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A comprehensive review of various types of sprayers used in modern agriculture

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Abstract
In modern agriculture, the use of sprayers has become indispensable for crop protection and management. The effectiveness and efficiency of sprayers are essential to achieving optimal yields. There are various types of sprayers available, such as boom sprayers, air blast sprayers, and electrostatic sprayers, each with its own advantages and limitations. Factors that influence their performance include nozzle design, spray quality, and application rate. Moreover, here we discuss recent developments in sprayer technology and their potential impact on the future of agriculture. This review aims to assist farmers, researchers, and agricultural practitioners in selecting the most appropriate sprayer for their specific needs and applications. It also provides insight into the current state and future prospects of sprayer technology, with the goal of promoting sustainable and efficient agricultural practices.

Keywords: Pest, insect, sprayer, efficiency, cost

1. Introduction

Sprayer is a device used in agriculture used to spray liquids like water, insecticides, and pesticides in agriculture. Application of chemical is the most important operations in farming to get higher yield. At present, different categories of sprayers and weeders that are manually operated, animal drawn, tractor mounted, and self-propelled types are available (Ambaliya *et al*. 2022) [2]. Agricultural sprayers have components like spray nozzle, liquid tank, sprayer pump, pressure regulator, valves and fluid plumbing and some sprayers have spray gun. This agriculture sprayers comes in various size, design and performance specifications. There are number of sprayers which are designed for different spraying applications like gardening, crops, trees, fruit, livestock needs, and weed control.

In the agricultural industry, pesticides play a significant role in the maintenance of crop health and consequently, the stability of the farmers' income. These machines are ideal for a variety of farming tasks during crop production cycle. These remarkable farming tools come in various sizes and types, from hand-held and manual sprayers to large trailed or mounted sprayers followed by advanced atomizers.

Sprayers are essential tools for the application of pesticides, herbicides, and fertilizers in modern agriculture. The use of sprayers has significantly increased in recent years due to their effectiveness in reducing crop damage and improving yields (Aktar *et al.* 2009) [1]. There are various types of sprayers available in the market, each with unique features and capabilities designed for specific applications. The proper selection of a sprayer for a specific crop and application is crucial for achieving optimal results. The different types of sprayers used in modern agriculture, including their working principles, advantages, and limitations. We will also discuss the latest advancements in sprayer technology, including precision agriculture and autonomous sprayers.

Farmers use various types of sprayers to manage pests and diseases in their crops. The selection of the right plant protection appliances is crucial for successful pest management and crop productivity. The selection of plant protection equipment should be based on several factors, including ergonomic, economic, efficacy, and ecological considerations. Ergonomics involves selecting equipment that is easy and comfortable to use, reducing operator fatigue and injury. Economic factors involve selecting equipment that is cost-effective in terms of purchase, maintenance, and repair. Efficacy involves selecting equipment that can deliver the appropriate amount of pesticide to the target area effectively. Ecological considerations involve selecting equipment that minimizes the environmental impact of pesticide application, such as reducing spray drift and minimizing pesticide runoff. Using the right plant protection equipment and techniques can help farmers effectively manage pests while minimizing the impact on the environment and maximizing crop productivity (Pankaj and Shashidhar 2018) [16].

The use of pesticides and herbicides in agriculture is critical for crop protection and increased yield. However, traditional methods of pesticide application often involve the use of fossil fuels and have adverse environmental impacts. In recent years, there has been increasing interest in developing sustainable and environmentally friendly pest control technologies. Solar-powered remote-controlled boom sprayers are one such technology that has gained significant attention in the agricultural industry. This type of sprayer uses solar panels to power its electric motors and can be operated remotely, reducing the need for fossil fuels and minimizing human exposure to chemicals.

2. Review of literature

2.1 Manual spraying

Mostly in India we used the old method and equipment for the agriculture. For agriculture the pesticide and water is mostly required after the some interval of time to remove the insect from the agriculture land.

2.1.1 Hydraulic knapsack sprayer

This is the manually operated sprayer, works with the help of hand lever to maintain constant pressure and has a tank capacity of 15 liters. This sprayer is used particularly for spot treatment.

2.1.2 Pneumatic or compressed system knapsack

In this sprayer, pumping is not necessary during spraying. After filling the liquid 2/3rd capacity the tank is pressurized. It is used in limited amount to spray on weeds in paddy and jute.

2.1.3 Motorized pneumatic

As a low volume sprayer, it is suitable for spraying concentrated spray liquid, a blast of air flows through spraying jet of delivery hose and nozzle tube and ejects spray liquid in this blast. Air blast atomizes spray liquid in to fine droplets. Air acts as carrier, faster the air is pressured, more the atomization. These sprayers are also used as blowers. Mist blower causes considerable loss of CPP (Crop Protection Products: herbicides, pesticides and fungicides) by winds.

2.1.4 Foot sprayer/pedal pump sprayers

This sprayer is operated by foot and popularly used for CPP application. It has provision of 1–2 long delivery hoses, fitted with either lance or 2-6 nozzle booms. This sprayer has advantage of high-volume spray and covers large area.

(a) Hydraulic Knapsack Sprayer

(b) Manual pneumatic knapsack sprayer

(c) Motorized pneumatic knapsack sprayer

(d) Foot Sprayer/Pedal Pump Sprayers

Fig 1: Manually operated sprayers

2.2 Animal operated spraying
Gupta *et al*. (2003) [7] designed and developed a bullock drawn fraction sprayer. The performance of the sprayer was evaluated for different parameters in laboratory and field conditions at pressure of 3.5 kg/cm^2. The average boom discharge observed was at 2.47 l/min and 2.53 l/min in laboratory and field conditions, respectively. The spray distribution pattern was uniform for all the nozzles at 400 mm height. The spray pattern becomes wider for the central nozzles at 400 mm height. The average horse power required to operate the machine was 0.486 hp. The average field capacity of the sprayer was 0.704 ha/h, which was almost seven times of the knapsack sprayer. The sprayer required only 1.44 man-hour to cover 1 ha area.
Amonye *et al*. (2014) [3] Designed and Developed animal drawn ground metered axle mechanism boom sprayer. The sprayer consists of a boom with multiple Controlled Droplet Applicator (CDA) atomizer nozzles, a gear pump, a chemical tank, and chair for an operator; all attached to a framework bolted to a rear axle. It was observed that the Dynamic Wheel Load assuming even distribution of load was found to be 1575 N and a net pull of 820 N. The net pull offers convenient task and shall easily swallow energy requirement for spraying uphill terrains.
Netam *et al*. (2021) [14] developed animal drawn solar powered sprayer. During the laboratory test, the suitable operating pressure of 4 kg/cm^2 was selected based on the discharge rate. The average discharge rate of 240 l/h was obtained at an operating pressure of 4 kg/cm^2. The actual field capacity was found to be 0.52 ha/h with the field efficiency of 83 %. The sprayer was capable to cover 4 rows. The average power output was found to be 0.87 kW. The cost of operation was 274.25 Rs/ha. Pay Back Period was found to be 0.26 years. The sprayer is capable to discharge the chemical spray solution of 432 l/ha.

Fig 2: Animal drawn sprayer

2.3 Power Operated Spraying
Spraying methods are manual spraying, animal spraying and power-based spraying. Further the machine drawn spraying methods are categorises as self-propelled, power tiller operated, tractor operated or tractor mounted and solar operated sprayers. Various reviews regarding these methods are studied as below.

2.3.1 Self-propelled sprayer
Mahal *et al*. (2007) [11] developed high clearance power sprayer for cotton. A self-propelled high clearance sprayer for spraying on cotton crop was developed. The sprayer is powered by a two cylinder 20 hp diesel engine and has a ground clearance of 1200 mm. Maximum Road speed of the sprayer was 20 km/h and can be operated at field speed up to 5 km/h. The boom width of the sprayer is 8.87 m with 14 nozzles spacing at 67.5 cm. Effective width of coverage is 9.45 m. Boom height can be adjusted from 315 mm to 1685 mm to suit different crop heights. Machines track width is 13201 mm. During operation two rows of cotton crop come under the machine chassis. The tank capacity is 1000 litres sufficient to cover 4 ha with one filling. The machine can cover an area of 2 ha/h and the tank were refilled every two hours. Tank refilling time is about 30-45 minutes depending upon the distance of water source. Mechanical damage caused by the movement of high clearance sprayer was less than that caused by commonly used tractor operated sprayers. Average yield obtained from Area sprayed by high clearance sprayer was 10 % higher than the area sprayed by tractor operated sprayer.
Ghafoor *et al*. (2022) [6] developed prototype self-propelled crop sprayer, including a 20-hp engine, 300 L liquid tank, and hydraulically-controlled spray boom with eight hollow cone nozzles. The spray symmetry of the hollow cone nozzle was evaluated under four pressures (2.5, 3, 3.5, and 4 bar) in the laboratory. The operating parameters of the sprayer, such as forward speed (4, 6, and 8 km/h), spray height (40, 55, and 70 cm), and pressure (3, 5, and 7 bar) were optimized by measuring three spray characteristics including droplet density, coverage percentage, and Volume Median Diameter (VMD) in the cotton field. The results revealed that the nozzle spray was symmetrical at 2.5 and 3 bar pressure as the R^2 value was higher than 0.96. The field test result showed that in all treatments, treatments T14 (6 km/h, 55 cm, 5 bar) and T22 (8 km/h, 55 cm, 3 bar) were suitable for spraying medium-to-low concentration solution (post-emergence herbicides and fungicides) and high concentration solution (insecticides and pre-emergence herbicides), respectively. The field efficiency of the sprayer was 61 %. The spraying cost per unit area was 55–64 % less compared to manual labour cost. In conclusion, a prototype self-propelled crop sprayer is an efficient and environment-friendly technology for small farms. Operating the sprayer at the optimal parameters also saves operational costs and time.

Fig 3: Prototype of self-propelled sprayer

2.3.2 Power tiller operated sprayer
Padmanathan and Kathirvel (2007) [15] evaluated the performance of power tiller operated rear mounted boom

sprayer for cotton crop. A power tiller operated rear mounted boom sprayer was developed for spraying cotton and other crops planted in rows and to produce uniform spray pattern using minimum amount of spray materials. The spray boom has sixteen hollow cone nozzles, placed 40 cm apart. It has a swath width of 3.2 m for a forward speed of 2 km/h. The effective field capacity of the sprayer was 0.72 ha/h. The performance of the power tiller operated boom sprayer was satisfactory at a pressure of 3 kg/cm^2 and can be adopted by the farmers for spraying cotton crop and other row crops. To facilitate for the convenience of the operator the design of the entire controls was provided near the operator seat so that very efficient spraying can be achieved without affecting the health of the operator. Providing additional clamp and pipes keeping in view the safety of the operator controlled the boom, chemical spraying did not affect the operator.

Power tiller-operated intra canopy sprayers for cotton and pigeon pea crops were created by Suresh *et al*. (2013) [19]. The canopy requirements of tall crops like cotton and pigeon pea led to the development of a five-nozzle boom system. assessment of the in a lab the system showed that the HCN 80250 hydraulic nozzle combined with the 125 mm air sleeve provides a proper droplet size distribution to get more than 90 % droplets within the 300-micron range and around 13-16 % percentage area covered on the front and rear of leaves in the entire canopy. An air aid system and similar boom were built for a power tiller controlled spraying system, and they were tested in the field. At a forward speed of 1.31 km/h, the practical field capacity was 0.146 ha/h for the pigeon pea crop. The percentage area covered by the droplets on the front and back side of the leaves was almost equal viz. 17.5-18 %. The mean droplet size varied from 120 to 124 microns with more than 90 % droplets less than 300-micron size.

Fig 4: Power tiller operated rear mounted boom sprayer for cotton crop

2.3.3 Tractor operated or mounted sprayer

Nalavade *et al*. (2008) [13] developed a tractor mounted wide spray boom for increased efficiency. A 15-m tractor mounted spray boom was developed considering the stresses acting on the boom structure. It was tested in the laboratory and in the field to evaluate its performance. The developed spray boom's performance was compared with existing 9-m spray boom developed by a local manufacturer. Further, both spray booms were evaluated from the economic point of view. Statistical analysis showed that there was no significant variation in spray uniformity within a field for all the test trials. A 15-m spray boom was found to be more economical than the existing 9-m spray boom.

Singh *et al*. (2010) [21] developed and field evaluated a tractor mounted air assisted sprayer for cotton. At three different forward speeds (0.5, 2.5, and 4.0 km/h) dye solution was sprayed on the crop by the tractor mounted, air assisted sprayer and conventional tractor mounted sprayers. Droplet size (NMD and VMD), uniformity coefficient, droplet density, percent areas covered by droplet spots per square centimetre and bio efficiency were studied. At a forward speed of 4.0 km/h, better uniformity coefficient 1.69 was obtained for the air assisted sprayer as compared to the conventional sprayer 2.04. The tractor mounted air assisted sprayer, droplet deposition on the underside of the leaves was in the range of 14 to 94 drops/cm^2 at different portions of the plant. At the forward speed of 4.0 km/h, the area covered by the droplets on the underside of top, middle and bottom leaves were 1.11, 0.93 and 0.44 % for air assisted sprayer but there was no droplet deposition by the conventional sprayer.

Jayashree and Krishnan (2012) [10] developed and evaluated the performance of tractor operated target actuated sprayer to reduce the off-target application of chemical and thereby reduce soil and environmental pollution. The main focus of the study was on how the amount of chemical delivered was affected by forward speed, simulation plate width, chemical concentration, and sensor height. According to mean comparison experiments, the smallest amount of chemical supplied (499 L) was attained at a 25 % chemical concentration, a simulation plate width of 100 mm, a forward speed of 3.5 km/h, and a sensor height of 300 mm above the plant canopy.

Babasaheb and Ravi (2013) [4] tested a tractor-operated hydraulic boom sprayer on a cotton crop in order to find the best pressure and discharge rate for minimising sprayer pesticide losses. Sprayer underwent testing in the field for cotton crop to investigate the effects of nozzle pressures (viz., 275.8, 413.7, 551.6, and 689.5 kPa) and discharge rates (viz., 0.45, 0.70, 0.90, and 1.35 l/min) on spray uniformity. A more uniform spray was produced with a nozzle discharge rate of 0.90 l/min and a nozzle pressure of 689.5 kPa, with droplet sizes ranging from 125.55 to 287.50 m, droplet densities of 18 to 30 drops/cm^2, and uniformity coefficients of 0.96 to 1.20.

Jassowal *et al*. (2016) [9] evaluated a tractor operated trailed type boom sprayer in field. Sprayer was operated in the cotton field at three forward speeds 2.5, 3.5 and 4 km/h and at five fluid flow pressures 3.5, 4.0, 5.0, 6.0 and 7.0 kg/cm^2 for its performance evaluation. It was observed that with variation in pressure, number median diameter of spray varied from 198.28 to 293.1 µm and volume median diameter was in the range of 300-452 µm. smaller size droplets were obtained at high pressure. Droplet density on leaves varied from 26 to 177 drops/cm^2. Area covered by droplet spots on upper side of the top leaves, middle leaves and bottom leaves varied from 14.18 to 24.70 mm^2/cm^2, 11.01 to 23.07 mm^2 /cm^2 and 8.74 to 17.22 mm^2/cm^2, respectively. Volume of spray deposition on upper side of the top leaves, middle leaves and bottom leaves varied from 330.19×10^{-6} to 677.87×10^{-6} cc/cm^2, 293.27×10^{-6} to 633.99×10^{-6} cc/cm^2 and 202.71×10^{-6} to 685.5×10^{-6} cc/cm^2, respectively. Field capacity of the sprayer was 4.23 ha/h at the forward speed of 4.0 km/h and the average fuel consumption was 4.88 l/h.

Sanchavat *et al.* (2017) [17] evaluated a tractor mounted boom sprayer was tested under laboratory conditions at varying pressure levels of 500, 600 and 700 kPa. For each pressure level spray angle, spray pattern, nozzle discharge, spray distribution and swath width were measured. The spray angle of the nozzle was 80º, 85º, and 88º at the pump pressure of 500, 600, and 700 kPa, respectively whereas the swath width was 1235, 1294 and 1375 mm at pump pressure level of 500, 600, 700 kPa, respectively. The average theoretical field capacity, effective field capacity and field efficiency was found to be 3.3 ha/h, 2.08 ha/h and 63.03 %, respectively for cotton crop.

Fig 5: Tractor mounted boom sprayer

2.3.4 Solar operated sprayer

Renewable Energy resources are the most preferable resources for generation of electrical energy because of environmentally friendly. Of all the renewable energy resources, solar power is the most resource mainly because it is free, unlimited and free from pollution. The solar energy is usually harvested through solar panels that are made up of photovoltaic cells. Approximately 80 % of all photovoltaic systems are mended into a standalone system

Sinha *et al* (2018) [18] concluded that, knapsack sprayers are very commonly used by small and marginal farmers for Pest control because of affordability and ease of operation but with lower outputs. An attempt was made to develop a solar powered sprayer which had higher output (0.3 ha/h) with lower physiological energy consumption and discomfort. An electronic control had been embedded for protection against deep discharge and over charging of battery for longer operational life. The system could be fully charged by solar energy within two hours of irradiation and can be operated continuously for six hours. This ensures quality spray with uniform droplet size in the swath. Anti-clogging filter had also been installed before the nozzle in nozzle head for trouble free operation as well as longer service life of nozzle.

Basavaraj *et al*. (2020) [5] developed and evaluated Solar Operated Sprayer. This equipment does not use any other external source of power for spraying and is operated by the user only; it reduces drudgery, economical and eco-friendly as it uses the solar energy which can be easily affordable by the farmers. The performance evaluation of the sprayer was carried out for spraying in sugarcane and paddy. The walking speed of the operator is about 2.5 km/h and which corresponds to a theoretical field capacity of about 0.6 ha/h. The effective field capacity of the sprayer was observed to be 0.5 ha/h and field efficiency was 83.33 % was observed. The maximum flow rate obtained for four-hole adjustable nozzles with a flow rate of 2.1 l/min and minimum flow rate was obtained for hallow cone nozzle with a flow rate of 1.021 l/min. The discharge rates for sugarcane and paddy were 110.81 and 101.26 l/h, respectively. The application rates for sugarcane and paddy were 195.25 and 154.75 l/ha, respectively.

Issa *et al*. (2020) [8] developed and tested movable solar operated sprayer for farming operation. The system operates in both direct mode and indirect mode. In the direct mode, the sprayer is operated from the electricity generated by 50W solar panel mounted on a movable frame and in the indirect mode it is operated on stored electrical energy in the lead-acid DC battery (12 V, 12 Ah). Priming diaphragm pump of 10W or mini-DC reciprocating cycle motor of 5W is used to generate the required operating pressure to spray the liquid pesticide formulations. The capacity of the storage tank is 20 liters for uninterrupted operation of 25.1 minutes with the discharge rate of 0.79 l/min through the electric flexible mists high-pressure multiple sprayers with four nozzles. Data generated from the theoretical formulae were used to fabricate the system using locally available and durable materials. The sprayer was tested in farmland on two different crops after charging the battery for 3 hours in sunlight. The results obtained were as follows: Power conversion efficiency 20.4 %, the time required to charge the battery 2.88 hrs, time taken to spray 1 acre of land 2.13 hrs, backup time of spray 14.5 hrs, application rate 0.04 l/m^2 and operating time of the battery 8hrs. The results obtained show that solar sprayer was effective and will be useful in rural areas where there is no constant power supply. The system is incorporated with an energy bulb and charging kit to light up the farmyard and for the operator to charge his/her phone.

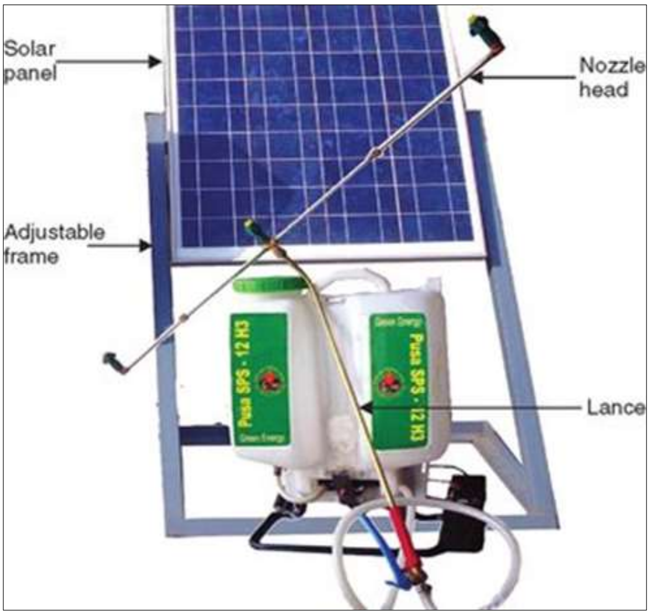

Fig 6: Solar powered knapsack sprayer

2.4 Drone mounted sprayer

This sprayer is very useful where human interventions are not possible for spraying of chemicals on crops including rice fields and orchard crops as well as crops under terrain lands. This technology greatly helpful for small farming community in reducing cost of pesticide application and environmental pollution but also biological efficacy of application technology.

Yallappa *et al*. (2017) [20] developed and field evaluated drone mounted sprayer mainly consists of BLDC motors, LiPo (Lithium polymer) batteries, pesticide tank, pump, and supporting frame. Six BLDC motors were mounted to hexa-copter frame to lift of 5 kg payload capacity. Two LiPo batteries of 6 cells – 8000 mAh were used to supply the necessary current required for the propulsion system. A 5-liter capacity conical-square shaped fluid tank was used to hold the pesticide solution. A 12 V DC motor coupled with pump was used to pressurize spray liquid and then to atomize in to fine spray droplets by means of four nozzles. A suitable aluminium supporting frame was used to mount the spray liquid tank, sprayer motor, spray and supporting legs (landing gears) for safe take-off and landing. The entire drone mounted sprayer operation controlling with the help of transmitter at ground level, HD FPV camera also provide at front down side of drone sprayer unit to monitoring the live spaying operation. The developed drone mounted sprayer was evaluated for its field performance in groundnut and paddy crop and the average field capacity was found to be 1.15 ha/h and 1.08 ha/h, respectively at a forward speed of 3.6 km/h and 1m height of spray. The cost of operation for groundnut and paddy crops using drone mounted sprayer has been worked out 345 and 367 Rs/ha, respectively. The spray uniformity was increased with increase in height of spray and operating pressure. A VMD and NMD of spray droplet size were measured and it was found to be 345 and 270 µm, respectively in lab condition.

Mogili *et al*. (2018) [12] concluded there are too many developments in precision agriculture for increasing the crop productivity. Especially, in the developing countries like India, over 70 % of the rural people depends upon the agriculture fields. The agriculture fields face dramatic losses due to the diseases. These diseases came from the pests and insets, which reduces the productivity of the crops. Pesticides and fertilizers are used to kill the insects and pests in order to enhance the crop quality. The WHO (World Health Organization) estimated as one million cases of ill effected, when spraying the pesticides in the crop filed manually. The Unmanned aerial vehicle (UAV) – aircrafts are used to spray the pesticides to avoid the health problems of humans when they spray manually. UAVs can be used easily, where the equipment and labours difficulty to operate.

Fig 7: Drone mounted sprayer

Results and Discussion

The Results and Discussion section of a review article on agricultural sprayers would provide a comprehensive overview of the various types of sprayers used in modern agriculture, highlighting their effectiveness, and discussing their impact on crop yield, quality, and overall farm productivity as summarized in Table 1. Additionally, the advantages and disadvantages of the different agricultural sprayers would be thoroughly discussed in Table 2. The section would also evaluate the environmental and economic implications of using different types of sprayers and make recommendations for their use in different agricultural applications.

Table 1: Comparison of different spraying methods

Sr. No.	Sparing Methods	Author	Discharge (l/min)	Field capacity (ha/h)	Efficiency (%)	Cost (Rs/ha)
1	Manual Spraying		-	-	-	-
2	Animal Drawn Spraying	Gupta *et al*. (2003) [7]	2.53	0.704	-	-
		Netam *et al*. (2021) [14]	240 l/h	0.52	83 %	274.25
3	**Power Operated Spraying**					
	Self-Propelled Sprayer	Ghafoor *et al*. (2022) [6]	-	2.19	61 %	147.87
	Power Tiller Operated Sprayer	Padmanathan and Kathirvel (2007) [15]	4.128	0.72	-	88.25
		Suresh *et al*. (2013) [19]	-	0.146	-	-
	Tractor Operated or Mounted Sprayer	Sanchavat *et al*. (2017) [17]	-	2.08	63.03 %	-
	Solar Operated Sprayer	Basavaraj *et al*. (2020) [5]	1.68	0.66	83.33 %	-
4	Drone Mounted Spraying	Yallappa *et al*. (2017) [20]		1.83	62.84 %	345

Table 2: Comparison of Spraying Methods

Sr no.	Methods	Advantages	Disadvantages
1	Manual Sprayer	Plant damage/pesticide losses are low Easy to maintain and repair	Time and labour consuming Slow compared to machine sprayers
2	Animal Drawn Sprayer	Less labour required as compared to manual method Cost-effective for small-scale farmers	Less efficient and require more time as compare to power operated sprayer Limited capacity and speed
3	Power Operated Sprayer	Highly efficient, time saving, minimum labour required Accurate and consistent application	Requires skilled operators and regular training Expensive to purchase and maintain
4	Solar operated sprayer	Environmentally friendly and sustainable Energy-efficient and low-cost operation No fuel or electricity costs	Initial cost may be higher than manual spraying May not be suitable for use in areas with limited sunlight
5	Drone Mounted Sprayer	Cover more area in short time Apply spraying immediately after rain, minimize obvious hazards and health risk	Require special knowledge and skills, Drones are weather sensitive, don't use at flowering stage

3. Conclusions

Modern agriculture relies heavily on the use of sprayers to apply pesticides, herbicides, and fertilizers to crops. The types of sprayers used in agriculture have evolved over time, with advances in technology and changes in farming practices. One of the most common types of sprayers used in modern agriculture is the boom sprayer. Boom sprayers use a series of nozzles mounted on a horizontal boom to apply pesticides or other chemicals to crops. These sprayers are typically mounted on tractors and can cover a large area quickly and efficiently.

In recent years, there has been growing interest in the use of solar-powered sprayers in modern agriculture. Solar-powered sprayers, such as the solar boom sprayer, use solar panels to power the pump and other components of the sprayer. This technology has several advantages over traditional sprayers, including reduced fuel consumption and lower carbon emissions.

Solar-powered sprayers also offer greater flexibility and mobility, as they are not dependent on a tractor or other vehicle for power. This can be particularly useful in remote areas or in regions where access to electricity is limited. Additionally, solar-powered sprayers are typically quieter than traditional sprayers, which can reduce noise pollution and minimize disruption to wildlife and neighbouring communities. while solar-powered sprayers offer several advantages over traditional sprayers, their effectiveness and cost-effectiveness in different farming situations needs to be evaluated on a case-by-case basis. The technology is still developing, and improvements in efficiency and cost may make them a more viable option for farmers in the future.

Overall, the type of sprayer used in modern agriculture depends on a variety of factors, including the type of crop being sprayed, the size of the area being treated, and the type of chemical being applied. The choice of sprayer depends on several factors, and advances in technology have made these sprayers more efficient and environmentally friendly.

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