AN ECONOMIC ANALYSIS OF ALTERNATIVE
HOLDING CONDITIONS FOR EGGS

By

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AN ECONOMIC ANALYSIS OF ALTERNATIVE

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CHAPTER I

INTRODUCTION

General Problem

The Oklahoma egg industry is undergoing a transition from producing and marketing eggs on a current receipt basis to a system requiring that eggs be graded according to U.S. Standards and Grades. The mandatory egg law for Oklahoma became effective November 1, 1957. Complying with the new law means drastic changes and some reorganization on the part of producers as emphasis is placed on grade, with quality control at the producer level conditioning returns.

At the retail and farm levels, eggs are classified and priced relative to interior quality. Therefore, net returns to egg producers are conditioned by the quality of eggs delivered to the egg handler. Decisions relating to such practices as source of stock, confinement to the laying house, nutrition, disease prevention, number of nests and type of nesting material, frequency of gathering eggs, cooling and holding conditions and frequency of marketing, may affect the quality of eggs delivered by the producer and, therefore, affect returns that accrue to the resources employed in production.

The interior quality of an egg is at its maximum when first laid. Thereafter the rate of deterioration depends upon the care and environmental conditions that prevail. Other things being equal, artificial egg cooling and frequency of marketing are of special importance to the maintenance of egg quality.

Grade A eggs sell for a higher price during the warm summer months because of the comparatively short supply relative to this quality. Although the total supply of all eggs during these summer months is ample, normal high temperatures generally reduce egg quality and result in greater proportionate supplies of Grades B and C than in other seasons. During the fall months, Grade A prices normally continue high as the result of lower total egg supplies. The price spreads between grades of eggs are greater during these same summer and fall months than for the remainder of the year. During the winter and spring seasons, egg production is at the seasonal peak. Grade A is in ample supply at a lower price and the price spreads between grades are less than for other seasons.

Given this setting regarding the pricing and production of eggs, this study is concerned with an economic analysis of alternatives for maintaining egg quality at the producer level. Since the holding condition is one of the most important factors affecting summer egg quality, technical and economic information relative to alternative holding conditions are essential for decision making at the producer level. This presents a problem of determining the economic consequences of alternative holding conditions and frequency of marketing so that the producer may make choices consistent with his goal.

Particular Problem

It was estimated that 90 percent of Oklahoma egg producers were small flock owners with 150 hens or less in 1956. This small flock size does not lend itself economically to the production and marketing of high quality eggs. Increasing flock size to a level that is economically efficient is only one of the many adjustments which can be made by the producer if he is to maximize the returns to the resources utilized in poultry production.

In adjusting to the emphasis on quality, there is a good possibility that costly errors may be made if producers install egg coolers. Some of these errors may include improper size, improper construction, or improper location of the cooler. An egg cooler, too large or too small, for the quantity of eggs to be cooled can result in excessive costs.

Within this framework the objective of this study is to provide Oklahoma egg producers with technical and economic information necessary for selection of the optimum type of holding condition. In developing this information the following problem areas are delineated:

1. To determine percent of Grade A eggs marketed under natural-holding conditions.

2. To determine the impact of artificial-holding conditions on egg quality.

3. To determine the impact of days held on quality under different holding conditions.

4. To estimate costs associated with alternative holding conditions under three price levels.

5. To estimate returns associated with alternative holding conditions under three price levels.

6. To determine the optimum holding and marketing practice to maximize returns from egg sales under alternative prices.

CHAPTER II

REVIEW OF LITERATURE

Temperature

Considerable research has been done relative to range of temperature suitable for cooling and holding eggs at the farm level. There appears to be general agreement that 55° to 60° F. provides adequate protection to egg quality for one to seven days. These temperatures reduce egg sweating to a minimum - a serious problem under extreme conditions when eggs are removed from the cooler for transportation to market.

Jensen and Stadelman[1] found that eggs refrigerated at 30° to 38° F. for more than a week had essentially the same quality as when they were placed in storage. They also found that a rapid decline in egg quality occurred during the normal marketing procedure. This decline was closely associated with the temperature of egg holding rooms.

Dawson and Hall[2] found that the greatest decline in albumen quality occurred during the first three days, regardless of temperature. Temperatures of 60° F. or lower were found to be practical for normal farm holding of eggs.

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[1] L. S. Jensen and W. F. Stadelman, "A Study of Egg Quality in Market Channels," Poultry Science 31:772-776, 1952.

[2] L. E. Dawson and C. W. Hall, "Relationship Between Rate of Cooling, Holding Container and Egg Albumen Quality," Poultry Science 33:624-628,

In a study of egg quality on thirty-eight poultry ranches in California, Lorenz and Newlon[3] found that egg room temperatures and frequency of marketing were important factors affecting egg quality.

Henderson[4] discovered that albumen quality decreased more in four days at 80° F than in ten days at 65° F. He found that a day or two at 100° F. produced flatter yolks than several months of cold storage at 34° to 38° F.

Fry of Oklahoma[5] reported deterioration of 15 Haugh units when eggs were held at 60° F. for seven days. When held at 60° F. for seven days, newly laid eggs with an initial Interior Quality of 94 or above would still be AA and those eggs with initial Interior Quality of 70 or above would still be Grade A.

Humidity

All reports generally agree that relative humidity of 80 percent or higher is necessary for maintaining egg quality if stored for an extended period. However, where eggs are marketed twice or more weekly, there is some difference of opinion as to the importance of relative humidity. General recommendations were that relative humidity at the farm level should be 65 percent or higher.

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[3] F. W. Lorenz and W. E. Newlon, "A Field Survey of Ranch Egg Quality," Poultry Science 23:418-430, 1944.

[4] S. M. Henderson, "Cooling and Holding Eggs on the Ranch," California Agricultural Experiment Station Circular 405.

[5] Jack L. Fry, Management and Holding Conditions As They Affect the Interior Quality of Eggs, (unpub. M.S. Thesis, Oklahoma State University, 1956).

For shorter holding periods, a week or less, humidity had little influence on albumen deterioration according to Funk[6], but did affect the amount of evaporation. Satisfactory results were obtained during short holding periods by Van Wagenen et al.[7] when the relative humidity was approximately 60 percent.

Jeffrey and Durago[8] found that relative humidities of 78 to 98 percent for winter temperatures and 62 to 93 percent for summer temperatures had no effect on the interior quality as measured by the height of the thick albumen.

Cost Data

Cost data for cooling and holding eggs at the farm level are limited. The same is true for returns resulting from providing proper egg holding facilities.

Jaska of Texas[9] reported amount of electricity used for cooling eggs on twelve Texas farms involving 17,462 cases of eggs. The KWH per case varied from 1.2 to 11.5, with an average use of 1.8 KWH. The associated costs were 5.4 cents per case or less than 0.2 cents per dozen.

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[6] E. M. Funk, Effects of Temperature and Humidity on the Keeping Quality of Shell Eggs, University of Missouri Agricultural Research Bulletin 382, 1944.

[7] A. Van Wagenen, C. O. Hall and H. Altmann, "Temperature and Humidity in the Short-Run Holding of Eggs," Proc. Seventh World's Poultry Congress 6:516-521.

[8] F. P. Jeffrey and V. Darago, Effect of High Humidity on Egg Quality During Short Holding Periods, New Jersey Agricultural Experiment Station Bulletin No. 692, 1940.

[9] Robert C. Jaska, What's New in Egg Cooling, Report to A.S.A.E., Texas A. and M., 1954.

CHAPTER III

EXPERIMENTAL PROCEDURE

To generate the necessary data for this study, a cooperative project was developed between the Department of Poultry Science and the Department of Agricultural Engineering at the Oklahoma Experiment Station. The experiment was designed to test a seven and a twenty-five case egg cooler. The test, covering a period of one year, was initiated to determine the effect on cost and returns of mechanical refrigeration compared with non-refrigeration and evaporative cooling. The period for comparison of refrigeration and non-refrigeration was identified as the seven months, September through March. The period for comparison of refrigerated and evaporative cooling was the five month period, April through August.

The two egg coolers were placed in operation and treatments started December 1, 1955. The seven-case cooler was located in the poultry farm egg room and the twenty-five case cooler in a feed room. The temperature in both coolers was approximately 60° F. throughout the experiment and relative humidity was approximately 65 percent.

The eggs receiving non-refrigerated treatment and held in the egg handling room were cooled by a small evaporative unit. The average of daily maximum temperatures in this egg handling room for the period April 1 to August 31 was 88.2° F., with a range from 77.5° F. to 94.6° F.

During the five month period, June through October, 1956, all eggs were weighed as they were placed in the two coolers. Through use of watt hour meeters installed by the Agricultural Engineering Department, the KWH of electricity used were recorded for each cooler.

Eggs for the project were gathered in wire baskets four times daily from the Experiment Station Poultry Farm and placed immediately in their respective assigned experimental areas. The eggs remained in wire baskets overnight for the removal of body heat and were then placed in egg cases until shipment to market weekly. Mechanically refrigerated eggs and non-refrigerated eggs were identified separately until after they had been graded. Grading was done by a commercial egg handler according to U. S. Standards and Grades.[1] Egg candling slips identifying treatment, grade and price per dozen were provided following each delivery.

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[1]Brentwood Egg Company, Tulsa, Oklahoma.

CHAPTER IV

IMPACT OF DAYS HELD

Egg quality deterioration based on days held at the farm level was found to be closely associated with egg holding temperatures.[1] Knowledge on the part of the producer as to the effect of time on egg quality reduction in relation to holding conditions, may materially assist in maximizing returns. Also, frequency of marketing, as a factor in determining the percentage of Grade A eggs, is extremely important in a production program. Higher relative prices for Grade A eggs give producers an economic incentive to organize production and marketing programs whereby they can maintain a fairly constant supply of Grade A eggs regardless of season or natural temperature and humidity.

Data from two sources were used to investigate this problem. Fry made a study of the change in egg quality measured in Haugh Units[3] per day up to seven days and at selected temperatures. The newly laid eggs used by Fry in his experiment averaged 90 Haugh Units.[4] At 60° F., according to Fry, there was a deterioration of 10 Haugh Units during the

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[1] Lorenz and Nelson, 418-430.

[2] Fry.

[3] R. R. Haugh, U. S. Egg and Poultry Magazine 43:552-555.

[4] It is universally agreed that eggs with thick white measuring 78 or more Haugh Units are Grade AA eggs and from 55 to 78 Haugh Units are Grade A eggs. Important to the expected initial Haugh Units of the production from a given flock is the period of time the hens have been in production. Pullet eggs generally are known to have the highest number of Haugh Units.

first two days and an additional five Haugh Units from the third to seventh days, inclusive. In this instance, it was evident that newly laid eggs stored at 60° F. remain within the upper Grade A classification up to and including the seventh day.

In the above experiment, eggs held for two days at 90° F. deteriorated 22 Haugh Units and eggs held five days deteriorated 35 Haugh Units. Eggs held for three days at 90° F. were no longer Grade AA. At the end of five days, these eggs were at the breaking point in Haugh Units between Grade A and Grade B (Figure 1). Quality reduction from one grade to another, measured in Haugh Units, is identified on the graph.

Jaska[5] reported on 644 cases of eggs from the Lindsey farm produced during the months of April through July. These eggs were stored under holding conditions, identified as mechanical refrigeration, evaporative cooling and natural. The eggs were marketed on schedules of 1-day, 2-days, 3-days and 6-days. The average temperature for mechanical refrigeration was 52.3° F. with a relative humidity of 80.4 percent; for the evaporative cooler, the average temperature was 74.2° F. with a relative humidity of 79.7 percent; and for natural holding conditions, the average room temperature was 77.3° F., with a relative humidity of 71.3 percent.

The percentage of Grade A eggs for each holding condition and the days held, as determined from the Jaska report, are shown in Table I.

The impact of days held on Grade A percentages in these Texas data further emphasizes the importance of frequent marketings. The percentage decline in Grade A eggs for the two-day holding and the following four

[5]Robert C. Jaska.

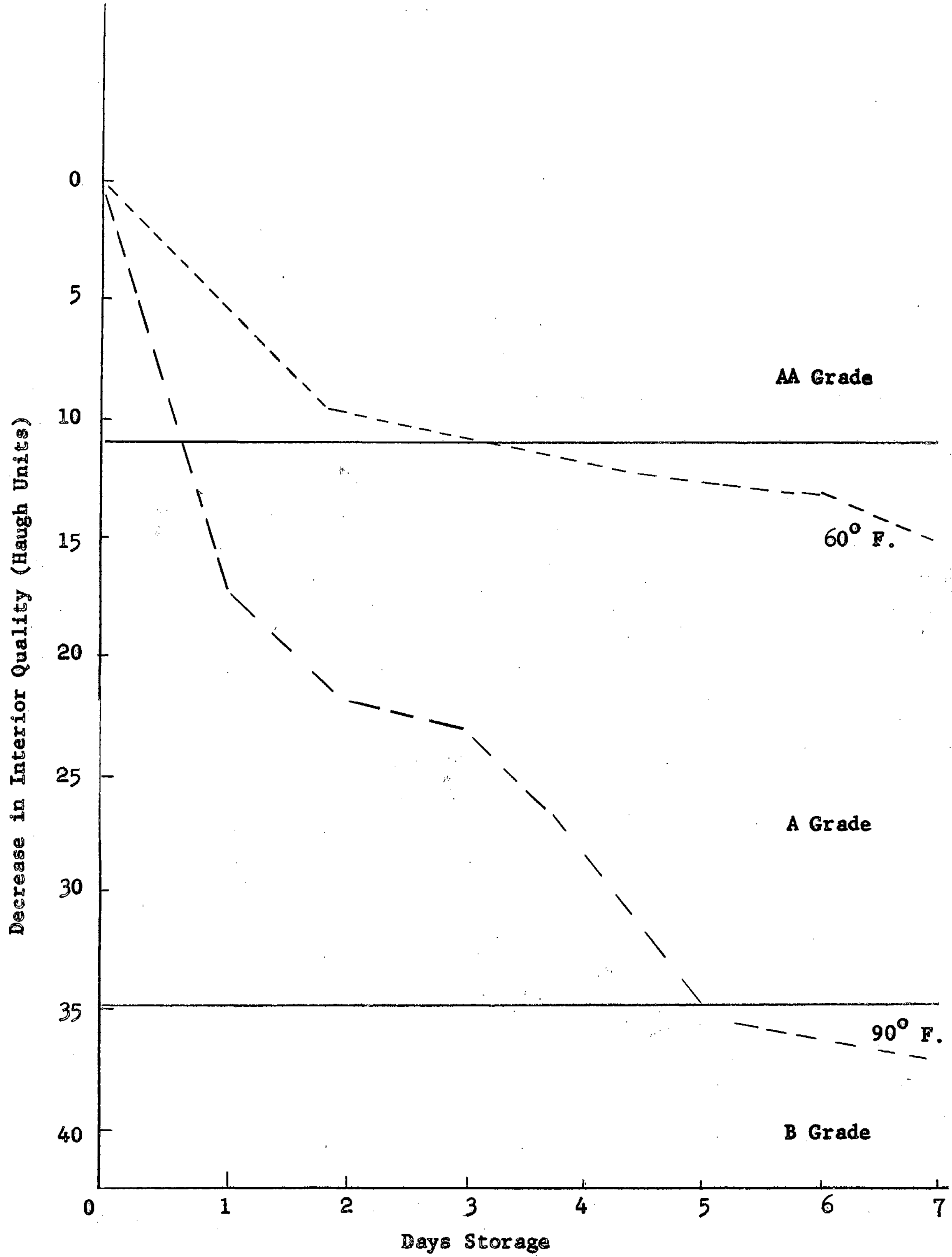

Figure 1. Decrease in Egg Quality, Measured in Haugh Units, for Storage at 60° and 90° F, by Days

days holding for refrigeration were 6 percent and 4 percent, respectively; for evaporative cooling, 7 percent and 25 percent; for natural conditions, 11 percent and 26 percent, respectively. Figure 2 provides a comparison of Grade A egg percentages for days held under the different holding conditions. In six days Grade A eggs declined 10 percentage points under mechanical refrigeration; 32 percentage points under evaporative cooling; and 37 percentage points under natural conditions.

TABLE I

PERCENT GRADE A EGGS UNDER DIFFERENT HOLDING CONDITIONS AND DAYS HELD

Holding conditions	1-day	2-days	3-days	6-days
		(Percentage)		
Mechanical	93.0	87.2	86.1	83.0
Evaporative	80.0	72.6	67.0	48.2
Natural	70.0	59.5	50.5	33.4

Regardless of holding condition, it was found that high frequency of marketing was very important to the producer, if a maximum percentage of Grade A eggs is to be placed on the market. The 90° F. temperature used in the Fry experiment was reached, or exceeded considerably, in Oklahoma during the high temperature months. With egg quality reduced to Grade B in five days when held under high temperature conditions, it is mandatory that the producer choose some type of artificial holding condition in order to realize the greatest returns.

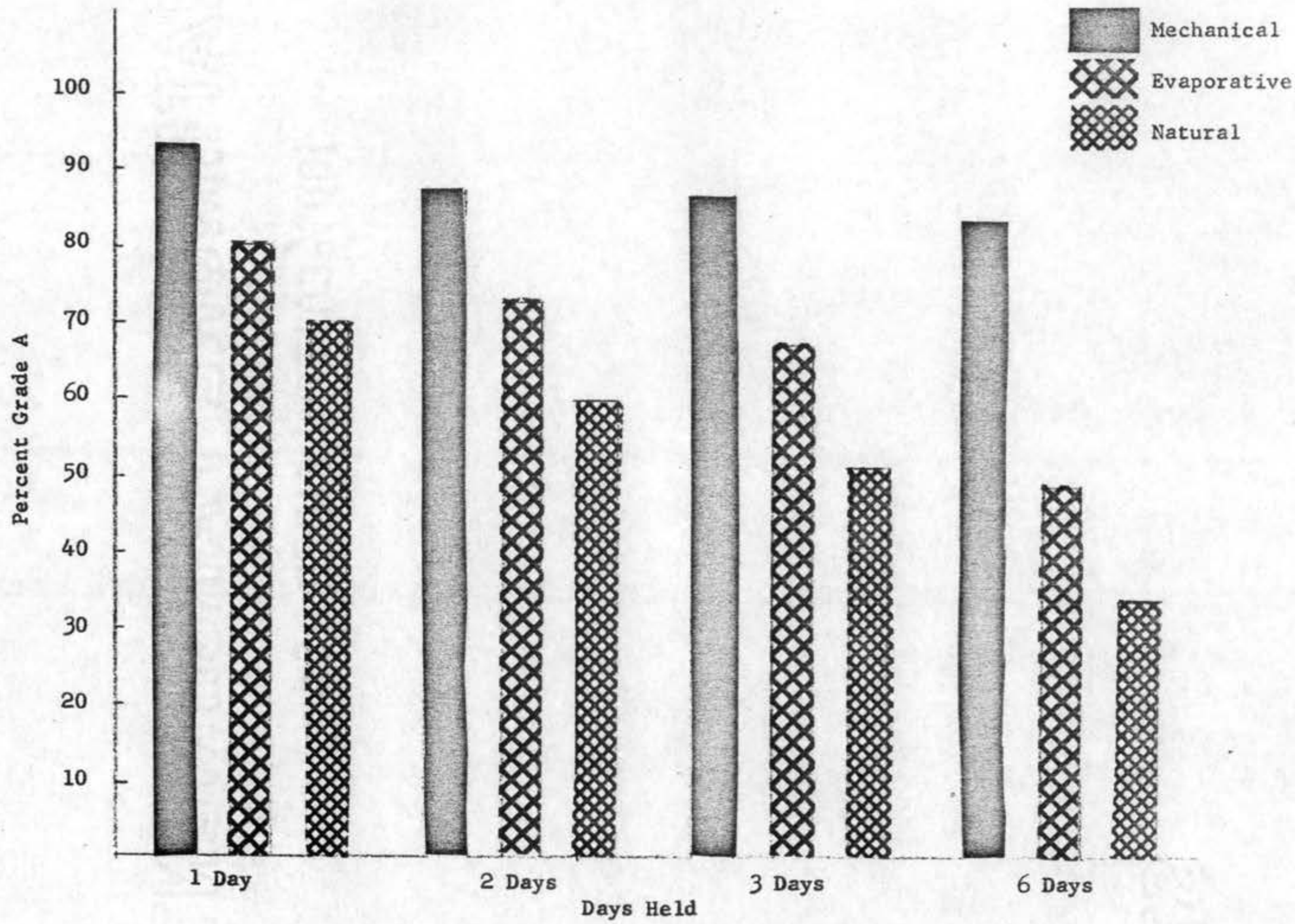

Figure 2. Percentage of Grade A Eggs When Held One, Two, Three and Six Days Under Different Holding Conditions, Texas Data, 1954

CHAPTER V

IMPACT OF HOLDING CONDITIONS

Holding condition environments and time periods for this study included mechanical refrigeration, 12 months; evaporative cooling, April through August; and natural conditions, April through July. The average temperatures for mechanical refrigeration, evaporative cooling and natural conditions were 60°, 73.8° and 77.3° F., respectively. The average humidities for these three types of holding conditions were 65.0, 74.7, and 71.3 percent, respectively.

Eggs held under mechanical refrigeration for the 12 months period yielded 87.76 percent Grade A, 5.97 percent Grade B and 4.27 percent Grade C (Table II). For the seven-month period, September through March, eggs held under refrigeration were 92.53 percent Grade A, 4.53 percent Grade B and 2.94 percent Grade C. Eggs held under mechanical refrigeration for the higher temperature months of April through August were 85.92 percent Grade A, 7.98 percent Grade B and 6.10 percent Grade C. During the four-month period, April through July, eggs held in mechanical refrigeration were 86.42 percent Grade A, 8.22 percent Grade B and 5.36 percent Grade C.

Although evaporative cooler data were reported by Oklahoma for the months of April through July, they were not used in this study because the evaporative cooling unit was faulty and operated at irregular intervals. To estimate the impact of evaporative cooling on egg quality during the higher temperature months, data were used from a study in Texas for

TABLE II

GRADE DISTRIBUTION OF EGGS FROM DIFFERENT HOLDING CONDITIONS

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						(Percentage)						
<u>Refrigerated</u>												
Grade A	93.60	93.70	87.18	91.32	82.78	86.27	85.46	83.95	92.25	91.86	94.98	94.57
Grade B	3.07	3.56	7.59	5.09	9.79	7.24	10.66	6.99	6.85	5.83	1.69	2.97
Grade C	3.32	2.73	5.21	3.57	7.41	6.49	3.85	9.07	1.17	2.29	3.31	2.45
<u>Non-Refrigerated</u>												
Grade A	86.52	86.15	88.55	63.40*	55.50*	40.70*	33.30*	52.64	90.53	91.86	88.12	85.83
Grade B	6.12	6.21	6.26	18.60*	24.00*	20.30*	20.70*	18.31	2.88	4.49	5.31	6.13
Grade C	7.35	7.62	5.17	18.00*	20.50*	39.00*	46.00*	29.04	6.58	3.65	6.56	8.10
<u>Natural</u>												
Grade A				46.50*	40.80*	27.20*	19.30*					
Grade B				27.50*	34.20*	24.20*	25.00*					
Grade C				26.00*	25.00*	48.60*	55.70*					

*Texas Data (1954).

the months of April through July and from the Oklahoma experiment for the month of August only. This provided five months of evaporative cooler data for comparison purposes. Since the Texas data provided Grade A percentages only, the percentages of Grades B and C were estimated for the four months of April through July. These estimates were based on expected percentages of Grades B and C as related to temperature conditions prevalent during these months when eggs were marketed weekly.

These eggs are identified with non-refrigeration for the months of April through August (Table II). Eggs held under evaporative cooling during this five-month period were distributed as follows: 49.1 percent Grade A; 20.4 percent Grade B; and 30.5 percent Grade C.

Under the comparative returns analysis section, all eggs held under evaporative cooling for the five months, April through August, were considered to be Grade A and B only. This provided basic data to complete alternative costs and returns. This was necessary to secure comparableness since only Grade A percentages were reported in the Texas data.

The Texas study reported percentages only for Grade A under natural conditions and provided data for comparison purposes for the four-months period, April through July. Distribution of Grades B and C were estimated on the basis of weekly marketings for prevailing temperatures and grade relationships during these four months. The grade distribution percentages for all eggs held under natural conditions for the four-month period were 33.39 percent Grade A; 27.79 percent Grade B; and 38.82 percent Grade C. The data on Grade A egg percentages relative to holding condition indicates that holding conditions may become highly important for some periods and relatively unimportant for other periods. In the experiment, mechanical refrigeration and evaporative cooling for the months of April through August for Grade A distribution percentages were 85.92 percent and 49.1 percent, respectively. It was further evident from this comparison that evaporative cooling during this period was not as satisfactory as mechanical refrigeration (Table II).

The advantage measured in terms of sustained quality were 86.42 percent Grade A for mechanical refrigeration compared with 33.39 percent Grade A for natural holding conditions during the period, April through July (Table II). This was a difference of 53 percentage points. The percentage of Grade A eggs under natural conditions was very low. It is doubtful that marketing firms would find it profitable to candle and grade eggs with such a low expected percentage of Grade A eggs.

The comparison of evaporative cooling and natural conditions for the same period, April through July, resulted in a slight gain in Grade A eggs. The percentage of Grade A eggs was 48.2 percent with the use of evaporative cooling compared with 33.39 percent for natural conditions. Although evaporative cooling provided less protection to egg quality than did mechanical refrigeration, it was an improvement over natural holding conditions.

A comparison can be made with the data taken from Table II regarding refrigeration compared with non-refrigeration or natural conditions for the seven-month period, September through March. The Grade A percentages for all eggs held and marketed weekly for this period were 92.53 percent from mechanical refrigeration compared with 88.24 percent from natural conditions. Although there were only 4.3 percentage points in favor of mechanical refrigeration, both percentages were relatively high. It is important to point out that eggs held under natural conditions in the experiment during these cooler months were located to take advantage of the natural holding temperatures which prevailed. Natural holding conditions during these cooler months can be modified and arranged to assure a greater utilization of the lower natural temperatures by most producers.

CHAPTER VI

TECHNICAL ENERGY REQUIREMENTS UNDER ALTERNATIVE TYPES OF HOLDING CONDITIONS

Two egg coolers were designed, constructed and placed in operation at the Oklahoma Experiment Station poultry farm. The 7-case cooler was designed to hold the eggs of a flock approximately 400 laying hens when marketing weekly, or approximately 800 laying hens when marketing eggs twice weekly. The 25-case cooler was designed to hold the eggs for a producer with a flock of approximately 1200 laying hens when marketing weekly, or approximately 2400 laying hens when marketing eggs twice weekly.

A cooling unit rated at 1/3 hp was installed in the 7-case cooler. A 1/2 hp unit was used in the 25-case cooler. Both cooling units were standard household air-conditioners and thermostats were reset to operate the units at lower temperatures (60° F.). According to the Agricultural Engineering Report, the 1/3 hp unit was oversized since it operated during the peak summer temperatures in the 7-case cooler less than one-half time.[1] On the other hand, the 1/2 hp cooling unit in the 25-case cooler would occasionally, during hot weather, operate continuously for two or three hours. However, in view of its performance, this unit was not under rated.

Instruments attached to each egg cooler continuously recorded temperature and humidity during the course of the experiment. It was found

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[1] G. L Nelson, "Results from Research on Farm Egg Coolers," (presented at "Electric Power for Quality Eggs" Short-Course, May 23, 1957, Stillwater, Oklahoma).

that the temperature in the 7-case cooler varied between 58° and 60°F. and in the 25-case cooler, between 58° and 61° F.

The relative humidity generally ranged between 65 and 70 percent in the 7-case cooler and from 55 to 70 percent in the 25-case cooler. Water filled pans were employed in both cabinets to help maintain a satisfactory humidity level. Without these pans, lower humidities would have prevailed in both units.

Energy Requirements for Refrigeration

Energy used by each of the egg coolers was metered during the months of July through October, 1956. Based on these energy use data, data on daily egg loading rate, and data on temperature difference between the coolers and the surrounding air, the Agricultural Engineering Department developed an energy use expression. The expression was as follows:

$Q = (C_e \rho \Delta t_c) + (U_m \lambda \Delta t_c \times 24)$ Heat/24 hours.

Q = Energy use by cooler per 24 hour period in BTU.

C_e = Specific heat of eggs placed in cooler.

= 0.772 BTU/pound eggs/degree F.

ρ = Weight of eggs placed in cooler/24 hour period.

Δt_c = Difference in temperature (°F) between eggs and cooler.

This portion of the expression determined the energy used in BTU to bring egg temperature down to that of the cooler and may be expressed as follows: (0.772 x Egg weight x temperature difference).

U_m = Mean insulative value for the cooler.

= 0.0893 for the 7-case cooler. (Values obtained by use of "heat flow" meter.)

= 0.867 for the 25-case cooler.

λ = Cooler square feet of surface area.

= 68.56 square feet for the 7-case cooler.

= 220 square feet for the 25-case cooler.

t_c = Temperature difference between cooler and surrounding air.

This portion of the expression determined the energy used per 24 hour period in BTU due to heat transfer and may be expressed as follows: ($24 \times U_m$ value x square feet of surface x temperature difference).

In terms of BTU per KWH, 3,412 BTU per KWH were used for conversion since all cost data were reported per KWH.

According to the agricultural engineers, the efficiency value of refrigeration units are influenced by the quality of the equipment in use, the conditions under which it operates and the voltage. The engineers suggested that an assumed efficiency value of 26 percent be applied to the energy use data. This value represents the efficiency rate which would be found under practical producer circumstances. It was assumed in the experiment that little loss of energy occurred through the cooler floors since normal soil temperature was reported to be between 57° and 63° F.

A constant temperature of 60° F. within the coolers, a constant temperature of 95° F. for eggs placed in the coolers and a constant egg weight of one and one half pounds per dozen were also assumed to determine energy used.

Energy consumed per dozen eggs was determined for various daily loading rates with the outside average temperature equal to the constant temperature of the egg coolers and 10°, 20°, and 30° F. above constant temperature of the egg coolers (Table III). When the outside temperature

TABLE III

KWH OF ENERGY REQUIRED PER DOZEN EGGS AT DIFFERENT LOADING RATES FOR OUTSIDE TEMPERATURES OF 60°, 70°, 80° and 90° F., USING THE 7-CASE COOLER

Dozens	Lbs.	60° Total	60° Per Dozen	70° Total	70° Per Dozen	80° Total	80° Per Dozen	90° Total	90° Per Dozen
		(KWH)							
5	7.5	0.212	0.042	1.869	0.373	3.523	0.704	5.18	1.03
10	15	0.426	0.042	2.084	0.208	3.738	0.373	5.39	0.539
20	30	0.853	0.042	2.507	0.125	4.16	0.208	5.82	0.291
30	45	1.280	0.042	2.934	0.097	4.59	0.153	6.25	0.208
50	75	2.134	0.042	3.788	0.075	5.44	0.108	7.10	0.144
60	90	2.561	0.042	4.21	0.070	5.87	0.097	7.50	0.125

was 60° F., the KWH of electricity required per dozen eggs was 0.042 for all daily loading rate. No heat transfer occurred. Additional energy was required, because of transfer heat, when the outside temperature exceeded that of the cooler. For example, 30 dozen eggs entered daily with the outside temperature at 70° F., required 0.097 KWH per dozen eggs compared with 0.042 when there was no heat transfer. However, the same quantity of eggs entered at 90° F. required 0.208 KWH per dozen or approximately five times the amount of energy where there was no heat transfer.

The energy use data generated in Table III are presented for comparison purposes in Figures 3 and 4 in order to extrapolate energy requirements per dozen eggs under alternative temperature and loading rate situations. Energy required per dozen eggs cooled and held for different outside temperatures up to 90° F., daily loading rates up to 30 dozens with weekly marketing are correlated in Figure 3. Twice weekly marketing, daily loading rates up to 60 dozens with the same temperature limitations are related in Figure 4. As the daily loading rate was increased under each of the marketing schedules, all other factors being equal, the energy requirement per dozen eggs decreased. For example, 10 dozen eggs entered daily for weekly marketing, with an outside temperature at 80° F. used 0.373 KWH per dozen eggs (Figure 3). When 30 dozen eggs were entered daily, under the same conditions, the energy requirement was reduced to 0.153 KWH per dozen. Maximum use of the 7-case cooler for twice weekly marketing, with 60 dozens entered daily at an outside temperature of 80° F., required 0.125 KWH of energy (Figure 4).

Energy used per dozen eggs entered daily in the 25-case cooler decreased as the quantity of eggs was increased to maximum capacity of

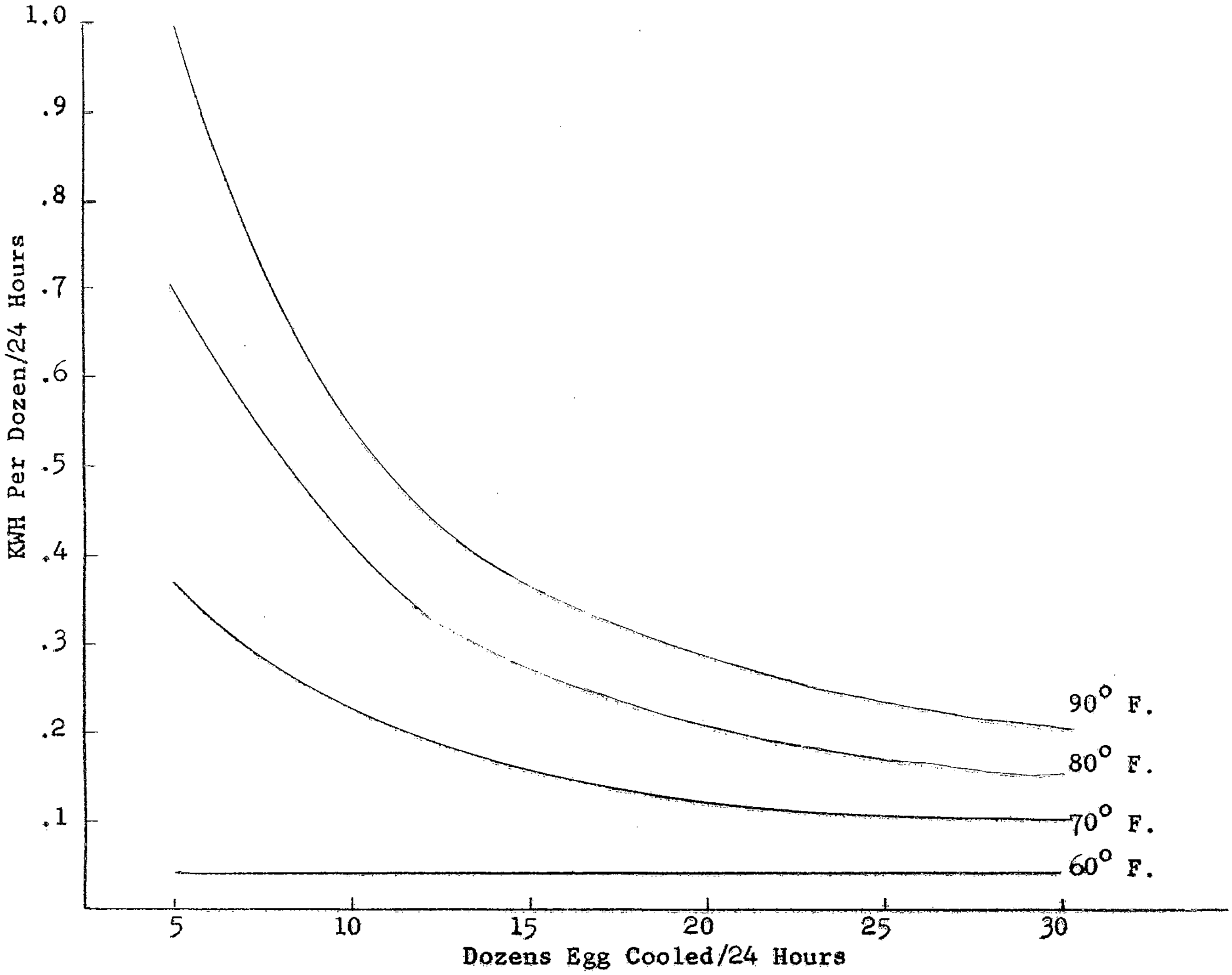

Figure 3. Unit Energy Use By 1/3 hp Mechanical Cooling Unit at 70°, 80° and 90° F. in 7-Case Cooler - Weekly Marketing

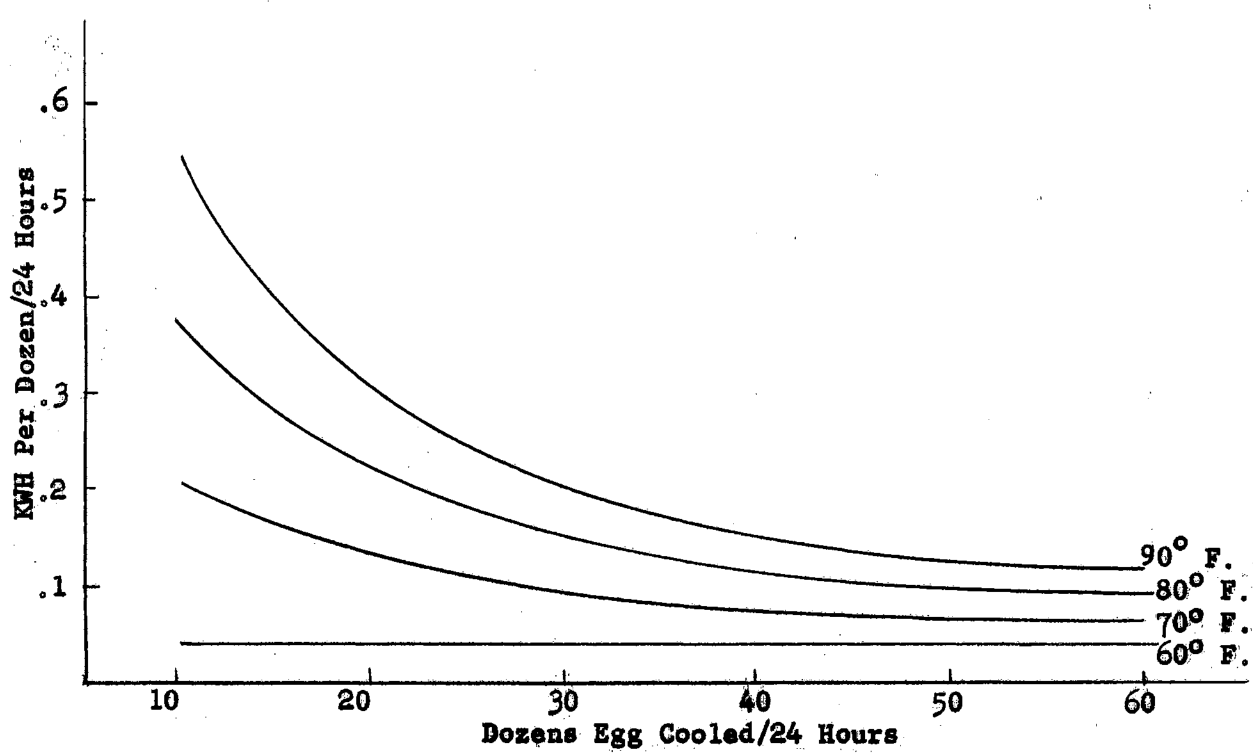

Figure 4. Unit Energy Use by 1/3 hp Mechanical Cooling Unit at 70°, 80° and 90° F. in 7-Case Cooler - Twice Per Week Marketings

the cooler. The average daily capacity was based upon the marketing schedule. For the 25-case cooler for weekly marketing, the average daily capacity was 107 dozen eggs and was 214 dozens daily for twice weekly marketing (Table IV). Energy required per dozen was reduced as the quantity of eggs increased. The extremes of energy used per dozen eggs, based on daily egg loading rates, were 1.6 KWH for 10 dozen compared with 0.113 KWH for 220 dozens.

The data in Table IV are presented for comparison purposes in Figures 5 and 6 in order to extrapolate energy requirements per dozen eggs under alternative temperature and loading rate situations. Energy required per dozen eggs cooled and held at different outside temperatures up to 90° F., with daily loading rates up to 110 dozens with a weekly marketing schedule are related in Figure 5. Twice weekly marketing, daily loading rates up to 60 dozen with the same temperature limitations are related in Figure 5. Energy required per dozen eggs at any given outside temperature was minimized when the cooler was used to capacity on a twice weekly marketing schedule.

Figures 3 and 4 for the 7-case cooler and Figures 5 and 6 for the 25-case cooler may be used to estimate KWH requirements per dozen eggs entered each 24 hour period up to capacity use, either for weekly or twice weekly marketing, and for temperatures ranging from 60° to 90° F. In order for a producer to minimize costs and maximize returns, it is important that the cooler be of proper size in relation to the size of flock. Through capacity use of either cooler with twice weekly marketing, costs may be still further reduced and returns increased.

TABLE IV

KWH OF ENERGY REQUIRED PER DOZEN EGGS AT DIFFERENT LOADING RATES FOR OUTSIDE TEMPERATURES OF 60°, 70°, 80° AND 90° F., USING THE 25-CASE COOLER

Dozens	Lbs.	60°		70°		80°		90°	
		Total	Per Dozen	Total	Per Dozen	Total	Per Dozen	Total	Per Dozen
					(KWH)				
10	15	0.42	0.042	5.6	0.5	10.8	1.08	16.0	1.6
20	30	0.84	0.042	6.03	0.301	11.23	0.561	16.46	0.823
35	52.5	1.49	0.042	6.7	0.190	11.9	0.340	17.0	0.485
70	105	2.96	0.042	8.19	0.117	13.38	0.191	18.57	0.265
110	165	4.69	0.042	9.9	0.09	15.1	0.137	20.3	0.184
170	255	7.23	0.042	12.46	0.0732	17.6	0.10	22.8	0.134
220	330	9.38	0.042	14.57	0.0662	19.8	0.090	25.0	0.113

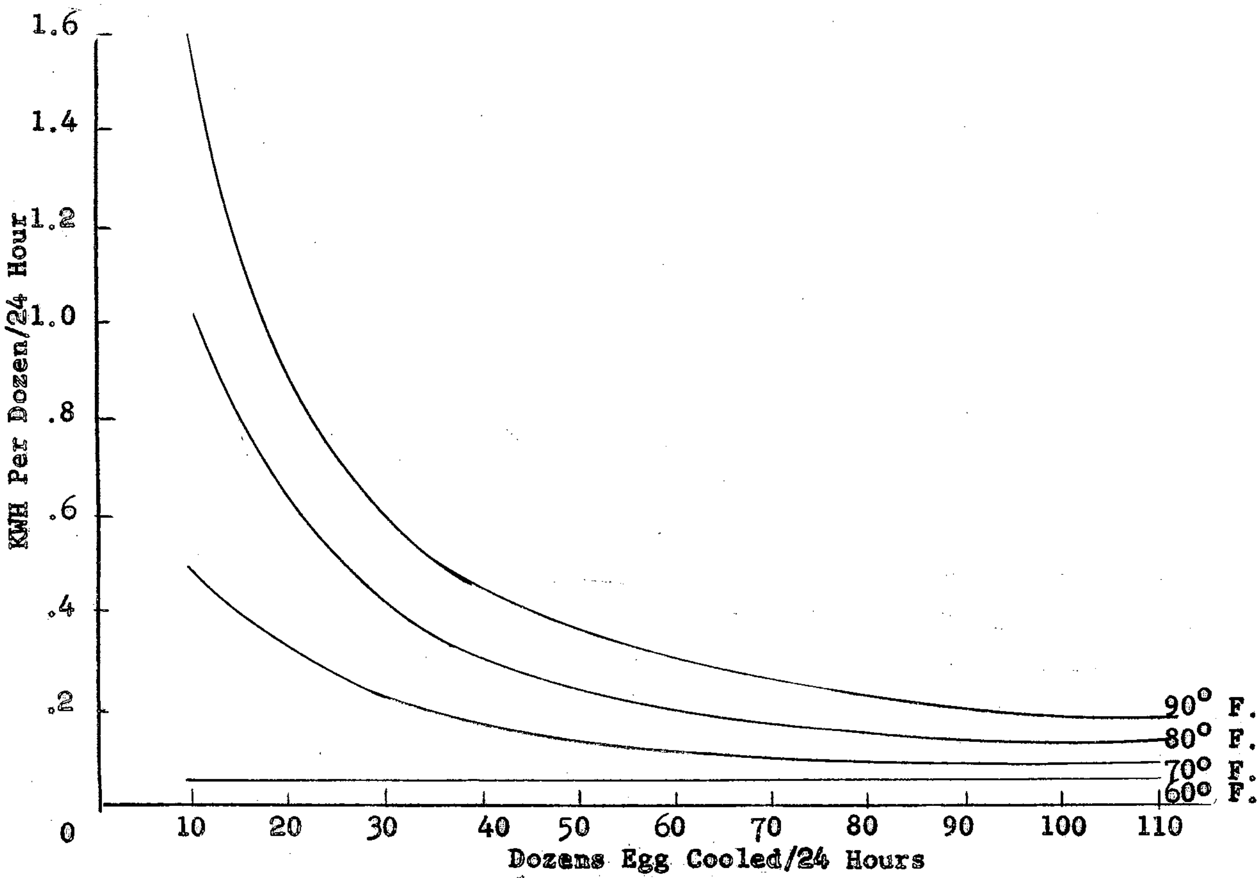

Figure 5. Unit Energy Use by 1/2 hp Mechanical Cooling Unit at 70°, 80° and 90° F. in 25-Case Cooler - Weekly Marketing

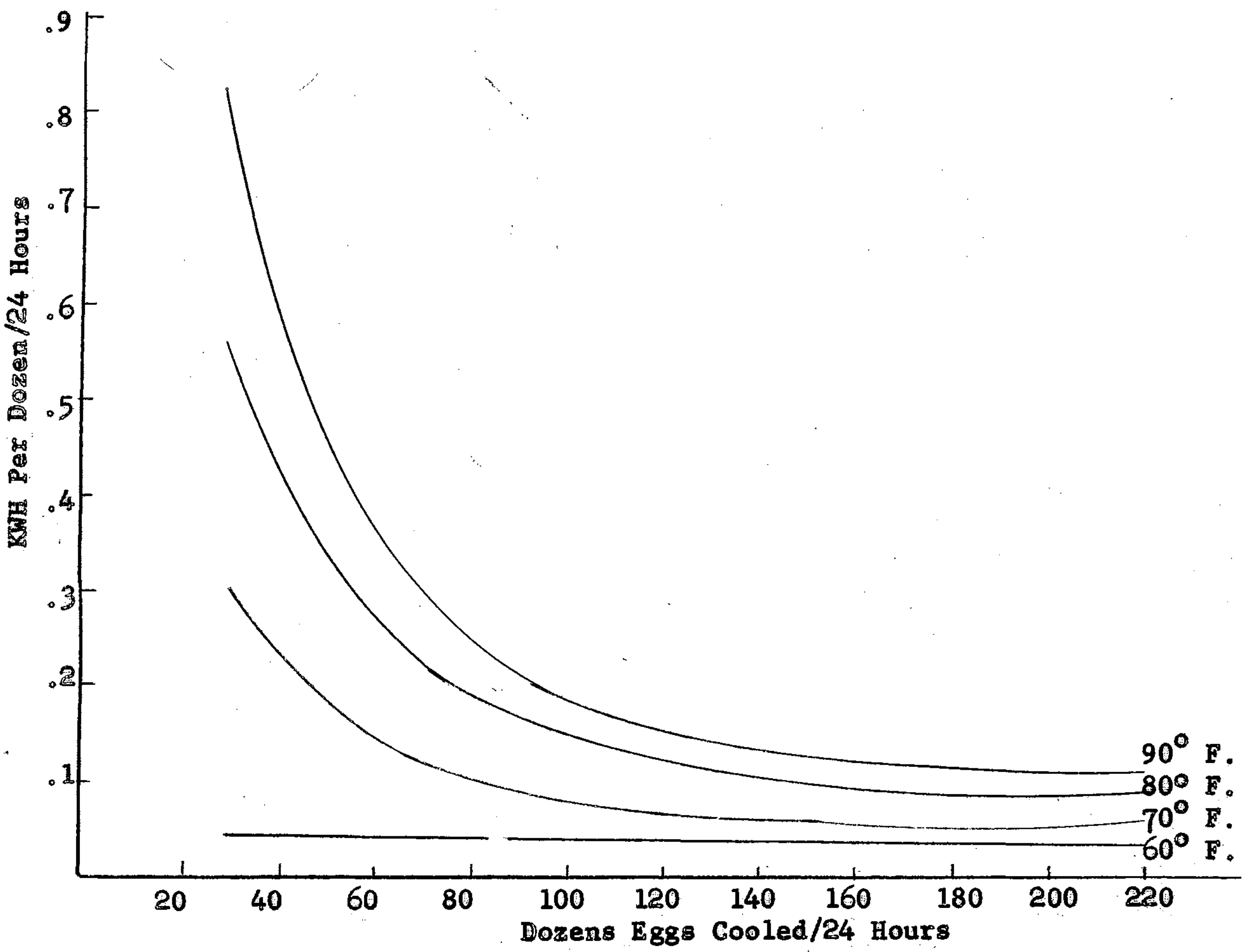

Figure 6. Unit Energy Use by 1/2 hp Mechanical Cooling Unit at 70°, 80°, and 90° F. in 25-Case Cooler - Twice Per Week Marketing

Energy Requirements for Evaporative Cooling

Energy requirements for the operation of a 2,000 CFM evaporative cooler were estimated by the Agricultural Engineering Department. The total amount of energy used by this unit remained constant when in operation, regardless of the quantity of eggs involved. The unit required 0.4 KWH per hour of operation or 9.6 KWH per 24 hour period. When in constant use during the months of April through August, the total estimated annual energy requirement was 1,468 KWH.

CHAPTER VII

ESTIMATION OF COST UNDER ALTERNATIVE HOLDING CONDITIONS

Refrigeration

Total and annual fixed costs for the 7-case and 25-case egg coolers were based upon information supplied by the Agricultural Engineering Department. Materials used in the construction of the coolers were purchased from a local lumber yard at retail prices. Labor costs were estimated at the going hourly wage scale for time spent in actual construction of each cooler. A normal retail price was paid for the 1/3 hp window air conditioner, however, the 1/2 hp unit used for the 25-case egg cooler was purchased at less than retail price.

The fixed costs for the two mechanical refrigerated egg coolers are shown below:

TABLE V.

FIXED COST FOR THE SEVEN-CASE AND THE TWENTY-FIVE CASE COOLERS

	Dollars
Seven-Case Cooler	
Materials	$ 68.02
1/2 hp window air conditioner	121.12
Construction labor	75.00
Total	$264.14
Twenty-Five Case Cooler	
Materials	$233.56
1/2 hp window air conditioner	112.50
Construction labor	225.00
Total	$571.06

The annual fixed costs for each of the two egg coolers were estimated by standard percentages of first cost, applicable to this class of equipment. Depreciation costs for each of the cabinets were based on a life expectancy of 15 years for the cabinets and 10 years for each of the cooling units. Interest on investment was based on 6 percent of one half of first cost or 3 percent of original investments. Annual repairs and maintenance costs were based on two percent of original costs for the cabinets and three percent for the cooling units. Percentages applied to total fixed cost for arriving at annual fixed cost on each cooler are shown below.

TABLE VI.

PERCENTAGES USED TO DETERMINE ANNUAL FIXED COSTS

Type	Cabinet	Cooling Unit	Cooling Unit
		(Percent)	
Depreciation	6 2/3	10	10
Interest	3	3	3
Repair and Maintenance	2	3	3
Total	11 2/3	16	16

Applying these total percentages to the total costs for each of the egg coolers used in the experiment, the annual fixed costs are shown in the table below.

Cost estimates were computed under the assumption that the 7-case and 25-case egg coolers were used to capacity with either weekly or twice weekly marketing. Average fixed cost for use of the 7-case cooler for weekly and twice weekly marketing were .0032 and .0016 cent per dozen eggs, respectively. Average fixed costs for the 25-case cooler for weekly and twice weekly marketing were 0.0008 and 0.0004 cents per dozen eggs. In a comparison of the fixed costs for the two coolers and the different marketing schedules, it may be pointed out that as the laying flocks were increased in size and a greater quantity of eggs cooled, a reduction occurred in fixed cost per dozen eggs. Twice weekly marketing compared with weekly marketing reduced fixed cost per dozen eggs by one-half.

TABLE VII

ANNUAL FIXED COST FOR CABINETS AND COOLING UNITS

Coolers	Size of Coolers	
	Seven-Case	Twenty-Five Case
Cabinets	$16.69	$53.50
Cooling Unit	19.38	18.00
Total	36.07	71.50

Increasing the quantity of eggs cooled from twice weekly marketing in a 7-case cooler to twice weekly marketing in a 25-case cooler reduced the fixed cost per dozen to one fourth or from 0.0016 to 0.0004 cents.

Variable costs for mechanical refrigeration were generated also under the assumption that the two coolers were used to capacity with both weekly and twice weekly marketing schedules. Electricity cost was assumed to be two cents per KWH. There were no variable costs for the months of January, February, November and December. In each case the energy-use-expression was applied to determine monthly energy requirements per dozen eggs for refrigeration.

The average annual variable costs for mechanical refrigeration per dozen eggs in the seven-case cooler, marketing weekly and twice weekly, were 0.0019 and 0.0012 cents, respectively. The average annual variable costs for the 25-case cooler, marketing weekly and twice weekly, were 0.0018 and 0.0010, respectively per dozen eggs. The pattern of variable costs started at zero in February, gradually increased to a peak in August, and decreased again to zero in November. This monthly variable cost followed the expected temperature pattern for Oklahoma. Variable costs per dozen are minimized when coolers are used at capacity with twice weekly marketings.

Total and average variable costs were computed for time periods to provide data for comparison purposes (Table VIII). These data for refrigeration indicated significantly higher costs for the period April through September, compared with the period September through March. Data on evaporative cooling costs were available only for the period of April through August. Average variable cost for this period is reduced one half by twice weekly marketing when compared with weekly marketing.

Alternatives in terms of size of flock and marketing schedules provide producers with means to reduce total costs (Table IX). Total annual cost for the seven-case cooler was $57.48 for weekly marketing with an average total cost per dozen eggs of .0051 cents. Twice per week marketing total annual cost was $62.51 with an average total cost per dozen eggs of 0.0028 cents.

Assuming capacity use of the 25-case cooler total annual cost for weekly marketing was $143.70 with an average total cost per dozen eggs of .0026 cents. Twice weekly marketing increased total annual cost to $162.92 but gave an average cost per dozen eggs of .0014 cents (Table IX).

TABLE VIII

TOTAL AND AVERAGE VARIABLE COSTS BY PERIODS FOR DIFFERENT HOLDING CONDITIONS AND MARKETING SCHEDULES

	September 1 - March 1		April 1 - August 31		April 1 - July 1	
	Total Variable Cost	Average Variable Costs Per Dozen	Total Variable Costs	Average Variable Costs Per Dozen	Total Variable Costs	Average Variable Costs Per Dozen
Refrigeration						
7-Case						
Weekly marketing	6.03	0.000948	15.38	0.00335	10.92	0.00298
Twice weekly marketing	8.10	0.000636	18.30	0.00195	13.46	0.00183
25-Case						
Weekly marketing	19.96	0.000879	52.24	0.00320	39.57	0.00303
Twice weekly marketing	28.34	0.000551	63.08	0.00192	47.03	0.00180
Evaporative (equivalent)						
7-Case						
Weekly marketing			29.36	0.0064		
Twice weekly marketing			29.36	0.0032		
25-Case						
Weekly marketing			29.36	0.0018		
Twice weekly marketing			29.36	0.0009		

TABLE IX

COSTS FOR THE 7-CASE AND 25-CASE COOLERS OPERATED TO FULL CAPACITY UNDER WEEKLY AND TWICE WEEKLY MARKETING

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total Costs	Average Cost Per Dozen
<u>7-Case Cooler</u>														
Weekly marketing variable costs	0	0	.78	1.35	2.51	3.15	3.91	4.46	3.17	2.08	0	0	21.41	0.001955
Twice weekly marketing variable costs	0	0	1.56	2.16	2.98	3.60	4.76	4.84	3.60	2.94	0	0	26.44	0.001207
Fixed costs														
Weekly													36.07	0.003294
Twice weekly														0.001647
<u>25-Case Cooler</u>														
Weekly marketing variable costs	0	0	2.79	4.75	7.03	10.34	12.47	12.67	10.27	6.90	0	0	72.20	0.001848
Twice weekly marketing variable costs	0	0	5.57	7.45	10.88	13.18	15.52	16.05	13.22	9.55	0	0	91.42	0.001088
Fixed costs														
Weekly													71.50	0.00085
Twice weekly														0.000425

Twice weekly marketings are advantageous to the producer from a cost standpoint. Total costs per dozen eggs cooled and held are reduced almost one half with twice weekly marketings compared with weekly marketing. These data suggest that producers can double flock size and change to twice weekly marketing and reduce the cost for holding eggs under refrigeration provided marketing costs are proportionate.

Evaporative

Evaporative cooling costs were based upon information secured through a conference with the Agricultural Engineers. The engineers assumed that a 2,000 CFM evaporative cooler would cost $80.00 for cooling the quantity of eggs held by the two mechanical refrigeration coolers and for all marketing schedules. The expected life span of seven years was used to estimate annual fixed cost instead of the usual ten years and no repair costs were used.

Although the evaporative cooler was operated only during the months of April through August, fixed costs were applied on an annual basis with the quantity of eggs cooled being equivalent to the number of dozens cooled and held in the egg coolers under mechanically refrigerated conditions. This provided comparable cost data for the various holding conditions and market schedules.

The average annual fixed cost for the evaporative cooler was estimated to be $11.43. The average fixed costs per dozen eggs cooled by an evaporative unit, the equivalent of seven-case and 25-case coolers, eggs marketed weekly were 0.0010 and 0.0005 cents respectively. Twice weekly marketings would reduce average fixed costs by 50 percent.

Variable cost for evaporative cooling applied only to the five month period, April through August, when this unit was in operation (Table VIII). Assuming a use rate of 9.6 KWH of energy per 24 hour period of operation, the total energy use for the five month period was 1,468 KWH. Energy cost at two cents per KWH resulted in a total variable cost of $29.36 for the five-month period. This total variable cost would remain the same regardless of the dozens of eggs cooled since the cooler was in continuous operation. However, the average variable cost per dozen eggs varied directly with the quantity of eggs cooled and held. The variable costs per dozen eggs, equivalent to the 7-case cooler for once and twice weekly marketing, were 0.0062 and 0.0032 per dozen. The variable costs, equivalent to the 25-case cooler for once and twice weekly marketing, were 0.0018 and 0.0009 per dozen eggs.

Total annual cost for evaporative cooling under all egg loading rate equivalents was $40.79. Total average costs per dozen eggs cooled and held for the five-month period, April through August, the equivalent of the 7-case cooler marketed weekly and twice weekly, were 0.0074 and 0.0039 cents per dozen. Average costs per dozen for the same five-month period for the 25-case cooler equivalent, with weekly and twice weekly marketing, were .0020 and .0010 cents per dozen cooled.

Comparisons of the average cost per dozen eggs cooled under these alternative holding conditions and the two marketing schedules for the months of April through August are found in Table VIII. The average costs per dozen with the 7-case cooler, refrigerated cooler compared with the evaporative cooler equivalent, marketed weekly, were 0.0065 and 0.0074 cents. With twice weekly marketing these costs were 0.0035 and 0.0039 cents per dozen.

The average costs per dozen during this same five month period with the 25-case refrigerated cooler were somewhat lower. For weekly marketing these costs were 0.0040 and 0.0020, and for twice weekly marketing were 0.0023 and 0.0010.

Under both mechanical refrigeration and evaporative cooling, the average costs per dozen decreased as the quantity of eggs cooled increased. With the 7-case evaporative cooler equivalent average cost per dozen exceeded that of mechanical refrigeration. However, as larger quantities of eggs were cooled in the 25-case cooler or equivalent, the average cost per dozen was reduced to one half the cost for mechanical refrigeration.

CHAPTER VIII

TOTAL RETURNS UNDER ALTERNATIVE HOLDING CONDITIONS

Seasonal Variation in Egg Prices

The physiological change in eggs resulting from holding conditions and marketing schedules and the economic significance of these factors are influenced by the seasonal nature of production.[1] Seasonal price changes result from a combination of demand patterns, grade distribution within seasonal segments of the production cycle, and the seasonal nature of production. In order to be consistent when analyzing the impact of egg prices on total returns, seasonal indexes were computed using 1952-57 monthly egg prices. The monthly average prices for the six-year period used in this investigation were prices paid to producers by the Brentwood Egg Company of Tulsa, Oklahoma.[2] These prices were assumed to be representative of seasonal price variations for eggs. They are not identical to prices reported by the Agricultural Marketing Service. However, these egg prices included prices paid by grades which were essential for this study.

The 1952-57 period of egg prices was chosen because this sample period embodied all types of conditions, including both high and low price years. In order to reflect prices paid producers, the unweighted

[1] Oklahoma State University Extension Circular 549, p. 4.

[2] Monthly prices paid by the Brentwood Egg Company, Tulsa, Oklahoma, were used through the courtesy of Don Volz, Manager.

average of monthly prices was the method used to measure seasonal variation.

The seasonal indexes of prices paid producers were computed for the 6-year period for Grades A, B and C (Table X). These seasonal indexes by grades are presented graphically in Figure 7.

Prices paid for Grade A eggs were relatively higher during the period, July through November. Low indexes for Grade B eggs predominated during two seasons of the year, namely, May and June and October through December. Grade C egg price indexes were significantly below average from August through December and were slightly above average during the other seven months. The lower grade egg prices are generally highest during the flush production period of late winter and early spring. The Grade A prices are generally lower during the flush production season although the proportion of the total production identified as Grade A is smaller.

In order to provide for estimates of the impact of the price level on total returns, alternative prices for high and low years were computed (Table XI). The year 1953 was selected as representative of high prices and 1955 for low prices. The average prices for these two representative years were adjusted by the monthly seasonal indexes (Table X). These annual average prices for the two years and the average for the period are categorized as High, Low and Average prices. The annual averages were computed by grades and are as follows: High prices, Grade A, 47.8, Grade B, 42.0 and Grade C, 37.7 cents; the Low price average for Grade A, 36.9, Grade B, 26.7, and Grade C, 20.7 cents; Average price, Grade A, 38.2, Grade B, 31.5, and Grade C, 25.7 cents.

TABLE X

INDEX OF MONTHLY AVERAGE EGG PRICES BY GRADES, 1952-1957

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
GRADE A													
Average	38.5	37.5	35.8	35.3	35.7	35.0	41.7	42.5	41.7	38.8	39.0	36.3	38.2
Index	100.8	98.2	93.7	92.4	93.5	91.6	109.2	111.3	109.2	101.6	102.1	95.0	
GRADE B													
Average	32.8	32.7	31.5	30.8	30.5	30.3	34.5	34.8	33.2	29.0	28.3	29.2	31.5
Index	104.1	103.8	100.0	97.8	96.8	96.2	109.5	110.5	105.4	92.1	89.8	92.7	
GRADE C													
Average	28.5	28.0	27.1	27.5	27.8	27.1	27.3	24.2	24.2	20.0	20.8	22.3	25.7
Index	110.9	108.9	105.5	107.0	108.1	105.5	106.2	94.1	94.1	77.8	80.9	86.8	

SOURCE: Brentwood Egg Company, Tulsa, Oklahoma

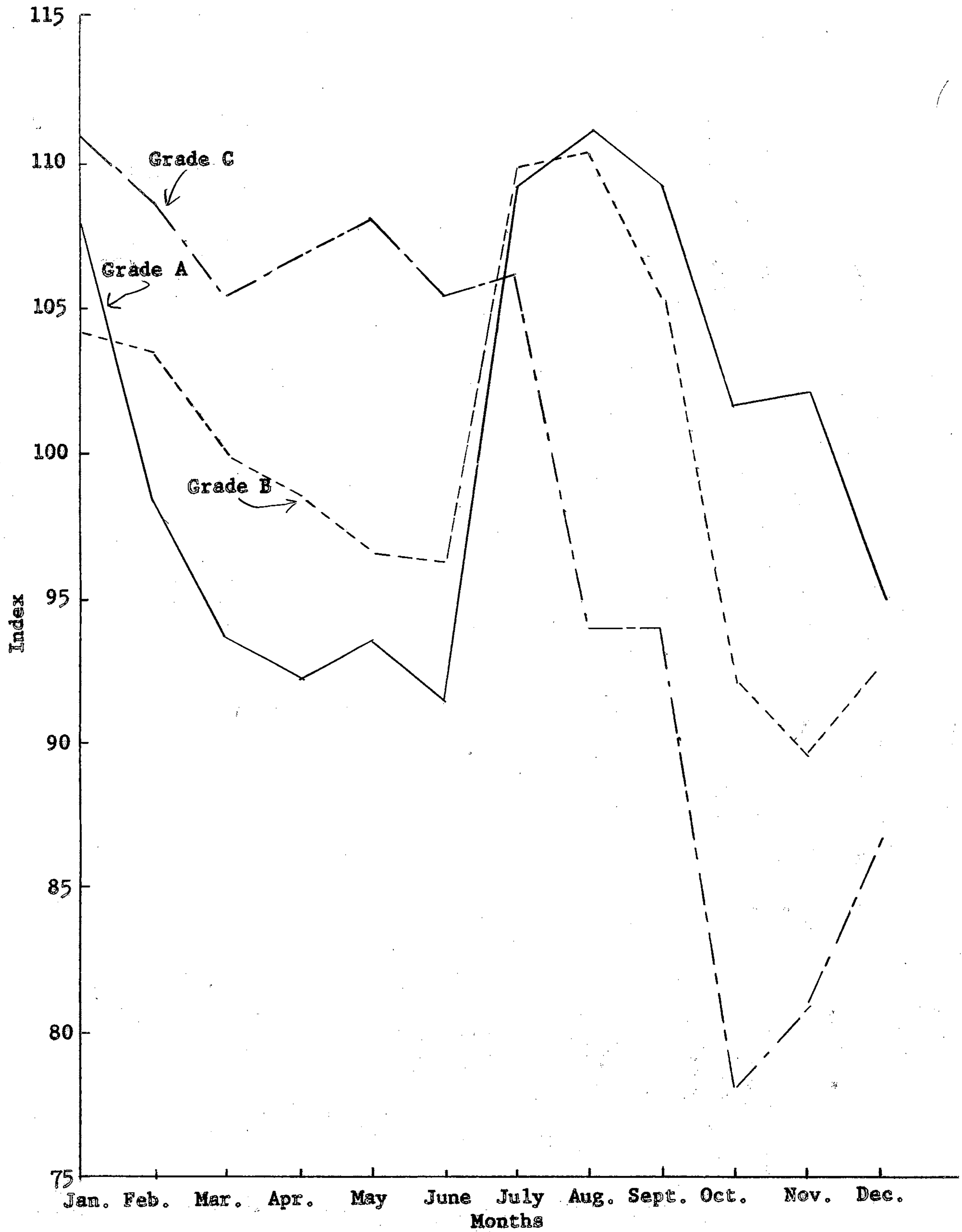

Figure 7. Index of Prices Paid Oklahoma Egg Producers, 1952-57

TABLE XI

ADJUSTED PRICE PER DOZEN EGGS PAID TO EGG PRODUCERS BY MONTHS UNDER THREE PRICE LEVELS

Grade and Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						(cents per dozen)						
GRADE A												
1953	48.2	46.9	44.8	44.2	44.7	43.8	52.2	53.2	52.2	48.6	48.8	45.4
1955	37.2	36.2	34.6	34.1	34.5	33.8	40.3	41.1	40.3	37.5	37.7	35.1
Average 1952-57	38.5	37.5	35.8	35.3	35.7	35.0	41.7	42.5	41.7	38.8	39.0	36.3
GRADE B												
1953	43.7	43.6	42.0	41.0	40.7	40.4	46.0	46.4	44.3	38.7	37.7	38.9
1955	27.8	27.7	26.7	26.1	25.8	25.7	29.2	29.5	28.1	24.6	24.0	24.8
Average 1952-57	32.8	32.7	31.5	30.8	30.5	30.3	34.5	34.8	33.2	29.0	28.3	29.2
GRADE C												
1953	41.8	41.1	39.8	40.3	40.8	39.8	40.0	35.5	35.5	29.3	30.5	32.7
1955	23.0	22.5	21.8	22.1	22.4	21.8	22.0	19.5	19.5	16.1	16.7	18.0
Average 1952-57	28.5	28.0	27.1	27.5	27.8	27.1	27.3	24.2	24.2	20.0	20.8	22.3

SOURCE: Brentwood Egg Company, Tulsa, Oklahoma

Total Returns

Total returns by periods or seasons were computed, assuming the experimental grade distribution at the three price levels under alternative holding condition. To supplement the empirical data generated in the Oklahoma experiment, the returns under non-refrigeration for the period April through July are returns to evaporative cooling using Texas data. The total returns to the evaporative cooler were calculated by assuming all eggs were Grades A and B. Natural conditions for the period, April through July are also based on the Texas data. Total returns were computed for both mechanically refrigerated egg coolers used to capacity, with a weekly marketing schedule.

Returns to the 7-case cooler or its equivalent, based on 10,950 dozen eggs, during the twelve-month period, for the high, low and average price levels were as follows: \$5,148.70, \$3,897.09 and \$4,079.42. Non-mechanical refrigeration returns for seven months of natural holding conditions plus five months of evaporative cooling are \$4,989.50, \$3,622.93 and \$3,878.27 for the three price levels. Returns accruing to evaporative cooling, A and B grades only, for April through August, are \$2,074.25, \$1,463.43 and \$1,607.77 for the three price levels. Returns from natural conditions for April through July are \$1,551.81, \$1,012.34 and \$1,152.10 (Table XII).

Returns to the 25-case cooler or its equivalent, 39,055 dozens, for a twelve-month period, and for the three price levels with mechanical refrigeration are as follows: \$18,363.15, \$13,901.35 and \$14,548.68. Non-refrigeration returns for seven months but including five months of evaporative cooling are \$17,796.96, \$12,918.64 and \$13,833.38. Returns

TABLE XII

TOTAL RETURNS FOR THE 7-CASE COOLER OR ITS EQUIVALENT UNDER HIGH, LOW AND AVERAGE PRICES AND UNDER DIFFERENT HOLDING CONDITIONS

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
						(Dollars)							
Refrigeration													
High	444.99	391.63	412.25	395.09	409.38	389.63	474.93	475.47	463.39	442.38	432.05	417.60	5,148.79
Low	338.88	298.38	310.03	299.38	304.59	291.86	357.22	356.55	353.30	337.07	330.95	319.78	3,897.99
Average	353.34	311.38	325.72	313.14	321.83	307.29	375.51	374.88	368.45	351.41	343.94	332.53	4,079.42
Non-Refrigeration													
High	441.34	388.48	412.61	386.11*	399.34*	373.94*	421.34*	435.41*	457.90	440.96	423.08	408.99	4,989.50
Low	330.95	290.76	311.05	274.02*	278.33*	247.25*	275.15*	304.19*	347.27	335.89	320.33	307.74	3,622.93
Average	348.01	306.33	326.27	297.50*	305.33*	278.67*	312.35*	332.75*	362.77	350.13	335.12	323.04	3,878.27
Evaporative													
A and B only													
High				387.24*	399.10*	376.05*	447.02*	464.84					2,074.25
Low				280.50*	284.83	260.94*	305.97*	331.19					1,463.43
Average				302.85*	310.48*	289.90*	343.17*	361.37					1,607.77
Natural													
High				380.78*	393.90*	369.31*	407.82*						1,551.81
Low				259.10*	264.99*	234.11*	254.14*						1,012.34
Average				288.37*	297.06*	270.23*	296.44*						1,152.10

*Texas Data (1954).

to evaporative cooling, A and B grades only, for April through August, are $7,407.47, $5,225.46 and $5,738.91. Returns to natural conditions for April through July are $5,534.79, $3,610.52 and $4,109.08 (Table XIII).

Returns under alternative holding conditions are essential for a comparison of additional returns which may accrue to a specific holding condition for a certain season or period and under the different situations. In comparing refrigeration and non-refrigeration for the twelve-month period, using the 7-case cooler with a total of 10,950 dozen eggs held under each condition, additional total returns to refrigeration assuming high, low, and average price levels are $159.29, $275.06 and $201.15. The 25-case cooler for the same twelve-month period with 39,055 dozen eggs held under each condition, gave additional returns to refrigeration compared with non-refrigeration of $566.19, $982.71 and $715.30 for the three price levels. In a comparison of refrigeration and non-refrigeration, for the seven months, September through March, additional total returns to refrigeration on the 6,360 dozens of eggs held under each condition for this period are $30.93 for high, $44.40 for low, and $35.00 for the average price level. Assuming the use of the 25-case cooler for the same seven-month period when 22,684 dozen were held under each condition, additional total returns to refrigeration over non-refrigeration were $99.97 for high, $155.12 for low and $116.92 for average.[3]

[3]Note: The added returns that accrue to refrigeration under the high price level are always less than under the low price level. The decline in grade discounts when prices decrease are greater than the change in prices.

TABLE XIII

TOTAL RETURNS FOR THE 25-CASE COOLER OR ITS EQUIVALENT UNDER HIGH, LOW AND AVERAGE PRICES AND UNDER DIFFERENT HOLDING CONDITIONS

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
						(Dollars)							
Refrigeration													
High	1587.10	1396.83	1470.31	1409.12	1460.10	1389.73	1693.91	1695.77	1651.98	1578.19	1540.91	1489.20	18,363.15
Low	1208.58	1064.22	1105.62	1067.77	1086.32	1041.10	1274.04	1271.58	1259.01	1202.59	1180.30	1140.22	13,901.35
Average	1260.14	1110.58	1161.60	1116.83	1147.84	1096.09	1339.27	1336.97	1313.31	1253.70	1226.65	1185.70	14,548.68
Non-Refrigeration													
High	1574.04	1385.76	1471.62	1377.17*	1424.34*	1333.74*	1502.83*	1552.85*	1632.95	1573.95	1508.89	1458.82	17,796.96
Low	1180.19	1037.48	1109.32	977.50*	992.84*	881.93*	981.42*	1084.76*	1238.31	1198.75	1142.44	1097.70	12,918.64
Average	1241.07	1092.92	1163.62	1061.19*	1089.06*	993.94*	1114.14*	1186.68*	1293.64	1249.64	1195.20	1152.28	13,833.38
Evaporative													
A and B only													
High				1381.22*	1423.66*	1341.25*	1603.53*	1657.81					7,407.47
Low				1000.62*	1015.96*	930.76*	1097.06*	1181.06					5,225.46
Average				1080.26*	1107.42*	1034.01*	1230.83*	1289.36					5,738.91
Natural													
High				1358.04*	1404.97*	1317.16*	1454.62*						5,534.79
Low				923.85*	945.28*	834.84*	906.55*						3,610.52
Average				1028.32*	1059.63*	963.74*	1057.39*						4,109.08

*Texas Data (1954).

In a comparison of refrigeration and evaporative cooling for the high temperature months of April through August, additional total returns to refrigeration from the 7-case cooler, on 4,590 dozen of eggs held under each condition, were $128.36 for high, $230.76 for low, and $166.05 for the average. Assuming use of the 25-case cooler for the same five-month period, where 16,371 dozen eggs were held under each condition, refrigeration showed additional returns of $457.70 for high, $822.36 for low, and $591.99 for average.

Comparing mechanical refrigeration and evaporative cooling for the five-month period of April through August, assuming that all eggs not Grade A are Grade B when held in the evaporative cooler, the 7-case cooler gave total additional returns in favor of refrigeration as follows: $70.25 for high, $146.17 for low, and $84.88 for average. The 25-case cooler, under the same circumstances and for the same period, gave to refrigeration additional returns of $241.16 for high, $515.35 for low, and $298.09 for average. Total returns for Grades A and B only were computed in this instance for evaporative cooling, since the basic Texas data provided only percentages of Grade A eggs. Through identifying all eggs as Grade B other than those known to be Grade A, minimum additional returns could be shown for refrigeration as compared with evaporative cooling.

Comparison of refrigeration and natural holding conditions for the four-month period of April through July, using the 7-case cooler with a total of 3,660 dozen eggs held under each condition, additional returns to refrigeration were $157.28 for high, $293.07 for low, and $207.50 for average. Under the same assumptions the 25-case cooler with 13,054 dozens held under each condition, the additional returns to refrigeration are $560.99 for high, $1,045.53 for low, and $741.24 for average

Total Returns Per Case

Total returns and total additional returns reflected the influence of different holding conditions under different price situations. These returns were converted to total returns per case due to the practice of marketing firms dealing largely with the case (30 dozen) as a unit.

The total returns per case as presented in Figure 8 were computed by use of data from the total returns section and the number of cases of eggs cooled for the period given. The data were converted to returns per case for eggs for the varied holding conditions and price situations as follows: refrigeration, September through March, $14.17 for high, $10.77 for low and $11.25 for average; non-refrigeration for September through March, $14.02 for high, $10.58 for low and $11.09 for average; refrigeration, April through August, $14.02 for high, $10.52 for low and $11.06 for average; evaporative cooler for April through August, $13.17 for high, $9.01 for low and $9.98 for average; evaporative cooler (Grades A and B only) for April through August, $13.56 for high, $9.56 for low and $10.50 for average; natural conditions for April through July, $12.77 for high, $8.30 for low and $9.44 for average (Figure 8).

Comparisons were made of total returns per case for the three price situations for refrigeration in comparison with other holding conditions to determine additional returns per case resulting from refrigeration.

Refrigeration compared with non-refrigeration for the period, September through March, gave additional returns per case of 15 cents

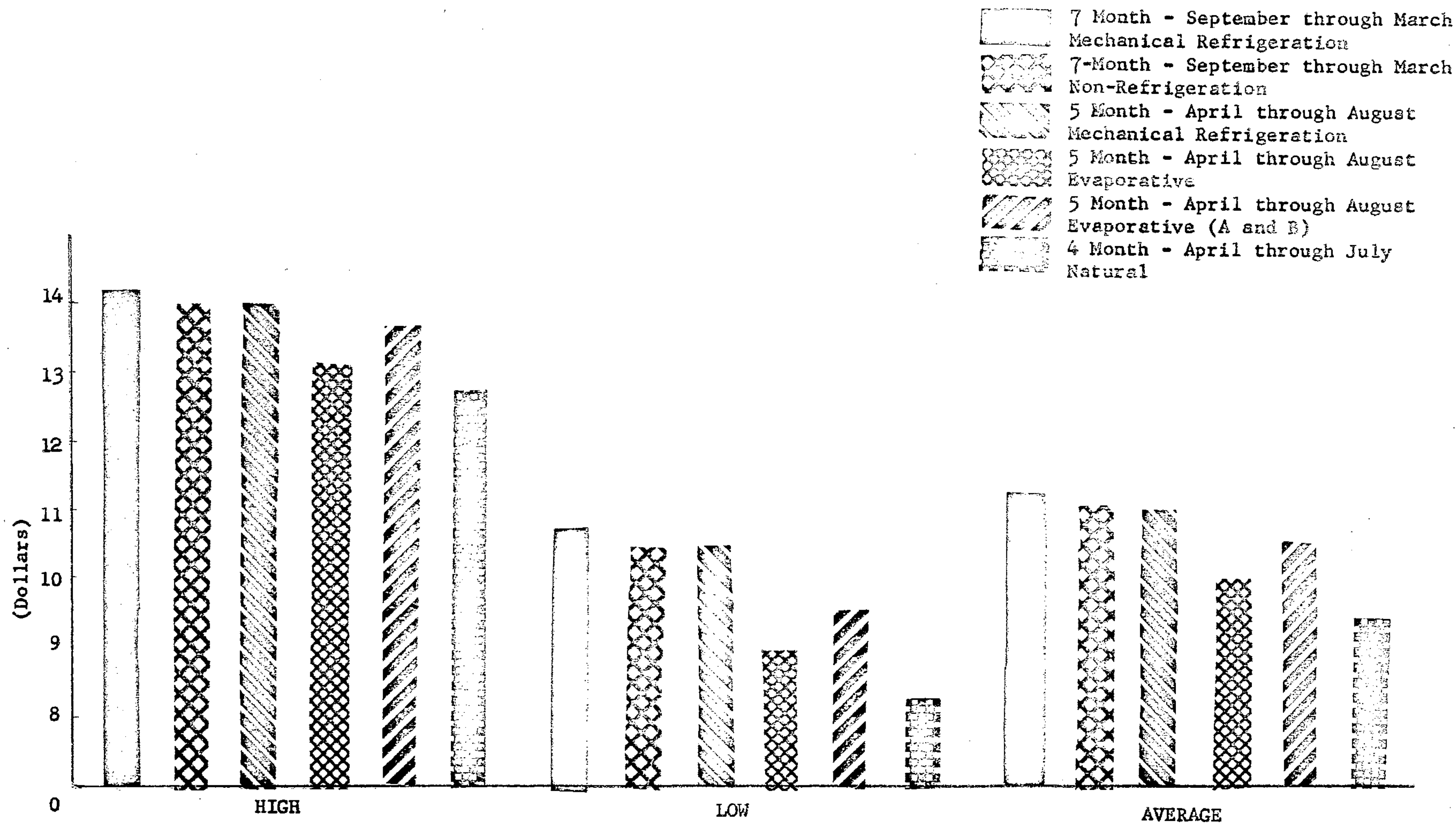

Figure 8. Total Returns Per Case Under Different Holding Conditions for Three Price Levels

for high, 19 cents for low and 16 cents for average during this period. Refrigeration compared with evaporative cooling for the period, April through August, gave added returns per case of 85 cents for high, $1.51 for low and $1.08 for average. Assuming that the eggs held under evaporative cooling from April through August were Grades A and B only, the added returns to refrigeration were 46 cents for high, 96 cents for low and 56 cents for average. Since the Texas data used for evaporative cooling provided only the percentage of Grade A eggs, the remaining percentage was assumed to be Grade B in the comparative analysis to prevent overstating the additional returns to refrigeration. Refrigeration compared with natural conditions for the period, April through July, gave added returns per case of $1.25 for high, $2.22 for low, and $1.62 for average.

Based on total returns per case there was a slight difference in favor of refrigeration over non-refrigeration for the cool weather months of September through March. There was, however, a considerable difference in added returns to refrigeration compared with evaporative cooling and natural conditions for the warm weather months.

Returns Under 3-Day and 6-Day Marketing Schedules

Frequency of marketing was investigated to obtain an estimate of the relative importance of twice weekly compared with weekly marketing within and between the various holding conditions. This segment of the study was based on the Texas data and eggs were placed under the various holding conditions during the months of April through July and marketed on 3-day and 6-day schedules.

Estimates for the 3-day marketing, twice weekly, gave the Grade A percentages under the various holding conditions as follows: 86.1 percent for mechanical refrigeration, 67.0 percent for evaporative cooling and 50.5 percent for natural conditions. The percentages of Grade A eggs for 6-day marketing were as follows: 83.0 percent for mechanical refrigeration, 48.2 percent for evaporative cooling and 33.4 percent for natural conditions.

The reduction in Grade A percentages from 3-day to 6-day marketing amounted to 3.1 percentage points for refrigeration, 18.8 percentage points for evaporative cooling and 17.1 percentage points for natural conditions. This analysis reflected the effects of time and holding conditions upon egg quality deterioration and, therefore, returns to the poultry enterprise.

In comparing total returns under the weekly and twice weekly marketing schedules, the three price levels during the months of April, May, June and July were applied (Table XIV). All eggs other than Grade A were considered Grade B in computing total returns per case. Total returns per case for refrigeration on the 3-day marketing schedule was $13.68 assuming the high seasonal price. Assuming the same conditions except for 6-day marketing, total return was $13.65.

TABLE XIV

TOTAL RETURNS PER CASE UNDER DIFFERENT HOLDING CONDITIONS AND MARKETING SCHEDULES

	3-Day Schedule			6-Day Schedule		
	High	Low	Average	High	Low	Average
	(Dollars)					
Mechanical Refrigeration	13.68	10.35	10.86	13.65	10.26	10.77
Evaporative Cooler	13.44	9.81	10.53	13.20	9.30	10.23
Natural Conditions	13.23	9.36	10.26	13.02	8.91	9.99

The additional returns per case for 3-day marketing compared with a 6-day marketing schedule when holding conditions and price schedules were the same were analyzed (Table XV). Additional return per case to 3-day marketing for refrigeration under high prices was 3 cents and for evaporative cooling under low prices was 51 cents.

TABLE XV

ADDITIONAL RETURNS PER CASE FOR 3-DAY MARKETINGS WITHIN HOLDING CONDITIONS

	High	Low	Average
		(Dollars)	
Mechanical Refrigeration	.03	.09	.09
Evaporative Cooler	.24	.51	.30
Natural Conditions	.21	.45	.27

Additional returns between holding conditions and between 3-day and 6-day marketing schedules were also analyzed (Table XVI). Under the low price level, refrigeration with 3-day marketing compared with natural conditions with 6-day marketing, gave additional returns of $1.44 per case. Assuming high prices, refrigeration with 3-day marketing gave additional returns per case of 48 cents over evaporative cooling with 6-day marketing. When refrigeration is compared with evaporative cooling, the additional return per case was 33 cents for refrigeration. Assuming an average price schedule, under 3-day marketing, refrigeration compared with natural conditions was 60 cents per case and evaporative cooling was 27 cents greater than natural conditions (Table XVI).

TABLE XVI

ADDITIONAL RETURNS PER CASE BETWEEN HOLDING CONDITIONS AND 3-DAY AND 6-DAY MARKETINGS

	High	Low	Average	Average Within 3-Day Marketing
		(Dollars Per Case)		
Mechanical vs. Evaporative	.48	1.05	.63	.33
Mechanical vs. Natural	.66	1.44	.87	.60
Evaporative vs. Natural	.42	.90	.54	.27

As egg producers seek greater returns, the alternatives of different schedules, weekly and twice weekly marketing, offers opportunities for additional returns. Refrigeration compared with non-refrigeration for the cool weather months gave comparatively small added returns. However, when refrigeration was compared to other holding conditions, the additional returns were important.

CHAPTER IX

NET RETURNS UNDER ALTERNATIVE HOLDING CONDITIONS

Net returns are more easily understood and more practical to apply when computed on a per case basis. Fixed and variable costs were previously calculated for refrigeration and evaporative cooling including the two marketing schedules and the coolers. It was assumed that both coolers or their equivalent, under natural conditions were used to capacity, for the three price situations of high, low and average.

Since basic data on grade distribution for twice weekly marketing were not provided in the Oklahoma Experiment Station Project, only net returns for the weekly marketing schedule were computed in this section. Total net returns for twice weekly marketing are found in the appendix. However, only fixed and variable costs were considered under the various holding conditions. Lacking data on the grade differential between weekly and twice weekly marketing, it was necessary to assume grade percentages for weekly marketing when computing net returns for twice weekly marketing.

Through application of the appropriate costs and returns data, the net returns per case were determined for each of the holding conditions.

Refrigeration

Monthly net returns per case to refrigeration for the three price situations were computed (Table XVII). Under high, low and average prices the net returns per case are relatively lower during the months of

TABLE XVII

NET RETURNS PER CASE TO REFRIGERATION FOR THREE PRICE LEVELS AND WEEKLY MARKETING

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						(Dollars)						
HIGH												
7-Case												
Weekly	14.25	13.88	13.16	13.01	13.02	12.77	15.09	15.09	15.25	14.10	14.30	13.37
25-Case												
Weekly	14.31	13.84	13.22	13.06	13.10	12.80	15.16	15.18	15.27	14.17	14.34	13.42
LOW												
7-Case												
Weekly	10.83	10.55	9.87	9.82	9.64	9.51	11.29	11.27	11.57	10.70	10.86	10.21
25-Case												
Weekly	10.88	10.54	9.92	9.87	9.72	9.56	11.36	11.34	11.60	10.77	10.97	10.26
AVERAGE												
7-Case												
Weekly	11.29	11.02	10.37	10.28	10.20	10.03	11.88	11.85	12.07	11.16	11.36	10.62
25-Case												
Weekly	11.35	11.04	10.43	10.33	10.27	10.08	11.96	11.93	12.11	11.23	11.40	10.68

February through June than for the other seven months. Under all price situations the net return per case for refrigeration for the month of June was lowest of the 12-month period. It was found that prices paid for Grade A eggs under all three price situations were lower in June than for any other month. The net returns per case was highest during the months of July, August and September. It was found that prices paid for Grades A and B were at a maximum during these three months. It might be pointed out that higher net returns per case for the summer months occurred at a time when energy requirements for refrigeration were highest.

Net returns per case for twice weekly marketing using the 7-case and 25-case coolers are found in Appendix Table I. The difference in weekly and twice weekly marketing reflected the difference in fixed and variable cost and did not consider grade differences.

Evaporative Cooling

As a basis for comparison, the net returns per case for evaporative cooling were computed for a 12-month period. The evaporative cooler was in operation during the five months of April through August and non-refrigeration conditions existed for the remaining seven months of September through March. In order that net returns for periods and different holding conditions were comparable, the fixed cost of evaporative cooling was distributed over the 12-month period.

The net returns per case were lower for the months of April through August when the evaporative cooler was operated (Table XVIII). This method resulted in fewer Grade A eggs during these months when evaporative cooling

TABLE XVIII

NET RETURNS PER CASE TO EVAPORATIVE COOLING FOR THREE PRICE LEVELS AND WEEKLY MARKETING

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						(Dollars)						
HIGH												
7-Case												
Weekly	14.12	13.76	13.20	12.76	12.77	12.35	13.48	13.93	15.15	14.11	13.99	13.08
25-Case												
Weekly	14.21	13.77	13.28	12.84	12.85	12.43	13.57	14.02	15.23	14.16	14.07	13.17
LOW												
7-Case												
Weekly	10.56	10.27	9.92	9.02	8.86	8.13	8.76	9.70	11.46	10.72	10.56	9.81
25-Case												
Weekly	10.65	10.27	10.00	9.10	8.95	8.21	8.85	9.78	11.54	10.82	10.64	9.90
AVERAGE												
7-Case												
Weekly	11.11	10.83	10.41	9.80	9.73	9.17	9.96	10.62	11.98	11.18	11.06	10.31
25-Case												
Weekly	11.20	10.87	10.50	9.88	9.83	9.26	10.05	10.70	12.06	11.27	11.14	10.39

provided only partial protection against quality deterioration. September net returns per case were highest of the year and resulted from a combination of comparatively high prices for the three price periods, plus the higher percentage of Grade A eggs. The September eggs were largely from pullets and are generally conceded to be the best quality eggs laid.

Net returns per case for twice weekly marketing, held under evaporative cooling and non-refrigeration, are found in Appendix Table II. The monthly net returns for weekly and twice weekly marketing were influenced by costs only. No grade differential was assumed.

Natural Conditions

Net returns and total returns per case for natural holding conditions were the same, since no holding costs were incurred. Returns per case used in this section were taken from the Texas data for the months of April through July where only Grade A eggs were given identified grade distribution and the remainder was estimated. Under natural conditions the percentage of Grade A eggs declined from 46.5 percent in April to 19.3 percent in June.

Highest net return per case was $13.16 for July, under a high price situation in spite of the reduction in the percentage of Grade A eggs. It was evident that Grade A and B price differentials were too low in July to offset the Grade A reduction. These net returns for natural holding conditions and the three price periods are presented in Table XIX.

Refrigeration Compared with Other Holding Conditions

Total net returns are not computed on a monthly basis for all holding conditions with weekly marketing. The net returns per case were regrouped by periods in order to compare the average net returns per case between holding conditions and for weekly marketing. Average net returns per case for twice weekly marketing were computed and are given in Appendix Table III.

TABLE XIX

NET RETURNS PER CASE FOR THREE PRICE LEVELS UNDER NATURAL HOLDING CONDITIONS

	April	May	June	July
High	$12.69	$12.71	$12.31	$13.16
Low	8.54	8.55	7.80	8.20
Average	9.61	9.58	9.01	9.56

Comparison of Net Returns

The net returns per case were computed for the three price levels in the period, September through March, and for the 7-and 25-case coolers or equivalent (Table XX). The calculated net returns for each distinct situation varied from zero to a maximum of four cents per case. Net returns per case indicated that in each instance very little was gained through use of refrigeration under the assumed price. In order to obtain these net returns to non-refrigeration, the producer would expect to take advantage of natural holding conditions which exist during the cool weather months by holding eggs near 60° F.

Net returns per case for refrigeration in comparison with evaporative cooling were analyzed for the five-month period of April through August (Table XX). The net returns are also shown for the three price

TABLE XX

AVERAGE NET RETURNS PER CASE FOR HIGH, LOW AND AVERAGE PRICE LEVELS UNDER DIFFERENT HOLDING CONDITIONS AND WEEKLY MARKETING

	HIGH		LOW		AVERAGE	
	7-Case	25-Case	7-Case	25-Case	7-Case	25-Case
			(Dollars)			
REFRIGERATION						
Annual Average	13.94	13.98	10.51	10.56	11.01	11.06
September-March Average	14.04	14.08	10.65	10.72	11.12	11.17
April-August Average	13.79	13.85	10.30	10.37	10.84	10.85
EVAPORATIVE						
Annual Average	13.55	13.63	9.81	9.89	10.51	10.59
September-March Average	13.91	13.98	10.47	10.54	10.98	11.06
April-August Average	13.05	13.14	8.89	8.98	9.85	9.94
NATURAL						
April-July Average	12.72	12.72	8.40	8.40	9.44	9.44

levels and for the 7-case and 25-case coolers. Differences in net returns are evident between the two holding conditions for all price levels and for both coolers. The average price gave net returns per case of $10.84 for refrigeration and $9.85 for evaporative cooling with the 7-case cooler. A comparison of refrigeration with evaporative cooling for this five-month period showed that the evaporative cooler did not provide maximum protection to egg quality.

The analysis of the relationships of net returns from refrigeration and natural conditions was based on a five-month period April through August. Net returns for April through August with April through July, respectively for refrigeration and April through July for natural conditions were presented in Table XX. These data are for the three price levels and for the 7-case and 25-case coolers or equivalent. Under the low price level with a 7-case cooler the average net returns per case to refrigeration was $10.30 and for natural conditions $8.40. Under all price situations and for both coolers the differences in net returns are comparatively large. Where eggs are held under natural conditions there exists an opportunity for increasing net returns and total income from egg production (Figures 9 and 10).

Further comparisons were made between refrigeration and other holding conditions by computing additional net returns per case to refrigeration above that received from evaporative cooling (Table XXI). Additional net returns per case are for each month under the three price levels and for the 7-case and 25-case coolers for weekly marketing. Returns to refrigeration were negative during March. This resulted from the fact that in the basic data the grade distribution under non-refrigeration

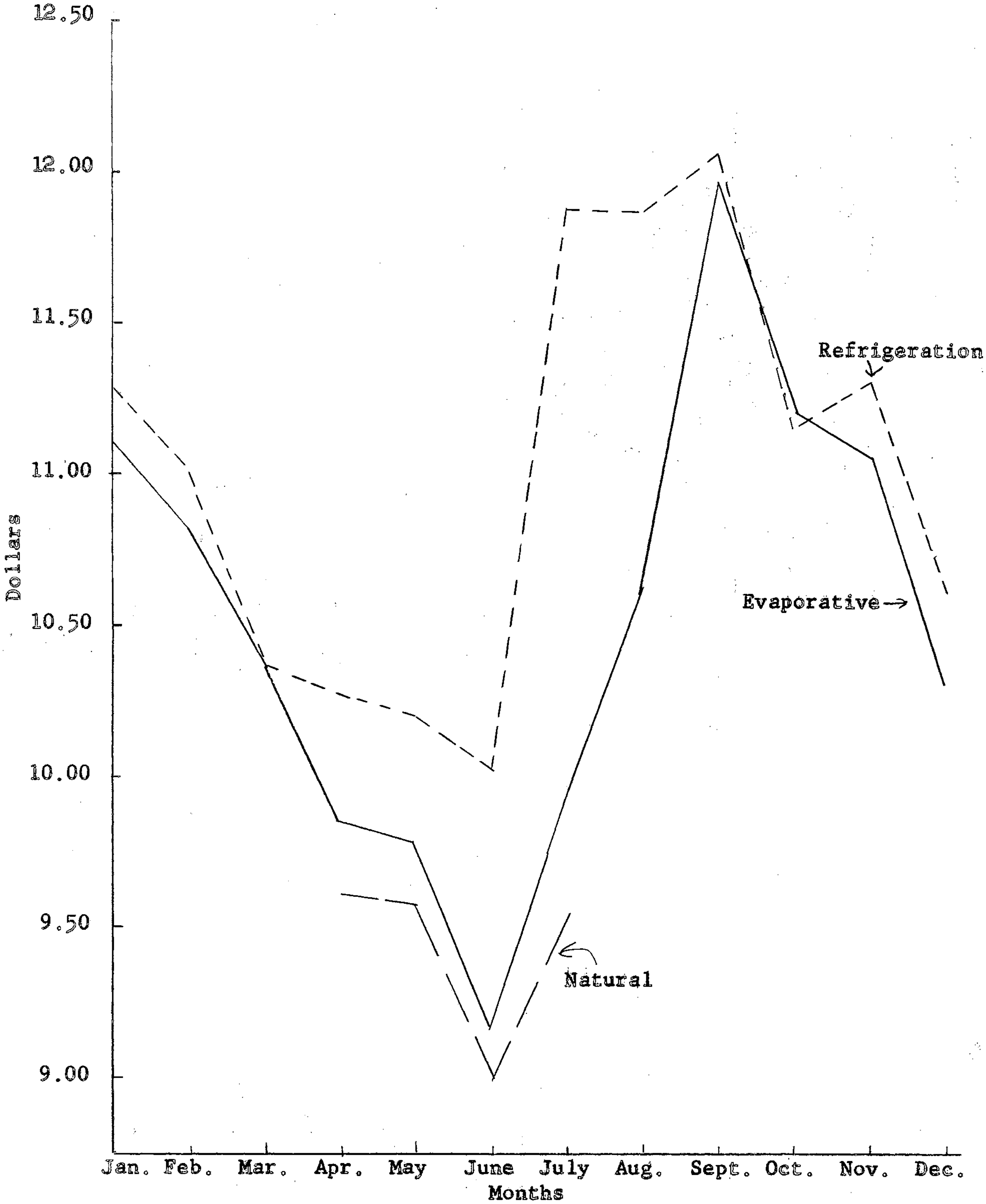

Figure 9. Net Returns Per Case Under Average Prices, for Different Holding Conditions and Weekly Marketing Using the 7-Case Cooler or Equivalent

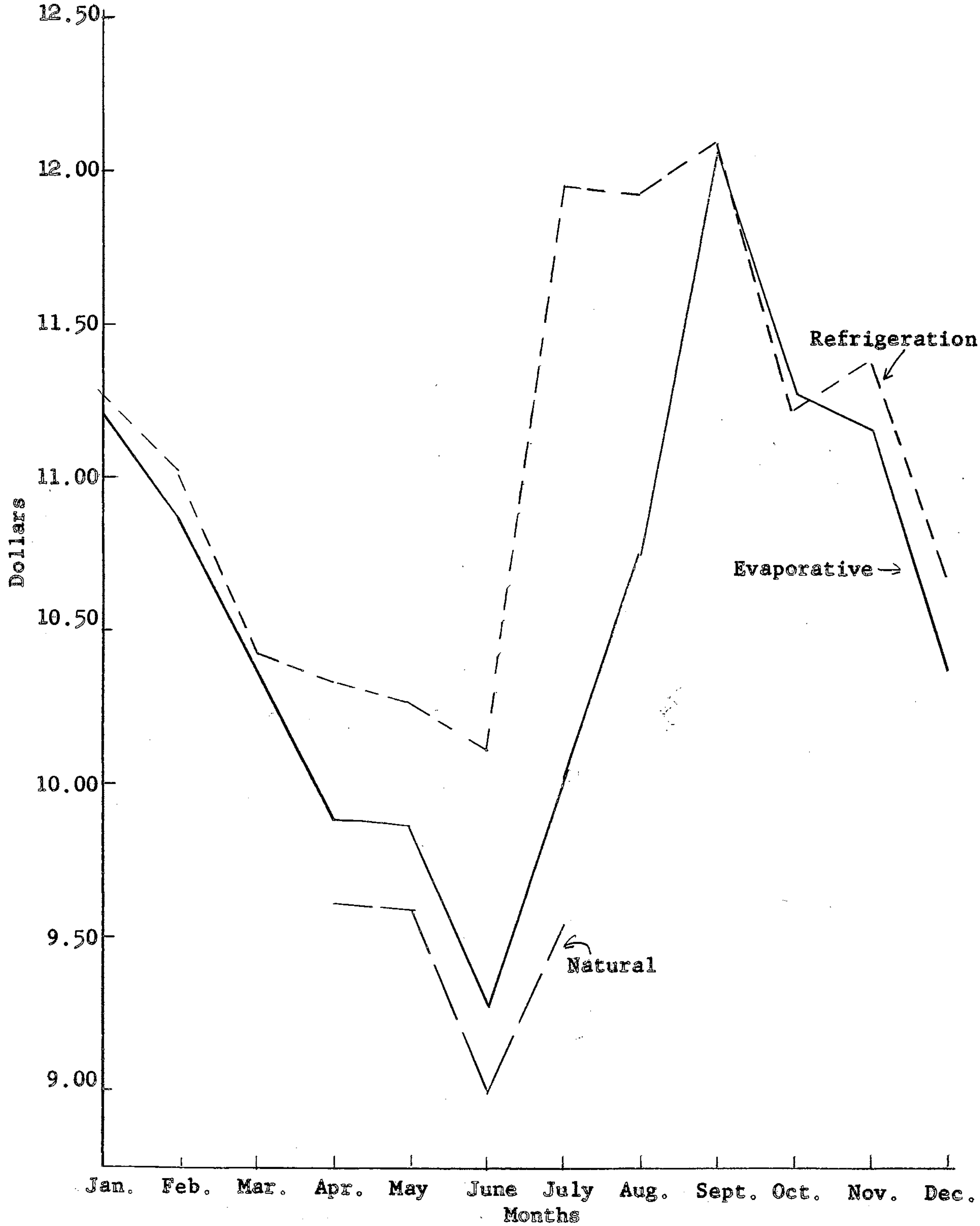

Figure 10. Net Returns Per Case Under Average Prices, for Different Holding Conditions and Weekly Marketing Using the 25-Case Cooler or the Equivalent

TABLE XXI

NET RETURNS PER CASE TO REFRIGERATION ABOVE THAT RECEIVED FOR EVAPORATIVE COOLING

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average	September-March Average	April-August Average
								(Dollars)							
HIGH															
7-Case															
Weekly	.13	.12	-.04	.25	.25	.42	1.61	1.61	.10	-.01	.31	.29	.39	.13	.74
25-Case															
Weekly	.10	.07	-.06	.22	.25	.37	1.59	1.16	.04	.01	.27	.25	.35	.10	.71
LOW															
7-Case															
Weekly	.27	.28	-.05	.80	.78	1.38	2.53	1.57	.11	-.02	.30	.40	.70	.18	1.41
25-Case															
Weekly	.23	.27	-.08	.77	.77	1.35	2.51	1.56	.06	-.05	.33	.36	.67	.18	1.39
AVERAGE															
7-Case															
Weekly	.18	.19	-.04	.48	.47	.86	1.92	1.23	.09	.02	.30	.31	.50	.14	.99
25-Case															
Weekly	.15	.17	-.07	.45	.44	.82	1.91	1.23	.05	-.40	.26	.29	.47	.11	.91

for March was a fraction of one percentage point more than for refrigeration. Likewise, added returns for October are near zero and negative for refrigeration. Grade distribution for refrigeration and non-refrigeration were quite close for the month of October and costs for refrigeration resulted in the negative results. The greatest additional net returns to refrigeration occurred for the month of July under all price situations. These high additional returns are the results of comparatively high prices for Grade A eggs for July and a difference in percentage of Grade A from refrigeration and evaporative cooling compared with other months. For July the Grade A percentage was 85.0 percent for refrigeration and 21.88 percent for evaporative cooling.

Impact of Frequency of Marketing (Quality Difference)

Net returns per case were computed for weekly marketing when eggs were cooled and held under the various holding conditions. Twice weekly marketing as an important economic factor in maximizing net returns were analyzed on a limited basis to indicate possible additional returns.

The Oklahoma Experiment Station did not provide grade distribution for twice weekly marketing. Texas experimental data for the months of April through July were used for this section. To provide net returns data on weekly and twice weekly marketing for comparison purposes, Grade A percentages were computed for the various holding conditions. Grade A percentages for weekly marketing were 83.0 percent for mechanical refrigeration, 48.2 percent for evaporative cooling and 33.4 percent for natural conditions. Grade A percentages for twice weekly marketing were 86.7 percent for mechanical refrigeration, 67.0 percent for evaporative cooling and 50.5 percent for natural conditions. Since the distribution for Grades B and C was not provided in the Texas data, all eggs other than Grade A were considered Grade B. Egg prices used in this analysis were for April through July and are identified as high, low and average.

Net returns per case for the 7-case cooler or equivalent, under the different holding conditions for weekly and twice weekly marketing were compared (Table XXII). Under mechanical refrigeration with average prices, net returns per case were $10.59 for weekly marketing and $10.76 for twice weekly marketing.

TABLE XXII

TOTAL NET RETURNS PER CASE UNDER DIFFERENT HOLDING CONDITIONS AND MARKETING SCHEDULES, 7-CASE COOLER OR EQUIVALENT

	Weekly Schedule			Twice Weekly Schedule		
	High	Low	Average	High	Low	Average
	(Dollars)					
Mechanical Refrigeration	13.47	10.08	10.59	13.58	10.25	10.76
Evaporative Cooler	13.09	9.19	10.12	13.38	9.75	10.47
Natural Conditions	13.02	8.91	9.99	13.23	9.36	10.26

Additional net returns per case for the 7-case cooler or equivalent within holding conditions for twice weekly marketing over weekly marketing were also compared (Table XXIII). With mechanical refrigeration the additional net returns per case to twice weekly marketing varied from 11 cents for high prices to 17 cents for average prices. Evaporative cooling varied from 29 cents for high prices to 56 cents for low prices, and natural conditions varied from 21 cents for high prices to 27 cents for average prices.

TABLE XXIII

ADDITIONAL NET RETURNS PER CASE FOR TWICE WEEKLY MARKETING WITHIN HOLDING CONDITIONS, 7-CASE COOLER OR EQUIVALENT

	High	Low	Average
		(cents per case)	
Mechanical Refrigeration	.11	.17	.17
Evaporative Cooling	.29	.56	.35
Natural Conditions	.21	.45	.27

The additional net returns per case for the 7-case cooler or equivalent, between holding conditions and once and twice weekly marketing, were also calculated (Table XXIV). The additional net returns per case to mechanical refrigeration for twice weekly marketing over evaporative cooling marketed weekly were 49 cents for high, $1.06 for low and 64 cents for average.

TABLE XXIV

ADDITIONAL NET RETURNS PER CASE BETWEEN HOLDING CONDITIONS AND ONCE AND TWICE WEEKLY MARKETING, 7-CASE COOLER OR EQUIVALENT

	High	Low	Average	Average within Twice-Weekly Marketing
		(dollars per case)		
Mechanical vs. Evaporative	.49	1.06	.64	.29
Mechanical vs. Natural	.56	1.34	.77	.50
Evaporative vs. Natural	.36	.84	.48	.21

Mechanical refrigeration compared with evaporative cooling for twice weekly marketing gave additional net returns of 29 cents. Refrigeration compared with natural gave 50 cents and evaporative cooling compared with natural gave added returns of 21 cents.

Net returns per case for the 25-case cooler or equivalent, under the varied holding conditions for once and twice weekly marketing were computed in Table XXV. The three price schedules were assumed for each holding conditions. Evaporative cooling for weekly marketing gave net returns per case under average prices of $10.20 and for twice weekly marketing $10.52.

TABLE XXV

TOTAL NET RETURNS PER CASE UNDER DIFFERENT HOLDING CONDITIONS AND MARKETING SCHEDULES, 25-CASE COOLER

	Weekly Schedule			Twice Weekly Schedule		
	High	Low	Average	High	Low	Average
			(Dollars)			
Mechanical Refrigeration	13.54	10.15	10.66	13.62	10.29	10.80
Evaporative Cooler	13.17	9.27	10.20	13.44	9.80	10.52
Natural Conditions	13.02	8.91	9.99	13.23	9.36	10.26

The additional net returns per case for the 25-case cooler or equivalent, for twice weekly marketing within holding conditions were also computed (Table XXVI). The additional net returns per case to twice weekly marketing for mechanical refrigeration varied from 8 cents for high to 14 cents for average. Evaporative cooling varied from 27 for high to 53 cents for low, and natural conditions varied from 21 cents for high to 27 cents for average.

TABLE XXVI

ADDITIONAL NET RETURNS PER CASE FOR TWICE WEEKLY MARKETING WITHIN HOLDING CONDITIONS, 25-CASE COOLER

	High	Low	Average
		(Dollars per Case)	
Mechanical Refrigeration	.08	.14	.14
Evaporative Cooling	.27	.53	.32
Natural Condition	.21	.45	.27

The additional net returns per case for the 25-case cooler or equivalent, between holding conditions and once and twice weekly marketing, were calculated (Table XXVII). The additional net returns per case to mechanical refrigeration for twice weekly marketing over natural holding conditions for weekly marketing were 60 cents for high, $1.38 for low, and 81 cents for average.

TABLE XXVII

ADDITIONAL NET RETURNS PER CASE BETWEEN HOLDING CONDITIONS AND ONCE AND TWICE WEEKLY MARKETING, 25-CASE COOLER

	High	Low	Average	Average within Twice Weekly Marketing
			(Dollars per Case)	
Mechanical vs. Evaporative	.55	.92	.60	.28
Mechanical vs. Natural	.60	1.38	.81	.54
Evaporative vs. Natural	.42	.89	.53	.26

The average additional net returns within twice weekly marketing for mechanical refrigeration compared with evaporative cooling resulted in added net returns of 28 cents. Refrigeration compared with natural conditions gave 54 cents and evaporative compared with natural gave 26 cents.

This analysis of additional net returns per case for twice weekly marketing over weekly marketing reflected increased net returns varying from 14 cents to 35 cents per case, depending upon size of flock and holding conditions. These net returns may have been greater if grade distribution provided information relative to the percentage of Grade C eggs. The difference in net returns to refrigeration from the two marketing schedules was relatively small, and other circumstances may have dictated the marketing schedule. For holding conditions other than refrigeration, the additional net returns were sufficiently high to warrant twice weekly marketing to maximize returns assuming constant marketing costs.

CHAPTER X

SUMMARY AND IMPLICATIONS

The major objective of this study was to determine the economic consequences of alternative holding conditions and frequency of marketing in order that the producer may make choices consistent with his goal. Basic data to achieving this objective were generated by an experiment designed to test and compare a 7-case and a 25-case farm egg cooler. Specifically, the holding conditions investigated were mechanical refrigeration, evaporative cooling and non-refrigeration or natural.

Necessary data for this study were generated by an experiment conducted jointly by the Department of Poultry Science and the Department of Agricultural Engineering at the Oklahoma Experiment Station. The experiment began December 1, 1955, and data were accumulated for the ensuing twelve months. In order to further investigate the implications of frequency of marketing, data were used from a Texas experiment for the months of April through July.

The impact of days held before marketing, as related to holding conditions, affected the percentage of Grade A eggs marketed. In particular, newly laid eggs held at 60° F. for seven days were still within the Grade A classification. However, eggs held at 90° F. for five days deteriorated 35 Haugh Units and were classified Grade B eggs.

The impact of holding conditions upon egg quality was investigated with eggs held under refrigeration, evaporative cooling and natural conditions. The eggs were candled and graded by a commercial egg handler. Egg candling slips identified treatment, grade and price, and were received after each weekly delivery. In order to investigate the impact of holding conditions upon egg quality, grade distribution by months and holding conditions were reported. The average annual percentages of Grade A eggs when refrigerated were 89.78 percent and when held under evaporative cooling and non-refrigeration were 77.14 percent. Grade A egg percentages under refrigeration in November were 94.98 percent and for non-refrigeration were 88.12 percent. Grade A egg percentages under refrigeration in July were 85.46 and for evaporative cooling 33.3 percent. This stressed the importance of artificial holding conditions during part of the year.

Technical energy requirements for the various holding conditions were generated through application of an equation developed by the Department of Agricultural Engineering. Original costs of equipment and a relevant depreciation schedule were developed to determine fixed cost per dozen eggs under the various holding conditions when coolers were used to capacity. Applying appropriate prices, variable costs were ascertained on a per dozen egg basis under the different holding conditions, by months. Average fixed and variable costs per dozen eggs cooled and held in the 25-case cooler for the period April through August were 0.0008 and 0.0032 cents, respectively. Average fixed and variable costs per dozen eggs for evaporative cooling, equivalent to the 25-case cooler, for April through August were 0.0005 and 0.0018 cents, respectively. Average total cost per dozen eggs cooled and held, with the 25-case cooler during the period September through March, was 0.0017 cents.

Seasonal egg prices for high, low and average price levels were estimated and applied to grade distribution by months to obtain total returns under all holding conditions. Egg prices were generated by the simple average method of indexes of prices to producers for the 6-year period, 1952-1957, inclusive. Total returns were converted to a per case basis for all holding conditions, marketing schedules, price levels and production periods. Total returns per case for the period, April through August, for refrigeration under the three price situations were $14.02, $10.52 for low and $11.06 for average. Total returns per case for evaporative cooling during the same period were $13.17 for high, $9.01 for low and $9.98 for average.

Fixed and variable costs were applied to total returns, resulting in net returns per case under the alternative holding conditions for weekly marketing. Based on the Texas data for April through July, additional net returns possible from twice weekly marketing were investigated. Comparisons were made of the net returns for alternative holding conditions, and additional net returns per case accruing to refrigeration were computed. The additional net return per case to refrigeration compared with evaporative cooling with the 7-case cooler for July, under low prices, was $2.53. The additional net return to refrigeration compared with non-refrigeration with the 7-case cooler for February under high prices was 12 cents.

The implications of this study for decision making by the egg producer largely involves the choices relating to holding condition and frequency of marketing. With the objective of maximizing net returns, the producer is concerned with those practices which will improve his position in a highly competitive enterprise. As shown by this study, a farm egg cooler of proper design and size may be used to increase net returns during the warm weather months of April through August. The magnitude of the additional returns to refrigeration during the summer months points up the economic impact of choices relating to holding conditions.

The selection of refrigeration compared with non-refrigeration during the months of September through March adds little to the total net returns. Where non-refrigeration is practiced, the producer can maximize returns by taking advantage of natural temperature conditions prevailing during the cool weather months and holding eggs at a temperature between 29° and 60° F.

As flock size increased from 400 to 2,400 hens, fixed and variable costs per case for refrigeration and evaporative cooling decreased and greater net returns accrued to the producer.

The marketing schedule selected is closely related to the holding condition chosen. With evaporative cooling and natural conditions during warm weather months, net returns are expected to increase in relation to frequency of marketing. With refrigeration during the warm months and with or without refrigeration during the cool months, a slightly higher percent of Grade A eggs are expected from twice weekly marketing. With refrigeration very little differences are expected in net returns per case between weekly and twice weekly marketing.

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APPENDIX

NET RETURNS DATA FOR WEEKLY AND TWICE WEEKLY MARKETING

APPENDIX TABLE I

NET RETURNS PER CASE TO REFRIGERATION, FOR THREE PRICE LEVELS AND DIFFERENT MARKETING SCHEDULES

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						(Dollars)						
HIGH												
7-Case												
Weekly	14.25	13.88	13.16	13.01	13.02	12.77	15.09	15.09	15.25	14.10	14.30	13.37
Twice weekly	14.30	13.93	13.21	13.07	13.10	12.87	15.19	15.20	15.35	14.17	14.35	13.42
25-Case												
Weekly	14.31	13.84	13.22	13.06	13.10	12.80	15.16	15.18	15.27	14.17	14.34	13.42
Twice weekly	14.33	13.87	13.24	13.10	13.13	12.87	15.22	15.24	15.34	14.21	14.37	13.44
LOW												
7-Case												
Weekly	10.83	10.55	9.87	9.82	9.64	9.51	11.29	11.27	11.57	10.70	10.86	10.21
Twice weekly	10.88	10.60	9.92	9.88	9.72	9.61	11.39	11.38	11.67	10.77	10.91	10.26
25-Case												
Weekly	10.88	10.54	9.92	9.87	9.72	9.56	11.36	11.34	11.60	10.77	10.97	10.26
Twice weekly	10.90	10.57	9.96	9.91	9.77	9.63	11.42	11.39	11.63	10.81	11.00	10.28
AVERAGE												
7-Case												
Weekly	11.29	11.02	10.37	10.28	10.20	10.03	11.88	11.85	12.07	11.16	11.36	10.62
Twice weekly	11.34	11.07	10.42	10.34	10.28	10.13	11.98	11.96	12.17	11.23	11.41	10.67
25-Case												
Weekly	11.35	11.04	10.43	10.33	10.27	10.08	11.96	11.93	12.11	11.23	11.40	10.68
Twice weekly	11.37	11.07	10.45	10.37	10.30	10.15	12.02	11.99	12.18	11.27	11.43	10.70

APPENDIX TABLE II

NET RETURNS PER CASE TO EVAPORATIVE COOLING, FOR THREE PRICE LEVELS AND DIFFERENT MARKETING SCHEDULES

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						(Dollars)						
HIGH												
7-Case												
Weekly	14.12	13.76	13.20	12.76	12.77	12.35	13.48	13.93	15.15	14.11	13.99	13.08
Twice weekly	14.17	13.81	13.25	12.81	12.82	12.40	13.53	13.98	15.20	14.16	14.04	13.13
25-Case												
Weekly	14.21	13.77	13.28	12.84	12.85	12.43	13.57	14.02	15.23	14.16	14.07	13.17
Twice weekly	14.23	13.79	13.30	12.86	12.87	12.45	13.59	14.04	15.25	14.18	14.09	13.19
LOW												
7-Case												
Weekly	10.56	10.27	9.92	9.02	8.86	8.13	8.76	9.70	11.46	10.72	10.56	9.81
Twice weekly	10.61	10.32	9.97	9.07	8.91	8.18	8.81	9.75	11.51	10.77	10.61	9.86
25-Case												
Weekly	10.65	10.27	10.00	9.10	8.95	8.21	8.85	9.78	11.54	10.82	10.64	9.90
Twice weekly	10.67	10.29	10.02	9.12	8.97	8.23	8.87	9.80	11.56	10.84	10.66	9.92
AVERAGE												
7-Case												
Weekly	11.11	10.83	10.41	9.80	9.73	9.17	9.96	10.62	11.98	11.18	11.06	10.31
Twice weekly	11.16	10.88	10.46	9.85	9.78	9.22	10.01	10.67	12.03	11.23	11.11	10.36
25-Case												
Weekly	11.20	10.87	10.50	9.88	9.83	9.26	10.05	10.70	12.06	11.27	11.14	10.39
Twice weekly	11.22	10.89	10.52	9.90	9.85	9.28	10.07	10.72	12.08	11.29	11.16	10.41

APPENDIX TABLE III

AVERAGE NET RETURNS PER CASE FOR HIGH, LOW AND AVERAGE PRICE PERIODS UNDER DIFFERENT HOLDING CONDITIONS AND MARKETING SCHEDULES

	HIGH				LOW				AVERAGE			
	7-Case		25-Case		7-Case		25-Case		7-Case		25-Case	
	Weekly	Twice Weekly	Weekly	Twice Weekly	Weekly	Twice Weekly	Weekly	Twice Weekly	Weekly	Twice Weekly	Weekly	Twice Weekly
	(Dollars)											
REFRIGERATION												
Annual Average	13.94	14.01	13.98	14.03	10.51	10.58	10.56	10.60	11.01	11.08	11.06	11.10
September-March Average	14.04	14.10	14.08	14.11	10.65	10.71	10.72	10.73	11.12	11.18	11.17	11.21
April-August Average	13.79	13.88	13.85	13.91	10.30	10.39	10.37	10.43	10.84	10.93	10.85	11.96
EVAPORATIVE												
Annual Average	13.55	13.60	13.63	13.65	9.81	9.86	9.89	9.91	10.51	10.56	10.59	10.61
September-March Average	13.91	13.96	13.98	13.98	10.47	10.52	10.54	10.56	10.98	11.03	11.06	11.08
April-August Average	13.05	13.10	13.14	13.16	8.89	8.94	8.98	9.00	9.85	9.90	9.94	9.96

APPENDIX TABLE IV

NET RETURNS PER CASE TO REFRIGERATION ABOVE THAT RECEIVED FOR EVAPORATIVE COOLING

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average	September-March Average	April-August Average
								(Dollars)							
HIGH															
<u>7-Case</u>															
Weekly	.13	.12	-.04	.25	.25	.42	1.61	1.16	.10	-.01	.31	.29	.39	.13	.74
Twice weekly	.13	.12	-.04	.26	.28	.47	1.66	1.22	.15	.01	.31	.29	.41	.14	.78
<u>25-Case</u>															
Weekly	.10	.07	-.06	.22	.25	.37	1.59	1.16	.04	.01	.27	.25	.35	.10	.71
Twice weekly	.10	.08	-.06	.24	.26	.42	1.63	1.20	.09	.03	.28	.25	.38	.13	.75
LOW															
<u>7-Case</u>															
Weekly	.27	.28	-.05	.80	.78	1.38	2.53	1.57	.11	-.02	.30	.40	.70	.18	1.41
Twice weekly	.27	.28	-.05	.91	.81	1.43	2.58	1.63	.16	.00	.30	.40	.72	.19	1.45
<u>25-Case</u>															
Weekly	.23	.27	-.08	.77	.77	1.35	2.51	1.56	.06	-.05	.33	.36	.67	.18	1.39
Twice weekly	.23	.28	-.06	.79	.80	1.40	2.55	1.59	.07	-.03	.34	.36	.69	.17	1.43
AVERAGE															
<u>7-Case</u>															
Weekly	.18	.19	-.04	.48	.47	.86	1.92	1.23	.09	.02	.30	.31	.50	.14	.99
Twice weekly	.18	.19	-.04	.49	.50	.91	1.97	1.29	.14	.00	.30	.31	.52	.15	1.03
<u>25-Case</u>															
Weekly	.15	.17	-.07	.45	.44	.82	1.91	1.23	.05	-.4	.26	.29	.47	.11	.91
Twice weekly	.15	.18	-.07	.47	.45	.87	1.95	1.27	.10	-.02	.27	.29	.49	.13	1.00

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