ESTIMATION OF THE COST OF INSECTICIDE APPLICATION IN APPLE ORCHARDS

TECHNICAL BULLETIN

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ICAR-CENTRAL INSTITUTE OF TEMPERATE HORTICULTURE

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Technical Bulletin

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Executive Summary

This report provides a detailed estimation of pesticide spray costs in apple orchards across three orchard systems—Traditional, Medium Density, and High Density—accounting for different tree age groups. Key highlights of the study include:

- Each section is designed to provide a brief background detail of the cost type followed by the methods adopted for calculating the values and finally the details of the actual cost figures in tabulated form.
- Pesticide Material Costs: A comparative cost analysis of commonly used insecticides was performed using prevailing market prices as of June 2024. Doses were standardized per 100 liters of spray solution based on manufacturer labels and recommended practices.
- Spray Volume Calculations: Spray solution volume requirements were calculated per plant and per kanal, considering variations in plant density and canopy volume across orchard types and tree ages.
- Cost of Application: The report rigorously analyses both fixed and variable costs of pesticide application. Fixed costs include depreciation, interest, and taxes on equipment (e.g., power sprayers), while variable costs comprise fuel, lubrication, repair, and labour. Two depreciation methods—ASA&BE and Straight Line—are applied for comparative insights.
- Total Spray Cost per Kanal: The combined cost of pesticide material and application ranges significantly depending on the insecticide used and the orchard type. For instance, the total spray cost using Neem oil 1500 ppm in orchards with older trees (>20 years) can exceed Rs. 2,500 per kanal, while lower-cost insecticides like Dimethoate 30 EC range between Rs. 544–1334 per kanal depending on orchard system and age.
- Decision-Support Utility: The cost model is modular and adaptable, allowing stakeholders to adjust for equipment age, inflation, input price variability, and labor availability.

Salient features

This economic estimation is intended to guide pesticide usage planning, budgeting, and optimization for better resource allocation and environmental stewardship in apple production systems.

- The document provides an in-depth look at the sub-components of spray application costs
- A key strength is its recognition that spray volume requirements vary significantly based on factors such as plant age, spacing within different orchard systems (traditional, high-density on M9 rootstock, and medium-density on MM-111 or MM-106 rootstocks), and canopy volume influenced by rootstock type. This allows for cost differentiation by orchard system and age group, providing highly relevant and actionable data.
- Practical Application: By combining fixed and variable components with material costs, the document offers a comprehensive economic overview of pesticide application.
- It calculates total application costs per hour and per kanal, leading to the final comprehensive cost of pesticide spray per kanal, segmented by orchard system and age group. This level of detail is invaluable for farmers to make informed decisions about their pest management strategies and overall farm economics.
- Basis for Financial Planning and Decision Making: The document provides specific figures and methodologies that can be extrapolated as per requirement.
- Budgeting: Farmers can use these estimates to plan their annual expenses for pest control.
- Comparative Analysis: It allows for comparison of costs across different orchard systems and age groups, potentially guiding investment decisions for new orchards or management practices for existing ones.
- Efficiency Improvement: Understanding the breakdown of costs can help identify areas where efficiency improvements or cost reductions might be achieved (e.g., optimizing spray volume, and equipment utilization).
- Policy Formulation: Agricultural agencies and policymakers can use this data to develop subsidies, support programs, or advisories for apple growers.
- Methodological Transparency: The document clearly outlines the methodologies used for calculating various cost components, such as the American Society of Agricultural and Biological Engineers(ASA&BE) and Straight-Line methods for depreciation, and the formulas for interest and Taxes, Insurance, and Housing(TIH). This transparency enhances the credibility and utility of the cost estimates.

Introduction

Efficient and cost-effective management of pests in apple orchards is critical for ensuring sustainable fruit production, especially in high-value crops like apples. With increasing pressure to adopt judicious pesticide usage and rising input costs, it is essential for orchard managers, policy-makers, and researchers to have access to detailed, data-driven cost estimations of pesticide applications. The most accurate method of determining the machine and operation costs is complete records of the actual costs incurred. Estimating costs is an alternative. This bulletin is designed to provide farm managers with an additional tool for their management decisions.

The provided document, titled "Estimation of the Cost of Insecticide Application in Apple Orchards," serves a crucial utility and holds significant importance, particularly for stakeholders involved in apple cultivation and agricultural economics. The primary utility of this document is to provide a comprehensive estimation of the costs associated with pesticide application in apple orchards. This detailed financial breakdown is essential for farmers, agricultural planners, and policymakers to understand the economic implications of chemical pest management.

The document categorizes expenses into two main components: Cost of insecticide material and spray application. The cost of insecticide material includes the prices of various insecticides, determined by the average of the lowest bulk market prices in Srinagar (J&K) as of June 1, 2024. It also details the recommended dosages per 100 liters of water from insecticide labels, CIB&RC guidelines, and advisories from SKAUST-K, Shalimar. The document provides a summary of these costs per kanal, differentiated by orchard system and age group.

Spray application costs cover all expenditures related to operating power sprayers, including labor, equipment depreciation, interest, fuel, insurance, and housing. These costs are further bifurcated into fixed costs and variable (operating) costs.

Fixed costs represent machine ownership costs that occur regardless of use. They include: Depreciation calculated using two methodologies: the American Society of Agricultural and Biological Engineers (ASA&BE) method (which considers remaining value factor, current list price, and accumulated usage) and the Straight-Line method (uniformly applying a 10% salvage value of initial investment). Interest on investment calculated based on the average cost of investment multiplied by an adjusted 'real' interest rate of 8% (accounting for a 5% inflation rate). Taxes, Insurance, and Housing (TIH): estimated collectively at 3% of the machine's average cost annually, based on typical estimates for property taxes (1%), insurance (0.5%), and housing (1.0%). The joint costs of depreciation and interest can also be calculated using a capital recovery factor.

Variable (Operating) costs are directly tied to machine usage. They include: Repairs and Maintenance estimated at 10% of the initial machine cost per year for sprayers Fuel estimated at 1.48 liters per hour for a 6.5 HP petrol engine sprayer. Lubrication estimated at 15% of fuel costs. Labor considers the number of personnel, daily wages, and an adjustment for non-field time (10% to 20% more than actual field machine time).

Estimated cost of Insecticide Application

The total cost associated with pesticide application in apple orchards is categorized as expenses into two main components: Cost of insecticide material and Spray application costs. The final cost of spray is calculated taken in to consideration the field capacity of the operation involved. In the first section the details of the cost associated with insecticide material and the basis of its calculation are described in detail.

A) Cost of Insecticide Material

This section details the most common insecticides used in apple orchards as on date. The respective market prices have been worked out as per the norms of price estimation mimicking end user experience. The recommendation of pesticides is not based on unit area to be sprayed, but on dilution basis (quantity of pesticide per 100 litre of water). Therefore, the basis of the calculation of actual requirement of insecticide material is not straight forward but derived based on the recommendation and actual quantity of spray solution needed. Further, the quantity of spray solution needed is dependent on the tree age, canopy size and other factors, hence those factors also need to be taken in to consideration. We first describe the market prices and dosages of the commonly used/ recommended insecticides and followed by the spray volume requirement of apple trees in different cultivation systems, and tree age. Based on all the three factors, cost of the insecticide material needed per unit area is derived.

i) Market price of insecticides: Prices per unit vary with package size. The average of the lowest bulk price available in the market (FOR basis) is used to calculate costs. Market prices are as on 01-06-2024 in Srinagar (J&K) (Table 1).

Table 1: List of common insecticides used in apple orchards and their unit prices*

S. No.	Insecticide	Commercial name and Manufacturer	Package size	Unit	Unit rate (Rs.)
1.	Dimethoate 30 EC	Rogor, FMC	0.5 L	L	750.0
2.	Chlorpyriphos 20 EC	Lethal, Insecticides India	1 L	L	400.0
3.	Quinalphos 25 EC	Dhanulux, Dhanuka Agritech Ltd.	0.5 L	L	750.0
4.	Thiacloprid 240 SC	Alanto, Bayer CropScience Ltd.	0.2 L	L	3520.0
5.	Bifenthrin 8 SC	Markar Super, Dhanuka Agritech Ltd.	0.1 L	L	1050.0
6.	Horticulture Mineral Oil	Servo Orchard Spray Oil, Indian Oil Corporation Ltd.	20 L	L	150.0
7.	Imidacloprid 17.8 SL	Confidor, Bayer CropScience Ltd.	0.1 L	L	3050.0
8.	Thiamethoxam 25 WG	Actara, Bayer CropScience Ltd.	250 g	Kg	3200.0
9.	Chlorpyriphos 50% Cypermethrin 5% EC	Super D, Dhanuka Agritech Ltd.	0.5 L	L	900.0
10.	Thiamethoxam 12.6% lambda cyhalothrin 9.5% ZC	Alika, Syngenta	0.5 L	L	2600.0
11.	Imidacloprid 6% + lambda cyhalothrin 4 % SL	Innovexia, Willowood Crop Science Pvt. Ltd.	1.0 L	L	1750.0
12.	Neem oil 1500 ppm	Margo Neem 1500, PJ Magro Pvt. Ltd.	0.25 L	L	1200.0

**** Use of a company or product name does not imply approval or recommendation of the***

product to the exclusion of others that also may be suitable.

ii) Dosages: Most doses are stated as amount per 100 liters of water. Reference doses are from insecticide labels and the CIB&RC recommended dosages of pesticide use. Additional doses are taken from the Package of Practices for Fruits and various advisories issued by SKUAST-K, Shalimar (Table 2).

Table 2: Recommended dosages of common insecticides and associated costs per 100 liters of spray solution

S. No.	Insecticides	Dosage (per 100 L water)	Cost of pesticide (per 100 L of spray solution)
1.	Dimethoate 30 EC	100 ml	75.0
2.	Chlorpyriphos 20 EC	250 ml	100.0
3.	Quinalphos 25 EC	200 ml	150.0
4.	Thiacloprid 240 SC	40 ml	140.8
5.	Bifenthrin 8 SC	75 ml	78.75
6.	HMO (Dormant spray)	2000 ml	300.0
7.	HMO (Summer oil)	500 ml	75.0
8.	Imidacloprid 17.8 SL	40 ml	122.0
9.	Thiamethoxam 25 WG	25 g	80.0
10.	Chlorpyriphos 50% Cypermethrin 5% EC	200 ml	180.0
11.	Thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC	40 ml	104.0
12.	Imidacloprid 6% + lambda cyhalothrin 4 % SL	60 ml	105.0
13	Neem oil 1500 ppm	300 ml	360.0

iii) Spray volume per unit area

Volume of spray solution needed per plant varies with plant age. The number of plants per unit area varies depending on plant spacing. Canopy volume also varies with type of rootstock like dwarfing rootstocks M9, semi-dwarfing rootstocks MM-111 ad MM-106, and trees on seedling rootstocks. Therefore, requirement of spray solution for each case has been calculated separately (Table 3).

Table 3: Spray volume requirements per plant and per kanal, differentiated by apple orchard system, plant spacing, and age

S. No.	Orchard system	Spacing (sq. m)	Plants per kanal	Age (Yrs.)	Volume of Spray solution per plant	Volume of Spray solution per kanal
1	Traditional orchard (without uniform row to row and plant to plant spacing; on seedling rootstock)	5 × 5*	20	1-5	3 L	60 L
				5-10	5 L	100 L
				10-20	8 L	160 L
				>20	15 L	300 L
2	High density orchard (on M9)	3 × 1	167	1-2	1 L	167 L
				2-5	1.5 L	250 L
				>5	2.5 L	418 L
3	Medium density orchard (on MM-111 or MM-106)	3 × 1.5	111	1-2	1 L	111 L
				2-5	2 L	222 L
				>5	4 L	444 L

**Recommended spacing for traditional orchards on seedling rootstock is 6 × 6 sq. m, but most of the established traditional orchards have irregular spacing, accommodating approx. 20 plants per kanal.*

iv) Summary of cost of pesticide material

After conversion of dosage as quantity per 100 L and requirement of spray solution as per the orchard type and age group of plants, we can now calculate the quantity of pesticide material needed per unit area (Table 4).

Table 4: Summary of estimated pesticide material costs per kanal by orchard system and age group

S. No.	Insecticides	Orchard age (Yrs.)									
		Traditional orchards				High density plantation			Medium density plantation		
		1-5	5-10	10-20	>20	1-2	2-5	>5	1-2	2-5	>5
1.	Dimethoate 30 EC	45.0	75.0	120.0	225.0	125.3	187.5	313.5	83.3	166.5	333.0
2.	Chlorpy-riphos 20 EC	60.0	100.0	160.0	300.0	167.0	250.0	418.0	111.0	222.0	444.0
3.	Quinalphos 25 EC	90.0	150.0	240.0	450.0	250.5	375.0	627.0	166.5	333.0	666.0
4.	Thiacloprid 240 SC	84.5	140.8	225.3	422.4	235.1	352.0	588.5	156.3	312.6	625.2
5.	Bifenthrin 8 SC	47.3	78.8	126.0	236.3	131.5	196.9	329.2	87.4	174.8	349.7
6.	HMO dormant spray	180.0	300.0	480.0	900.0	501.0	750.0	1254.0	333.0	666.0	1332.0
7.	HMO Sum-mer Oil	45.0	75.0	120.0	225.0	125.3	187.5	313.5	83.3	166.5	333.0
8.	Imidacloprid 17.8 SL	73.2	122.0	195.2	366.0	203.7	305.0	510.0	135.4	270.8	541.7
9.	Thiamethox-am 25 WG	48.0	80.0	128.0	240.0	133.6	200.0	334.4	88.8	177.6	355.2
10.	Chlorpy-riphos 50% Cyperme-thrin 5% EC	108.0	180.0	288.0	540.0	300.6	450.0	752.4	199.8	399.6	799.2
11.	Thiameth-oxam 12.6% + lambda cyhalothrin 9.5% ZC	62.4	104.0	166.4	312.0	173.7	260.0	434.7	115.4	230.9	461.8
12.	Imidacloprid 6% + lambda cyhalothrin 4 % SL	63.0	105.0	168.0	315.0	175.4	262.5	438.9	116.6	233.1	466.2
13.	Neem oil 1500 ppm	216.0	360.0	576.0	1080.0	601.2	900.0	1504.8	399.6	799.2	1598.4

B) Spray Application Costs

The cost of spray application includes several components such as labor, equipment depreciation, fuel, interest on investment, insurance, and storage. In general, the total cost of operating any farm implement or tool is divided into two main categories: Fixed Costs, and Variable (Operating) Costs. Fixed costs are expenses associated with owning a machine, and they are incurred whether or not the machine is in use. These costs decrease on a per-hour basis as the machine is used more frequently. Fixed costs typically include depreciation, interest on capital, taxes, insurance, and storage or housing. Variable or operating costs, on the other hand, depend directly on how much the machine is used. These costs are only incurred during actual operation and include expenses such as fuel, lubricants, repairs, maintenance, servicing, and labor. In cost analysis, both fixed and variable costs are considered to determine the total cost per hour of using a machine, tool, or implement.

a) Fixed Costs Fixed costs are associated with owning the machine and are incurred regardless of whether the machine is used. These costs are spread over the annual usage, meaning that as usage increases, fixed cost per hour decreases. Fixed costs typically include: Depreciation, Interest on investment, Taxes, Insurance, and Housing or shelter costs. The components of fixed costs are described in the following sections.

i) Depreciation

Depreciation represents the reduction in the machine's value over time due to wear, age, or obsolescence. Mechanical wear may vary, affecting resale value. Sudden changes in technology or design can also make a machine outdated, lowering its market value. However, in most cases, age and accumulated working hours are the main factors determining its remaining value. To estimate annual depreciation, two values are needed:

Economic life: The period (in years) over which the cost is calculated. This is usually shorter than the actual service life, as machines are often traded before they are completely worn out. A typical guideline is 10–12 years for farm implements and 15 years for tractors.

Salvage value: The estimated value of the machine at the end of its economic life. It may reflect the trade-in value, resale value, or zero if the machine is used until fully depreciated.

The straight-line method to calculate depreciation per hour is:

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

Where:

D = Depreciation cost per hour (in Rs)

C = Initial cost of the machine (in Rs)

S = Salvage value, often taken as 10% of original purchase price

L = Expected life of the machine (in years)

H = Annual working hours

Alternatively, the ASA&BE method estimates salvage value as:

$$Salvage\ Value = Current\ List\ Price \times Remaining\ Value\ Factor$$

The remaining value factor depends on machine age (see Annexure -I). For example, a 5-year-old machine may retain 50% of its value. Total depreciation can also be calculated as:

$$Total\ Depreciation = Purchase\ Price - Salvage\ Value$$

The total depreciation figure is divided by the estimated years of useful life to get the annual depreciation. Then, divide by annual usage (in hours) to get depreciation per hour.

For a 6.5 HP power sprayer (with 200 ft spray pipe, gun, and nozzles), the average economic life is taken as 10 years. Spraying one kanal of orchard takes 60 minutes. Assuming 10 sprays per season and an average orchard size of 10 kanal, annual usage is estimated at 100 hours. If the machine is now 5 years old, the depreciation is calculated accordingly (refer to Table 5 for detailed values).

Table 5. Depreciation of power sprayers utilizing the ASA&BE and Stright-Line Method for fixed cost calculation

Method of calculation	Original purchase price (Rs.)	Current list price (Rs.)	Salvage value (Rs.)	Total Depreciation (Rs.)	Depreciation Rate (Rs./hr.)
ASA&BE	35,000	33,000	16,500	18,500	18.5
Straight-Line	35,000	33,000	3,500	15,750	31.5

ii) Interest

When a machine is purchased using borrowed funds, the lender sets the interest rate. However, if the machine is purchased using the farmer's own capital, the relevant interest charge is based on the opportunity cost—i.e., what the capital could have earned if used elsewhere in the farm business.

Annual interest charges are calculated using the actual interest rate and the average investment cost. This average investment cost is typically the mean of the machine's purchase price and its expected salvage value. Inflation affects the real cost of capital investment. Since loans are repaid in future currency that may have lower value, inflation effectively reduces the real interest burden. To account for this, the nominal interest rate should be adjusted by subtracting the expected rate of inflation. For instance, assuming a nominal interest rate of 13% and an inflation rate of 5% (base year 2011–12), the real interest rate becomes 8%.

The interest on investment is given by

$$\boldsymbol{Interest} = \frac{(C+S)}{2} \times \frac{\mathrm{i}}{(100 \times H)}$$

Where:

C = initial cost of the machine

S = salvage value at the end of its useful life

i = real interest rate (adjusted for inflation)

H = number of hours in in a year

This formula calculates the interest per hour of machine use. For example, the hourly interest cost of a power sprayer can be found using the values in Table 6. This hourly rate is then multiplied by the number of hours the machine is used in spray operations.

Table 6: Hourly interest costs for power sprayers based on different salvage value calculation methods

Method	Original purchase price (Rs.)	Machine Age (Yrs.)	Salvage value (Rs.)	Average purchase price (Rs.)	Interest (Rs. /hr.)
ASA&BE	35,000	5	16,500	25,750	20.6
Straight-Line	35,000	5	3,500	19,250	15.4

iii) Taxes, Insurance and Housing (TIH)

In regions where property taxes apply to agricultural equipment, these are typically estimated at around 1% of the machine's average value annually. Any applicable sales or road taxes are generally spread out over the useful life of the equipment.

Insurance coverage for farm machinery is essential to safeguard against losses due to unforeseen events such as fire. The prevailing insurance premium for such equipment is usually about 0.5% of its average value per year.

The quality and extent of shelter provided for farm machinery can vary widely. However, storing machines under cover and having appropriate tools and maintenance facilities helps reduce field breakdowns and slows down wear from exposure to the elements. This not only enhances the dependability of the machinery during use but also helps retain its resale value. An annual housing cost of 1% of the average machine value is commonly recommended.

Altogether, the combined annual cost for taxes, insurance, and housing is estimated at 3% of the machine's average value. This total TIH cost, when expressed on an hourly basis, is calculated using the formula:

$$TIH = \frac{3 \times A}{100 \times H}$$

where:

A is the average value of the machine, and

H is the annual number of hours the machine is used.

The cost calculation for TIH per hour of usage for the power sprayer is given in table 7.

Table 7: Estimated taxes, insurance, and housing (TIH) costs for power sprayers

Method	Original purchase price (Rs.)	Machine Age (Yrs.)	Average purchase price (Rs.)	Total TIH (Rs.)	Rate of TIH (Rs./hr.)
ASA&BE	35,000	5	25,750	772.5	7.72
Straight-Line	35,000	5	19,250	577.5	5.77

The estimated costs of depreciation, interest, taxes, insurance, and housing are added together to find the total ownership cost or total fixed cost.

Table 8: Summary of total fixed costs per hour for power sprayers, based on two calculation methods

Method	Depreciation Rate (Rs./hr.)	Interest (Rs. /hr.)	Rate of TIH (Rs. /hr.)	Total fixed cost (Rs. /hr.)
ASA&BE	18.5	20.6	7.72	46.82
Straight-Line	31.5	15.4	5.77	52.67

b) Operating costs (variable costs)

These include costs associated with repairs and maintenance, fuel, lubrication, and operator labor.

i) Repair and Maintenance

Expenditures on repairs arise due to routine servicing, mechanical wear, and occasional damage. These costs can differ significantly across regions, primarily due to variations in soil composition, the presence of stones, topography, climate, and other local conditions. The most accurate way to estimate repair expenses is by referring to historical data from your own machinery. Well-maintained records help determine whether a particular machine has experienced higher or lower than average repair needs and can signal when major servicing is due. They also reflect the effectiveness of your maintenance practices and mechanical skill.

In the absence of such specific records, repair costs must be approximated using industry averages. Historical data suggests that the cumulative repair costs over the lifespan of a machine typically start at around 10% of the machine's purchase price per 3,000 hours of operation annually, potentially reaching up to 70% of the original cost by 10,000 hours of total use.

For sprayers and similar equipment, a standard approach is to estimate annual repair and maintenance expenses at approximately 10% of the machine's initial value. The formula to compute this cost is

$$Repair\ and\ Maintenance\ (R\&M) = \frac{10\ \times C}{100\ \times H}$$

Where, C = Initial cost of the machine, and H = Annual hours of use.

ii) Fuel costs

To estimate average fuel use for power equipment operating throughout the year—irrespective of the specific attachment—a general guideline based on engine type and power output can be applied

- 0.060 × maximum PTO horsepower for petrol engines
- 0.044 × maximum PTO horsepower for diesel engines

For 6.5 HP sprayer with petrol engine, the hourly fuel consumption comes to 0.39 gallon per hour, which is 1.48 litre per hour.

iii) Lubrication

On most farms, lubrication expenses typically amount to about 15% of the fuel expenditure. Therefore, after determining the hourly fuel cost, multiplying that figure by 0.15 provides a reasonable estimate for the hourly lubrication cost.

Table 9 summaries the cost estimation for repair and maintenance, fuel charges and lubrication costs for the power sprayer in our example.

Table 9: Hourly variable operating costs for power sprayers: repairs & maintenance, fuel, and lubrication

Equipment	Original purchase price (Rs.)	Repair and maintenance (Rs. /Yr.)	Repair and maintenance (Rs. / hr.)	Fuel consumption (L/hr.)	Fuel expense (Rs. /hr.) *	Lubrication cost (Rs. /hr.)
Power sprayer, 6.5 Hp	35,000	3,500	35.0	1.48	148.47	22.27

**Cost of petrol per litre @ Rs. 100.31 as on 01 June, 2024.*

iv) Operator cost

In performing custom work, the actual number of operators engaged for carrying out the operation is used for calculation of operator charges. The prevailing rate of wages is adopted for calculation.

$$\textit{Operator cost (Rs. /hr.)} = (\textit{Number of persons engaged} \times \textit{wages per day})/\ 8$$

In general, a minimum of 2 labour units is needed for the spraying operation. Based on field efficacy data, two labour units can manage to spray 5-8 kanals of apple orchard in a day depending on the volume of spray solution to be sprayed. It has been found that two labour units can manage to spray 200 L of spray solution per hour. Therefore, the actual requirement of labour for spraying apple orchards needs to be adjusted as per the orchard density, rootstock, and age which all cumulate to total volume of spray solution needed for spraying. Here, we classify the orchards in to two group- those that need < 200 L of spray solution per kanal and those that need 200 – 450 L per kanal.

Assuming labour charges @ Rs. 700 per unit for a working day of 8 hours and requirement of two labour units, the following calculations are made (Table 10).

Actual hours of labor usually exceed field machine time by 10 to 20 percent, because of travel and the time required to lubricate and service machines. Consequently, labor costs can be estimated by multiplying the labor wage rate times 1.1 or 1.2. We have taken the adjusted labour rates at 20% more than actual in the current analysis.

The calculations assume farm machinery is available in or nearby the orchard and water source is also available nearby.

Table 10: Labor Cost per Hour and per Unit Area for Power Sprayer Operations, Including Adjustments for Non-Field Time

Orchard type	Labour rate (Rs. / hr.)	Spray solution needed (L/ kanal)	Actual time required (hr./ kanal)	Area sprayed (kanal/ day)	Labour cost per unit area (Rs. /k)	Labour cost per unit area (Rs. /k) (adjusted)	Labour cost per unit time (adjusted) (Rs. /hr.)
Type-I	175.0	< 200	1	08	175.0	210.0	210.0
Type-II	175.0	200 to 450	2.25	3.55	393.75	472.5	210.0

Summary of Variable/ Operational Costs

The total operational costs per hour are given by the sum of costs associated with repair and maintenance, fuel, lubrication, and labor charges (Table 11).

Table 11: Summary of total variable/operational costs per hour for power sprayers, categorized by spray volume

Orchard type	Spray solution needed (L/kanal)	Repair and maintenance (Rs. /hr.)	Fuel expense (Rs. /hr.)	Lubrication cost (Rs. / hr.)	Labour cost per unit time (Rs. / hr.)	Total Variable Cost (Rs. /hr.)
Type-I	< 200	35.0	148.47	22.27	210.0	415.74
Type-II	200 to 450	35.0	148.47	22.27	210.0	415.74

c) Summary of operational costs

i) Total costs per operation

After all costs have been estimated, the total ownership cost per hour can be added to the operating cost per hour to calculate total cost per hour to own and operate the machine (Table 12).

Table 12: Summary of total cost to own and operate power sprayers per hour, categorized by spray volume

Orchard type	Spray solution needed (L/kanal)	Total fixed cost (Rs. /hr.)		Total variable cost (Rs. /hr.)	Total application costs (Rs. /hr.)	
		ASA&BE	Straight-Line		ASA&BE	Straight-Line
Type-I	< 200	46.82	52.67	415.74	462.56	515.23
Type-II	200 to 450	46.82	52.67	415.74	462.56	515.23

ii) Field capacity and cost of operation per unit area

Field capacity is given as area per unit time. The hourly work rate or field capacity of an implement or self-propelled machine can be estimated from the effective width of the machine (in feet), its speed across the field (in miles per hour), and its field efficiency (in percent). The field efficiency is a factor that adjusts for time lost due to turning at the end of the field, overlapping, adjusting the machine, and filling or emptying tanks and hoppers. Total cost per hour can be divided by the hourly work rate in kanals or acres per hour or tons per hour to calculate the total cost per acre or per ton.

Time required to complete unit area = 1/field capacity

As described previously, two labour units can manage to spray 5-8 kanals of apple orchard in a day depending on the volume of spray solution to be sprayed. Therefore, orchards are classified in to two group- those that need < 200 L of spray solution per kanal and those that need 200 – 450 L per kanal. Actual time required (hr./kanal) is 1 hr. for in the first case (< 200 L), and 2.25 hr. in the second case (200 – 450 L per kanal). Therefore, the total cost per operation can be calculated as follows:

Total cost of operation = combined total cost per hour × Number of hours per unit area

The summary of calculations for total application cost per kanal, categorized by spray volume is given table 13.

Table 13: Summary of total application cost per kanal, categorized by spray volume

Orchard type	Spray solution needed (L/kanal)	Total application costs (Rs. /hr.)		Field capacity (hr./kanal)	Total application costs (Rs. /kanal)	
		ASA&BE	Straight-Line		ASA&BE	Straight-Line
Type-I	< 200	462.56	515.23	01	462.56	515.23
Type-II	200 to 450	462.56	515.23	2.25	1040.76	1159.26

C) Cost of pesticide spray per kanal

Total fixed and variable costs are added to determine the combined total cost per hour of operating the machine. This should include the cost of pesticide material needed for spray. As the fixed costs are calculated using both the ASA&BE and Straight-Line methods, the final table of calculations is presented separately for calculations using the two methods. The variable costs for orchards requiring < 200 L and 200-450 L spray solution have adjusted accordingly for the orchard types in both the tables (Table 14 and 15).

Table 14: Final comprehensive cost of pesticide spray per kanal, including material and application, by orchard system and age group (fixed costs calculated by ASA&BE method)

S. No.	Insecticides	Orchard age (Yrs.)									
		Traditional orchards				High density			Medium density		
		1-5	5-10	10-20	>20	1-2	2-5	>5	1-2	2-5	>5
1.	Dimethoate 30 EC	507.6	537.6	582.6	1265.8	587.8	1228.3	1354.3	545.8	1207.3	1373.8
2.	Chlorpyriphos 20 EC	522.6	562.6	622.6	1340.8	629.6	1290.8	1458.8	573.6	1262.8	1484.8
3.	Quinalphos 25 EC	552.6	612.6	702.6	1490.8	713.1	1415.8	1667.8	629.1	1373.8	1706.8
4.	Thiacloprid 240 SC	547.0	603.4	687.8	1463.2	697.7	1392.8	1629.3	618.8	1353.3	1665.9
5.	Bifenthrin 8 SC	509.8	541.3	588.6	1277.0	594.1	1237.6	1369.9	550.0	1215.6	1390.4
6.	HMO dormant spray	642.6	762.6	942.6	1940.8	963.6	1790.8	2294.8	795.6	1706.8	2372.8
7.	HMO Summer Oil	507.6	537.6	582.6	1265.8	587.8	1228.3	1354.3	545.8	1207.3	1373.8
8.	Imidacloprid 17.8 SL	535.8	584.6	657.8	1406.8	666.3	1345.8	1550.7	598.0	1311.6	1582.4
9.	Thiamethoxam 25 WG	510.6	542.6	590.6	1280.8	596.2	1240.8	1375.2	551.4	1218.4	1396.0
10.	Chlorpyriphos 50% + Cypermethrin 5% EC	570.6	642.6	750.6	1580.8	763.2	1490.8	1793.2	662.4	1440.4	1840.0
11.	Thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC	525.0	566.6	629.0	1352.8	636.2	1300.8	1475.5	578.0	1271.6	1502.5
12.	Imidacloprid 6% + lambda cyhalothrin 4 % SL	525.6	567.6	630.6	1355.8	637.9	1303.3	1479.7	579.1	1273.9	1507.0
13.	Neem oil 1500 ppm	678.6	822.6	1038.6	2120.8	1063.8	1940.8	2545.6	862.2	1840.0	2639.2

Table 15: Final comprehensive cost of pesticide spray per kanal, including material and application, by orchard system and age group (fixed costs calculated by the Stright-Line method)

S. No.	Insecticides	Orchard age (Yrs.)									
		Traditional orchards				High density plantation			Medium density plantation		
		1-5	5-10	10-20	>20	1-2	2-5	>5	1-2	2-5	>5
1.	Dimethoate 30 EC	560.2	590.2	635.2	1384.3	640.5	1346.8	1472.8	598.5	1325.8	1492.3
2.	Chlorpyriphos 20 EC	575.2	615.2	675.2	1459.3	682.2	1409.3	1577.3	626.2	1381.3	1603.3
3.	Quinalphos 25 EC	605.2	665.2	755.2	1609.3	765.7	1534.3	1786.3	681.7	1492.3	1825.3
4.	Thiacloprid 240 SC	599.7	656.0	740.5	1581.7	750.4	1511.3	1747.8	671.5	1471.8	1784.4
5.	Bifenthrin 8 SC	562.5	594.0	641.2	1395.5	646.7	1356.1	1488.4	602.6	1334.1	1508.9
6.	HMO dormant spray	695.2	815.2	995.2	2059.3	1016.2	1909.3	2413.3	848.2	1825.3	2491.3
7.	HMO Summer Oil	560.2	590.2	635.2	1384.3	640.5	1346.8	1472.8	598.5	1325.8	1492.3
8.	Imidacloprid 17.8 SL	588.4	637.2	710.4	1525.3	719.0	1464.3	1669.2	650.7	1430.1	1700.9
9.	Thiamethoxam 25 WG	563.2	595.2	643.2	1399.3	648.8	1359.3	1493.7	604.0	1336.9	1514.5
10.	Chlorpyriphos 50% + Cypermethrin 5% EC	623.2	695.2	803.2	1699.3	815.8	1609.3	1911.7	715.0	1558.9	1958.5
11.	Thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC	577.6	619.2	681.6	1471.3	688.9	1419.3	1594.0	630.7	1390.1	1621.0
12.	Imidacloprid 6% + lambda cyhalothrin 4 % SL	578.2	620.2	683.2	1474.3	690.6	1421.8	1598.2	631.8	1392.4	1625.5
13.	Neem oil 1500 ppm	731.2	875.2	1091.2	2239.3	1116.4	2059.3	2664.1	914.8	1958.5	2757.7

Further Reading

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Annexure-I

For a 6.5 HP power sprayer (with 200 ft spray pipe, gun, and nozzles), the average economic life is taken 10 years. Spraying one kanal of orchard takes 60 minutes. Assuming 10 sprays per season and an average orchard size of 10 kanal, annual usage is estimated at 100 hours. Taking the original purchase price as Rs. 35,000.0 and Current list price as Rs. 33,000, the detailed calculations on depreciation over the life time are given in Table A1.

Table A1: Remaining salvage value and depreciation of power sprayers

Machine age (Years)	Remaining salvage value (%)	Salvage value (Rs.)	Total depreciation (Rs.)	Annual depreciation (Rs.)	Depreciation rate per hour of usage (Rs. /hr.)
1	65	21450	13550	1355	13.55
2	60	19800	15200	1520	15.2
3	56	18480	16520	1652	16.52
4	53	17490	17510	1751	17.51
5	50	16500	18500	1850	18.5
6	48	15840	19160	1916	19.16
7	46	15180	19820	1982	19.82
8	44	14520	20480	2048	20.48
9	42	13860	21140	2114	21.14
10	40	13200	21800	2180	21.8

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