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Shankar Lal

Department of Farm Machinery and Power Engineering, College of Technology and Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

SS Meena

Department of Farm Machinery and Power Engineering, College of Technology and Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Hasan Nawaz Khan

Department of Farm Machinery and Power Engineering, College of Technology and Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Corresponding Author:

Shankar Lal

Department of Farm Machinery and Power Engineering, College of Technology and Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Estimation of cost economics of developed battery operated boom sprayer

Shankar Lal, SS Meena and Hasan Nawaz Khan

Abstract

Agriculture is the backbone of Indian economy. About 50 percent of population is employed in agriculture sector contributing about 18 percent of country's GDP. The loss due to attack by pests and insects in Indian scenario is 15 to 20 percent hence proper mechanization of agricultural operations is a necessity for minimizing the losses of yield. For the efficient use of pesticides and fertilizer is must in order to reduce the cost of farming. Indian farmers are still inclined to theoretical method of pesticides spraying, but this leads to more wastage of pesticides and less yield. The farming area is dealing with issues with limit issues, contracting incomes, and work deficiencies and expanding customer requests. Present study results revealed that total cost of operation for one hectare by hand operated, ground wheel operated sprayer and battery operated boom sprayer were found as Rs. 725, Rs. 236.83 and Rs. 213.88 per hectare, respectively.

Keywords: cost economics, estimation, GDP, contracting incomes

Introduction

India itself to be agriculture based country; approximately 75% of the population depends on farming directly or indirectly. Farming is the backbone of Indian economy. Agriculture contributes about 18% to the total GDP and provides employment to over 50% of the population but till now our farmers are doing farming in same traditional ways. There is need of development in this sector and essentially on fertilizer pesticides spraying technique, because it requires more efforts and time to spray.

The agribusiness area is dealing with issues with limit issues, contracting incomes and work deficiencies and expanding buyer requests. In addition, out of the 215.6 million acres of irrigated land, around 44% is used for herbs, and 13% is used for shrubs, 14% for climbers and others 5%. The pest sprayers which are on the market can be used for any one of these sectors (Kiran *et al.* 2018) ^[1].

A farmer willing to buy a new sprayer is often faced with a problem of selecting a machine from large choice of models of varying size and capacities available in the market. It is important that he makes the right choice for economical and efficient use (Singh and Kandoria, 1999) ^[4]. A decision should be made concerning which of the four: duster, high volume sprayer, low volume sprayer or ultra-low volume sprayers are required. The dusters are preferred in the arid and semi-arid areas where water is scarce. If the sprayer is the choice, the selection should be such that it is meant for applying spray liquids in the high volume as well as low volume (Srivastava 1990, and Srivastava *et al.* 1994, Smith and Wilkes 1977) ^[5-7]. High volume sprayers are selected where more than 400 litres per hectare is to be sprayed. If spray volume is in between 5 to 400 litres per hectare, low volume sprayers are selected. Ultra low sprayers are only selected where volume of spray liquid to be applied is less than 5 litres per hectare.

Pesticides use is an important aspect of the modern agriculture. Cultivated plants are attacked by insects, fungus and virus parasites, as well as weeds, which are not favorable to their growth. Weeds can be eradicated by effective cultivation, but pests and diseases have to be kept under control with chemical spray and powder application. Chemical are now being used to kill weeds without damaging the crop in addition to the weeding tools. Chemicals are either sprayed in liquid forms or applied as a dry powder. To protect the crop, farmers use a large quantity of pesticides than actually required. This cause's high loss of pesticides nearly one-third of pesticides applied to crop (ground as well as drift) and requires more time for its application. This also adds to health hazards as well as ecological and environmental destruction. Therefore, in application of pesticides, the technique used should be such that

minimum quantity of pesticides is applied to cover the target-leaf-foliage with less environment pollution and maximum pest control. Spraying is an important operation to be performed by the farmer to protect the cultivated crops from insects, pest, fungi and diseases for which various pesticides, fungicides, insecticides and nutrients are sprayed on crops for crop protection. Spraying is the secondary tillage operation. A sprayer is a mechanical device used to spray the liquids like herbicides, pesticides, fungicides. Pesticides are widely used in agricultural production to prevent or control pests, diseases, weeds, and other plant pathogens in an effort to reduce or eliminate yield losses and maintain high product quality. Although pesticides are developed through very strict regulation processes to function with reasonable certainty and minimal impact on human health and the environment, serious concerns have been raised about health risks resulting from occupational exposure and from residues in food and drinking water. Occupational exposure to pesticides often occurs in the case of agricultural workers in open fields and greenhouses, workers in the pesticide industry.

The application rate and discharge rate of boom sprayer were found to be 480 l/ha and 0.576 l/min, respectively. The optimum application rate, swath width, discharge rate, nozzle angle at boom height of single wheel drive boom sprayer were found to be 106 l/ha, 95 m, 1.21 l/min and 43.5 degree respectively. The field capacity of the boom sprayer was 0.072 ha/h and for single wheel drive boom sprayer was 0.08125 ha/h Kumar (2015) [2].

Material and Methods

Location of experiment

A battery operated boom sprayer was designed and fabricated in the Departmental Workshop of Farm Machinery and Power Engineering and evaluated at field of College of Technology and Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur.

Economics evaluation of developed battery operated boom sprayer

The cost of spraying operation consists of fabrication cost, rental cost, insurances cost, repair cost, maintenance cost and labor wages. The cost of operation of battery operated boom sprayer is divided in two parts first in fixed cost and second is variable cost. The fixed cost is independent of the operational work while variable cost varies according to the use of spraying machine. Cost of the machine and its operation was calculated in Rs/ha using straight line method of application and economic evaluation of machine was calculated.

Straight line method

In the straight-line depreciation method, an equal reduction of value is used for each year the machine is owned. This method is used to estimate costs on a specific period of time, provided the proper salvage value is used for the age of the machine. The annual depreciation value can be calculated by (Singh, 2020) [3].

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

Where,

D = Average annual depreciation (Rs/annum)

P = Purchase price (Rs)

S = Salvage value, taken as 10% the purchase price

L = Life of machine (Years)

A. Total fixed cost

1. Depreciation charge

Depreciation cost means a loss in the value of a machine due to time and use. Often, it is the largest of all costs. Machine depreciate, or have a loss of value, for several reasons such as age, wear and tear of machine and obsolescence. The annual depreciation charge can be determined by the following formula.

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

Where,

D = Depreciation charge (Rs/hr.)

P = Development charge (Rs)

S = Salvage value = 10 percent of P

L = Life of the machine in year

H = Number of working hour per year

2. Interest (I)

A large expensive item after depreciation for agricultural machinery is the interest. It is a direct expense item on borrowed capital. Even if cash is paid for purchased machinery, money is tied up that might be available for use elsewhere in the business. Interest rates vary 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.

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

4. Housing rate

Taking housing charge @ 1 percent of development charge per year

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

5. Taxes rate

Taking taxes charge including GST @ 18 percent of development charge for whole life

B. Total operating charge

1. Repair and maintenance charge

Repair and maintenance costs are considered as an essential and significant part of machinery ownership. Occasional repairs and periodic maintenance are required to maintain a machine in good working order and ensure a high degree of reliability. The more a machine is used, the greater is its need for repair. Repair and maintenance charge was taken 5 percent of the development charge of the machine per year.

$$= \frac{5 \text{ percent of P}}{H}$$

2. Labour charges

Labour charge was taken 400 per day for eight working hour.

Results and Discussion

A battery operated boom sprayer has been developed to increase area coverage and perform spraying without the application of fuel, petrol and diesel. The mechanical device is used to operate the pump through the scotch yoke mechanism. The scotch yoke mechanism is powered by frame shaft. It increases swath width, theoretical field capacity, and effective field capacity and also increases field efficiency. Ergonomics parameters such as heart rate, ODR and body part

discomfort rate (BPDS) were also found and compared with the manually operated sprayer. The values of ergonomics parameters of developed battery operated boom sprayer were less when compared with the values of ergonomics parameters of battery operated knapsack sprayer.

Cost economics

The cost of spraying the Brinjal crop with battery operated boom sprayer was assessed and compared with battery operated knapsack sprayer and ground wheel operated sprayer. The total cost of developed battery operated boom sprayer was Rs 30000. The assessed value has been shown in the Table 1.

Table 1: Cost estimation of developed sprayer for one hectare

Development cost of spraying machine (Includes material charge and labor charge for fabrication)	: 30000 Rs
Labor charge	: 400 Rs/day
Life of spraying machine	: 8 years, 2400 h
Working hours per year	: 300 h
Salvage value	: 10 percent of the purchase cost
Interest rate (Per year)	: 10 percent of the purchase cost
Insurance (Per year)	: 2 percent of the purchase cost
Taxes of spraying machine for whole life	: 18 percent of the purchase cost
Housing (Per year)	: 1 percent of the purchase cost
Repair and maintenance costs (Per year)	: 5 percent of the purchase cost
Depreciation cost calculated by using	: Straight-line method

The capacity of hand operated knapsack sprayer, ground wheel operated sprayer and developed battery operated boom sprayer was found to be 0.072 ha/hr. (Kumar, 2015) [2], 0.281 ha/hr. and 0.284 ha/hr. respectively. The cost of operation for one hectare by hand operated, ground wheel operated sprayer and developed battery operated boom sprayer was calculated as 725 Rs/ha, 236.83 Rs/ha and 213.88 Rs/ha respectively. The cost of spraying per hectare in hand operated was much higher than the ground wheel operated sprayer as well as the cost of spraying per hectare in ground wheel operated sprayer was higher than developed battery operated boom sprayer.

Conclusion

Insects and pests are the main factors that are responsible for loss of yield and income of the farmer. Traditional broadcasting has led to decrease the efficiency and more quantity of pesticides is needed to cover the farm land. Due to development of spraying equipment which is not only efficient but also feasible for the Indian farmer had a tremendous impact on productivity. These pesticides spraying machine are able to administrate pesticides and also fertilizer which have had to modern farming and reduction of losses and increase productivity. The pesticides spraying machine have created a foundation for agriculture mechanization. It has also led in improvement of ergonomical aspect of Indian farmer as spraying to be done effortlessly and with ease. Also due to high field capacity and application rate of these developed machine more land is covered in very less duration. Thus agricultural operations can be done at the right time by reducing the losses due to time as well. Due to less initial cost of these machines overall costs of farming have been reduced as less amount of pesticides is needed. Total cost of operation for one hectare by hand operated, ground wheel operated sprayer and battery operated boom sprayer were assessed to be 725 Rs/ha, 236.83 Rs/ha and 213.88 Rs/ha respectively.

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