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Cost Analysis of Developed Orchard Spraying System for Unmanned Aerial Vehicle

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ABSTRACT: Mango is the most important commercial grown fruit crop and world's mango production is averaging about 22 million metric tons per year. India is largest fruit producer after china. However, the country having advantages over mango producing countries, but productivity continues to be low. To increase the overall plant health and fruit yield as well as to protect the tress from harmful fungal diseases, spraying is necessary for mango orchard. As mango is important fruit crop of Konkan region and its spraying operation is done conventionally, the operation is time consuming. UAVs are commonly used for spraying orchards. In conventional method of spraying results in excessive application of chemicals and less uniformity which further leads to more production cost. Application of pesticides with the help of UAV could have advantage of spray over crops and covering large areas quickly. UAV fly at proper height can increase pesticide penetrate effectively. This paper presents details study about cost economics of developed orchard spraying system for unmanned aerial vehicle which can reduce spraying cost and loss pesticide.

KEYWORDS: mango producing countries

I. INTRODUCTION

Precision agriculture is an agriculture production system based on the information technology which is based for the purpose of determine, analyze and manage of the factors such as temporal and spatial variability in the field to obtain maximum profit, sustainability and environmental protection (Unal *et al.*, 2013). Mango (*Mangifera indica* L.) is the most important fruit of India and is known as "King of fruits". Indian mangoes come in various shapes, sizes and colours with a wide variety of flavour, aroma and taste. The Indian mango is the special product that substantiates the high standards of quality and bountiful of nutrients packed in it. In India, mangoes are mainly grown in tropical and subtropical regions from sea level to an altitude of 1,500 m. Mango is important fruit crop of Konkan region grown on 1.10 lakh ha productive area was under mango cultivation having annual production of 2.6 lakh metric tons. In crop and fruits production system pesticides are applied in agricultural fields to protect crops and fruits. The crop yield is generally reduced by 40 per cent mainly due to attack of pest, disease and weed and farmers have adopted many chemical control for controlling them. Pests are prominent issues in crop production. Indian farmers use conventional methods to spray pesticides in the field which leads to excessive use of chemicals, less spray uniformity, low deposition, higher cost of spray operation and environment pollution. There are too many technologies involved in today's agriculture, out of which spraying pesticides using UAVs is one of the emerging technologies. In the recent years, the development of Unmanned Aerial Vehicles (UAVs) supported the of precision agriculture. Field operations over smaller field can especially benefit for use of UAVs. UAV or commonly known as drones, are beginning to emerge as an incredible solution for many of the challenges. UAV platforms has given a new solution for crop management as well as monitoring, especially where small farm areas have to be monitored. Also this technology perfect for agriculture, because these are mainly vast in rural areas, where privacy and safety issues regarding the drones are less of concern than in many other UAV applications.



II.MATERIAL AND METHOD

The cost of operation of the developed an orchard spraying system for UAV was calculated using IS: 9164-1979 test code guide for estimating cost of farm machinery operation. Also the payback period and breakeven point was determined by using the test code. The cost analysis consisted fixed cost and operating cost for UAV, calculated by following formula.

Fixed cost:

1. Cost of machine (C)
 2. Depreciation (Rs. /h) = $(C-S) / (L \times H)$
 3. Interest (Rs. /h) = $((C+ S)/2) \times I / H$
 4. Insurance, taxes and housing (Rs. /h) = 2 per cent of initial cost
- Total fixed cost = 2+3+4

Variable cost:

5. Repair and maintenance cost: 10 per cent of initial cost
6. Power consumption cost for battery charging
7. Operator charge

Total operating cost = Fixed cost + Variable cost

Where,

- C= Initial cost of UAVs, Rs
- H= Annual use of UAVs, h
- I = Interest rate, %
- L = Total life of UAVs, year
- S= Salvage value, Rs.

2.1 Breakeven point

The breakeven point of developed orchard spraying system for unmanned aerial vehicle is an indication that the UAV should work at least for that estimated point of time which is in the hours of operation per year. The breakeven point is expressed considering the relations between annual fixed costs, custom charges per hour and total operating cost which is given below.

$$\text{Breakeven point (H)} = \frac{\text{Annual fixed cost } \left(\frac{\text{Rs}}{\text{h}}\right)}{\text{Custom charges } \left(\frac{\text{Rs}}{\text{h}}\right) - \text{Total cost of operation } \left(\frac{\text{Rs}}{\text{h}}\right)}$$

2.2 Payback period

The payback period of developed orchard spraying system in years has been worked out on relationship of annual use of working hours, total cost, total benefits and initial investment of UAVs. The payback period determined by following formula.

$$\text{Payback period} = \frac{\text{Initial investment}}{\text{Net benefits}}$$

Where,

- Net benefits = Total benefits- total cost
- Total benefits = Working hours x custom charges
- Total cost = Fixed + Annual hours usage x variable cost

III.RESULT AND DISCUSSION

The cost of operation of the developed orchard spraying system for unmanned aerial vehicle has been calculated to BIS standard IS: 9164-1979 guide for estimating cost of farm machinery operation. The following assumptions were considered for working out the cost economics of the orchard spraying system for unmanned aerial vehicle.



Initial cost of UAV, Rs	3,60,000/-
Life of UAV sprayer, years	5
Life of battery, years	3 (Charge and discharge up to 200 times)
Life of motors, h	800
Salvage value, %	10
Interest rate, %	15
Taxes and insurance, %	2
Unit power cost, Rs/unit	7 (for battery charging)
Annual use of UAV sprayer, h	250
Operator cost, Rs/day	400
Depreciation	Straight line method

I. Operating cost for developed orchard spraying system for unmanned aerial vehicle

a. Annual fixed cost

i) Depreciation (D):

The annual deprecation value can be calculated by the following equation

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

Where,

D = Depreciation per hour (Rs/h)

P = Purchase price or capital investment (Rs/h)

S = Salvage value, 10 per cent of the purchase price

L = Life of machine, years

H = Number of working per year

$$D = \frac{360000 - (10/100) \times 3600000}{5 \times 250}$$

$$D = 259.9 \text{ Rs/h}$$

ii) Interest (I):

Annual interest was calculated by using following equation

Here, $I = 15\%$, $S = 0.1 \times P$

R=Rate of interest per year

S= Salvage value

P= Purchase price

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

$$= \frac{360000 + 36000}{2} \times \frac{0.15}{250}$$

$$I = 118.8 \text{ Rs/h}$$



iii) Insurance, Taxes and Housing : -

$$\begin{aligned} \text{Insurance, taxes and housing taken as 2 per cent of the initial cost} \\ &= \frac{2\% \text{ of } P}{250} \\ &= \frac{0.02 \times 360000}{250} \\ &= 28.8 \text{ Rs/h} \end{aligned}$$

$$\begin{aligned} \text{Total fixed cost (i + ii + iii)} &= 259.9 + 118.8 + 28.8 \\ &= 407.5 \text{ Rs/h} \end{aligned}$$

b. Operating cost

i) Repair and maintenance costs:

Repair and maintenance cost was taken 10% of the purchase price of the machine per year

$$\begin{aligned} \text{Repair and maintenance costs} &= \frac{0.10 \times 360000}{250} \\ &= 75.54 \text{ Rs/h} \end{aligned}$$

ii) Power consumption cost for battery charging:

Power cost for battery charging was calculated on the basis of actual power consumption in charging the battery for spraying operation

Cost of 1 unit power	: 7 Rs
1 unit power	: 1000 watt or 1kwh
Power consumption for full charging the battery	: 355.2 watts x 2 battery = 710.4 W
Time taken to full discharging of battery	: 10 min x 2 battery = 20 min
For power consumption for full charging the battery in 1 ha	: 710.4 w x 4 times = 2841.6 = 2.8U
Power consumption cost	: 7 x 2.8 = 19.6 Rs/h

iii) Operator charge:

The cost of operator was calculated from the actual labor charges paid in rupees per day at the prevailing rates Rs. 400/day is paid for operator, 4 h taken for one day

$$\text{Driver charge} = 400/4 = 100 \text{ Rs/h}$$

$$\text{Total operating cost} = i + ii + iii = 144 + 19.6 + 100 = 263 \text{ Rs/h}$$

$$\begin{aligned} \text{Total cost of operation for developed orchard spraying system for unmanned aerial vehicle} \\ &= 407.5 + 263.6 = 671 \text{ Rs/h} \end{aligned}$$

Effective field capacity of orchard spraying system was 4.53 ha/h

$$\begin{aligned} \text{Cost of operation of spraying} &= \frac{671}{4.53} \\ &= 148.12 \text{ Rs/ha} \end{aligned}$$

$$\text{Over Head charges @ 25 \% of the total cost of operation} = 167.75 \text{ Rs/h}$$

$$\text{Profit @ 25\% of the overhead charges} = 41.93 \text{ Rs/h}$$

$$\begin{aligned} \text{Custom hiring charges Rs/h} &= (\text{Total operating cost} + \text{Overhead charge} + \text{Profit}) \\ &= 880.68 \text{ Rs/h} \end{aligned}$$

$$\begin{aligned} \text{Break even point, } \frac{\text{h}}{\text{annum}} &= \frac{\text{Annual fixed cost } \left(\frac{\text{Rs}}{\text{h}}\right)}{\text{Custom hiring charges } \left(\frac{\text{Rs}}{\text{h}}\right) - \text{Total cost of operation } \left(\frac{\text{Rs}}{\text{h}}\right)} \\ &= \frac{407.5 \times 250}{880.68 - 671} \\ &= 485 \text{ h/annum} \end{aligned}$$

Average net annual profit, Rs

$$\begin{aligned} &= \{ \text{custom hiring charges (Rs/h)} - \text{Total operating cost (Rs/h)} \} \times \text{Annual usage} \\ &= (880.68 - 263.6) \times 250 \\ &= 1,54,270/- \end{aligned}$$

$$\begin{aligned}\text{Pay back period, years} &= \frac{\text{Initial cost of machine}}{\text{Avg. Net annual price}} \\ &= \frac{360000}{154270} \\ &= 2.33 \text{ years}\end{aligned}$$

IV. CONCLUSION

The operating costs of the developed orchard spraying system for unmanned aerial vehicle were computed using machine costs, labour charges, and other expenses. The operating costs of the developed orchard spraying system were 148.12 Rs/ha. The breakeven point of an orchard spraying system for unmanned aerial vehicle was estimated to be 485 h per annum. The payback period of an orchard spraying system was determined to be 2.33 years.

REFERENCES

1. Brown, C. R., & Giles, D. K. (2018). Measurement of Pesticide Drift from Unmanned Aerial Vehicle Application to a Vineyard. *Transactions of the ASABE*, 61(5), 1539–1546
2. Chen, S.; Lan, Y.; Zhou, Z.; Ouyang, F.; Wang, G.; Huang, X.; Deng, X.; Cheng, S. Effect of Droplet Size Parameters on Droplet Deposition and Drift of Aerial spraying by Using Plant Protection UAV. *Agronomy* 2020, 10, 195
3. Chen S D, Lan Y B, Li J Y, Zhou Z Y, Liu A M, Mao Y D. Effect of wind field below unmanned helicopter on droplet deposition distribution of aerial spraying. *Int J Agric & Biol Eng*, 2017; 10(3): 67–77.
4. Carvalho, F. K., Chechetto, R. G., Mota, A. A. B., Antuniassi, U. R. Challenges of Aircraft and Drone Spray Applications. *Outlooks On Pest Management*, 2020
5. Chngling W, He X, Wang X, Wang Z, Wang S, (2016) Distribution characteristics of pesticide application droplets deposition of unmanned aerial vehicle based testing method of deposition quality balance. *Trans of the Chinese society Agril Engg* 32 (24) : 89-97
6. Giles D, Billing R. Deployment and performance of an unmanned aerial vehicle for spraying of specialty crops. *International Conference of Agricultural Engineering*, Zurich, 2014, 7, C0589.
7. Guo S, Li J, Yao W, Zhan Y, Li Y, Shi Y (2019) Distribution characteristics on droplet deposition of wind field vortex formed by multirotor UAV. *PLOS ONE* 14(7): e0220024.
8. Harsha, V., Deepak, S., Aditya. P. and Sanjivi. A., 2014, Development of automated aerial pesticidesprayer. *Int.J. Research in Engg.and Tech.*, 3(4):856-861
9. He, X (2018) Rapid development of unmanned aerial vehicles (UAV) for plant protection and application technology in China. *Outlook Pest Mgmt* 29:162–167
10. He X K, Bonds J, Herbst A, Langenakens J. Recent development of unmanned aerial vehicle for plant protection in East Asia. *Int J Agric & Biol Eng*, 2017; 10(3): 18–30.
11. Huang, Y., Hofmann, W. C., Lan, Y., Wu, W., & Fritz, B. K. (2009). Development of a spray system for an unmanned aerial vehicle platform. *Applied Engineering in Agriculture*, 25, 803–809.
12. Huang, Y., Thomson, S. J., Hoffmann, W. C., Lan, Y., & Fritz, B. K. (2013). Development and prospect of unmanned aerial vehicle technologies for agricultural production management. *International Journal of Agricultural and Biological Engineering*, 6(3), 1-10. <http://dx.doi.org/10.3965/ijabe.20130603.001>
13. Hunter JE III, Gannon TW, Richardson RJ, Yelverton FH, Leon RG (2019) Coverage and drift potential associated with nozzle and speed selection for herbicide applications using an unmanned aerial sprayer. *Weed Technol.* doi: 10.1017/wet.2019.101



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