

# Wind Machines Cost Analysis

cost records studied for effectiveness of machines in frost protection, operation and maintenance

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**Conflicting reports** on the effectiveness of wind machines—installed as a substitute for the artificial heating of citrus orchards—prompted a study of the efficiency of the machines, under Orange County conditions.

Cost records on 33 dual-propellered gasoline-motored wind machines in 21 different citrus orchards in Orange County were obtained for analysis.

The average coverage of each machine was estimated at 15 acres, although some were rated at 20 acres by the manufacturer.

The 33 machines were grouped according to the number of hours run during the frost season. The average cost of operation and depreciation in the 1948-49 season was \$7.94 per machine hour, or 70c per acre hour.

Over-all costs included fuel, oil, labor, repairs and depreciation. Average over-all costs for the 33 machines were computed by dividing the total costs for each item by the total number of hours run. The itemized costs and range of costs reported for each item are shown in the second following table.

The average operating cost was \$4.89 per machine hour and the range of operating costs was from \$2.93 to \$14.91 per

**The Average Costs for Various Hours of Operation**

Number wind machines	Number hours operated	Cost per machine hour	Cost per acre hour
11	75 or less	\$12.89	\$.85
9	76-120	8.93	.60
13	121-270	6.53	.45
33	Av. 113	Av. \$7.94	Av. \$.70

**Itemized Costs and Range of Costs**

	Average cost per machine hour	Range of costs reported per machine hour
Gasoline ..	\$2.81	\$1.47 to \$3.71
Oil .....	.09	.03 to .56
Labor .....	.94	.20 to 1.83
Repairs ...	1.05	0 to 7.46
<b>Total operating</b>	<b>4.89</b>	<b>2.93 to 14.91</b>
<b>Depreciation at 10%</b>	<b>3.05</b>	<b>1.33 to 8.00</b>
<b>Total cost</b>	<b>\$7.94</b>	<b>\$6.19 to \$18.31</b>

**Comparison of Fruit Grades According to the Number of Heaters per Acre**

Number of orchards	Number heaters per acre	Per cent fruit grades			
		1st grade	2d grade	Orchard run	Culls and by-products
8	0	35.2	14.1	4.1	46.6
2	3-6	42.3	19.0	24.3	14.3
5	10-12	58.2	3.2	7.7	30.8
4	30-50	55.7	20.2	2.4	21.7

hour. This wide range was due to the greater or lesser number of hours run by any given machine.

Depreciation was based on an average machine life of 10 years. The average depreciation charge was \$3.05 per machine hour, and the range varied from \$1.33 per hour for the machine that was operated 270 hours, to \$8.00 per hour for the machine operated only 60 hours during the season.

## Supplementary Heating

Sixteen orchards in the survey were equipped with supplementary heaters. The number varied from three to 50 heaters per acre.

Comparisons of fruit grades from the orchards in the survey were tabulated and grouped according to the number of heaters per acre, as shown in the table in columns two and three.

It may be concluded from the data and comparisons obtained that a few heaters per acre—in addition to the wind machines—provide better protection than where no supplemental heating is practiced. It appears that the use of 10 to 12 heaters per acre may be an optimum number for this purpose.

The heaters included in this survey were fired only on nights of lowest minimum temperatures. Most operators interviewed fired the heaters when the thermometer fell to 26 degrees.

## Comparisons Briefed

Nineteen orchards protected with wind machines and 19 unprotected orchards were paired for comparison with orchards in the same vicinity. A summary of the comparisons is stated briefly:

1. Of the 19 protected orchards, 14 reported more first-grade fruit than nearby unprotected orchards.

2. Eleven of the protected orchards reported less second-grade fruit than nearby unprotected orchards.

3. Twelve protected orchards reported less orchard-run fruit than nearby unprotected orchards.

4. Less cull and by-products fruit were reported by 15 of the 19 protected orchards than were reported by nearby unprotected orchards.

## Operational Facts

Some fundamental facts in connection with the use of wind machines—based on engineering research and field studies—are given below for the guidance of prospective users:

1. Wind machines do not create heat.

2. They help mix warm and cold air masses, such as stirring radiated heat from the ground through the trees and orchard.

3. The machines hasten the drying of foliage and fruit on damp nights, thus reducing the susceptibility to freezing.

4. Wind machines usually are effective without supplementary heating during nights of temperature inversion ceiling.

5. Wind machines are limited in their area of influence. The tendency often is to over-rate their area of protection.

6. Heat radiation from the earth on cold nights is greatest from soils that are compact or noncultivated; less from loose or cultivated soils, and least from soils with covercrops.

Citrus growers and operators of wind machines should understand these fundamentals. It will help them make adjustments in their orchard operations that should result in more efficient and more economical frost protection.

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