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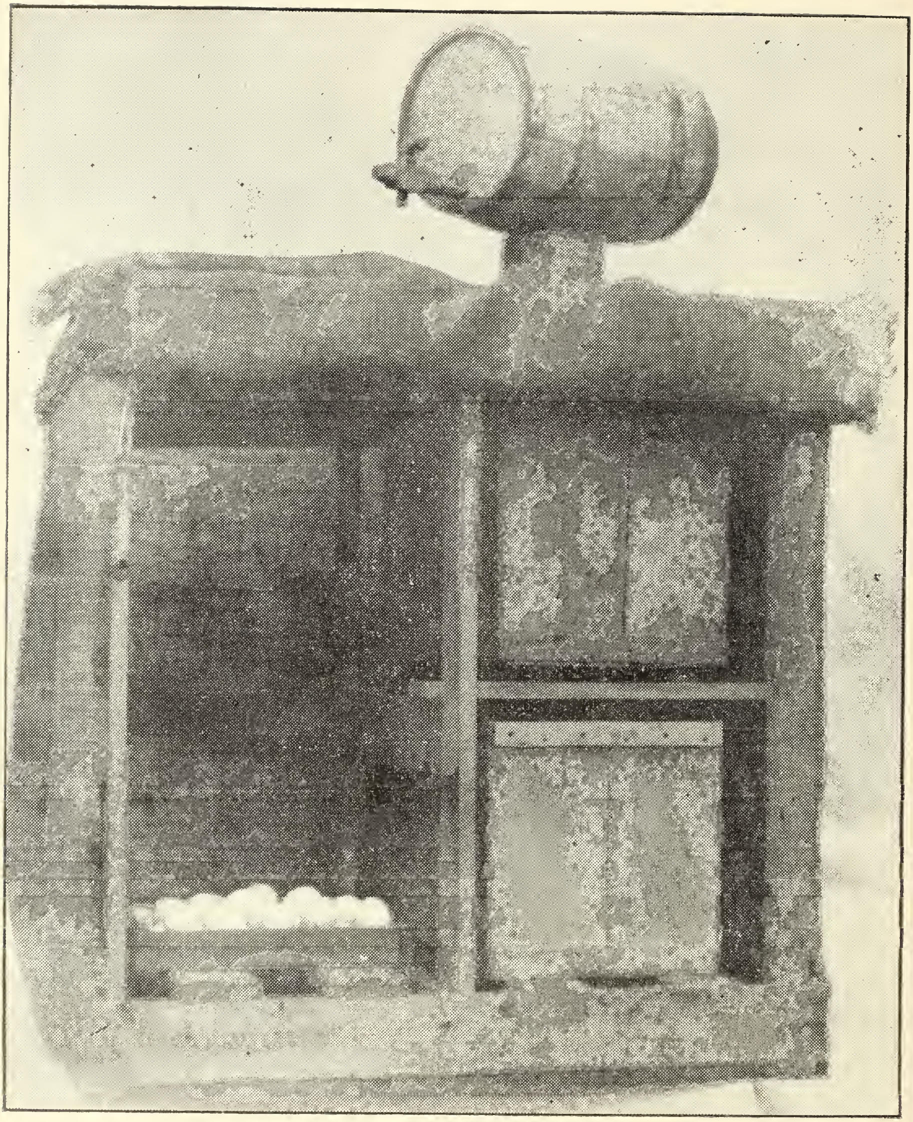

Figure 1. The Oklahoma egg cooler. Note eggs in separate cooling compartment until cased in early morning, 2-case storage capacity, and water keg for moistening where running water is not available.

Construction and Operation of the Summer Egg Cooler

By C. A. ROBERTS and H. D. POLK

Recent expansion of commercial egg production in Mississippi, made largely in answer to increased demands for food needed by our soldiers and our allies, has emphasized the importance of efficient methods of temporary storage on the farm from the time the egg is laid until it is marketed.

Large government purchases of eggs for use in military training centers and for export are made on the basis of grade. Quality eggs bring attractive prices, while eggs of inferior quality are not wanted, even at much lower prices. A considerable commercial egg-producing industry is being built up to supply these war demands; and after peace comes, it is anticipated that commercial egg production will continue, marketings to be through regular commercial channels.

Therefore, for sale through government purchases as at present, or for sale through regular commercial channels later, the quality of eggs marketed by Mississippi farmers will not only determine the price received per dozen or per case, but will largely determine also whether attractive markets may continue to be gained and held.

For highest quality, eggs should be gathered three times each day, and marketed daily. Many farmers not in position to market eggs daily, have mechanical or ice refrigerators in which to keep the eggs. Large numbers of farmers, however, are not so fortunately situated. As a result, much of the commercial egg production is marketed once to twice a week, and serious losses are incurred through lowered egg quality because of inadequate farm storage facilities.

To meet the needs of poultrymen unable to market eggs as often as three times a week, or lacking refrigerator storage facilities, the Oklahoma Agricultural Experiment Station some years ago constructed and introduced an inexpensive homemade egg cooler which operated quite satisfactorily under Oklahoma conditions. Used by the Mississippi Station during 1941, however, it was only partially successful. Results of this work are shown in tables 1 and 4.

It was believed that the lack of complete success of the Oklahoma egg cooler in 1941 was due chiefly to differences in climate, principally in the steady wind usually present in Oklahoma but often lacking in Mississippi. Hence, during 1942, a cooler was constructed in which the Oklahoma cooler was altered only in detail, to provide for the greater evaporation of water. Results from the use of the remodeled egg cooler are shown in tables 2 and 5.

Previous tests of the egg cooler have been made with the cooler under the shade of a tree. To determine whether such shade was necessary or helpful, during the latter half of 1942, the work was done with the cooler in the open sunshine. Results are shown in tables 3 and 6.

Four Types of Storage Tested

The Oklahoma egg cooler as slightly revised by the Mississippi Station is a homemade double stand, which is covered with burlap, and the cloth is kept moist by the constant dripping of water. Thus, it makes use of the cooling effect of evaporation. At the same time the evaporation principle provides humidity and thus prevents evaporation of the moisture content of the egg. Materials may be found on most farms, and but little mechanical skill is required for its construction.

In the three experiments reported, one egg cooler was kept moist; the other was kept dry to serve as a check against the moist cooler.

A third method of storing was in an

ordinary cellar, which was dry and relatively cool.

The fourth method tested was room storage; in this case, the incubator room of the poultry department of the Mississippi Experiment Station.

Under all of the four methods, the eggs were kept in open containers for one day for maximum cooling, then were placed in standard 30-dozen egg cases.

The egg cooler was not used either in the cellar or in the room storage.

Since the tests were made during summer, eggs were gathered three times daily—at 10 a. m., 2 p. m., and 4 p. m.—during the warmest weather, and were immediately placed in storage. The production of eggs varied, of course, from day to day, but was evenly divided among the four storage lots. Readings of humidity and temperature were taken three times daily, at 6 a. m., 12 m., and 6 p. m., central standard time. Eggs in all lots were graded at 4 p. m. every Friday afternoon during the test. Since each day's addition of eggs was separately marked, this weekly reading gave the grades of eggs which had been in storage 1 day, 2 days, 3 days, 4 days, 5 days, 6 days, and 7 days.

Grades of Eggs

Since government purchases of eggs utilize an increasingly large portion of the commercial egg crop in Mississippi, the prevailing egg grades are used in this report. The AA grade corresponds to U. S. Specials, Grade A to U. S. Extras, Grade B to U. S. Standard, and Grade C to U. S. Trade. There are but few Grade AA eggs. Prices vary from time to time and from place to place. Generally, about 2 cents per dozen more is paid for Grade A than for B, and for Grade B than for Grade C eggs.

Experiments in 1941

The egg coolers, both moist and dry, used in 1941 were constructed after specifications by the Oklahoma Experiment Station. By reference to table 1, it will be noted that the temperature in the moist cooler averaged approximately 5 degrees lower than in the dry cooler, and approximately 8 degrees lower than in room storage. The dry cooler was slightly cooler than room storage but not so cool as the cellar.

By reference to table 4, showing the effect of these four storage conditions on egg grades, it will be noted that after the fourth day of storage in the moist cooler, mold was increasingly present to the extent that on the seventh day, approximately one-third of the eggs had surface mold and thus were thrown into the lowest price classification, while four eggs were inedible because of the interior mold. In the 1941 test, the dry cooler was not as good as the moist cooler on the first 5 days of storage, after which surface mold developed in the moist cool-

Table 1. Average results showing temperature and relative humidity of storing eggs under 4 storage conditions. Egg coolers in shade. May 20-September 18, 1941

	Eggs stored in cooler; cooler kept moist	Eggs stored in cooler; cooler kept dry	Eggs stored in cellar	Eggs stored in room
Temperature*				
6 a. m.	73	75	77	79
12 m.	79	87	81	88
6 p. m.	78	85	81	88
Relative humidity*				
6 a. m.	95	87	85	83
12 m.	90	69	79	65
6 p. m.	92	74	79	66

*Readings at hours shown, central standard time.

er. Room storage was the least desirable of all at every day of storage of the four methods tested, although it was approximately as good as the dry cooler on the seventh day of storage.

Experiments in 1942—Egg Coolers in Shade

Since the mold which largely destroyed the effectiveness of the moist cooler during 1941, was due to excessive accumulated moisture, simple changes were made in construction so that excessive moisture might not accumulate or come in contact with the eggs or egg cases. These changes appear to have accomplished the desired effect, and reference to table 5 reveals that no egg mold was indicated in the moist cooler eggs.

The effectiveness of the moist egg cooler is clearly shown in this study. For storage periods of more than 5 days, it will be noted that in the dry cooler, the number of Specials and Extras (Grade A eggs) decreased with every day of storage—from 111 eggs on the first day to only 25 on the seventh day.

Under room storage, the number of top grade eggs similarly decreased from 96 on the first day to 25 on the seventh. In the moist cooler, approximately three times as many Grade A eggs remained on the seventh day.

The effectiveness of a cool, dry cellar for the storage of eggs is likewise shown in this study. The cellar was, in fact, slightly superior to the moist cooler during the first 4 days of storage, about equal to the moist cooler on the fifth day of storage, but slightly inferior to the moist cooler on the sixth and seventh days of storage.

Storage Experiments in 1942—Coolers In Open Sunshine

To determine whether shade was necessary for the most satisfactory operation of the egg cooler, the wet and dry coolers were moved during the last 6 weeks of the 1942 experiment into the open sunshine.

It will be observed in table 2 that the average temperatures were slightly higher under all storage methods than during the preceding period when both coolers were kept in the shade. A very considerable difference was noted in egg grades, as shown in table 6. Relatively fewer eggs were in Grade A after 1 day of storage, although the deterioration in quality was in about the same proportion. Relatively more eggs were in Grade B after 1 day of storage. Also, the increase in numbers of Grade B eggs differed greatly from the relative increase shown while the cooler was in the shade. However, it should be stated that eggs stored in the room and in the cellar were likewise of somewhat lower grade during the second period of the test than in the first period.

Under the apparently unfavorable circumstances of direct sunshine and the ab-

Table 2. Average results showing temperature and relative humidity, of storing eggs under 4 storage conditions. Egg coolers in shade. June 1-July 26, 1942.

	Eggs stored in cooler; cooler kept moist	Eggs stored in cooler; cooler kept dry	Eggs stored in cellar	Eggs stored in room
Temperature*				
6 a. m.	72	75	76	77
12 m.	79	88	80	88
6 p. m.	78	85	80	85
Relative humidity*				
6 a. m.	94	83	83	79
12 m.	83	61	76	63
6 p. m.	87	65	75	63

*Readings at hours shown, central standard time.

Table 3. Average results showing temperature and relative humidity, of storing eggs under 4 storage conditions. Egg coolers in sunshine. July 27-August 30, 1942.

	Eggs stored in cooler; cooler kept moist	Eggs stored in cooler; cooler kept dry	Eggs stored in cellar	Eggs stored in room
Temperature*				
6 a. m.	71	73	77	75
12 m.	82	89	79	86
6 p. m.	79	84	80	86
Relative humidity*				
6 a. m.	93	88	82	84
12 m.	81	63	76	66
6 p. m.	85	67	76	66

*Readings at hours shown, central standard time.

Table 4. Effect on egg grade after storage from 1 to 7 days under four storage methods. Egg coolers in shade. May 20 - September 18, 1941.

Treatment and Grade	1st day (No. eggs)	2nd day (No. eggs)	3rd day (No. eggs)	4th day (No. eggs)	5th day (No. eggs)	6th day (No. eggs)	7th day (No. eggs)
Moist Cooler							
Grade AA (U.S. Special)	20	16	12	16	4	4	2
Grade A (U.S. Extra)	255	260	217	243	209	153	117
Grade B (U.S. Standard)	43	39	68	95	88	83	81
Grade C (U.S. Trade)	0	3	3	0	32[3]	85[2]	119[1]
Inedible*	0	0	0	0	0	0	4
Dry Cooler							
Grade AA (U.S. Special)	19	8	0	0	0	0	0
Grade A (U.S. Extra)	251	217	191	198	148	115	88
Grade B (U.S. Standard)	46	85	97	148	179	178	196
Grade C (U.S. Trade)	1	8	12	7	13	30	50
Inedible*	0	0	0	0	0	0	0
Cellar							
Grade AA (U.S. Special)	26	17	7	1	0	0	0
Grade A (U.S. Extra)	249	230	190	201	156	142	134
Grade B (U.S. Standard)	41	69	97	140	162	155	169
Grade C (U.S. Trade)	2	3	6	17	17	26	31
Inedible*	0	0	0	0	0	0	0
Room							
Grade AA (U.S. Special)	0	0	0	0	0	0	0
Grade A (U.S. Extra)	283	188	136	131	96	71	60
Grade B (U.S. Standard)	79	108	119	146	159	168	171
Grade C (U.S. Trade)	4	23	45	76	80	90	101
Inedible*	0	0	0	0	0	0	0

[1] 110 eggs had surface mold; [2] 79 eggs had surface mold; [3] 30 eggs had surface mold.

*The term "inedible" refers to eggs made so by germ development during storage; eggs which were inedible when placed in storage, largely due to blood spots, were discarded and were not included in the above figures.

sence of shade, the moist cooler proved more efficient in the preservation of quality than any other method tested. As in the previous tests, the cellar proved to be almost as satisfactory as the moist cooler. The dry cooler was approximately equal to room storage, but both were unsatisfactory.

Observations on Results

The foregoing results of two seasons' work on the temporary storage of eggs seem clearly to indicate that farmers who have cool dry cellars in which to store the eggs, especially where eggs are marketed at least twice per week, have perhaps the most satisfactory and trouble-free method of egg storage short of refrigeration.

Where neither cellar nor refrigerator is available, the moist egg cooler seems to have proved its worth. It appears that the moist egg cooler is best kept under shade. The same egg cooler without moisture is little, if any, better than room storage.

Interpretation of Table 5

It is believed that the work done while the egg coolers were in the shade during the first half of the 1942 test is most representative of the effect of the moist cooler on the grade of stored eggs. This is because difficulty experienced in 1941 had been overcome, and because the moist cooler appeared to operate more satisfactorily in the shade than in open sunshine. Therefore, attention is particularly directed toward results shown in table 5.

As set forth previously, Grade AA eggs are most valuable, Grade A eggs are more valuable than Grade B, Grade B eggs are more valuable than Grade C eggs, and inedible eggs are valueless. Therefore, in comparing methods of storing, it is well to note the number of eggs in each of these five grades on any day or all days of storage. Thus, in lot 1, in the moist cooler, of 179 eggs graded after one day's storage, 27 Grade AA, 95 were Grade A, and 56 Grade B; whereas, in the cellar, of 174 eggs stored, 17 were Grade AA, 115 were Grade A, and 41 Grade B. This would indicate that the cellar was slightly more satisfactory for one day's storage. After 7 days storage, of 181 eggs stored in the moist cooler, 4 were in Grade AA, 72 were Grade A, 92 were Grade B; whereas, in the cellar, of 181 eggs stored 7 days, there were no Grade AA eggs, 57 were Grade A and 96 were Grade B. There were 13 Grade C eggs in the moist cooler and 28 in the cellar, thus indicating that while the cellar might have been preferable during short storage periods, the moist cooler was preferred where eggs are marketed only once a week. Similar comparisons will show the superiority of these two storage mediums over the two other mediums tested.

All along it has been known that eggs should be marketed frequently. Daily marketing, wherever possible, has been commonly recommended; marketing at least three times a week has been suggested as the minimum necessary for the sale of quality eggs.

A detailed study of table 5 will show just what happens when eggs are kept under the four tested methods of storage. Comparison of the top market grades, as suggested in the paragraph above reveals that the frequent marketing of eggs is still highly important even when using the best storage method studied in this test. Regardless of the method of storage, there is deterioration from day to day after the egg is laid. Under the best methods (moist cooler, and cellar) the deterioration is slight for the first 2 days but increased thereafter. In the case of the least desirable method of storage (room) there is depreciation in quality after even one day of storage, which increases from day to day, until on the seventh day there is a serious economic loss due to the lowering of all grades and to the increase of inedible or worthless eggs.

Not all egg producers, however, market eggs three times or more per week without serious cost for transportation to market or loss of valuable time. It is suggested that a detailed study of table 5 will enable many producers to compare the cost of moving eggs to market more frequently, with the cost in decreased egg value because of holding longer periods, thus to arrive at a point at which it may be most profitable to market eggs.

In any event, wherever refrigeration or a cool dry cellar is not available, it is recommended that the moist cooler be con-

Table 5. Effect on egg grade after storage from 1 to 7 days under four storage methods. Egg coolers in shade. June 1 - July 26, 1942.

Treatment and Grade	1st day (No. eggs)	2nd day (No. eggs)	3rd day (No. eggs)	4th day (No. eggs)	5th day (No. eggs)	6th day (No. eggs)	7th day (No. eggs)
Moist Cooler							
Grade AA (U.S. Special)	27	20	10	6	4	2	4
Grade A (U.S. Extra)	95	104	93	79	95	88	72
Grade B (U.S. Standard)	56	64	68	85	80	72	92
Grade C (U.S. Trade)	1	1	1	2	5	8	13
Inedible*	0	0	0	0	0	0	0
Dry Cooler							
Grade AA (U.S. Special)	7	10	2	0	2	1	0
Grade A (U.S. Extra)	104	85	67	51	52	34	25
Grade B (U.S. Standard)	66	81	79	87	87	83	84
Grade C (U.S. Trade)	2	15	21	38	42	51	66
Inedible*	0	0	0	0	1	1	4
Cellar							
Grade AA (U.S. Special)	17	22	10	3	0	0	0
Grade A (U.S. Extra)	115	115	98	89	74	56	57
Grade B (U.S. Standard)	41	52	63	77	102	97	96
Grade C (U.S. Trade)	1	2	1	4	8	20	28
Inedible*	0	0	0	0	0	0	0
Room							
Grade AA (U.S. Special)	6	5	0	0	0	0	0
Grade A (U.S. Extra)	90	87	69	42	31	25	25
Grade B (U.S. Standard)	65	72	72	88	91	97	64
Grade C (U.S. Trade)	12	24	33	42	56	56	79
Inedible*	0	2	0	1	5	5	13

*The term "inedible" refers to eggs made so by germ development during storage; eggs which were inedible when placed in storage, largely due to blood spots, were discarded and were not included in the above figures.

structed and put in operation, especially during the summer months.

Constructing the Cooler

To construct a summer egg cooler the following steps are suggested:

1. Prepare the bill of materials as listed under "bill of materials."

2. Examine figure 1 (shown on page 1).

(a) Nail together the framework of the sides and the center partition. The 6 upright pieces are 36 inches long. The space between the top of the bottom crosspiece and the top of the center crosspiece is 13½ inches.

(b) Use the remaining five 36-inch 1x4 pieces to complete the framework. Use one piece each at the top and bottom in front, and one each at the top, bottom and center in the back. The top edge of the center piece in the back should be ¾ of an inch above the top edge of the crosspieces.

(c) Turn the framework bottom up and place a piece of the roofing in place, using 3 of the 1x12x33¾-inch pieces and one of the 1x2x33¾-inch pieces. Nail a floor over the roofing material, and to the framework. The roofing material will make the bottom air-tight, and thereby prevent warm air from entering the cooler from the bottom and raising the temperature in the cooler.

(d) Turn the framework back over and nail the top on, using the remaining 1x12x33¾-inch and 1x2x33¾-inch pieces. Bevel the edges all the way around and nail the roofing material in place over the top as illustrated in figure 1. Place nails only along the beveled edges. If they are placed elsewhere the cooler will leak.

(e) Fit the remaining 1x4 pieces in place to form false bottoms. See figure 1, right and left side. Use the three remaining 1x2 pieces to form a support on the right side for the upper egg case.

3. Examine figure 2.

(a) Rip one of the burlap bags at the seam and place over the top of the cooler. Trim the edges so they do not hang below the bottom edge of the 1x4 around the top of the framework. Stretch the burlap smooth but not tight.

(b) Rip open the remaining sacks. Sew together the amount needed to enclose three sides of the cooler. Leave the front open. The lower edge of the burlap must hang even with the bottom of the cooler. Roll the upper edge of the burlap around the lath to take up the surplus.

The lath should be rolled outward so the burlap hangs next to the framework from top to bottom. The upper edge of the lath should be about 1½ inches from the top of the cooler. Five egg-case nails are sufficient for attaching each lath. Attach the bottom of the burlap to the framework at each end only.

(c) Cut a piece of burlap for the front so that it will extend 4 inches on either side. Attach the front in the same manner as the rest of the sack material. Tack each end of the top part of the front to the sides. Arrange a nail or hook on each side at the bottom to which the front may be attached to prevent it from blowing open.

Bill of Materials

List of material necessary to construct a 2-case summer egg cooler.

11 pieces 1x4x36
11 pieces 1x4x32
2 pieces 1x4x33¾
1 piece 1x4x19½
2 pieces 1x2x29
2 pieces 1x2x33¾
6 pieces 1x12x33¾

Table 6. Effect on egg grade after storage from 1 to 7 days under four storage methods. Egg coolers in sunshine. July 27 - August 30, 1942.

Treatment and Grade	1st day (No. eggs)	2nd day (No. eggs)	3rd day (No. eggs)	4th day (No. eggs)	5th day (No. eggs)	6th day (No. eggs)	7th day (No. eggs)
Moist Cooler							
Grade AA (U.S. Special)	1	0	0	0	0	0	0
Grade A (U.S. Extra)	40	22	21	23	25	22	31
Grade B (U.S. Standard)	75	91	93	100	88	84	79
Grade C (U.S. Trade)	3	4	5	4	12	12	13
Inedible*	0	0	0	0	1	0	0
Dry Cooler							
Grade AA (U.S. Special)	0	0	0	0	0	0	0
Grade A (U.S. Extra)	31	21	19	12	26	8	4
Grade B (U.S. Standard)	85	92	81	97	81	98	82
Grade C U.S. Trade)	3	6	20	17	18	13	36
Inedible*	0	0	0	0	0	0	0
Cellar							
Grade AA (U.S. Special)	0	0	0	0	0	0	0
Grade A (U.S. Extra)	37	24	30	41	21	14	13
Grade B (U.S. Standard)	74	84	84	78	94	93	98
Grade C (U.S. Trade)	2	9	9	10	9	12	14
Inedible*	0	0	0	0	0	0	0
Room							
Grade AA (U.S. Special)	0	0	0	0	0	0	0
Grade A (U.S. Extra)	24	23	34	10	14	7	3
Grade B (U.S. Standard)	88	85	74	86	95	97	85
Grade C (U.S. Trade)	5	10	7	28	18	16	37
Inedible*	0	0	0	0	0	0	0

*The term "inedible" refers to eggs made so by germ development during storage; eggs which were inedible when placed in storage, largely due to blood spots, were discarded and were not included in the above figures.

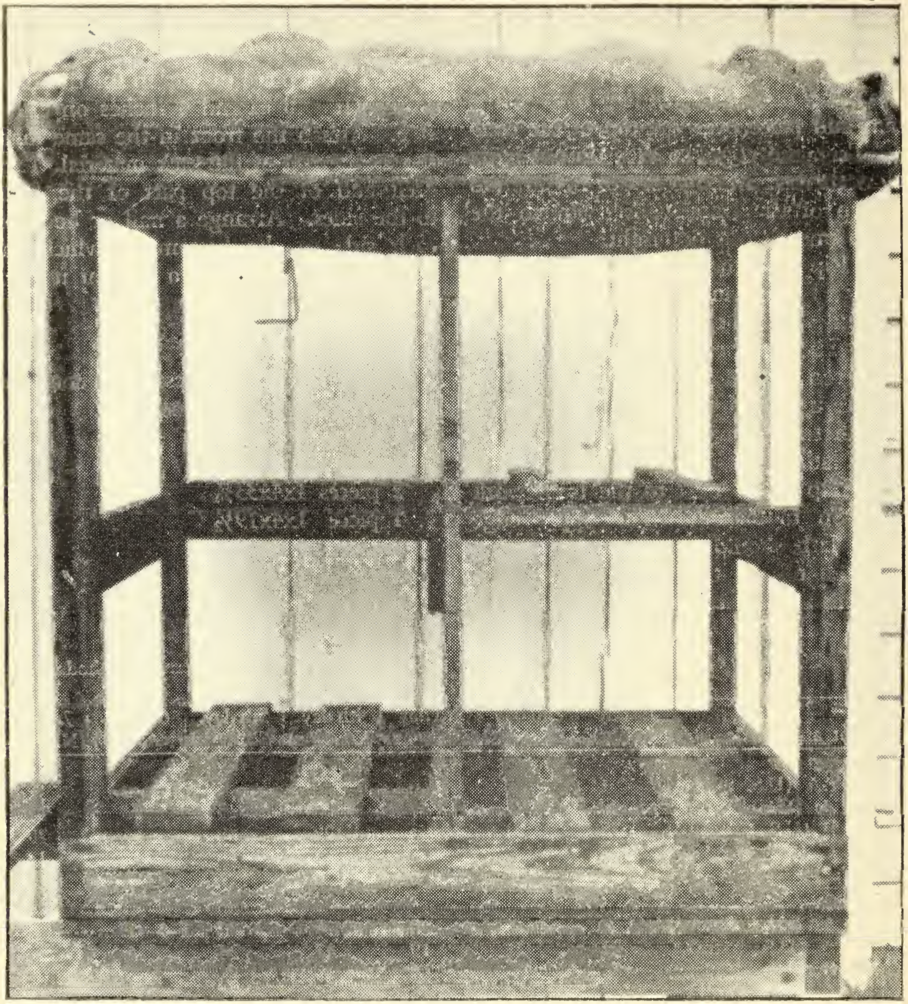

Figure 2. The egg-cooler as adapted to Mississippi conditions. Note that strips at bottom to support cases are suspended within the bottom frame, and do not touch either the bottom frame or the moistened burlap. The burlap is tacked to the lower edge of the top frame, all the way around.

2 pieces lath 36½ inches long
2 pieces lath 33¾ inches long
2 pieces 33¾x36 composition roofing for top and bottom
5 burlap bags measuring at least 40 inches from top to bottom
1 pound No. 5 or 6 nails
1 pound ½-inch roofing nails.

Operating the Cooler

The cooler should be placed on a stand 24 to 36 inches above the ground. Preferably it should be located in the shade, but it should not be so located that it will be sheltered from the wind. The efficiency of the cooler depends on the air passing through the wet burlap and being cooled by evaporation of the moisture.

The cooler does not need protection from the weather. However, it should be firmly attached to the stand and the stand anchored to the ground to prevent strong winds from overturning it.

The top of the cooler must be level so that water from the top will feed down around all sides equally. A dry spot anywhere on the burlap will raise the temperature within the cooler. If piped water is not available, a small reservoir placed at a higher level than the top of the cooler will answer the purpose as a source of water. Note figure 1. Whatever method is used for supplying water, the water must fall in the center of the top of the cooler. Otherwise an equal distribution of water over the sides of the cooler will not be obtained and dry spots will occur on the burlap.

It is important that just enough water to keep the burlap wet be permitted to escape the source of water supply. The burlap should not be so wet that water constantly runs from its bottom edges. If the burlap is so wet that the air cannot pass through its meshes the interior of the cooler is likely to become stagnant and warm.

Operate the cooler empty a few days to be sure it is functioning satisfactorily.

Keep egg cases and fillers and flats in the cooler at least overnight before placing eggs in them. See figure 2. In this way the cases and equipment will be cooled down and will not cause the temperature within the cooler to rise.

Eggs should be cooled in the separate compartment overnight before they are cased. See left side of figure 1.

The coolest time during any 24-hour period is usually between five and six a. m. If the eggs are placed in the cases at that time after cooling overnight, the cooled cases, fillers and flats will afford insulation that will prevent the eggs from warming up much during the day.

The cooler should never be opened except when necessary for routine operations.

Occasionally a mold accumulates on the casing equipment, and may attack the eggs and lower their quality. This mold can be avoided to a certain extent by changing cases each time eggs are marketed, so that eggs enter the cooler in dry cases.

Any one gathering of eggs should not be left in the cooler longer than 6 or 7 days. The summer egg cooler is desirable only as a means of preserving egg quality from one market day to the next.

Eggs should be marketed at least once a week, and more often if possible.

It should be remembered that egg quality is at its best when the egg is laid, and that it loses quality thereafter regardless of the method of preservation.