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# Economics of a Wheel Operated Boom Sprayer for Small Holding Farmers

***Obaid Zaffar[1*] and Sanjay Khar[2]***
*[1]Research Scholar, Division of Farm Machinery and Power Engineering*
*Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha, Jammu (J&K), India.*
*[2]Professor and Head, Division of Farm Machinery and Power Engineering*
*Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha, Jammu (J&K), India.*

*(Corresponding author: Obaid Zaffar*)*
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**ABSTRACT: Pesticides have substantially aided in the development of agricultural yields by controlling pests and diseases and these pesticides are either sprayed using knapsack sprayer or tractor operated boom sprayers. The knapsack sprayer has very low field capacity and tractor operated sprayer are costly. The present study was conducted to carry out the economic analysis of a wheel operated boom which was developed at Division of Farm Machinery and Power Engineering, Sher-e-Kashmir University of Agricultural Sciences Technology of Jammu. The fabrication cost of the developed sprayer was about ₹5600 including the of cost of booms, nozzles and other required accessories. In general, the operation cost of wheel operated boom sprayer was about 55 ₹/h. The operational cost in terms of per hectare of working were 195, 146 and 109 ₹/ha with attachment boom carrying two, three and four nozzles' respectively. In comparison to the conventional spraying the wheel operated boom sprayer results in the time saving of 53.7, 66.25 and 74.0 % with the use of boom carrying two, three and four nozzles respectively. The study concluded that a wheel operated boom sprayer was economically feasible and also results in saving of time and reduces drudgery in comparison to the conventional knapsack sprayer.**

**Keywords:** Sprayer, operational cost, nozzle, straight line method.

## INTRODUCTION

India is a vast country with a huge population contributing to about 17 percent of the world's population, 2.3 percent of world's geographical area, 4.2 percent of world's water resources and 2 percent of the world's total pesticide consumption (Dhole and Jadhav 2018). The country with such a large area of 157.35 Mha agricultural land i.e., the second largest agricultural land in the world is entirely dependent on the pesticide application to restrict the losses caused by the pests. India is ranked 10$^{th}$ in terms of the consumption of pesticide with per- capita consumption of 0.6 kg/ha. The total agriculture land under chemical plant protection is about 30 percent with 65 percent for insecticides, 16 percent for herbicides, 15 percent for fungicides and 4 percent including other disease-causing agents. (Krishijagran, 2014) Indian agriculture is currently suffering an annual loss of about ₹ 2.5 lakh crores due to the insect pests**.** The losses reported in rice, maize and oilseeds were 25, 18 and 12 percent respectively (Dhaliwal *et al.* 2015).

For the control of pests and insects' various methods are used i.e., chemical, physical, biological and mechanical, but chemical method has a shown faster use for control of pests and herbaceous diseases, in which chemicals are sprayed using sprayers. The sprayer atomizes the spray fluid which may be in the form of suspension, emulsion or solution and converts the solution in to small droplets and releases it from the nozzle to distribute it properly. The pesticides are mostly applied by using a lever operated Knapsack sprayer which has low field capacity and causing lot of fatigue to the farmer. On the other hand, the motor operated or tractor operated agriculture sprayers are costly which are not afforded by a small holding farmer.

In the union territory of Jammu and Kashmir about 94.78 percent of the farmers are marginal and small. The level and scope of farm mechanization in the region is very poor because of small and irregular fields, undulating topography, lack of skilled man power, poor facilities for repair, maintenance and manufacture of implements. In addition, the low investment capacity of farmers makes the mechanization difficult and farmers prefer low-cost knapsack sprayer which results muscular disorder, discomfort and drudgery to the operator. So, aim of the present study is to assess the cost economics of a wheel operated boom sprayer developed by the Division of

Farm Machinery and Power Engineering, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu.

Several studies have been conducted in order to assess the economic feasibility of various sprayers. Vidhale *et al.* (2004) compared air assisted boom sprayer with a lever operated knapsack sprayer for spraying on cotton crop. They found that operating cost of air assisted sprayer was ₹ 76.32/ha and for lever operated knapsack it was ₹ 260/ha. The time saving in case of air assisted sprayer was 89.11% and cost saving was 71% over lever operated knapsack sprayer. Padmanathan and Kathirvel (2007) investigated the performance of the power tiller operated boom sprayer with respect to the power operated Knapsack sprayer. The results revealed that the power tiller operated boom sprayer worked satisfactory and saved both time and cost of operation per hectare by 51 percent than that of power operated knapsack sprayer. The cost economics of a battery-operated boom sprayer and compared same with hand operated and ground wheel operated. The results revealed that the operation cost of the battery-operated sprayer was ₹ 213.88 per hectare in comparison to ₹ 725.0 and 236.83 for hand and ground wheel operated sprayer respectively.

## MATERIALS AND METHODS

**Location of the experiment.** A Wheel operated boom sprayer was developed in the Division of Agricultural engineering and evaluated at Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (Zaffar, 2020).

**Experimental setup.** The study was conducted at Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu on the knoll khol crop and spraying operation was done in a plot size of 20 ×20 m representing a typical knoll khol field at a mature crop stages 68-74% of leaf ground coverage and 0.25m plant height (Fig. 1). A total of nine trials were performed using wheel operated boom sprayer for three different types of booms i.e., Boom carrying two nozzles, Boom carrying three nozzles and boom carrying four nozzles. A constant speed of 3.1 km/h was kept throughout all the treatments. The spraying operation was done at a height of 50 cm with nozzle to nozzle spacing of 50 cm from the target surface.

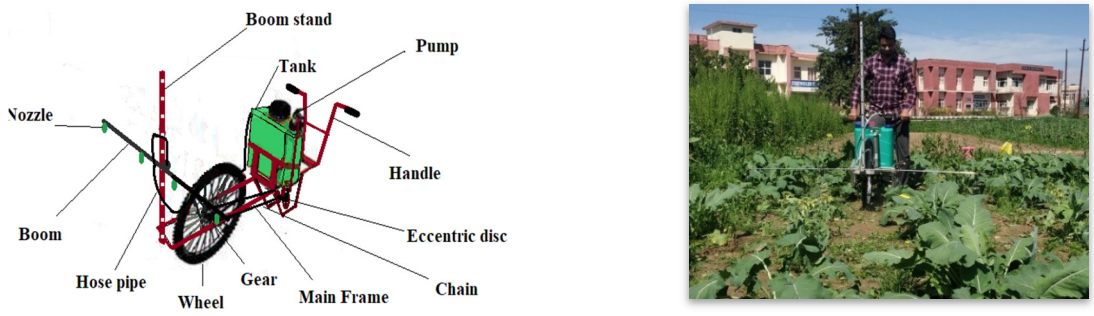


**Fig. 1.** Evaluation of the developed wheel operated boom sprayer in field of knoll khol crop.

**Economic evaluation.** The Economic evaluation of a wheel operated boom sprayer mainly consisted of the fixed cost and the variable cost. The fixed cost is independent of the operational work and consists of parameters namely depreciation, interest, insurance and housing while as variable cost varies according to the use of the machine. The Cost of the machine and its operation for three types of booms with three different widths of operation were calculated in Rs/ha and the straight-line method was used for calculation of depreciation of the machine over the time period. The calculated cost was than compared with the cost of operation using knapsack sprayer. The cost of operation using knapsack was obtained from previous studies conducted by different researchers.

*A. Total fixed cost*

**1. Depreciation charge.** The straight-line method was used to calculate the depreciation which constitutes a loss in the value of a machine due to time and use. The annual depreciation charge can be determined by the following formula (Petronijević *et al*., 2012).

$$D = \frac{P - S}{L \times H}$$

Where;

D = Depreciation
P = Purchase cost
S = Salvage value (@ 10% of purchase cost)
L= Life of machine in years
H= Number of Working hours per annum

**2. Interest.** Interest is a direct expense item on borrowed capital and varies considerably but usually are between 12 and 16%. Annual interest is calculated on an average investment by using the following formula.

$$I = \frac{P + S}{2} \times \frac{i}{H}$$

Where;
I = Annual interest charge (Rs/h)
i = Interest rate (decimal)

**3. Insurance.** Taking insurance charge @ 1 percent of the development charge per year

$$\text{Insurance Cost} = \frac{\text{1 percent of P}}{\text{H}}$$

**4. Housing rate**

Housing charge @ 1 percent of development charge per year

$$\text{Housing rate } \frac{\text{1 percent of P}}{\text{H}}$$

*B. Variable Cost*

**1. Repair and maintenance charge.** Repair and maintenance charge was taken 6 percent of the development charge of the machine per year and same is can be written as follows;

$$\text{Repair and maintainance charge} = \frac{\text{6 \% of Purchase Cost}}{\text{H}}$$

**2. Labour Charge.** Labour charge was taken 350 per day for eight working hours.

**Total cost.** The total cost is the summation of the fixed cost and variable cost

Total Cost = Fixed Cost ₹/h + Variable Cost ₹/h

**C. Total operational Cost**

$$= \frac{\text{Total cost } (\frac{₹}{\text{h}})}{\text{Field capacity of machine } (\frac{\text{ha}}{\text{h}})}$$

## RESULTS AND DISCUSSION

The cost economics of a wheel operated boom sprayer was determined based on the fixed and variable cost. The total fabrication cost of the prototype was ₹5600 and the life of the sprayer was estimated at 5 years (200 hours per year).

*A. Fixed Cost*

**1. Depreciation charge**

$$D = \frac{\text{P} - \text{S}}{\text{L} \times \text{H}}$$

$$\text{D} = \frac{5600 - 560}{5 \times 200}$$

$$\text{D} = ₹5.05/\text{h}$$

**2.Interest**

$$\text{I} = \frac{\text{P} + \text{S}}{2} \times \frac{\text{i}}{\text{H}}$$

$$\text{I} = \frac{5600 + 560}{2} \times \frac{10}{100 \times 200}$$

= ₹1.54/h

**3. Insurance**

$$\text{Insurance Cost} = \frac{\text{1 percent of P}}{\text{H}}$$

$$\text{Insurance Cost} = \frac{1\,\%\,5600}{200}$$

$$= \frac{56}{200} = ₹0.28/\text{h}$$

**4. Housing rate**

$$\text{Housing rate} = \frac{\text{1 percent of P}}{\text{H}}$$

$$= \frac{1\,\%\,5600}{200}$$

$$= \frac{56}{200} = ₹0.28/\text{h} \cong ₹0.0$$

**Fixed Cost(₹/h) =** (Depreciation charge + Interest + Insurance + Housing rate) ₹/h

= (5.05 + 1.54 + 0.28 + 0.28)₹/h

= 7.12 ₹/h

*B. Variable cost*

**1. Repair and maintenance charge**

$$\text{Repair and maintainance charge (R\&M)} = \frac{\text{6 \% of Purchase Cost}}{\text{H}}$$

$$= \frac{6\,\%\,5600}{\text{H}}$$

$$= \frac{336}{200} = ₹1.68/\text{h}$$

**2. Labour charge**

$\text{Wagesoftheoperator} = ₹350/8 = ₹43.75/\text{h}$

**Variable cost (₹/h) =** (R&M + Labour charge) ₹/h

= (1.68 + 43.75) ₹/h

= 45.43 ₹/h

**Total Cost (₹/h) =** Fixed Cost (₹/h) + Variable Cost (₹/h)

= (7.12 + 45.43) ₹/h

= 52.55 ₹/h

*C. Total Operational cost*

**I. Total operational cost of wheel operated boom sprayer using two nozzles boom**

The wheel operated boom sprayer fitted with the boom carrying two nozzles forms the swath width of 50 cm with the field capacity of 0.32 ha/hand actual field capacity of 0.27 ha/h. Thus,

$$\text{Total operational cost (two nozzles)} = \frac{52.55\ ₹/\text{h}}{0.27\ \text{ha/h}}$$

= 194.6 ₹/ha = 195 ₹/h

**II. Total operational cost of wheel operated boom sprayer using three nozzle boom**

The wheel operated boom sprayer fitted with the boom carrying three nozzles forms the swath width of 100 cm with the theoretical field capacity and actual field capacity of 0.48 ha/hand 0.36 ha/h respectively.

$$\text{Total operational cost (two nozzles)} = \frac{52.55\ ₹/\text{h}}{0.36\ \text{ha/h}}$$

= 145.9 ₹/ha = 146 ₹/h

**III. Total operational cost of wheel operated boom sprayer using four nozzle boom**

The wheel operated boom sprayer fitted with the boom carrying four nozzles forms the swath width of 150 cm constituent the field capacity of 0.65 ha/h and actual field capacity of 0.48 ha/h. Thus,

$$\text{Total operational cost (two nozzles)} = \frac{52.55\ ₹/\text{h}}{0.48\ \text{ha/h}}$$

= 109.4 ₹/ha = 109 ₹/h

**Table 1: Economics of a wheel operated boom sprayer.**

| Particular | Value |
|---|---|
| Cost of machine (₹) | 5600 |
| Life of machine (years) | 5 |
| Annual use (h) | 200 |
| Depreciation (₹ $h^{-1}$) | 5.05 |
| Interest (₹ $h^{-1}$) | 1.54 |
| Housing (₹ $year^{-1}$) | 56 |
| Insurance (₹ $year^{-1}$) | 56 |
| Fixed cost (₹ $year^{-1}$) | 1424 |
| Fixed cost (₹ $h^{-1}$) | 7.12 |
| Repair and Maintenance (₹ $h^{-1}$) | 1.68 |
| Wages of operator (₹ $day^{-1}$) | 44.00 |
| Operating cost (₹ $h^{-1}$) | 45.00 |
| Total operational cost (₹ $h^{-1}$) | 53.00 |
| Total operational cost for two nozzles boom (₹ $ha^{-1}$) | 195.00 |
| Total operational cost for three nozzles boom (₹ $ha^{-1}$) | 146.00 |
| Total operational cost for four nozzles boom (₹ $ha^{-1}$) | 109.00 |

## CONCLUSIONS

The fabrication cost of the wheel operated boom sprayer was estimated to be ₹5600 including the cost the boom and the nozzles. In all three types of booms the field capacity obtained was greater than the field capacity (0.125 ha/h) by conventional knapsack sprayer which resulted in 53.7, 66.25 and 74.0 % saving of time using the boom with two, three and four nozzles respectively. The operating cost (₹/ha) of wheel operated boom sprayer obtained was only ₹194.6, 145.9 and 109.4/ha which is very low in comparison to the traditional spraying method adopted by the marginal and small farmers. Thus, the development wheel operated boom sprayer serves the purpose in terms of economic feasibility and also results in saving of time and reduces drudgery in comparison to the conventional knapsack sprayer.

## FUTURE SCOPE

In view of the saving of time and reduction in drudgery in comparison to the conventional knapsack sprayer, it is suggested that prototypes of wheel operated boom sprayer may be fabricated through various prototype development centres in the country and local manufacturers for distribution to small and marginal farmers particularly in hilly areas on subsidy.

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**Conflict of Interest.** None.

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