ISSN 2393-8471

International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME)
Vol. 11, Issue 2, pp: (9-17), Month: October 2024 – March 2025, Available at: www.paperpublications.org

Solar Powered Fertilizer Sprayer Machine for Small Scale Farmers

Sarang Dure[1], Alfiya Sayyad[2], Shraddha Kapse[3], Prof. S.S.Mane[4], Prof. S.N.Gaikwad[5], Prof. V.S.Gangane[6]

[1,2,3] U.G Student,[4,5,6] Assistant professor

Department of Mechanical Engineering

Shri Tuljabhavani College of Engineering, Tuljapur-413601, India

DOI: https://doi.org/10.5281/zenodo.14502192

Published Date: 16-November-2024

Abstract: **Power requirement is a significant challenge for our country. Now a days, with the reduction in conventional energy resources of energy the usage of alternative energy options is in a rise. To meet this huge energy demand one of the important sources that can be used is the solar power. As this solar energy is being used in many other places like pumping water from the well, it will also prove helpful to the farmer by implementing it in agriculture sector. By introducing solar energy, the environmental contamination due to the usage of diesel and petrol is controlled. Hence in agricultural sector solar energy can be used for applications of fertilizers and pest repellents, with the help of Solar sprayers. In this paper we have discussed that instead of using fossil fuels like fossil fuels, hydrocarbons fuels, conventional fuels, etc., for spraying fertilizers solar-based spraying machine is used, where the later proves to be more effective than the traditional methods.**

Keywords: Solar powered fertilizer Sprayer; Fossil Fuel; Solar Energy; Energy saver.

1. INTRODUCTION

The works aim to develop a solar-powered fertilizer sprayer machine to enhance agricultural productivity while reducing dependency on non-renewable energy sources. To provide an eco-friendly, cost-effective, and efficient alternative for spraying fertilizers in agricultural fields. Farming is the foundation of our nation. In horticulture part, splashing of pesticides is an imperative undertaking to monitor the harvests from creepy crawlies for getting high return. Be that as it may, ranchers are mainly abuse antiquated run of the mill methods like hand worked and fuel worked sprayer framework for splashing pesticides. Fuel is expensive and in a few spots fuel probably won't be accessible. The usage of sun-oriented power framework is Associate in nursing substitute goals for these restrictions. Subsequently, a star supercharged farming synthetic sprayer is implied and imaginary. The framework was structured and manufactured by considering parameters like wanted splashing capacity, low weight, minimal effort, simple nature, high employable time and for snappier inclusion of room. In this way, the star sprayer was invented to be a cost for cash item inside the horticultural segment. Sprayer gives ideal usage of pesticides or any fluid with least endeavours. In Indian ranches commonly 2 sorts of splash siphons are utilized for showering, they're hand worked splash siphon and fuel worked shower siphon, out of that hand worked splash siphons are favoured. To murder the vermin and creepy crawlies pesticides, composts are splashed either physically or by exploitation sprayers. Prior, the pesticides and composts were wet physically, yet they will finish in hurtful consequences for ranchers. In order to beat this drawback, entirely unexpected showering systems have been created. These sprayers incorporate entirely unexpected instruments and furthermore the cost of device is for the most part high. A sun oriented worked sprayer is easy to deal with and support free, in this way is sensible to the ranchers. In this manner a sun powered worked sprayer is planned and created

ISSN 2393-8471

International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME)
Vol. 11, Issue 2, pp: (9-17), Month: October 2024 – March 2025, Available at: www.paperpublications.org

2. IDEA GENERATION

Developing a solar-powered fertilizer sprayer machine requires a combination of mechanical engineering, electronics, and agricultural know-how. Below is a step-by-step guide to generating and developing such a machine:

2.1. Define Objectives and Requirements

- **Purpose**: Identify the primary purpose of the sprayer (e.g., fertilizer application, pesticide spraying, etc.).
- **Capacity**: Decide on the size and capacity (e.g., tank size, spraying area coverage).
- **Target users**: Determine if it's for small-scale farmers or large-scale agricultural use.
- **Budget:** Outline a budget for design, prototyping, and testing.

The innovation in agricultural equipment is one of the majors is phase civilized life and the development of agricultural tools is a fundamental need toward the improvement the agricultural. Farmers used same traditional method and equipment's for all ages, for examples: seed spraying, weeding etc. which have problem such as slow growth rate, irrigation, fertilization, crop monitoring of large areas. An autonomous, low maintenance and portable robot can serve this purpose more accurately and efficiently with much better performance output. The robot avoids human efforts ranging from the field path following to uniformly spraying of fertilizer at equal distance intervals using field area constrains prescribed by the farmer

3. OBJECTIVE

Defining objectives for a solar-powered fertilizer sprayer machine involves aligning the goals with its functionality, user needs, sustainability, and performance. Here's a systematic approach:

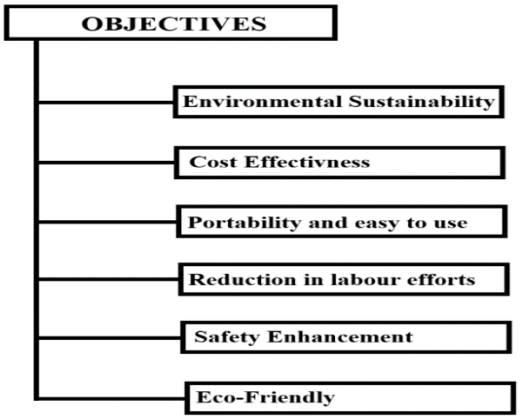

Figure 1: Objective

4. METHODOLOGY

The innovation and manufacture of the solar-powered fertilizer sprayer machine involve merging solar panels for energy generation, designing components such as the fertilizer hopper and distribution system, constructing the machine, and incorporating technological features like Bluetooth control for wheel movement and Arduino-relay systems for sprayer operation, ensuring efficient and sustainable fertilizer spraying operations.

The design of manufacturing fertilizer spray machine is more important for this paper. So, the design of framework design is very important as for the proper development in fertilizer system. This design ensures proper balanced of system during the design periods.

5. PROBLEM STATEMENT

5.1 Problem: High fuel costs and environmental impact

Traditional sprayers rely on fuel-powered engines, contributing to high operational costs and greenhouse gas emissions.

Solution: Use solar panels to harness renewable energy, eliminating the need for fossil fuels and reducing carbon emissions. A solar-powered battery system can store energy for use on cloudy days or at night.

ISSN 2393-8471

International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME)
Vol. 11, Issue 2, pp: (9-17), Month: October 2024 – March 2025, Available at: www.paperpublications.org

5.2 Problem: Limited access to electricity in rural areas

Farmers in remote locations often lack reliable access to electricity, making it difficult to use electric sprayers.

Solution: Design the machine to be self-sufficient with an integrated solar power system, ensuring functionality even in off-grid areas.

5.3 Problem: Labour-intensive manual sprayers

Manual spraying is time-consuming, physically demanding, and inconsistent in application.

Solution: Automate the process with a solar-powered pump that provides consistent spray pressure. Include ergonomic features like a lightweight frame and adjustable spray nozzles to make the machine user-friendly.

5.4 Problem: Uneven fertilizer distribution

Manual methods often result in over-application or under-application, leading to wasted resources or reduced crop yields.

Solution: Incorporate adjustable nozzles and a calibrated flow rate mechanism to ensure uniform distribution of fertilizers.

5.5 Problem: High initial costs of solar-powered systems

Farmers might hesitate to invest in solar-powered machines due to perceived high costs.

Solution: Use affordable and durable materials for construction. Partner with governments or NGOs to provide subsidies or financing options to make the machines more accessible.

6. BLOCK DIAGRAM

To design block diagram for a solar-powered fertilizer sprayer machine, it should include the key functional blocks that represents their system's components and their interconnections. Below is the block diagram to indicate the components.

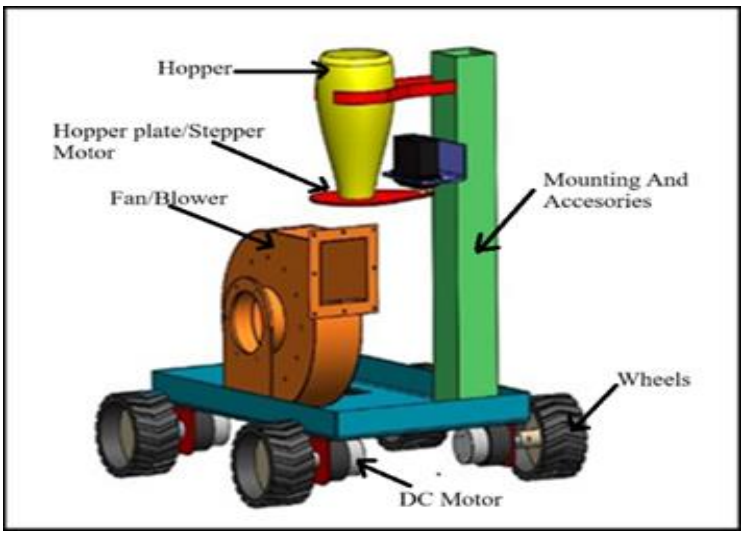

Figure 2: Block Diagram of Solar Powered Fertilizer Machine

7. MAIN COMPONENTS

As shown in Figure 1- we indicate the components of solar powered fertilizer sprayer machine and this component and to this information are as follows:

7.1 Hopper:

Solar powered fertilizer sprayer machine hopper is a critical component in agricultural machinery designed for sustainable farming. The hopper in a solar powered fertilizer sprayer serves as the storage compartment for the fertilizer, ensuring an efficient and uniform distribution during spraying. The hoppers size is varies based on the machine design. It is typically ranges from 10 to 50 litres for small to medium machines and higher for larger equipment. Power from solar panels drives

motors or pumps for fertilizer distribution. Smart sensor may include adjusting spray patterns based on field's requirements. Conical or rectangular design for smooth fertilizer flow. Anti clogging mechanisms, such as agitators or vibration systems, are often integrated.

7.2 Solar Plate:

When designing or evaluating a solar-powered fertilizer sprayer machine combines renewable solar energy with agricultural equipment to provide an ecofriendly, efficient, and cost-effective solution for spraying fertilizers.

a. Converts sunlight into electricity.

b. Typically made of photovoltaic cells.

c. The size and wattage depend on machine powers requirements.

- **Specifications**

a. Type: Mono-crystalline or Polycrystalline (Mono-crystalline is more efficient).

b. Power Rating: Typically ranges from 50W to 200W depending on the power requirements of the sprayer.

c. Voltage: Usually 12V or 24V, compatible with the battery system.

7.3 Battery:

The battery used in a solar powered fertilizer sprayer machine plays a critical role in storing energy generated by solar panels for uninterrupted operations. Such a commonly used batteries in machine are as follows:

7.3.1 Lead-Acid batteries:

a. Cost-effective and widely used.

b. Deep cycle versions are better suited for solar application.

c. Heavier but reliable for low power machines.

- **Specifications:**

a. Commonly 12v or 24v, depending on the motor and solar panel specification.

b. Measured in ampere-hours (ah). Typically, ranges are:

c. 7Ah to 20Ah for small sprayers.

d. 40Ah or more for larger sprayers with high-capacity tanks.

e. Measured in watt-hours (wh). Ensure the battery can store enough energy to match daily spraying needs.

Requirements: Must be compatibles with solar panels voltage and current output. Should include a battery management system (BMS) for lithium-based batteries to prevent overcharging, overheating, or deep discharge.

7.4 Fan:

7.4.1 Centrifugal Fans: Description: These fans move air perpendicular to the axis, creating higher pressure for more robust airflow.

- **Specifications to Consider:**

a. Power Consumption: Ensure low power consumption (e.g., 5W–20W) for compatibility with solar systems.

b. Voltage: Typically operates on DC voltage supplied by the solar panel or battery (e.g., 12V or 24V).

c. Airflow Rate: Measured in cubic feet per minute (CFM), based on the spraying or cooling needs.

d. Size: Compact fans are preferred for portability but should meet performance requirements.

7.5 Arduino UNO: Arduino UNO is a popular microcontroller board based on the ATmega328P microcontroller, featuring digital and analogy input/output pins, USB connectivity for programming and power, and a user-friendly interface for developing and prototyping various electronic projects and applications

7.6 Bluetooth Module: The HC-05 is a commonly used Bluetooth module that enables wireless communication between electronic devices. It operates on the Bluetooth 2.0 standard and supports Serial Port Protocol (SPP) for serial communication. The module can be easily interfaced with microcontrollers like Arduino and Raspberry Pi, allowing for wireless control and data transmission over short distances. With its simple AT command set, the HC-05 is user-friendly and versatile, making it suitable for a wide range of applications such as home automation, robotics, and wireless sensor networks

7.7 wheels:

- **Wheel Design and Specifications**

7.7.1 Type of Wheels:

a. Pneumatic Wheels: Commonly used for better shock absorption and smoother movement on uneven terrains.

b. Solid Rubber or Plastic Wheels: More durable and maintenance-free, suitable for flat or semi-flat surfaces.

c. Caterpillar Tracks (Optional): For challenging terrains requiring better traction.

- Features and Benefits of Wheels in Solar Sprayer Machines

a. Portability: Easily move across various field conditions.

b. Stability: Wider wheels or dual-wheel systems enhance balance when carrying heavy loads.

c. Adjustability: Some machines allow for adjustable wheel width to adapt to different crop row spacings.

d. Automation Compatibility: Wheels can be fitted with motors for autonomous or semi-autonomous movement.

7.8 Frame and Mountings: The frame and mounting structure for a solar-powered fertilizer sprayer machine is designed to ensure durability, stability, portability, and efficient integration of the components. Below are the typical components and materials used for such a structure:

7.8.1 Frame Material:

7.8.1.1 Material Options:

a. Mild Steel (MS): Durable, cost-effective, and easy to weld. Requires proper anti-corrosion treatment.

b. Aluminium Alloy: Lightweight, corrosion-resistant, and suitable for portability.

c. Stainless Steel: Best for long-term durability and corrosion resistance, especially in agricultural environments.

d. Composite Materials: Lightweight and resistant to harsh weather conditions.

e. Properties to Consider: Corrosion resistance (due to exposure to fertilizers and moisture). Lightweight for ease of transport. Adequate strength to bear the load of the solar panel, battery, and sprayer components.

7.8.2 Mounting Structures:

a. Solar Panel Mount: Adjustable or tilt able mounting brackets to optimize the solar panel's angle for maximum sunlight absorption. Rust-proof material like galvanized steel or anodized aluminium. Shock absorbers to protect the panel during transportation.

b. Battery Mount: Enclosed or semi-enclosed casing to protect from environmental factors. Vibration dampers are to reduce mechanical stress on the battery.

7.8.3 Frame Design:

a. Base Frame: A rectangular or square base to house all components, ensuring even weight distribution. Wheels (preferably with treads for agricultural fields) for easy mobility.

ISSN 2393-8471

International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME)
Vol. 11, Issue 2, pp: (9-17), Month: October 2024 – March 2025, Available at: www.paperpublications.org

b. Support Columns: Upright columns for mounting the solar panel at a height that minimizes shading and avoids obstruction.

c. Tool or Accessory Racks: Optional provision for storing small tools or accessories.

7.8.4 Portability Features:

a. Wheels: Rubber or pneumatic tires for easy movement across uneven terrains. Locking mechanism to stabilize the machine during use.

b. Foldable Components: Collapsible solar panel mounts for easier storage and transportation.

7.8.5 Protective Coatings: Anti-rust and weather proof coatings are applied to prevent degradation of metal frames in outdoor conditions.

8. WORKING

After the charging of the battery, the power stored in the battery can be used for solar sprayers for spraying fertilizers, etc., which is connected through the DC pump motor. DC fuelled siphons utilize direct current from engine, battery, or sunlight-based capacity to move liquid in an assortment of ways. Mechanized siphons commonly work on 6, 12, 24, or 32 volts of DC control. In this machine solar panel is used to capture solar energy and then it is converted into electrical energy which in turn is used to charge 12V battery, which then gives the necessary power to a shunt wound DC motor. This power is then transmitted to the DC motor to drive the wheels. A solar-powered fertilizer sprayer machine is an eco-friendly agricultural tool designed to reduce manual labour and energy costs while increasing efficiency in spraying fertilizers.

The machine is equipped with solar panels that capture sunlight and convert it into electrical energy. The electrical energy generated is stored in a rechargeable battery for continuous operation, even during cloudy weather or low light conditions. Solar power is used for the purpose of spraying fertilizers. Here the Solar panel is linked to the battery with the help of power controller. It is connected to battery through the charge controller for power regulation. Here the voltage regulation is important for the purpose of preventing battery damage from the condition of excessive charging. After the battery recharging, the energy retained in the battery can be used for solar-power sprayers for fertilizers dispersion, etc., which is linked via the DC pump motor. This DC pump motor acts as an alternative to diesel engines for the pumping of fertilizers. As we are replacing diesel engines with DC pump motor it helps in minimizing environmental contamination significantly.

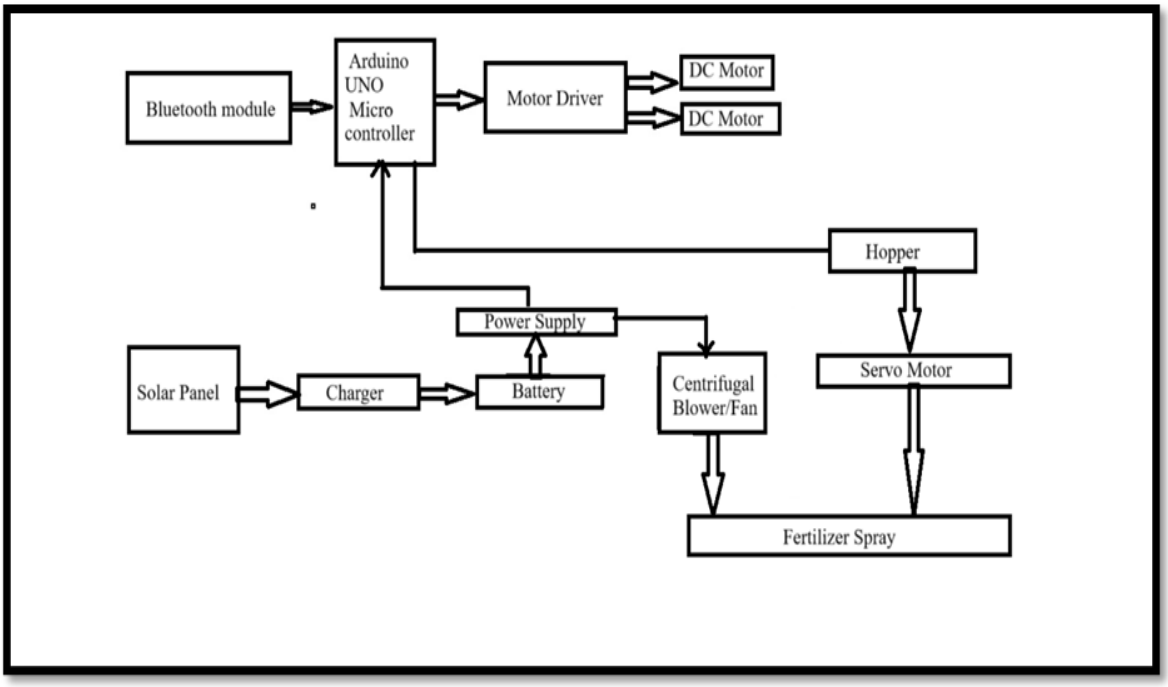

Figure 3: working of Solar Powered Fertilizer Sprayer

ISSN 2393-8471

International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME)
Vol. 11, Issue 2, pp: (9-17), Month: October 2024 – March 2025, Available at: www.paperpublications.org

9. DESIGN CALCULATION

Maximum power obtained from the panel = (Maximum voltage a solar cell) × (Maximum current of solar cell)

$$=12.3\times1.62$$

$$=19.926\ W$$

Maximum power obtained from the battery = Voltage × Current

$$=12\times12$$

$$=144\ Wh\ (Watt\text{-}hour)$$

Time required charging the battery = (power from the battery) ÷ (power generated from the solar panel)

$$= 144\div19.926$$

$$= 7.2\ hrs$$

Maximum running time of the sprayer = (Power from the battery) ÷ (Power consumed by motor)

$$= 144 \div (1.5\times12)$$

$$= 8\ hours.$$

10. ADVANTAGES & DISADVANTAGES

10.1 Advantages

1. Environmentally Friendly: Solar power is a clean and renewable energy source, reducing greenhouse gas emissions and dependence on fossil fuels.

2. Cost Savings: Once installed, solar power is essentially free, reducing operational costs compared to traditional fuel powered machines.

3. Versatility: Solar power allows the seed sprayer to be used in remote areas without access to electricity grids, expanding agricultural capabilities.

4. Quiet Operation: Solar-powered machines typically operate quietly, reducing noise pollution compared to fuel powered alternatives.

5. Long-Term Investment: With proper maintenance, solar panels can have a long lifespan, providing a consistent power source for the seed sprayer over many years.

10.2 Disadvantages:

1. Initial Cost: The upfront cost of purchasing and installing solar panels and associated equipment can be higher compared to traditional fuel-powered machines.

2. Weather Dependence: Solar power generation is dependent on weather conditions, such as sunlight availability. Cloudy days or extended periods of inclement weather can reduce the efficiency of the seed sprayer.

3. Limited Power Output: Solar power systems have a limited power output, which may not be sufficient for high-demand agricultural operations or during peak usage times.

11. APPLICATION

1. Remote Farming Areas: In remote areas where access to electricity grids is limited or non-existent, solar-powered seed sprayer machines can provide an efficient solution for farmers to sow seeds without relying on traditional fuel-powered equipment.

2. Off-Grid Farming: Even in areas with access to electricity, certain fields or plots may be located far from power sources. Solar-powered seed sprayers offer a practical solution for off-grid farming, eliminating the need for long power cables or fuel transportation.

3. Small-Scale Farming: Small-scale farmers or community gardens may benefit from solar-powered seed sprayer machines, as they offer a cost-effective and environmentally friendly alternative to larger, fuel-powered equipment. These machines can help increase productivity and yield without significant financial investment.

4. Precision Agriculture: Solar-powered seed sprayers can be integrated into precision agriculture systems, allowing farmers to precisely control the distribution of seeds based on soil conditions, crop types, and other variables. This enhances efficiency and reduces waste.

5. Research and Development: Solar-powered fertilizer sprayers can be used in agricultural research and development projects to test new seed varieties, planting techniques, or crop management strategies. Their versatility and mobility make them suitable for experimental field trial.

12. COST CALCULATIONS

Approximately costing of solar powered fertilizer sprayer machine model involves analysing all aspects of its design, development, production, and deployment.

Here's a cost structured approach.

Table 1: Approximate Costing

Sr. No.	Component	Price (Rs.)
1	Hopper	500
2	Blower/Fan	1000
3	Wheel	300
4	Solar panel	2000
5	Arduino UNO	1000
6	Battery	4200
7	Frame And Mountings	3000
8	DC motor	1500
9	Labour Cost	1500
Approximate Cost		**15000/-**

13. CONCLUSION

- **Sustainability:** Utilizes renewable solar energy, reducing reliance on non-renewable fuels and lowering carbon emissions.
- **Cost-Effectiveness**: Minimizes operational costs by eliminating the need for expensive fuels or electricity.
- **Environmentally Friendly:** Promotes eco-friendly agricultural practices, contributing to a greener environment.
- **Efficient Fertilizer Application:** Ensures uniform and precise application of fertilizers, enhancing crop yield and reducing wastage.
- **Labour-Saving**: Reduces manual labour and operational effort, making it easier for farmers to manage their fields.
- **Portability and Ease of Use:** Designed for easy handling and transportation, catering to small and medium-scale farmers.

REFERENCES

[1] Georgios Fontaras, Panayotis Pistikopoulos, Zissis Samaras 2008 Atmospheric Environment 424023

[2] Smart Solar Powered Agricultural Fertilizer Sprayer To cite this article: Srinivasan Mallan et al 2021 IOP Conf. Ser.: Mater. Sci. Eng. 1084 01207, Solar Sprayer; Fossil Fuel; Solar Energy; Energy saver. Here in this paper, we have examined insight regarding the compost splashing framework.

[3] fabrication of multipurpose solar power fertilizer sprayer S.Raju , A.V.N.Shanmukh, Ch.V.Sai Krishna, L.Sai Kiran Reddy , Ch.V.Rutwic Kalyan , P.Sai Pavan Asst. Prof., Department of Mechanical Engineering , KKR & KSR Institute of Technology & Sciences, vinjanampadu, Guntur, Andhra Pradesh-522017,India 1,2,3,4,5Students, Department of Mechanical Engineering , KKR & KSR Institute of Technology & Sciences, vinjanampadu, Guntur, Andhra Pradesh-522017,India

[4] Smart Solar Powered Agricultural Fertilizer Sprayer To cite this article: Srinivasan Mallan et al 2021 IOP Conf. Ser.: Mater. Sci. Eng. 1084 01207, Solar Sprayer; Fossil Fuel; Solar Energy; Energy saver.

[5] Development and Manufacture of Solar Power Seed Sprayer Machine Prof. R. B. Khule , Kundan Gahukar , Bhawar Ninawe , Sourabh Balbudhe4 Assistant Professor, Department of Electronics & Telecommunication Engineering KDK college of Engineering, Nandanvan Nagpur-440009,

[6] A Literature Review on Development of Solar Agro Sprayer (SAS) Bhagyashri V. Thorait , Quraishi Mudassir , Mittal Vispute Aishwarya Pimpariya , LishaAhire5 1,2,3,4,5(Department of Electrical Engineering, MMANTC, Savitribai Phule Pune University, Maharashtra, India)

[7] Ghalib Ahmed Tahir, Chu Kiong Loo (Senior member, IEEE) 20 March 2020. Another agricultural researcher undertook a comprehensive investigation to evaluate the impacts of various seeding techniques, machinery, and different rates of oilseed rape application on seeding emergence, plant establishment, and final grain yield. This study aimed to provide valuable insights into optimizing oilseed rape cultivation practices for enhanced productivity.

[8] Ammar A.M. AI- Talib, Yap Chee Xiam, Aim Atiqa, Nor Fazilah Abdullah, UCSI University, 56000 Kuala Lampur, Malaysia, 9 Feb 2023By systematically comparing the effects of different seeding techniques, machinery, and application rates, valuable insights were gained regarding their respective contributions to overall crop performance. This research provides valuable guidance for farmers and agricultural practitioners seeking to optimize oilseed rape cultivation practices to achieve higher yields and improve overall efficiency.

[9] Jeonghyeon Pak, Jeongeun Kim, Yonghyun Park, Hyoung IL Son (Senior Member, IEEE) 7 May 2022. The research findings strongly suggest that bullock-drawn planters are increasingly indispensable for sowing operations, particularly due to the scarcity of skilled workers proficient in traditional sowing methods. With a dwindling pool of skilled laborers, mechanized solutions like bullock-drawn planters offer a viable alternative, ensuring efficient and timely sowing without relying heavily on manual labor.

[10] Offer GJ, Howey D, Contestabile M, Clague R, and Brandon NP 2010 J. Energ.Poli.38 24.

[11] Saeid B, Scott J. Moura, Joel C. Forman, Hosam K. Fathy 2010 J. Power Sources 196

[12] Andrew Burke, Marshall Miller 2010 J. Power Sources, 196 514.

[13] Srinivasan Mallan, K Karthick, B Cheran and S Karthickram [1,2,3,4] Bannari Amman Institute of Technology, Sathyamangalam, Erode - 638401