length, weight, cost, ecological effects, and spray efficiency. To improve ease of use and comfort, different models have been created. This includes versatile frameworks prepared with portable charging capabilities. This ensures versatility in rural locations with limited access to power sources. Studies have proved that solar-powered spraying innovations are better than conventional fuel-based strategies. Solar-based energy decreases carbon outflows, operational costs, and asset use. In this manner, we adjust to the basic needs of eco-conscious rural households. These robotized frameworks guarantee increased accuracy, adaptability, and labor productivity and also contribute to revolutionizing agricultural operations and efficiency.

Material and methodology

Solar Panel

Mounting Bracket Acquire is a mounting bracket to firmly secure the solar panel onto the sprayer ensuring it can withstand various weather conditions.The placement position of the panel on the sprayer is at a

spot that receives solar light exposure throughout the day.

Wiring connections between the panel and the power system may involve wiring from the panel to charge the controller and then to the sprayer's battery.Charge Controller Place is a charge controller between the panel and battery to manage charging cycles and prevent overcharging.Regularly clean the surface of the panel to uphold its efficiency while also inspecting connections and wiring for any signs of wear or corrosion.Within a setup, a solar panel transforms solar light into electricity. This generated power operates a pump that extracts water from a reservoir or source dispersing it onto fields.

Specification

Maximum power output:	10 watts
Maximum power current:	0.60A
Short circuit current:	0.71A
Open circuit voltage:	22V

Lead-acid battery

A lead acid battery is a rechargeable one, that has two removable lead plates suspended in sulphuric acid. The lead is dipped into the sulphuric acid, which helps in the process being carried out in a controlled manner.They embody the batteries in the process of generating electric current from the chemical reaction. After that, oxygen reacts with the cathode and consequently, the production of electric energy happens. In the end, regeneration of the charge happens to re-fill the battery.

The primary active materials required to construct a lead acid battery are:

Lead peroxide (PbO_2): The plate formed as the positive pole is hard, brownish-black, rigid, and brittle.Sponge lead (Pb): The development of the PbSO4 plate as a negative lead electrode while in soft-natured conditions of sponge occurs due to Pure lead present as Pb.Dilute sulfuric acid (H_2SO_4): An Amine with strong power and good ions exhibits electrical charge. Ionized the very strongest and this heat released from the H+ cations hydrolysis. It is used for the lead acid battery with a ratio of water pH =3:1

Lead acid battery work

The lead-acid battery uses the heavy metal lead, thus classified as a toxic battery type. The lead sulfate storage battery is manufactured by dipping the plate made of lead peroxide and the sponge plate of lead in dilute sulfuric acid. The electrons are released from the positively charged plate on one end of the circuit and the negatively charged plate on the other end serves as the receiving vessel. In sulfuric acid diluted, molecules of acid split into H+ and SO_4.When it comes to the PbO_2 plate, it donates electrons to the hydrogen ions, and then H+ ions are changed into hydrogen atom, which takes part in the reaction again, forming PbO and H_2O (water).The PbO is thus transformed into the $PbSO_4$ by the H_2SO_4 acidic solution and generates water. The migrating SO_4 ions (anions) are moving towards the anode electrode, where they will make the necessary electron surrenders and become radical SO_4. This extremely active SO_4 cannot exist in the absence of other chemicals, thus it reacts with the lead sulfate ($PbSO_4$) of the anode and produces lead peroxide (PbO_2) and sulfuric acid (H_2SO_4).

Charging a battery

Charging is an electrochemical process that transfers the chargeback. It turns the electric energy from the charger into the chemical energy in the battery. Nevertheless, a battery does not keep electricity but it keeps the chemical energy needed to produce electricity. A battery charger produces a current that has the opposite direction of the regular current. This is because the voltage of the charger is higher than the battery voltage. The charger generates a surplus of electrons at the negative plates, while the hydrogen ions are attracted to the positive ones.The hydrogen reacts with the lead sulfate to form sulfuric acid and lead, and at the point where the bulk of the sulfate is gone, the hydrogen rises from the negative platesThe lead sulfate on the positive plates reacts with oxygen in the water to regenerate the lead dioxide and oxygen bubbles are seen on the positive plates just before the reaction is done. This is called gassing.

Advantages of lead-acid battery:

1. Lead is a heavy battery that lacks enough capacity to produce the power that it can deliver.
2. The production costs are relatively low.
3. Its high surge current capability is a priority, the device is used where portability and handling are less important not with high capacity.

Disadvantages of lead-acid battery:

1. Being highly dense, the specific energy of the battery is low because of the vertically directed lead.
2. It takes a long time to charge a lead-acid battery system.
3. If the charging current is too high, it will generate the phenomenon of sulfation [it refers to the replacement of a hydrogen atom of an inorganic compound with a sulfate (-OSO2OH) functional group] which may lower the performance of the battery and shorten the lifecycle of the battery.

Applications of lead-acid battery:

The lead-acid battery is mainly used in motorized vehicles, for storage of energy generated by photovoltaic cells and wind turbines, and for backup power supplies.

Motor

Typer of material used in Motor:

1. Wire
2. Core
3. Insulator
4. Permanent magnet

Working of motor

The principle of electromagnetism states that a force is applied when an electric current is present in a magnetic field.A device that converts electrical energy into mechanical energy is known as an electric motor.Motors contain various parts that enable the spinning motion to continue and supply the required power.Motors can operate on both direct current (DC) and alternating current (AC).An electric motor consists of a stator, rotor, brushes, power source, and commutator.

Voltage = 12V DC supply

A 12V DC motor is small, inexpensive, yet powerful enough for many applications. A prime example is MET(Minnesota Electric Technology) Motors, which has been creating high-quality permanent magnet DC motors for more than 45 years.

Power required = 20 W

A 20W AC torque motor will perform well at 50 or 60 Hz if it provides a high torque at low speed. With our torque motor having good starting torque and incremental characteristics, speed control can be obtained by only regulating the voltage of the power supply. The special rotor gives the machine a good performance in threading, winding, and controlling the tension. It pumps 20L per minute.

Advantages of motor

1. When operated motor provides high energy efficiency.
2. Motors never emit any pollutants.
3. The motor has low maintenance and quiet operations.
4. Even at low speeds motor has high torque.

Disadvantages of motor

1. The motor has a high initial speed along with a limited range.
2. The motor is a battery-dependent component with a power grid limit.
3. The motor has a power grid limitation.
4. The motor has a complex control system.

Applications of motor

Electric motor applications highly include blowers, fans, machine tools, pumps, turbines, power tools, compressors, ships, and paper mills.

Water hose nozzle

Introduction

A nozzle is an important component in the layout of a solar fertilizer sprayer. It plays a crucial role in the even distribution of fertilizer over the crops. The nozzle is a small device that converts a liquid fertilizer into tiny droplets, ensuring even coverage across the field.

Selection of nozzle

The selection of the right nozzle plays a crucial part in effective fertilizer applications. Factors that are considered while selecting a nozzle are size, spray pattern, and pressure. A selected nozzle and the type of fertilizer used must be compatible with one other.

Working of nozzle

The working of a nozzle is based on receiving liquid fertilizer from the system and converting it into fine droplets. As the liquid travels through the nozzle, it is converted into smaller particles creating spray. The pressure and flow rate control the size of the droplets, ensuring that they are small enough for proper coverage without causing any issues.

Specifications

Max. Working Pressure load: 4000 PSI
Min. Working Pressure load: 40 PSI
Discharge GPM(Gallons Per Minute): 1.5 to 3 lit.

Working principles

Agricultural pesticides aim to get uniform distribution of the chemicals throughout the crop vegetation. The emitted solar energy is converted into photo-voltaic energy in the solar panel. The produced solar energy is stored in the battery and it is connected to the pump to operate. When the pump attains the power required to operate, it creates a suction and sucks the pesticide liquid from the tank. It comprises solar panels, lift converters, switches, batteries, DC motors, pesticide tanks, and shower nozzles. It utilizes solar-based energy to work. First, solar-powered energy is consumed by the solar panel. This solar-powered energy is then changed over into electrical energy by the photovoltaic cell.Solar-based agricultural sprayer inspires easy tasks. The whole unit is convenient and can be worked by a single individual or a controlling unit.The solar light-based board gives a shadow on the leader of the controller which gives assurance from high solar-based power. The release rate of a solar-based sprayer estimated in field conditions, is about 0.023 liter/sec (82.8 liter/hour) [1]. The strolling velocity of the controller is about 2.8 km/hour and the swath width of the sprayer is about 0.6 m, which relates to a hypothetical field limit of about 0.17 hectare/hour [1]. The viable field limit of the sprayer is seen to be 0.14 ha/h which relates to a normal inclusion of 1 hectare/day of an 8-hour task [1]. Then the hose is attached to the pump and it is connected to a nozzle at the end of the hose. The thin amount of liquid from the hose is transported to get ejected from the nozzle.An adjustable knob is fitted at the end of a hose to regulate the flow of fluid from the pesticide tank.At the end, it passes over the nozzle which is arranged for our convenience of spraying the farm fields. It is done through solar power which produces the power required to run this equipment with the spraying technique.

What issues this model tackles:

The fast battery drainage problem is solved by solar panel systems and the energy it generates.It's a manual operation vehicle that cuts fuel usage and costs along with the harmful effects caused by silencers on crops.A proper handling system is to minimize hand muscle pain and good grip for pressure maintenance.High accuracy and larger sweeping areas drastically reduce the wastage of fertilizers.

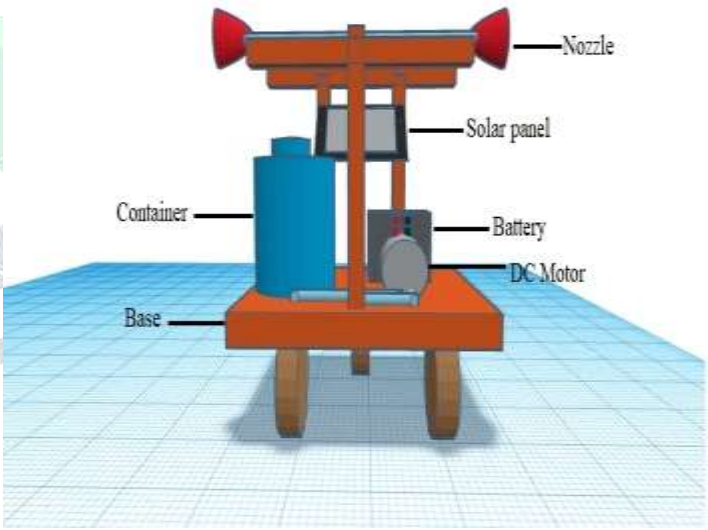

Figure 1.1Solar powered fertilizer sprayer model

Literature Review

Solar energy is one of the eminent renewable alternatives as it is the eco-friendly sustainable option for energy reduction with a decreasing dependence on non-renewable resources. India is a country with an agricultural background. 3/4 of its people live through farming. Similarly, the farmer's practices today are

close to the practices of their ancestors for tasks like hoeing, spraying, and seeding. One of the issues which is the most crucial in farming is spraying. Opportunity exists for the building of advanced spraying techniques. Currently, the world has a high demand for traditional energy sources like oil and fossil fuels. Perhaps, the invention of gun sprays, pesticides, and fertilizers to mention but a few have brought a tremendous evolution to the agriculture sector. In most cases, the development of sprayers gives farmers what they always want, namely high crop yields. Solar-powered sprinklers are a cheaper and more eco-friendly alternative to the pesticide sprayer running on fossil fuels. The solar-energy-based agricultural sprayer developed is the groundwork of the present innovation.In this project, we will develop a solar-based agricultural sprayer. A solar-based sprayer is a great way to use solar energy. It is used in the agricultural business field and is similarly used for a few purposes. Electricity can be stored in batteries, and then excess energy can be used for domestic appliances like bulbs, mobile charging, etc.

Research Objectives

Research on solar-powered fertilizer sprayers is a first step toward addressing problems in modern farming and offers strong yields and profits while acting as a role model for environment-friendly agriculture. The aim is to reduce labor efforts in traditional sprayers. Farmers can cover a larger area of land with much less physical stress. This solar energy helps in reducing carbon emissions by reducing dependence on oil. The design and production of sprayers with lightweight design, affordability, and fast field coverage is the major aim of this research study. A detailed analysis of traditional sprayers is an important part of the survey process which will provide useful insights. Along with the advantages and disadvantages of implementing solar technology. The aim is to ensure farmers get a wide range of solar solutions that boost productivity and support long-term sustainability.

Statistics:

Cost Comparison:

The average cost of traditional fertilizer sprayer models and labor in India over the past 5 years is approximately between ₹35,000 to ₹70,000.Initial investment in solar powered sprayer model ranges around ₹50000 to ₹80000 on the other hand, operational costs for the model seem to be 30-40% lower compared to traditional models.

Back Pain Numbers:

Out of 14.65 Crore farmers in 2015 from India, 83.55% of them experienced Lower Back Pain, a majority share of it from the weight of fertilizer container sprayers carried on their backs [15]. Every year this number gets more and more along with increasing medical bills exponentially.

How many farmers suffer?

Around half (50-60%) of all Indian farmers (26 Crore in 2019) experience back pain [15].Specific activities like rice planting (83%) and head-loading (72%) can lead to even higher rates [15].Younger farmers might be more susceptible.

What's the impact?

On average 4 working days per month are lost as missed workdays because of the pain farmers face. Loss of workdays may have a significant impact on income reduction, with one of the studies stating that up to 22% reduction [16].

Other Health-Related Issues:

Over the years hospital bills for the other health-related issues faced by farmers due to heavy labor on average were between ₹3000 to ₹10000 per patient which includes issues such as musculoskeletal disorders, respiratory problems, skin diseases, and injuries from agricultural accidents.

Design

Photographs of model

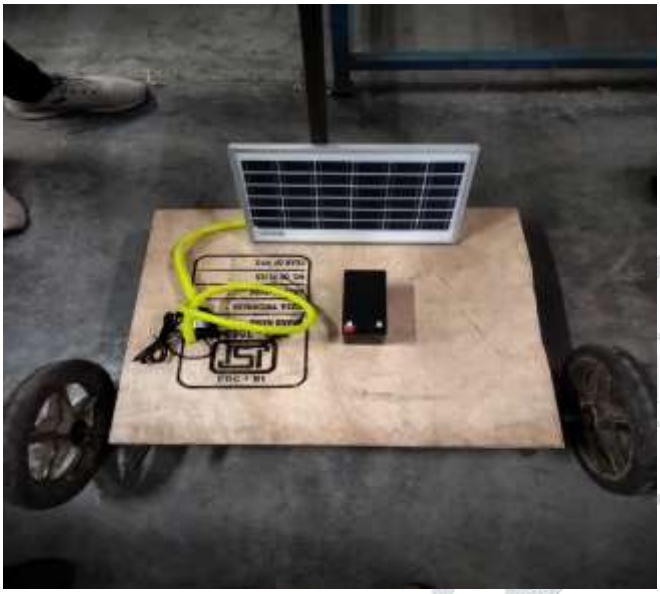

Figure 2.1 Solar-powered fertilizer sprayer model during assembly

What are the variety of uses?

An agricultural crop sprayer is a gear kit used for applying liquid substances to plants or crops. These substances could be fertilizers, or pesticides as these substances play an important role in maintaining the health of a crop during its growth cycle.A sprayer is used to spray a liquid. Sprayers are generally used for water projection, weed killing by fertilizers, and pest maintenance chemicals.There are various applications of sprayers which include forestry, landscaping, pest control, horticulture, hydroponics, and many more.

Best usability field of our model:
Our model offers its best use in the field of farming which requires large amounts of fertilizers, pesticides, and sprinkled water.
Its larger spraying and sweeping area capacity makes it ideal for gardening and lawn purposes.

Results

Problems in the agriculture field:

Farmer's complaints about back discomfort have grown due to traditional fertilizer spraying practices. These approaches frequently entail physical labor and repeated motions that might result in strain and damage.Furthermore, the combustion costs connected with these systems contribute to environmental contamination and raise farmers' operational expenditures.To address these difficulties and promote sustainable agricultural practices, novel solutions prioritizing farmer well-being are required.Farmers may lessen the physical strain on their bodies and reduce the environmental effect of their operations by using solar-powered fertilizer sprayers. These sprayers are powered by renewable energy and provide a more efficient alternative to traditional techniques.

Comparison with other models:
Our model has larger, wider, and heavier dimensions compared to other similar models.As our model provides nozzles with flexibility and a container with a large storage capacity of 8 liters makes it efficient to cover a large sweeping area with customized spraying patterns.This Experimental setup cost ranged around ₹8000 to ₹10000. This setup can be charged by a solar panel and operates on battery power whereas the power source may vary in similar models.

Conclusion

Solar-powered models are replacing current conventional fertilizer sprayers in agriculture. These sprayers use less fossil fuel by using solar energy to power the spraying system. The research's primary achievements include designing and producing solar-powered sprayers. These sprayers focus on low weight, low cost, and speedy farm coverage.

The working cost of the solar-powered sprayers was also found to be lesser, making them an economic solution for farmers. Also, the use of solar energy in agricultural business helps in reducing the need for fossil fuels. This benefits the environment. It also provides a long-term, sustainable solution in agricultural practices.

These discoveries highlight the importance of solar-powered fertilizer sprayers. They promote cheap and

friendly agricultural practices. The decrease in working costs and increased productivity make them an option for farmers. They are looking to improve their work while reducing their environmental effects.

Solar-powered fertilizer sprayers have significant suggestions for future research. They also have viable applications in agribusiness. Spraying fertilizers using solar energy offers various benefits. These include reduced pollution, increased productivity, and low costs. Future research can focus on moving forward with the design and usefulness of solar sprayers. Field coverage capacities can be increased. Self-contained renewable energy sources can be developed.

References

1. Solar Powered Pesticide Sprayer, K Kandasamy. B. Babu, J.D. Nallasivam, J. Saravanan, Solar Powered Pesticide Sprayer, International Journal of Production Technology and Management (IJPTM), 08, January 2017.
2. Dr.Sanjay D.Nikhade, Niket Nardewar, Mohmad Afzal, Mohmad Sameer, "Solar Powered Multifunction Pesticides Sprayer", International Journal for Research in Engineering Application & Management (IJREAM), 01, APR 2022.
3. Shubham S. Sontakke, Pooja C.Wanjari, et al ., Solar Powered Pesticide Sprayer Using Iot, International Research Journal of Modernization in Engineering Technology and Science Volume:02/Issue:06/June-2020
4. Shailesh Malonde, Shubham Kathwate et al, Design and Development of Multipurpose Pesticides Spraying Machine, International Journal of Advanced Engineering and Global Technology, Vol-04, Issue-03, May 2016
5. Malatesh D, Manjunath H, Nilakanth D, Mallikarjun P."Solar Powered Sprayer for Agricultural and Domestic Purpose".International Journal of Research in Engineering and Science (IJRES). 06 June. 2017.
6. Abhishek Jivrag, Vinayak Chawre, Aditya Bhagwat, " Solar Operated Multiple Granulated Pesticide Duster " WCE 2011, July 6 - 8, 2011, London, U.K
7. Pritam J.M., Yogesh G.A., Akash S.B., and Rajendra S.k., "Solar operated spray pump" International Research Journal of Engineering and Technology (IRJET), Vol. 03, No. 02, 2016
8. Akshay, M.N. and Waghmare, G., "Design and fabrication of solar operated sprayer for agricultural purpose" National Conference on Innovative Trends in Science and Engineering, Vol. 4, No. 7, 2016
9. Joshua, R., Vasu, V. and Vincent, P., "Solar Sprayer -An Agriculture Implement", International Journal of Sustainable Agriculture 2 (1): 16-19, 2010.
10. Nitin Das, Namit Maske, VinayakKhawas, Dr. SK Chaudhury, Er. RDShete, Agricultural Fertilizers and Pesticides Sprayers - A
11. Review, International Journal for Innovative Research in Science & Technology|Volume 1, Issue 11, April 2015.
12. "Solar photovoltaic for sustainable agriculture and rural development"'. By B. van Campen, D. Guidi and G. Best, Environment and Natural Resources Working Paper No. 2 FAO, Rome, 2000.
13. Surender Kumar, Design of Solar Hybrid Pesticide Spray System, International Journal of Technical Research & Science, Volume 2 Issue VIII, September 2017.
14. Issa, W.A, Design, Fabrication, And Testing of A Movable Solar Operated Sprayer For Farming Operation, International Journal of Mechanical Engineering and Technology (IJMET), Volume 11, Issue 03, March 2020, pp. 6-14.
15. Yallapa D . et al, Development, and Evaluation of solar Powered sprayer with multi-purpose application, IEEE Xplore-2016.
16. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4540856/
17. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4690741/