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Factors Affecting Egg Quality

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SUMMARY

Breeding

Egg quality is inherited and any marked or permanent improvement will have to be brought about by selective breeding. Some progress may be made through selection of hatching eggs, but much faster progress can be made through selection of breeding stock. Progress can be made through the use of pedigreed male birds and the application of the progeny test and family averages.

Feeding

In general, the type of ration that will give good production will produce eggs of good quality. Yolk color is influenced by the amount of green feeds and yellow corn in the ration. The amount of thick and thin albumen an egg contains at the time it is laid is an inherited characteristic and is not influenced by feed. Thin-shelled eggs may be caused by lack of minerals, lack of vitamin D, improper balance of these ingredients, and high temperatures.

Management

Cleaner and more uniform eggs will be produced if the laying flock is confined and the laying house and nests are kept clean. Eggs should be gathered three or four times a day and cooled immediately before they are cased. Eggs should be marketed at least twice a week during warm weather. They should be held in an egg-storage room at a temperature ranging from 40 to 65 degrees with a relative humidity above 80 per cent. Market eggs should be infertile. Hatching eggs should be cared for in a similar manner as market eggs in order to obtain high hatchability.

Storage

The egg room should be insulated. A humidifier, with an electric fan and excelsior pad, is effective in lowering temperatures and in maintaining high relative humidity in the egg room. The humidifier fan can be operated continuously at a cost ranging between 60 and 90 cents per month. The evaporator cooler can be constructed on the farm from plans shown in this bulletin. Eggs placed in a wire tray in the humidified egg room will cool to room temperature in 3½ hours; eggs placed in metal or wire buckets require 12 to 18 hours to cool to room temperature.

Factors Affecting Egg Quality

By

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INTRODUCTION

OREGON produces a surplus of commercial eggs, which must be sold outside of the State in competition with eggs from other producing areas. The industry, therefore, has of necessity been built on a quality basis. Less than 60 per cent of the market eggs produced, however, qualify for the top grades, a fact that indicates there is room for much improvement in the production and preservation of egg quality through better breeding and farm holding conditions.

The egg is a very perishable article of food. The income of the producer depends on the egg reaching the consumer with as much of its original quality as possible. The quality of the egg is never improved after it is laid. It is lowered very quickly by many factors of management and by being exposed to high temperatures and low humidity. Any farmer who produces a surplus of eggs that must enter the channels of trade should provide suitable farm storage holding conditions for preserving the original quality of the eggs.

A farm egg-storage room or its equivalent should not be considered as an expense. It is a necessary piece of equipment, an investment that will pay dividends to the owner and to the industry.

In producing and maintaining egg quality, three major problems are involved: breeding, feeding, and care of the eggs after they are produced.

EFFECT OF BREEDING ON EGG QUALITY

Egg quality inherited. There are at least five inherited characteristics that have a bearing on egg quality. They are: egg size, egg shape, shell color, shell texture, and interior quality. Any marked or permanent improvement of any one or all of these characters will have to be brought about by selective breeding.

Selecting hatching eggs. There is some correlation between the type of egg a chick comes from and the type of egg the chick will produce when mature. For this reason, only first-grade eggs should be used for hatching.

Egg size, shape, and color have nothing to do with the interior quality, but they do have a direct bearing on the grade. Therefore, undersized, odd-shaped, or off-colored eggs should be eliminated when hatching eggs are selected.

Shell texture is influenced considerably by high temperatures and type of ration fed. Some hens produce eggs with much better shells than others under the same environment, a fact which indicates shell texture may be influenced by heredity. For this reason, eggs with poor shells should be rejected as hatching eggs.

Acknowledgments: The authors wish to express appreciation to W. T. Cooney and H. E. Cosby, of the Poultry Department, and C. I. Branton and Raymond Pederson, of the Agricultural Engineering Department, for their assistance in conducting the research and in compiling the results for publication.

Various research workers have indicated that the percentage of thick and thin albumen an egg contains at the time it is laid is an individual characteristic of the bird and is inherited. Some breeders and hatcherymen make a practice of candling eggs before they go into the incubator. When this is done, eggs with a thin watery albumen and loose mobile yolk can be eliminated.

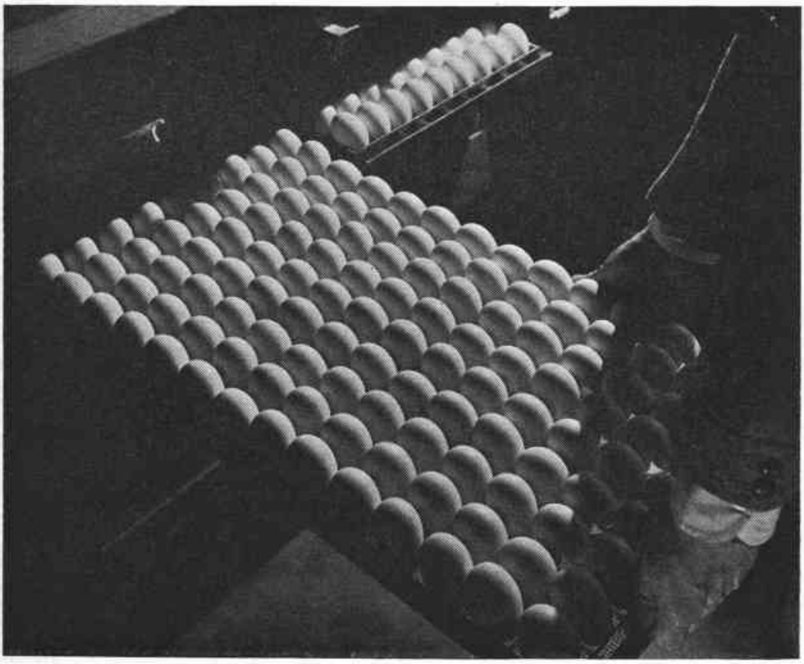

Figure 1. Only first-grade eggs should be used for hatching.

Selecting breeding stock. While some progress may be made in egg quality through the selection of hatching eggs, much faster and more permanent progress can be made if selection is practiced on the breeding stock. With such a program, pedigreed birds should be used, or at least pedigreed males. In commercial breeding, flocks in which pedigreed birds are not used, occasionally a flock will be found producing especially high-quality eggs. Such flocks, when discovered, should be perpetuated. Hatcherymen and breeders should be encouraged to study egg quality as revealed through the candle and the opened egg when selecting breeding stock.

Inasmuch as these various egg-quality characteristics are inherited, both the male and female have an influence on the quality of eggs their offspring will produce. In breeding for egg quality, however, the influence of the male bird is often overlooked.

Research workers from the U. S. Department of Agriculture Research Center at Beltsville, Maryland, report that by selecting breeding males on the basis of their sisters' and daughters' egg weights, the average egg weight of the female offspring was steadily improved. The average egg weight was increased from 21.9 ounces in December 1934 to 24.6 ounces in December 1938. In 4 years of this kind of selective breeding, pullets have been developed that lay fewer small eggs when they start to lay and produce eggs that have averaged higher in weight for the first year of lay. Improvement in other characteristics, such as shell color, shell texture, and interior quality, can no doubt be made through the use of pedigreed males.

Progeny test and family averages. If pedigreed males or females are being used in the breeding pens, the progeny test, or family averages, or both, should be taken into consideration. The progeny test is judging the breeding value of an animal by the performance of its offspring. This is the only way to measure the true breeding value of any animal. If information on the progeny test is not available, family averages should be the next consideration. For example, the type of eggs a male bird's sisters produce is a good indication of the egg characteristics he will transmit to his offspring. The family averages of the ancestors should also be taken into consideration when selecting pedigreed breeders.

Body size and egg size. It has been demonstrated that there is a correlation of body size and egg size within the breed. Within the breed, the larger birds have a tendency to produce the largest eggs. They not only produce larger eggs, but on the average they are better producers. In selecting breeding stock, body size, equal to or slightly above standard weight, should be taken into consideration.

Abnormal eggs. A few freak eggs such as dwarf eggs, double-yolked eggs, eggs within eggs, and abnormally shaped eggs may be produced under any system of breeding, feeding, or management. The laying of such eggs is the result of some abnormal disturbance of the reproductive organs. As a rule, the production of abnormal eggs is not a serious economic problem and is not inherited.

Occasionally a blood or meat spot will be found in an egg. A blood spot is generally caused by a slight hemorrhage at the time the yolk is released from the ovary. A meat spot is the result of a piece of tissue or some foreign material having found its way into the oviduct and appearing as a piece of tissue or meat spot floating in the albumen. Such eggs are considered unfit for food and should be eliminated in candling.

EFFECT OF FEEDING ON EGG QUALITY

Balanced rations. Generally speaking, well-balanced rations designed for high egg production will produce eggs of good quality. The usual procedure in feeding laying hens is to keep a laying mash, oyster shell, and grit, before the birds at all times. In addition, they are fed what scratch grains they will clean up in the evenings, with a light feeding of scratch grain in the mornings.

Yolk color. One of the most desirable characteristics in first-grade eggs is uniformity. Variation in yolk color is the most noticeable characteristic of eggs that is influenced by the ration. The principal yellow pigment of the yolk is found most abundantly in green feeds and yellow corn. If the total ration does not contain more than 20 to 30 per cent corn and more than 5 per cent alfalfa, the yolks will be uniform in color and not too dark.

Thick and thin albumen. The amount of thick and thin albumen an egg contains at the time it is laid is an inherited characteristic and is not influenced by the type of ration fed. High temperatures and low humidity are potent factors in changing the thick albumen to thin watery albumen after the egg is laid. These factors, along with heredity, apparently account for the variation found in the condition of the albumen.

Thin watery whites are sometimes associated with the feeding of succulent green feeds. Large quantities of green feed will produce dark-colored yolks, often referred to as "grass eggs," but experimental results indicate that it does not influence the condition of the albumen.

Thin- and soft-shelled eggs. Thin-shelled eggs may be caused by lack of calcium or vitamin D in the ration. Approximately 95 per cent of the shell is calcium carbonate; thus an ample supply of calcium must be available to the hen either in the form of oyster shell, limestone grit, or calcite, all of which are high in calcium. In order that a hen may assimilate this calcium a sufficient amount of vitamin D must be present in the feed or obtainable through the sunlight. Although an adequate supply of calcium and vitamin D is necessary to produce shells of good quality, there is no indication that excessive feeding of them will improve shell texture.

High temperatures during the summer months also have an influence on shell texture. When the temperature rises above 80 degrees, there is a sharp reduction in egg size and the shells become thinner and more fragile. Birds kept in a cool, insulated, well-ventilated house during summer months will produce shells of better quality.

A soft-shelled egg is one that has been laid prematurely and before the secretion of shell material in the uterus. This may be caused by the shell gland failing to function or may occur before the reproductive organs become properly adjusted when a bird first starts to lay. There is no positive preventive of all soft-shelled eggs. When a well-balanced ration is fed and a well-planned system of management is followed, the number of soft-shelled eggs will be small and unimportant.

Off-flavored eggs. Off-flavored eggs may usually be traced to the type of ration fed or to faulty storage conditions. Occasionally some individual hen will continue to produce off-flavored eggs regardless of the feed and care of the eggs. Such a condition, however, is seldom encountered. Rape, turnips, onions, fat fish, or fish oils of poor quality, if fed in excess, may produce eggs with an off-flavor or bad odor. If a laying flock has free range, especially if it has access to a barnyard, there will be a wide variation in the quality of the eggs produced, which will often include strong or off-flavored eggs. Undesirable flavors will be absorbed by eggs held if they come in contact with strong odors.

EFFECT OF MANAGEMENT ON EGG QUALITY

Clean eggs essential for quality. One of the most important problems in poultry keeping is the production of clean eggs. Stained or dirty eggs are unattractive in appearance and must always be sold at a discount. Dirty eggs will spoil much more quickly than clean eggs. When the egg is laid, it is protected with a "bloom" called the cuticle. If the egg is soiled and then washed, scraped, wiped, or cleaned with a sand blaster, the cuticle is destroyed, which increases the opportunities for bacteria or molds to penetrate the shell pores and cause spoilage.

In order to reduce the number of dirty eggs, the laying house and nests must be kept clean. There should be at least one nest for every five hens. The nests should be well littered with rice hulls, straw, shavings, or excelsior, and the material used should be changed frequently to insure freedom from odors and filth. There should be wires or screen netting under the perches to keep the birds from walking in the droppings. If the birds have clean feet, they will not be so apt to soil the eggs. If the flock is confined or provided with a wire sun porch, cleaner eggs will be produced. Dirty eggs should be cleaned; but much time and labor will be saved and quality improved if clean eggs are produced.

Gather often and cool immediately. The interior quality of warm or heated eggs deteriorates rapidly. Eggs should be gathered three to four times a day to preserve the original quality and prevent them from getting dirty. If eggs remain in the nest during warm weather, or if several eggs are laid in the same nest, the quality is rapidly reduced. Wire pails that are kept clean make desirable egg baskets.

The sooner eggs are cooled after they are laid, the better the quality will be. Eggs should not be cased until they have been completely cooled. Trials conducted at the Oregon Experiment Station show that a single layer of eggs on a wire tray cool at a much faster rate than eggs in a wire basket, galvanized pail, or a chilled egg case. (See Figure 15.)

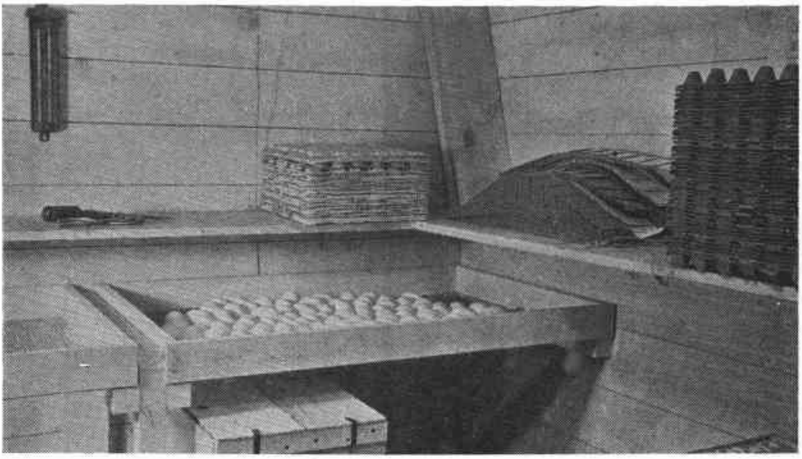

Figure 2. Eggs should be placed in a single layer on a wire tray to cool before they are cased.

Time, temperature, and humidity important factors. The three most important factors in preserving quality after the eggs are laid are time, temperature, and humidity. Eggs are a perishable product and unless given proper care deteriorate very rapidly. The sooner eggs are marketed, the better the quality will be. With proper environment, however, the quality can be maintained for a considerable length of time. During summer months, eggs should be marketed at least twice a week. They should be protected from high temperatures and low humidity while held on the farm or in transit to market. In order to preserve the original quality, eggs should be kept at a temperature ranging from 40° to 65° F. with a relative humidity above 80 per cent.

When the temperature is high and humidity low, the deterioration that takes place in the egg is greatly increased. Under these conditions, the thick albumen is changed to a thin, watery albumen; bacteria, if present, multiply rapidly; the passage of water from the albumen to the yolk is increased; and evaporation, which increases the size of the air cell, takes place at a rapid rate. Experimental results indicate that high humidity is even more important than low temperature in preserving egg quality.

Rough handling lowers quality. A new-laid egg is made up of three layers of albumen, an outer layer of thin white, a middle layer of thick white, and an inner layer of thin white. The outer layer makes up about 22 per cent of the albumen by weight, the inner layer about 25 per cent, and the middle layer of thick white about 53 per cent. Rough handling of eggs has a tendency to break down these partitions between the layers of thick and thin albumen, causing the thick white to become diluted with the thin white. Rough handling of eggs has a tendency to increase the number of tremulous air cells, which is a factor in reducing the number of first-grade eggs. A tremulous air cell is a dislocated or movable air cell. A normal air cell is located in the large end of the egg between the two shell membranes and is free from any movement.

Market eggs should be infertile. Cell division will take place in a fertile egg when the temperature is above 68° F. When this occurs, the quality deteriorates rapidly. It is much easier to preserve quality with infertile eggs. Male birds should never be allowed in the laying flock except when hatching eggs are desired.

Proper care of hatching eggs essential. In general, hatching eggs should be cared for in a manner similar to that described for market eggs. When eggs are held longer than 7 days, there is a slight reduction in hatchability and after 14 days, the reduction increases quite rapidly. Hatching eggs

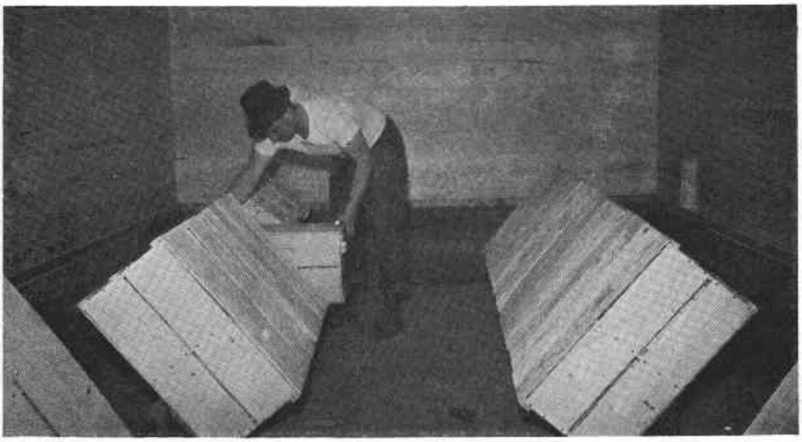

Figure 3. Hatching eggs should be held in an egg-storage room and turned daily if held longer than a week.

should be gathered often, cooled immediately, and kept at a temperature between 40° and 65° F., with a humidity above 80 per cent. When fertile eggs are exposed to temperatures above and below 68 degrees, cell division will first start and then stop, which may reduce hatchability, as some embryos may die before the eggs ever go into the incubator. Some eggs that are taken out of the incubators as infertile may be eggs in which the embryos died while being held for hatching or during early stages of incubation. Some of the reduction in fertility and hatchability that occurs during the latter part of the hatching season and when warm weather approaches is due to improper care of the hatching eggs. Hatching eggs should be turned daily if held longer than a week. (See Figure 3.)

EFFECT OF STORAGE CONDITIONS ON EGG QUALITY

Egg grades improved by proper storage. Table 1 emphasizes the advantage of holding eggs in a humidified egg-storage room in comparison with eggs held in a feed room and in an unhumidified egg-storage room.

In this experiment the humidified egg-storage room was 5 by 10 feet, with double walls and ceiling lined with sawdust and equipped with a cooler and humidifier as described elsewhere in this publication. The unhumidified egg-storage room was similarly constructed except that it was not equipped with a cooler and humidifier. The feed room was 10 by 20 feet, located in one end of a laying house. The eggs were gathered four times a day, divided into three lots and allowed to cool over night in their respective holding rooms before they were cased.

Three trials were conducted and the eggs were held 5, 8, and 6 days respectively. The cases were numbered 1, 2, 3, and unidentified as to holding conditions when candled. The eggs were graded by the same commercial candler.

Of the eggs held in the humidified egg-storage room on the average 63.61 per cent qualified for AA grade; 34.07 per cent qualified for AA grade in the unhumidified egg-storage room; and only 23.43 per cent qualified for AA grade in the feed room.

The large reduction of first-grade eggs held in the feed room and unhumidified room in the second trial was apparently due to increased length of time the eggs were held. Eggs in the humidified room continued to maintain their quality during this period.

As indicated in Table 1, the average relative humidity was 23 per cent higher in the humidified egg room than in the unhumidified storage room and 31 per cent higher than in the feed room. The average maximum daily temperature was 4° lower in the humidified room than in the unhumidified room and 14° lower than in the feed room. This is particularly significant since the unhumidified room was located on the first floor of a two-story poultry house, whereas the humidified storage room was located in a much warmer one-story poultry house.

Construction of an insulated egg room. The egg room should be located close to the laying house for convenience in placing the eggs in cool storage immediately after each gathering. Frequently one end of the laying house is used for an egg-storage room. A well-constructed room where the temperature can be maintained at from 40° to 65° F. and the relative humidity can be held at 80 per cent or above is particularly important in maintaining

Table 1. FARM EGG-STORAGE CONDITIONS AND THEIR EFFECT ON EGG GRADES.

	Days eggs held	Number of eggs	U. S. egg grades				
			AA	A	B	C	Chex
			Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Eggs held in feed room (Average relative humidity 52%, average maximum temperature 80° F.)							
Trial No. 1	5	360	35.28	56.67	5.83	0.83	1.39
Trial No. 2	8	360	1.67	31.67	66.67	.00	.00
Trial No. 3	6	360	33.33	46.66	20.00	.00	.00
Average	....	......	23.43	45.00	30.83	.28	.46
Eggs held in unhumidified egg-storage room, 2-story building (Average relative humidity 60%, average maximum temperature 70° F.)							
Trial No. 1	5	360	47.22	49.44	2.50	0.83	0.00
Trial No. 2	8	360	3.33	43.33	53.33	.00	.00
Trial No. 3	6	360	51.66	40.00	6.66	.00	1.66
Average	....	......	34.07	44.26	20.83	.28	.56
Eggs held in humidified egg-storage room, 1-story building (Average relative humidity 83%, average maximum temperature 66° F.)							
Trial No. 1	5	360	62.50	34.44	1.67	0.28	1.11
Trial No. 2	8	360	61.67	35.00	1.67	1.67	.00
Trial No. 3	6	360	66.66	26.66	6.66	.00	.00
Average	....	......	63.61	32.04	3.33	.65	.37

egg quality. The egg room should be insulated to give best results. Matched siding or shiplap can be used on the exterior walls of the room and the interior lined with matched lumber or plywood. This is nailed to the vertical studding and dry sawdust or shavings can be used as insulation material to fill the space between the inner and outer walls. It is important that the insulation material be dry before being placed in the wall. Ceiling insulation is important and should be similar to the walls. If a dry, inexpensive, insulation material is not available the egg room can be lined with ½-inch insulation board. This will not be equal to the dry shavings or sawdust, but should be very satisfactory.

The egg room should have two 10-inch-square ventilation holes, preferably on the north side of the room. One should be located near the floor and one near the ceiling. They should be screened on the outside and have sliding doors on the inside.

The entrance door can be made up on the farm with 6-inch flooring on the outside and plywood or insulation board on the inside with one or two layers of building paper between. Diagonal bracing would be required. The door should fit tight against the jam to prevent air leakage.

The size of the room should be approximately 5 × 10 feet for twice-a-week egg delivery for flocks of 1,500 to 2,000 birds.

Cooling and humidifying the egg room. During the summers of 1939 and 1940 tests were conducted at the Oregon Agricultural Experiment Station to determine the effectiveness of a water evaporator cooler for maintaining satisfactory temperature and relative humidity in an insulated egg room. This cooling and humidifying unit consists of an electric fan that is used to draw the air through a 4-inch pad of excelsior that is kept wet by a water-drip trough located above the pad. As the outside warm air is drawn through this wet pad it is cooled principally by the evaporation of water into the air that is drawn through the wet excelsior pad and discharged into the egg room. This process increases the relative humidity and cools the air in the egg room.

Records of the temperature and relative humidity in the insulated egg room and in the adjacent feed room were kept from June 17 to July 13, 1940. Records were taken at 4:00 p. m. daily in order to check on the temperature and humidity during the warmest part of the day. (See Table 2 and Figure 4.)

During most of this time the temperature and relative humidity were also recorded for each 24-hour day by the use of graphic instruments. (See Figures 5, 6, and 7.)

During this 27-day test in the egg room the average relative humidity at 4:00 p. m. was approximately 80 per cent and the average temperature was 65.3° F., while at the same time in the feed room the average relative humid-

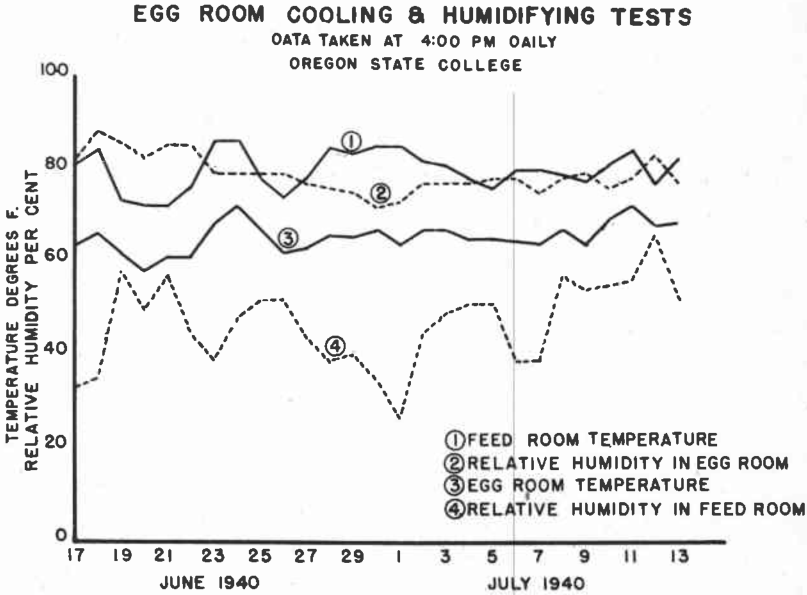

Figure 4.

ity was 45.8 per cent and the temperature was 79.3° F. The egg room was 10° to 20° cooler than the adjacent feed room during the warmest part of the day. (See fourth column, Table 2.)

Table 2. TEMPERATURE AND RELATIVE HUMIDITY DATA EGG ROOM WITH EVAPORATOR COOLER V. S. FEED ROOM, OREGON STATE COLLEGE

Date	Temperature at 4:00 p. m. daily			Relative humidity at 4:00 p. m. daily			Maximum daily temperature		
	Feed room	Egg room	Difference	Feed room	Egg room	Difference	Feed room	Egg room	Difference
	Degrees F.	*Degrees F.*	*Degrees*	*Per cent*	*Per cent*	*Per cent*	*Degrees F.*	*Degrees F.*	*Degrees*
June 17	81	63	18	33	82	49	81	66	15
18	83.5	65.5	18	34	89	55	87	67	20
19	72.5	62.5	10	58	85	27	73	62.5	10.5
20	71.5	58	13.5	49	82.5	33.5	72	60.5	11.5
21	71.5	61	10.5	57	85	28	72	62	10
22	76	61	15	45	84.5	39.5	76	64.5	11.5
23	86	67	19	39	79	40	86	69	17
24	86	71.5	14.5	48	78.5	30.5	89	72	17
25	78.5	67.5	11	52	79	27	80.5	69	11.5
26	74	62	12	52	79	27	74	63	11
27	78	62.5	15.5	44	77	33	78	64.5	13.5
28	84	66	18	39	76	37	85	69	16
29	83.5	65.5	18	40	75	35	84	69	15
30	85	67	18	35	72	37	85	67	18
July 1	75	64	11	26.5	73	46.5	81	66	15
2	81.5	67	14.5	45	77	32	82	67.5	14.5
3	81	66.5	14.5	49	76.5	27.5	83	67	16
4	78	65	13	51	77	26	79.5	65	14.5
5	76	65	11	51	78	27	78	65	13
6	80	64.5	15.5	39	78	39	80	66	14
7	80	64	16	39	75	36	81	66.5	14.5
8	79	67	12	57	78	21	80	67.5	12.5
9	77.5	64	13.5	54	79	25	78	67	11
10	81	69	12	55	76	21	84.5	69.5	15
11	84	71.5	12.5	56	78	22	85.5	72	13.5
12	76	68	8	65.5	82.5	17	77	69	8
13	82	68.5	13.5	52	77	25	82	70.5	11.5

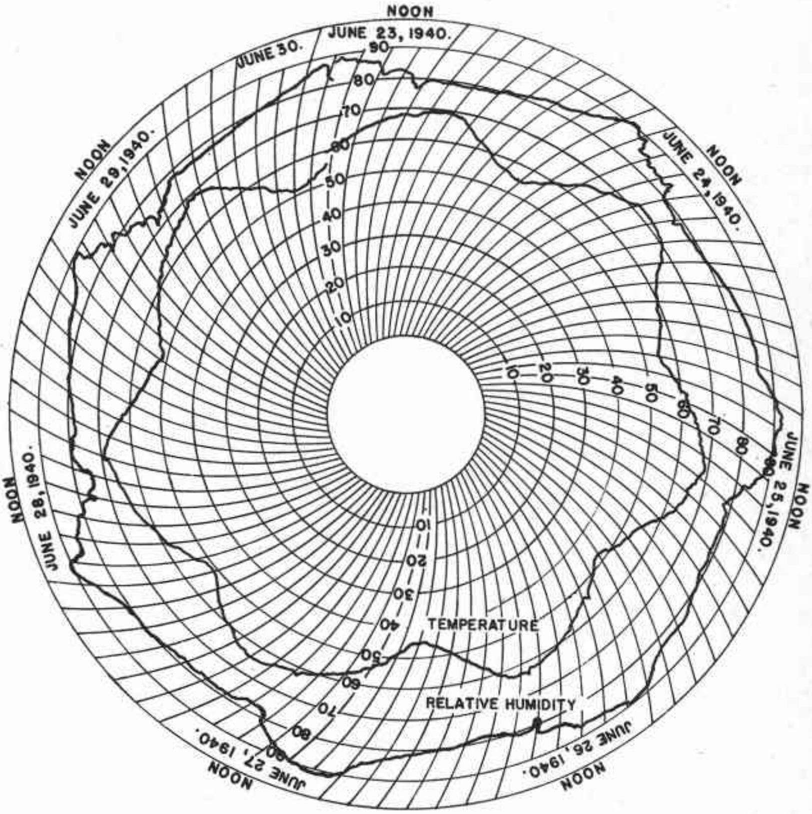

Figure 5. A record of the temperature and relative humidity conditions within the egg-storage room from June 23 to June 30, 1940.

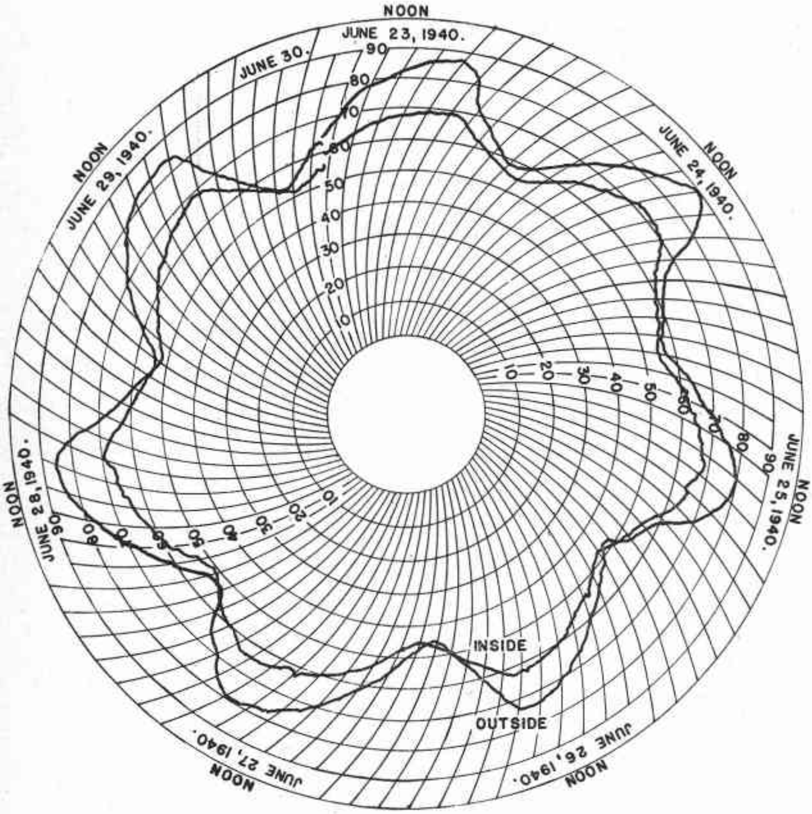

Figure 6. A comparison of the temperature inside the egg-storage room with the temperature in the adjacent feed room. Inside refers to egg room and outside refers to the adjacent feed room.

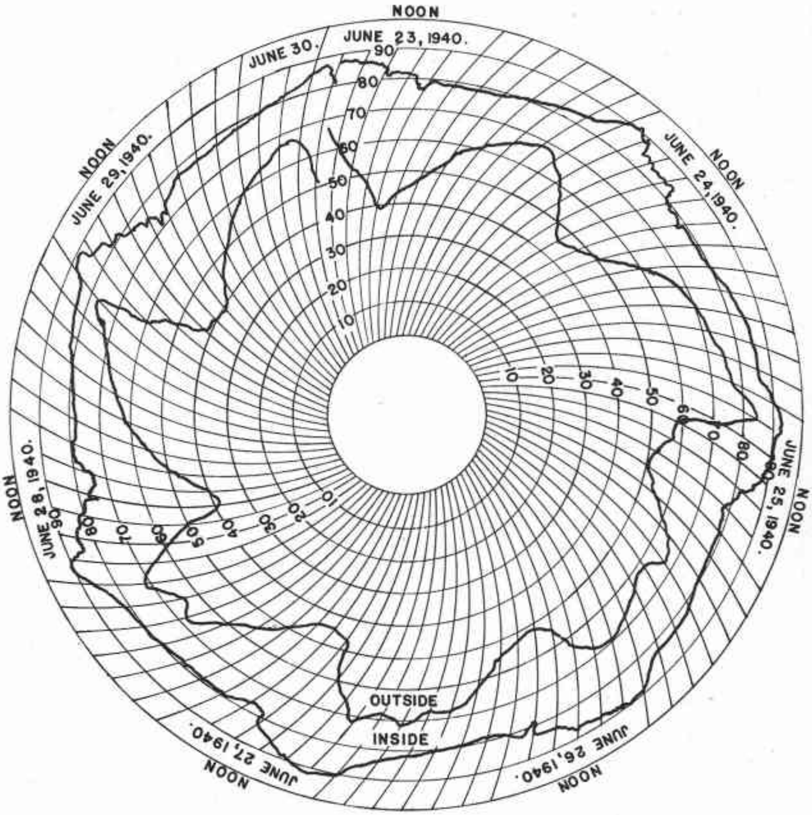

Figure 7. A record of the relative humidity within the egg-storage room and the relative humidity in the adjacent feed room. Inside refers to egg room and outside refers to adjacent feed room.

It was in the warm dry weather when it was most needed that the evaporator cooler lowered the temperature of the egg room 18° to 20°. During each 24-hour day the egg-room temperature usually ranged from about 50° to 68° F. After the excelsior in the evaporator cooler had been used for about

Figure 8. Evaporator cooler installed at Poultry Department egg room, Oregon State College.

2 months it appeared that it might not be as effective as it was when it was started early in June. On August 3 the excelsior was replaced with a new supply. Records kept for 5 days before and 5 days after the change showed that the relative humidity was kept 5 and 10 per cent higher in the egg room after the change and the air moved through the pad more freely. The old excelsior had become water logged and partly clogged with dust. It is recommended that the excelsior be changed once or twice during the summer.

If mold should develop in any part of the egg room or humidifier, it is suggested that lumps of copper sulphate (blue vitriol) be placed in the trough above the excelsior pad, as this would kill any mold growth that might develop in the pad.

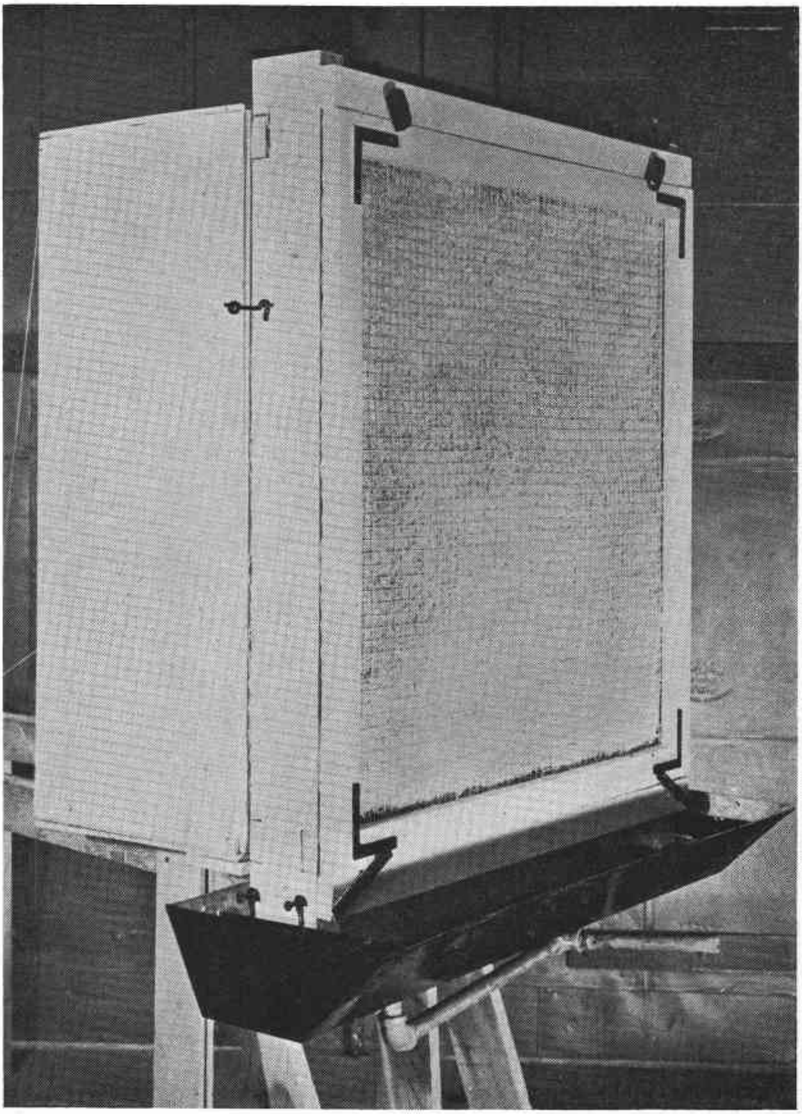

Figure 9. Evaporator cooler showing excelsior pad and drip pan.

Cost of fan operation. The ventilating fan used in these tests drew 45 watts of electric current for operation. In a 24-hour day this would amount to (24 × 45) 1,080 watt hours, or 1.08 kilowatt hours, hence, the cost of operation would probably be between 60 and 90 cents per month.

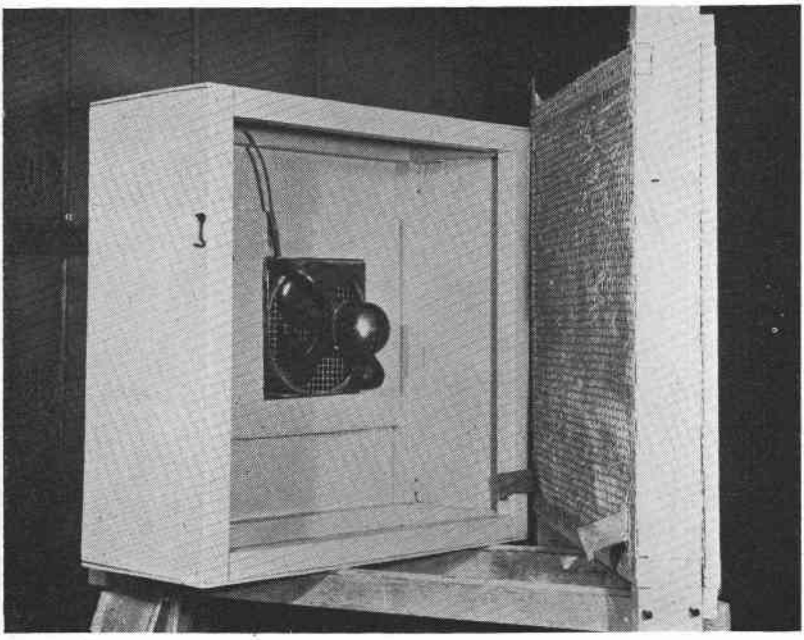

Figure 10. Evaporator cooler with excelsior pad section unhooked to show air assembling box and fan mounting.

Construction of the evaporator cooler. Figure 8 shows an egg-storage room that is located at one side of the feed room in one of the 500-hen laying houses at Oregon State College. The evaporator cooler shown in the upper right-hand corner of the picture provides cooled and humidified air.

Construction details for the evaporator cooler are shown in Figures 9 to 14 inclusive. Figure 9 is a photograph of the assembled unit as it would be attached to an egg-storage room. The excelsior pad held between the two 2 × 4's by a wire screen is shown in the immediate foreground with a water-supply trough above the pad and a drip pan below the pad. Figure 10 shows how the excelsior pad is attached to the plywood box on one side and the ventilating fan is mounted on the opposite side. Particular attention is directed to the 2 × 2-inch framing of the plywood box and to the ¼-inch metal plates that hook over the bottom 2 × 2. These plates support the weight of the excelsior pad and hold it tightly to the fan box at the bottom. Screen-door hooks on either side hold the pad tightly against the box. Figure 11 gives dimensions for the plywood box. The ½-inch mesh hardware cloth can be nailed to the 2 × 4's on one side, but must be on a removable frame on the other side so as to put the excelsior in place. Figure 12 gives dimensions for the construction of the excelsior pad. Figure 13 gives details on the construction of the pan to catch the drip from the excelsior pad.

Figure 14 shows the water-supply trough that is used to drip water across the top of the excelsior pad. A float-type shut-off valve, of the poultry drinking-

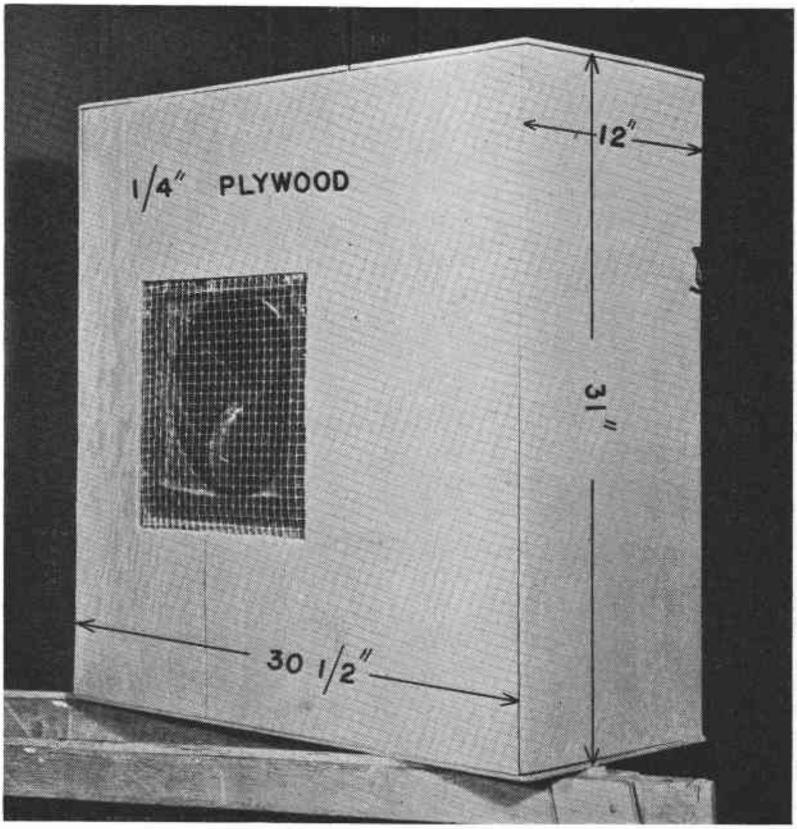

Figure 11. Air assembling box of evaporator cooler showing dimensions. Note hardware cloth over front of the fan to prevent accidental contact with fan blades.

fountain type, is used to regulate the water level in the trough. The trough is made of 4-inch galvanized eave trough. In the bottom of the trough two rows of holes with nine holes in each row are punched with the point of a twopenny nail. The rows are an inch apart and the holes are spaced approximately 3 inches apart in the row. The holes are staggered in the two rows. In order to make the water drip directly below the holes a saw-toothed strip of galvanized iron is soldered on the bottom of the trough along each row of holes and between the rows.

The points of this saw-tooth are made to project directly below each of the holes. The saw-toothed strips are made from 28-gauge galvanized iron strips 1 inch wide. A trough 26¾ inches long made in this manner will allow about 18 gallons of water per hour to drip on the pad. It may be necessary to inspect the holes and clean them occasionally.

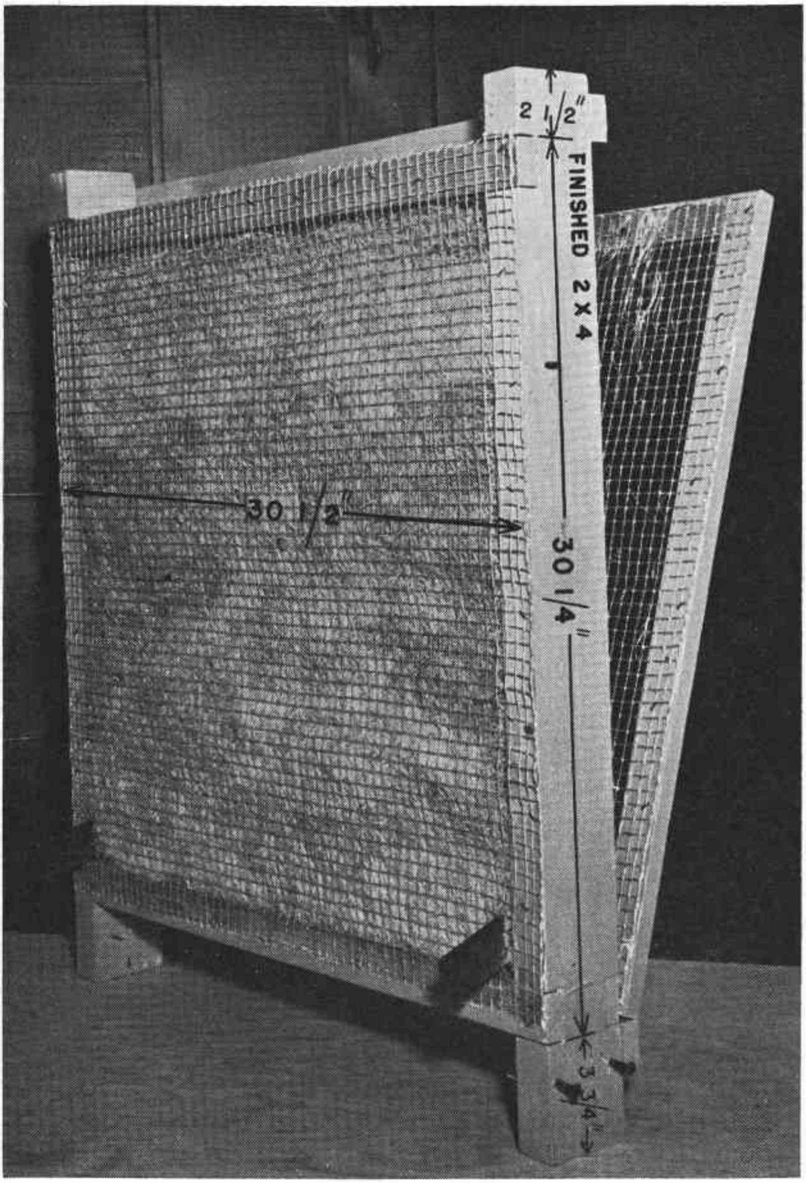

Figure 12. Excelsior pad of evaporator cooler showing construction and dimensions.

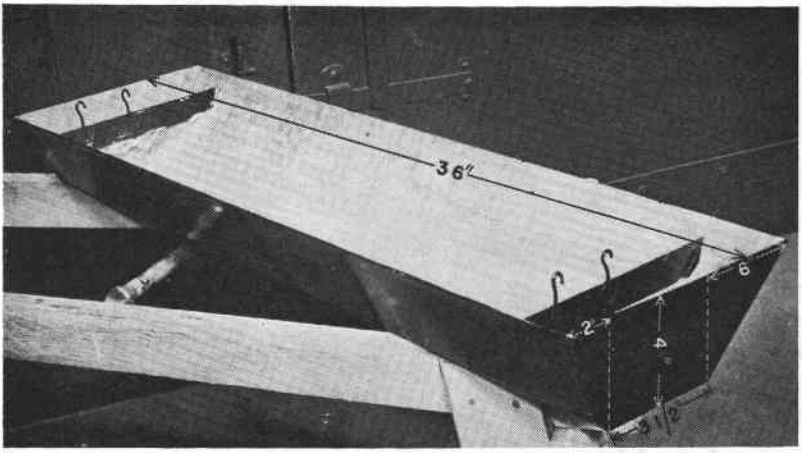

Figure 13. Construction details of pan for catching drip.

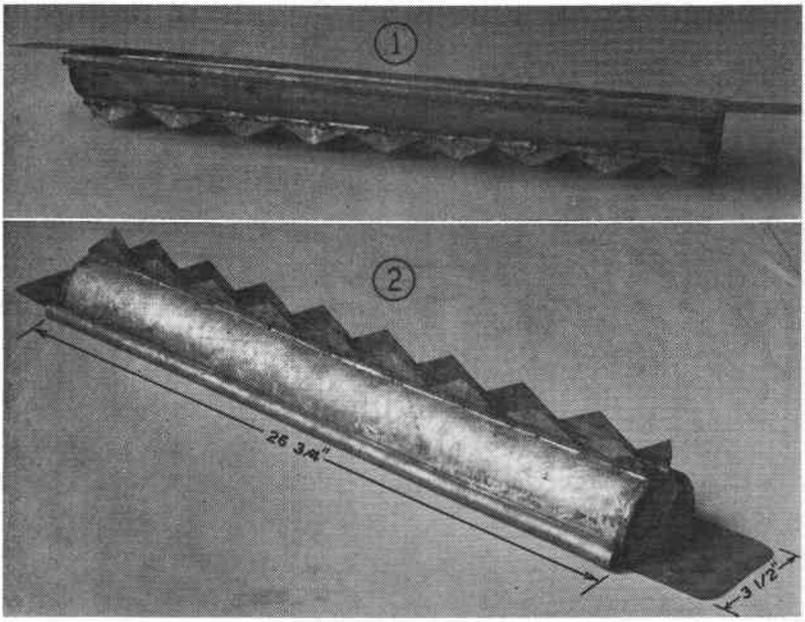

Figure 14. Water supply trough. (1) Shows trough in upright position. (2) Shows trough turned upside down to view two rows of drip points which must be soldered to the bottom side of the trough.

The fan. A well-constructed ventilating fan 10 to 12 inches in diameter that will deliver 400 cubic feet per minute against a static pressure equal to .04 inch of water is required. The fan should be built for continuous operation.

Egg-cooling tests. Tests of the insulated egg room and the evaporator clearly demonstrated that quite satisfactory temperature and humidity for egg storage on the farm between shipments can be maintained during the summer.

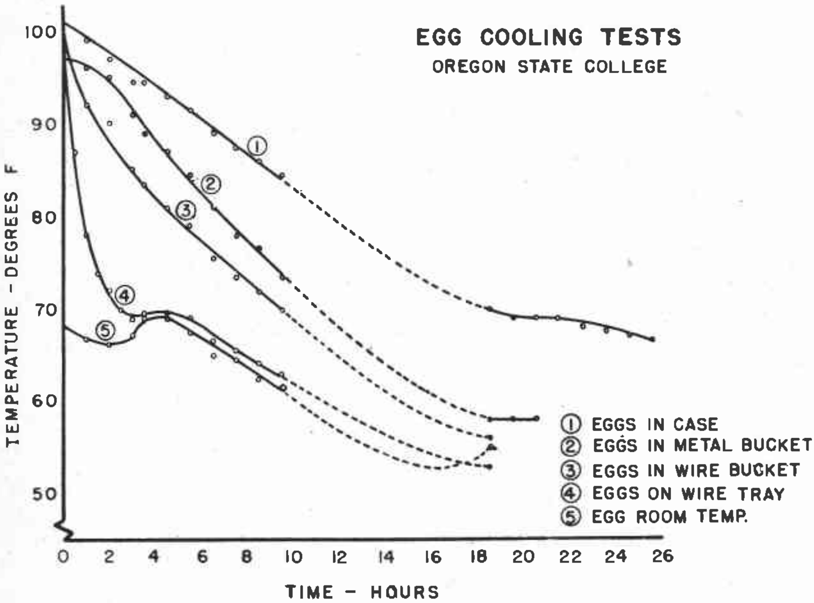

Figure 15.

The time required for eggs to cool to room temperature, however, after being gathered from the nests and placed in the egg room will vary greatly depending on the type of container in which they are placed.

Tests were made to determine the rate of cooling of eggs that were placed in the humidified egg room in (1) a regular egg case, (2) a metal bucket, (3) a wire bucket, and (4) a single layer of eggs on a wire tray. (See Figure 2.) A very small hole was made in one egg of each lot placed in the four different types of containers. Temperatures were taken electrically by placing thermocouples inside the eggs and extending the wires to a potentiometer pyrometer. The eggs were heated to a temperature of 100° F. in an incubator prior to cooling. The very great difference in time required for the eggs in the various containers to cool to approximately egg-room temperature is shown in Figure 15.

The tests were started at 1:30 p. m. During the warm afternoon there was a rise in temperature in the egg room, which was followed by a drop in temperature during the night. The eggs in the wire trays cooled to approximate room temperature much faster than the others, requiring 3½ hours. The eggs placed in shipping cases cooled at the slowest rate, requiring more than 24 hours to cool. The eggs in the wire bucket and the metal bucket cooled considerably slower than those in the wire tray.

This should be very convincing evidence of the importance of placing the freshly gathered eggs on wire trays in the egg room until the eggs are fully cooled before placing them in shipping cases.