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Development of animal drawn solar powered sprayer

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Abstract
Agricultural farms required a large portion of power to perform different farm operations. Small and marginal farmers have small and sparse lands to cultivate and conduct agricultural operations. These farmers own bullocks and draught animals and utilise them to work on their farms. Draught animals are beneficial to the environment as they consume crop waste and produce manure. Small and marginal farmers, on the other hand, are also unable to use mechanical weed eradication methods due to their small land holdings and totally dependent on costly chemical based pesticides. Hence an animal drawn prototype solar powered sprayer was developed. 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 Rs. 274.25/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.

Keywords: sprayer, animal drawn, solar power, multi-purpose tool carrier (MPT), solar panel, DC pump

1. Introduction
Agriculture provides a living for around 54.6 per cent of the country's overall population (Census, 2011) [3]. Manual labour, animal power, and mechanical power are all used in agricultural work in India. With land holdings of less than 2 hectares, small and marginal farmers make for 86.2 per cent of all farmers in India (Agriculture Census, 2015-16) [2]. Animal power has long been a source of power in Indian agriculture. Despite the country's growing use of mechanical power in the form of tractors, power tillers, self-propelled machinery, diesel engines, and electric motors, draught animals remain an important source of farm power. The country's draught animal population is 49.69 million, with bullocks accounting for 44.48 million, buffalo for 4.09 million, and other significant draught animals accounting for 1.12 million (Indian Livestock census, 2012) [1]. Despite the rise of mechanical power sources, draught animals still cultivate roughly half of the net planted area and are a key mode of commodities delivery in rural regions. Draught animals are good for the environment. They eat crop waste and create manure as well. Draught animals are the dominant contributor of farm power in Chhattisgarh, and small and marginal farmers rely heavily on them. Chhattisgarh has 3.27 million draught animals. The cost of operation rises when wages of labourers and the cost of animal breeding rises. To reduce operating costs, implements that can execute many farm tasks at the same time must be developed. As a reason, animal drawn machinery development is vital in farm mechanisation for optimal use of draught animals and increased output in the state. Small and marginal farmers possess tiny land holdings and cannot use mechanical weed removal methods other than hand. Manual weed eradication is a time-consuming task that adds to the overall expense of the process. In addition, these farmers apply certain herbicides to agricultural fields which help in controlling the weed problem. In order to supply enough nutritious food for the ever-increasing population, the use of pesticide and fertilizer spraying is one of the most crucial activities in agricultural production. Spraying machines are the most frequent and essential way of administering pesticides and fertilizers in modern agriculture. Spraying is done using either a hand-operated spray pump or engine-operated spray pump. The biggest disadvantage of a hand-operated spray pump is that the user cannot use it constantly for more than 5-6 hours before becoming exhausted. Fuel was necessary for the fuel-operated spray pump, which was costly and difficult to come by in rural areas. At the same time, a sprayer that runs on gasoline emits carbon dioxide, which is a pollutant and harmful to the environment. Hence, solar energy is a renewable energy source that is plentiful, therefore sprayers can be powered by solar energy using solar panels. In order to solve these challenges, like covering a vast area while avoiding labour shortages, a animal

drawn solar-powered sprayer for various crops is required.

2. Materials and Methods

The procedure embraced for development of animal drawn solar powered sprayer consists of consideration of crop boundaries, machine boundaries and meteorological boundaries. The implement, Multi-Purpose Tool carrier along with other necessary attachments were fabricated in the Department of Farm Machinery, SVCAET&RS, IGKV, Raipur. All the dimensions and mechanical specifications to develop the machine were used to create a virtual prototype in 3D software AUTOCAD (2019). The requirements of a MPT suiting to local soil and crop conditions, cultivation practices, spraying practices and draught ability of local bullocks were evaluated. Mild steel of C-30 angle iron was used for the frame and hitch. The main frame was
strengthen by joining the two angle iron pieces edge to edge, making square cross section and joined together by welding so that enough strength can be obtained to withstand the load encountered in actual field condition during the spraying operation. Two transport wheels made of flat iron were provided on either side of tool frame for ease transportation during field operations. The diameter of the wheel is 400 mm and width of wheel is 70 mm. A box type rectangular frame with hand control wheel and screw jack are provided for raising and lowering the tool frame for depth control. The tool frame is to be kept parallel to ground surface for easy working during field operations. A beam of length 3 m made from M.S. pipe of diameter 50 mm was fixed along with hand control wheel for maintaining proper hitching angle. The angle of hitch of the beam can be adjusted through set of holes. The boom frame was made up from MS square pipe 25 * 25 mm, 18 gauge. The length of the boom was 1500 mm. The height of the boom was made adjustable so that the operator can adjust it according to the height. The selection of materials for the sprayer is very vital steps in which solar PV module, solar charge controller, battery, battery, DC pump, spray nozzle and chemical storage tank were selected. A solar operated sprayer with 4 nozzles pesticides spraying machine has been developed for field crop. The machine consists of boom support structure, solar power unit, pumping unit, chemical delivery unit and chemical storage tank. Hollow cone and flat fan pattern nozzles were used on the boom. Plastic tank (HDPE) of 150 litre was used for chemical storage purpose. The pump is connected to the solar panel along with the battery. Boom support structure is provided with retrofitted stand to be easily pulled in the field and maneuvered with the handle. The isometric view of developed sprayer and its parts specification is shown in figure 1 and table 1, respectively.

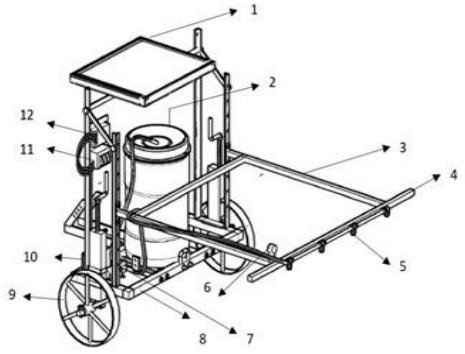

Fig 1: Isometric view of developed animal drawn solar powered sprayer

Table 1: Part name

Part No.	Part
1.	Solar PV module
2.	Chemical storage tank
3.	Boom extension
4.	Boom/Lance
5.	Nozzle
6.	Pressure gauge
7.	Pump
8.	MPT mainframe
9.	Wheel
10.	Battery
11.	Switch board
12.	Solar charge controller

2.1 Working

A solar powered sprayer with four nozzles spraying machine has been developed for field crop. The machine consists of MPT, boom support structure, solar powered unit, pumping unit, chemical storage tank, and chemical delivery unit. Hollow cone and flat fan pattern nozzle were used on the boom and HDPE tank of 150 l capacity for chemical storage purpose. The pump receives power from the solar panel, which is connected, to the battery. The solar radiation received at the panel is intermittent due to several climatic and environmental conditions. So to supply a constant electrical power, a 12V battery is selected to maintain the pumping energy required by the DC pump. The suction and delivery pipes delivered the chemical from the pump to the boom frame for spraying.

2.2 Components and specification

The electric DC pump from the local market has been selected with specifications having 7-8 kg/cm^2 at a maximum discharge rate of 4 l/min.4 hollow cone and 4 flat fan nozzles were selected on alternative purposes of spraying depending on spray angle and crop parameters. A single solar PV module of 40-watt capacity was selected for solar energy conversion into electrical energy. A charge controller was also selected in align of solar PV module. A 150 L cylindrical storage tank of fitting dimension on the MPT frame was specified to store and supply the required chemical while spraying operation. The different materials used in fabrication of the various components and parts of the animal drawn solar powered sprayer are shown in table 2.

Table 2: The different materials used in fabrication of the various components and parts of the animal drawn solar powered sprayer

S. No.	Part	Material/Type	Specification
1.	MPT mainframe	Mild steel C-30	Angle 35×35×5 mm
2.	Lifting mechanism	Mild steel	Dimension = 80×40 mm
3.	Drive wheels	Mild steel	Diameter = 400 mm
4.	Boom frame	Mild steel	Dimension = 25×25 mm
5.	Solar PV module	Poly crystalline	40 Watts
6.	Solar charge controller	PVC	Capacity = 6 Amp
7.	Battery	Lead – Calcium	12 V, 7 Ah
8.	DC pump	Diaphragm type positive displacement	7-8 kg/cm^2, 4 l/min
9.	Chemical storage tank	HDPE	150 l

3. Results and Discussion

The animal drawn solar powered sprayer was developed and fabricated in the workshop of the Faculty of Agricultural Engineering, SVCAET&RS, IGKV, Raipur and the performance of the developed sprayer was evaluated in the actual field and laboratory conditions, with soybean crop, during Kharif 2020. The row spacing of soybean crop at different positions in the field was measured and row and plant spacing was found to be 30 cm and 10 cm respectively. Solar power through solar PV modules was used as the main source of power and the capacity of the PV module was 40 Watt. The laboratory test conducted for operating pressure at 3 levels ranging from 3-5 kg/cm2, the suitable operating pressure of 4 kg/cm2 was selected based on the discharge rate. During the laboratory test, the average discharge rate of 240 l/h was obtained at an operating pressure of 4 kg/cm2. The actual field capacity of animal drawn solar powered sprayer for spraying on soybean crop was found to be 0.52 ha/h with the field efficiency of 83%. The animal drawn solar powered sprayer was capable to cover 4 rows at a stretch over the field crop. The developed spray boom had 4 nozzles on a suitable boom frame and the stability was maintained at the time of spraying. For spraying operation, the average power output for a pair of bullock has been worked out and found to be 0.87 kW. Based on the laboratory and field trials it is found that the animal drawn solar powered sprayer is capable to discharge the chemical spray solution of 432 l/ha and the adjustment of discharge depends upon the operating pressure. The high ground clearance of 0.5 m provided in the sprayer unit does not damage the crop during spraying.

4. Conclusion

The working of the developed machine was satisfactory. The animal drawn solar powered sprayer worked satisfactorily for field crop and the average bullock speed was found to be 2.7 km/h. The average draft observed for spraying using animal drawn solar powered sprayer was 441 N. The cost of operation of the machine was found rupees 274.25 ₹/ha. The payback period was found to be 0.26 years. The total cost of the machine was 12000 ₹.

5. References

1. 20th Livestock Census. Department Of Animal Husbandry and Dairying, National Informatics Centre (NIC) All India Report, 2012.
2. Agriculture Census. Agriculture Census Division Department of Agriculture, Co-Operation & Farmers Welfare Ministry of Agriculture & Farmers Welfare Government of India, 2016.
3. Census data. Office of the registrar general and census commissioner, Ministry of Home Affairs, Govt. of India, 2011.
4. Joshua R, Vasu V, Vincent, P. Solar sprayer an agriculture implement. Int. J Sustain. Agric 2010;2(1):16-19.
5. Khan K, Moses SC. Performance evaluation of manually operated multi-crop planter for okra. Journal of Pharmacognosy and Phytochemistry 2017;1:264-269.
6. Khalid AA. Effect of nozzle height and type on spray density and distribution for aground field sprayer. King. Saud. Univ, Riyadh, 2010, 1-19.
7. Robson SS, Mauri M, Delly OF, Carlos JC, Anderson CS, Daniel ML. Development of a solar photovoltaic backpack sprayer. Plant. Prot. and Crop. Prot. 2014;5(4):395-401.
8. Research highlight. Status of Draught Animal Power and its relevance to Indian Agriculture. AICRP on Increased Utilization on Animal Energy with Enhanced System Efficiency. ICAR-CIAE, Nabi Bagh, Berasia Road, Bhopal, 2019, i.
9. Research highlights. Status of Draught Animal Power and its relevance to Indian Agriculture. AICRP on Increased Utilization on Animal Energy with Enhanced System Efficiency. ICAR-CIAE, Nabi Bagh, Berasia Road, Bhopal, 2019, 1.
10. Zoeb K. Unique solar operated sprayjet. J Mech. and Civ. Engg 2014;4(9):43-46.