CHANGES IN EGG QUALITY FROM COUNTRY ASSEMBLER TO CITY RECEIVER

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Changes in Egg Quality
From Country Assembler to City Receiver

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H. E. Langelare
Major professor

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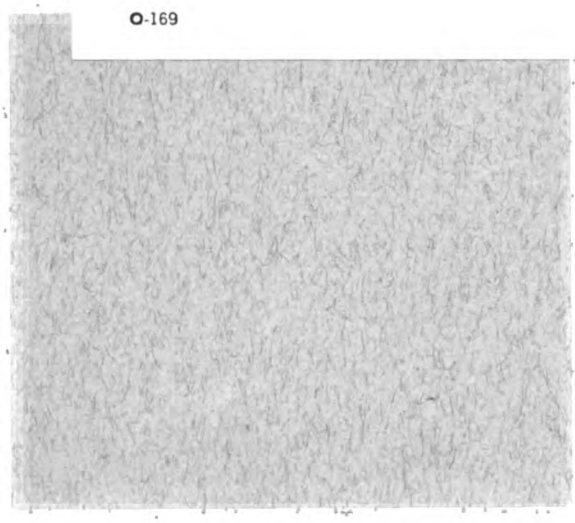

CHANGES IN EGG QUALITY

FROM COUNTRY ASSEMBLER TO CITY RECEIVER

by

Charles C. Sheppard

A THESIS

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INTRODUCTION

Changes in egg quality have increased as the consumer has become farther from the point of production in both time and distance. This separation has increased the importance of marketing and the various problems connected with it. The grading of eggs is a relatively new function in the process of marketing eggs. The reason for this is that eggs were not marketed, as we know it now, to a very great extent until after the first World War. Just before and since that war the population had increased at a very rapid rate. The increase has been centralized in the cities, towns, and villages due to the labor demands during the industrialiation of the United States. Previous to this time many people kept their own chickens and grading was not necessary. With the coming of the automobile the garage gradually took the place of the back-yard chicken coop and run. Another thing that contributed to the movement of flocks out of the back yard were the animal restrictions that were placed in the zoning ordinances.

The newness of the business has meant that many poor practices have been adopted haphazardly. Gradually these poor practices are being eliminated. Some of the things that have been changed have to do with packaging. There are men in the business now that remember having received eggs by the barrel. These were shell eggs packed in straw or oats in the barrels. The types of packaging materials have also changed. From the straw and oats the change was made to the standard egg case. This was at first a heavy wooden case. It was gradually made of lighter and thinner wood. Now many of the cases are made of paper and cardboard. The flats and fillers have been changed from the old brown strawboard to

the new grey and white flat and filler. This has eliminated a tendency to stain the egg shells. The old strawboard flat and filler also tended to give a paper taste to the eggs. This was practicularly true if the eggs were stored and went through a sweating process on the way out of storage. Something that is new in the egg case is the filler-flat. It is a combination filler and flat in one piece instead of two. It has two advantages, it is cheap and it is stronger or less conducive to damage.

The method of transportation of eggs has also gone through a change in this period of time. It now takes hours where it took days when eggs were first brought to market. The switch has been from boat and slow freight to motor truck and express. Quite a few car lots are shipped by fast freight in refrigerated cars. Eggs in barrels used to be shipped up the Ohio River from Cincinnati to Pittsburgh. They were exposed to the sun and the rain. The buyers have been known to buy one barrel rather than the other, because less chicks had hatched in the one they bought.

Some of the other changes that have taken place have to do with the storage of eggs. The storage of eggs on the farm and in the local grocery has had a suggested revision. It is known that as eggs approach 100° F. they will incubate and chicks will hatch if the eggs are fertile. The cooler the eggs are kept the slower cell division takes place. The embryo dies at about 68° F. The deterioration of egg quality is a chemical reaction. The lower the holding temperature, the slower the chemical reaction. The usual recommendation for maintaining egg quality is to hold eggs at 40° - 50° F. Most farm homes and stores used to keep their eggs at temperatures considerably higher than 40° - 50° F. Instead

of being kept in the kitchen near the stove, eggs are now being kept in the cellar or at least a cool room.

It has been known almost from the start of time that eggs evaporate. Therefore, the humidity of the air surrounding the eggs is of considerable importance. If the air is not near saturation, the egg loses water to the air. This means egg quality decline. Extension workers have advocated adding moisture to the egg holding room for about twenty years.

The length of time or age of an egg is also important from a quality angle. Since the long time, six to ten months, storage of eggs has been taking place, general observation has told us that the eggs are not as good when they come out of storage as when they go into storage. A change in practice of storing poor eggs during the surplus season and eating the good ones has almost completely reversed itself. Now, only the best are stored and the poor quality is sent out for immediate consumption.

Many of these things are known concerning egg quality decline. The actual place and amount of quality loss has not been studied so extensively. The usual procedure has been for everyone in the business of producing handling eggs is to blame everyone else for the egg quality declines. It was the purpose of this study to establish the amount of egg quality loss that is due to the handling of eggs from the country assembler to the city receiver.

OBJECTIVES

The object of this study was to try to find out how much, where, and to explain why eggs decline in quality between the time they arrive at the country assembler until they arrive at the city receiver.

It was considered desirable to determine the physical and economic loss of egg quality in one particular step in the marketing channel. Selected factors associated with this quality change were examined with regard to their relative importance. By studying this problem of quality change under actual commercial conditions, it was hoped to provide an indication of the procedures needed to make egg marketing, in general, more efficient. To be more specific if the hoped for results of this study were to be applied, it would mean that the consumer could probably obtain better quality eggs and with less of the consumer expenditure dissipated in wastes during marketing.

ORGANIZATION AND AREA OF STUDY

This report is part of a regional study of egg quality that was done in the North Central States in 1948. The agencies that cooperated in getting the North Central study done were the Bureau of Agricultural Economics, Farm Credit Administration, and the Production and Marketing Administration of the United States Department of Agriculture; the various State Experiment Stations, and the Federal-State Egg Grading Service. This thesis was prepared from the Michigan data which was compiled as a part of the larger study.

The area covered was the central and southern half of the lower peninsula of Michigan and adjoining states marketing eggs in Michigan. This area was determined by selection of a sample from a list of city receivers of eggs. This list was taken from the files of the Michigan State College Poultry Extension Department and the Michigan Federal-State Egg Grading Service. The sample was selected on the basis of the following reasons:

1. The volume of eggs was of considerable concern. The city receiver had to have a volume of over 10,000 cases of eggs a year to be considered.

2. Location as to poultry concentration, providing area coverage. In order to study normal practices the study had to be made under normal handling practices, because of this very sparsely settled poultry area had to be eliminated.

3. Function or type of organization with respect to procurement and processing.

DESCRIPTION OF CITY RECEIVER

After the selection of the city receiver was made they were contacted to find out their willingness to serve as a source of material for the study. The city receiver was classified as the person to whom the country assembler shipped his eggs. In all but one instance these city plants were located in the City of Detroit. When these plants were visited, a schedule of questions was completed on each plant. Some of the answers of this questionnaire are compiled in Table 1. It is interesting to note that the temperature range reported was from 32° - 65° F. This temperature was due to mechanical refrigeration in all cases. Outside temperatures could not affect the holding room temperature. Four city receivers stated that the reason that eggs had lost quality before arriving at the city point was due to poor farm care. Another one blamed it on the fact that the eggs had been washed which is usually done by the farmer. Temperature was mentioned twice as the cause of poor egg quality. The other factors mentioned - time, rough handling, and age of the eggs. Of those firms surveyed, eggs were the main part of the business of five companies. Dairy products were the main part of the business done by four companies. The unusual combination of wholesale fruits and vegetables with eggs was reported by the last firm. In spite of the fact that less than 5 percent of the eggs graded in Michigan are graded by Federal-State Graders, five out of ten of the buyers designated U. S. Grades as a buying grade. Four buyers have no grade on which they base their purchases. One bought on what was reported as wholesale grades. One interesting thing is the speed with which these buyers reported they turned over their merchandise. In eight cases, the eggs were held for only one to three days. In the

other two cases eggs were held as long as ten days. In both of these last two instances, the temperatures at which the eggs were held was 33° - 40° F.

TABLE 1

Summary of Operating Features Reported by Selected City Receivers

City Receiver Number	Temperature at Which Eggs are Held	What Factor* Causes Loss of Quality in Receipts	Principal Type of Business	Graded Eggs Bought	Number of Days Eggs are Held
1	35° - 40°**	High holding temperature	Eggs	U. S. Grades	3
2	50° - 60°	Excessive lapse of time	Dairy Products	Some on U. S. Grades	2-3
3	45° - 50°	Farm production and marketing practices	Butter	None	2
4	50° - 55°	Farm production and marketing practices	Eggs	U. S. Grades	1-2
5	35° - 65°	Retail handling practices	Eggs	None	1-3
6	33°	Farm production and marketing practices	Fruit & Vegetables	Wholesale Grades	7-10
7	32° - 35°	Rough handling	Eggs	None	3-5
8	35° - 40°	Washing of eggs	Dairy Products	U. S. Grades	3-7
9	38° - 40°	Farm production and marketing practices	Dairy Products	U. S. Grades	1-3
10	35° - 40°	High holding temperature	Eggs	None	1-10

* The factor reported here was the most important cause for the loss in egg quality in the opinion of the city receiver.

** Degrees of temperature recorded in Fahrenheit.

DESCRIPTION OF COUNTRY ASSEMBLER

From the city receiver the names of some of his suppliers or country assemblers were obtained. The country assembler was contacted and general operating information was received from them. The term country assembler was used in this study to represent a firm that centralizes eggs from the farmer. This assembler had a business establishment in a small town. Farmers delivered eggs directly to this place of business. The assembler also might have a truck and established pick-up routes. It was reported that the farmers on these routes were visited at least once each week at which time their eggs were picked up. The eggs were practically always candled for quality and weighed for size at the country assembler's station. Table 2 gives some of the various facilities and services that these firms performed. The volume handled in 1947 varied from 150 cases to 100,000 cases. Better than half, nine out of 17, of these buyers did not buy on any grade. This may not be entirely true as some nest run buyers graded producers. They bought only from producers with good eggs. In spite of the fact that refrigeration has been recommended for years, eight of those country assemblers did not have refrigeration. Temperatures ranged from 30° - 70° F. in the egg holding rooms.

TABLE 2

Summary of Operating Features Reported by Selected Country Assemblers

Country Assembler Number	Cases of Eggs 1947	Purchase from Farmer on Bases of Quality	Operate Truck Routes	Temperature at Which Eggs are Held	Artificial Refrigeration
1	150	No	No	Room Temperature	None
2	13,040	No	Yes	Room Temperature	None
3	18,200	No	Yes	55° *	Yes
4	7,800	No	Yes	30° - 55°	Yes
5	8,500	No	Yes	Room Temperature	None
6	60,000	Yes	Yes	48° - 58°	Yes
7	5,000	No	Yes	45° - 60°	None
8	5,700	No	Yes	40° - 70°	None
9	8,000	Yes	Yes	32° - 40°	Yes
10	1,200	No	Yes	Room Temperature	None
11	6,000	Yes	Yes	46°	Yes
12	12,000	No	Yes	55° - 58°	Yes
13	13,000	Yes	Yes	45°	Yes
14	11,485	Yes	No	45°	Yes
15	6,100	Yes	Yes	60°	None
16	100,000	Yes	Yes	40°	Yes
17	15,600	Both	Yes	68°	None

* Degrees of temperature reported in Fahrenheit readings.

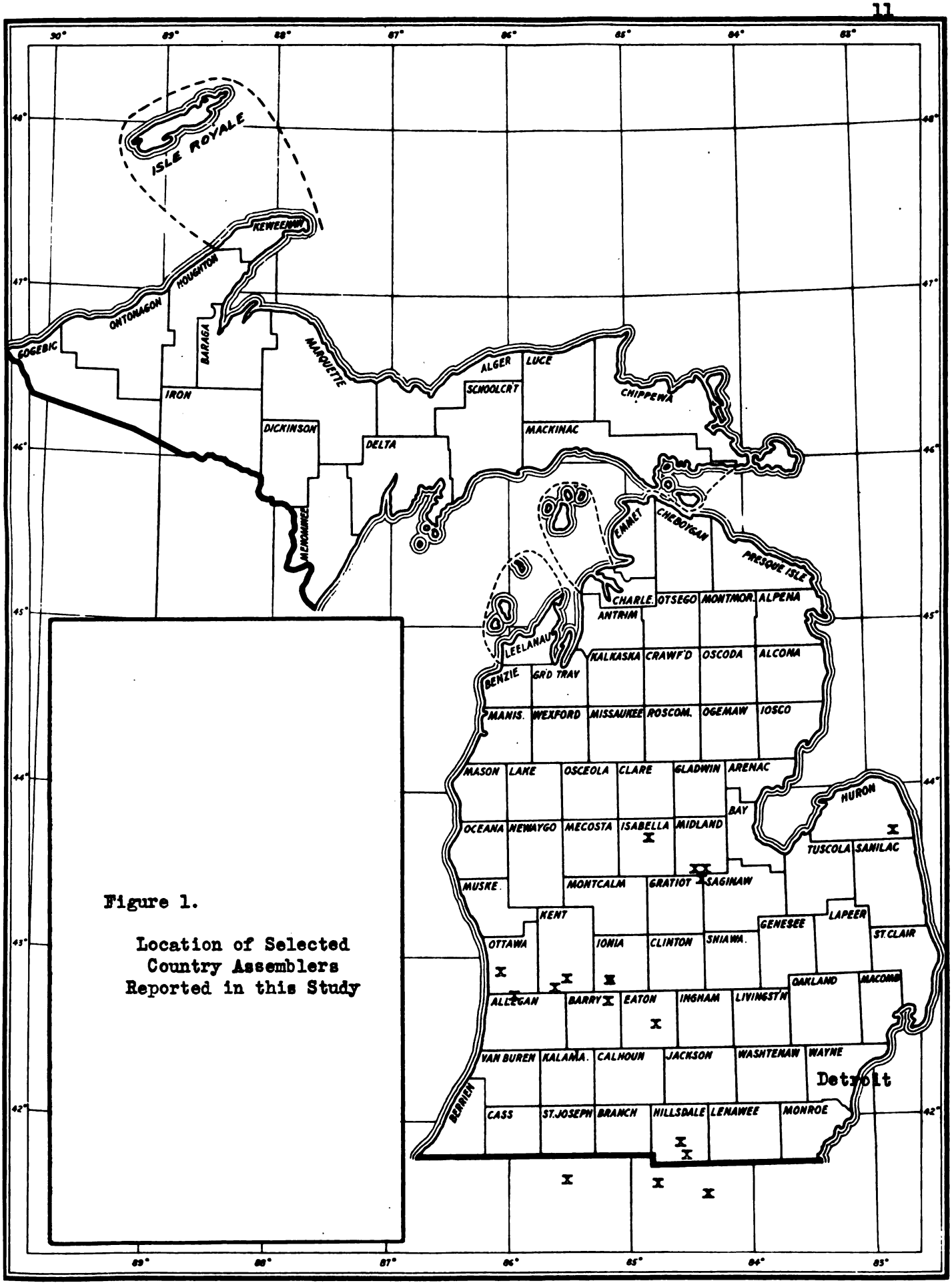

Figure 1.

Location of Selected Country Assemblers Reported in this Study

METHOD OF INSPECTION

When the lists of country assemblers and their city receivers had been completed the inspection work started. Inspectors licensed by the Federal-State Egg Grading Service visited each country assembler. He was to inspect eggs as they were received at that point. These eggs were to travel to the city receiver under the normal handling conditions. The same inspector would make a re-inspection on the eggs that had been used in the original inspection. The inspector noted besides the quality, the weather, method of transportation, method of purchase and sale, prices paid, and other data that might be needed.

The method of inspection was the standard method used by the Federal-State Egg Grading Service. The eggs that were to be inspected were selected from producers that had delivered eggs to the country assembler that day. Eggs brought in by the station truck routes could also be used. Ten inspections were to be made at the country point. If there were not enough eggs received during the inspection visit, the previous day's eggs could be used. The standard inspection consisted of one hundred eggs tabulated according to the standards of quality for individual shell eggs. In order to standardize the experiment, the inspectors were asked to use their portable candling lights at all times.

The candling process usually took place in a dark room. The candler, by twisting or twirling the egg before the light, observed the size of the air cell, the quality of the egg white, and the yolk condition. The poor quality egg had a watery white which allowed the yolk to revolve freely inside the egg shell and the good quality egg had a thick or viscous white which had a tendency to hold the yolk well centered in the shell.

Quality of Eggs at First Grading

In this study a total of 390 cases of eggs were inspected. Out of each case 100 eggs were inspected making a total of 39,000 eggs. Table 3 gives a complete breakdown of the eggs by grades. Of these eggs, only 76.1 percent graded as U. S. Grade A or better, not including stains and dirts. These eggs consisted of either those delivered to the country assembler by the producer or those received from truck routes. These eggs were supposed to be inspected on the day that they were received. A few cases were taken out of the stock that had been brought in the day or two before the inspector arrived.

It has been shown by Lorenz and Newton (1944) and supported by Davidson, Dawson and Sheppard (unpublished) that 95 percent or better of fresh eggs are Grade A or better. In this report, the farmer apparently has lost almost one-fourth of the AA's and A's by not caring for the eggs properly before delivery to the country assembler. The original five percent or less loss was ignored because they were undergrades due to things over which marketing agencies had no control. They were blood spot eggs and eggs that had rough shells and irregular shapes. These represented breeding and feeding problems - not marketing problems. This left a twenty percent quality decline that was due to the farmers' egg handling practices.

In converting this loss to economic terms, the difference between Large U. S. Grade A and Large U. S. Grade B was found to average approximately six cents per dozen or one-half cent per egg, in Detroit in 1948, according to the Market News Service. If we assume that the same price differential existed between all A's and B's, the farmer has already lost

thirty-six cents per case of eggs represented in this study. This, of course, assumed only a one grade drop from A to B.

Another look at Table 3 shows that there was a seasonal variation in egg quality. The fall group showed a considerably better egg quality, 80.26 percent A's or better as compared with the spring group at 74.56 percent and summer with 74.17 percent. This might be due to better egg quality in the fall as reported by Knox and Godfrey (1938). It may also be due to the higher temperatures that were prevalent in the spring and summer months.

Quality of Eggs at the Second Grading

Table 4 gives the results of the second grading. Here it was found that the eggs had dropped from 76.1 percent to 69.4 percent all A's or better. This amounted to a 6.7 percent decline, or 6.7 eggs dropped one grade. The same method, as described on page 13, was used to figure the economic loss. This loss could be attributed to the country assembler and the transportation to the city receiver. It actually amounted to about twelve cents loss per case.

Another point of comparison between these two tables brought out the seasonal quality drop. The fall eggs had a drop from 80.26 percent A's or better to 75.86 or a 4.4 percent quality decline. The spring grading showed a drop from 74.56 to 67.26 or 7.3 percent decline. The summer drop was from 74.17 to 66.0 percent or 8.17 percent decline. It will be shown again later that the better the original quality at the country assembler, the better was the condition of eggs at the second grading.

TABLE 3

Summary of Grading Results at the Country Assemblers by Seasons, 1948

Grades	AA	A	B	C	S & D*	Checks	Leaker & Loss
Percent of Eggs							
Graded in Spring	33.3	41.3	16.3	2.1	3.26	3.28	.48
Graded in Summer	17.8	56.4	10.8	1.0	8.62	4.98	.35
Graded in Fall	22.8	57.7	8.4	.68	7.78	2.53	.37
Graded 3 Seasons	24.4	51.7	11.9	1.3	6.5	3.7	.45

TABLE 4

Summary of Grading Results at the City Receivers by Seasons, 1948

Grades	AA	A	B	C	S & D*	Checks	Leaker & Loss
Percent of Eggs							
Graded in Spring	26.5	40.7	21.1	3.6	3.22	4.29	.45
Graded in Summer	12.4	53.6	16.5	2.18	8.46	6.13	.64
Graded in Fall	19.7	56.1	12.1	.8	7.68	3.05	.44
Graded 3 Seasons	19.3	50.1	16.7	2.2	6.5	4.6	.5

* Stained and Dirty eggs of various interior quality grades.

Cracked Eggs at the First and Second Gradings

The number of cracked eggs at the first grading was 3.7 percent of the eggs graded or an average of about 13 eggs per case. Since the average price difference between U. S. Large Grade A eggs and cracks in Detroit in 1948 was about 24 cents a dozen or two cents an egg, the economic loss could be estimated at 26 cents a case.

There were 5.03 percent of the eggs, at the first grading at the country assembler, in the summer as compared to 3.31 percent in the spring and 2.59 percent in the fall. In the summer, the loss in value of the eggs was thirty-six cents per case. There are two possible factors that could have caused this difference in number of cracked eggs. According to investigations by Wilhelm (1939) egg shell quality declines from November and December to August or September. This is reportedly due to either the age of the hen or temperature or both at the time the egg was laid. These cracked eggs represent a point at which the farmer can increase his return by proper feeding and more careful handling.

There were .05 percent of the eggs in the leaker classification at the first grading. (Leakers are cracked eggs whose contents are leading from the shell and usually have no marketable value). With large eggs worth five cents each, the economic loss due to leakers amounted to a cent a case that was attributable to the farmer.

The increase in cracks, between the country assembler and the city receiver, was from 3.7 percent to 4.6 percent or an average of 3.5 eggs per case. Using the same price differences as in the above paragraph, the monetary loss amounted to seven cents per case. The increase in leakers between gradings was from .05 percent to .2 percent. This loss amounted to three cents per case. These two losses together made a ten

cent loss per case due to cracked and leaker eggs that was attributable to the country assembler and transportation to the city receiver. Ten cents may seem small but most operators would be very happy to be assured of that much increased profit on each case of eggs that they handle.

Combining the losses due to changes in interior quality and due to cracked eggs, the average amount of loss in the value of the eggs that could be attributable to the producer handling practices and the transportation to the country assembler could be estimated at 55 cents a case*. Similarly, the combined loss between country assembler and the city receiver amounted to 22 cents per case. These declines in value could be expected to be borne specifically by the producer and the country assembler respectively to the extent that the eggs were purchased on the basis of grade. Furthermore, even though grading was not practiced at either transaction, somewhat comparable losses would be borne by the same individuals and agencies because of the important of reputation of the eggs of either the producer or assembler. Reputation frequently influences the premiums or discounts that are usually a part of a case count transaction (ungraded buying). Likewise, reputation affects the willingness of the buyers to purchase all of the eggs offered by the seller throughout the year without excessive discount.

* This figure corrects for the duplication of loss indicated if losses due to change in interior quality and cracking were merely combined.

Effect of Truck Compared to Producer Delivery on Egg Quality At the Country Assembler

It was found in this study, contrary to popular opinion, that eggs picked up on truck routes were of better quality than those eggs delivered directly by the producer. Table 5 shows that better eggs were delivered to the country assembler by truck route than by producer. The fall group had to be eliminated from this table because no eggs were delivered by producers to the country assemblers studied during this period. It is probable that the assembler had better control over the production and handling practices of producers that they service more completely. In the fall months, because of greater competition for eggs resulting from the usual seasonal decline in volume, the people that deliver their own eggs to the country assembler apparently find various different outlets for their eggs. The original quality of eggs picked up on truck routes was 74 percent A's or better as compared to 58.7 percent from the producer delivered eggs. It should be pointed out that 215 cases were omitted from this table because they had been pregraded by the country assembler with a resultant loss in identity as to truck or producer delivery, and because the fall grading showed no producer delivered eggs.

Quality of Brown and White Eggs at First Grading

It has often been believed that brown eggs grade higher in quality than white eggs. This statement is made because in candling eggs for quality the appearance of the yolk shadow of brown shelled eggs, when the egg is held before the candling light, is much harder to see because of the brown shell. The white egg having a white shell allows the yolk

TABLE 5

Producer Vs. Truck Route Quality at First Grading

		Number of Cases	Average Percent A's or Better
Spring	Producer	13	57.54
	Truck	65	79.45
Summer	Producer	20	50.6
	Truck	77	69.4
Both Seasons	Producer	33	58.7
	Truck	142	74.0

TABLE 6

The Quality of Brown, White and Mixed Eggs at the First Grading

	Number of Cases	Average Percent A's or Better*
Whites	313	81.3
Browns	65	82.2
Mixed	12	72.7

* A's including stains and dirts.

shadow to be seen much more easily. Table 6 shows that there was very little difference between the grade qualities of the eggs delivered. The eggs had almost identical quality, 81.3 percent A's or better for white as compared to 82.2 percent for brown. This apparent similarity in quality does not justify the price differences often existing between brown and white shelled eggs.

Change in Quality

Upon the first examination of Table 7, the old popular notion that brown eggs held up better than white eggs might seem to be the case. Actually, according to the interior quality loss, the browns dropped a little further, 7.9 points* as compared with 7.1 points for the whites. This is contrary to popular belief among the city receivers of eggs. They believe that the browns will hold up better than whites. The shell damage incurred would seem to bear out the proposition that brown eggs hold up better than whites. The browns dropped 2.5 points in shell damage as compared with 3.5 points for the white eggs. The overall drop, 10.6 points for the white eggs as compared with 10.4 points for browns, was not significantly different.

* A point decline represents one egg per 100 going down one grade or the equivalent. See Appendix for further explanation.

TABLE 7

Comparison of White and Brown Egg Quality Change Between First and Second Grading

Season	Quality Loss White				Quality Loss Brown and Mixed			
	Cases (number)	Ave. Interior Quality Drop (points)	Shell Damage (points)	Total Quality Loss (points)	Cases (number)	Ave. Interior Quality Drop (points)	Shell Damage (points)	Total Quality Loss (points)
Spring	98	8.7	3.3	12.0	32	7.4	3.0	10.4
Summer	124	8.04	4.9	13.0	19	11.1	3.0	14.1
Fall	91	4.1	1.9	6.0	24	6.0	1.5	7.5
Ave. Three Seasons		7.1	3.5	10.6		7.9	2.5	10.4

Temperature as it Affects Egg Quality

It has been pointed by investigators that temperatures have considerable affect on egg quality. Wilhelm and Heiman (1938) report that eggs lose 40 percent of their original quality in twenty hours at 90° F., three days at 70° F., twenty-four days at 50°F., and 134 days at 30° F., Perry (1938) also showed the detrimental effect of temperature on fresh eggs. Table 8 gives some idea of how temperature affected interior egg quality change. This temperature was taken to get an indication of some of the farm holdings and delivery conditions which might affect quality change between the country assembler and city receiver.

Effect of Case Temperature

The method of taking the case temperature was to insert the thermometer into the middle of the case from the top. There was a significant difference when measured statistically between the 51°- 60° F. and 61° - 70° F. group in the first grading. This was also true in the second grading (Table 8) where the groups were large enough to be significant. The other variables besides temperature that are concerned with egg quality may have hidden some of the effects of temperature alone. An example is that the time the eggs are held at these temperatures is very important. For example, if the eggs are held at 68°F. for ten days, more damage in quality may take place than those held at 71° F. for one day.

It might be well to point out the temperature of the eggs at the first grading was higher than at the second grading. This indicated that the marketing agencies studied did a better job of cooling the eggs than the farmer.

TABLE 8

Case Temperature and Interior Quality Change

Temperature degrees	No. of Cases	Average Interior Quality Change (points)*
	First Grading	
41-50**	17	6.7
51-60	160	5.5
61-70	205	8.1
71-80	7	16.28
	Second Grading	
41-50	79	4.7
51-60	209	7.2
61-70	99	8.2
71-80	2	20.5

* One point equals one egg dropping one grade

** Degrees of temperature reported in Fahrenheit readings.

The eggs were generally graded relatively soon after receipt by the country assembler. It could therefore be expected that the case temperature at this point was largely due to the farmers' handling practices. This is borne out by the fact that there were only 177 cases below 60° F. at the first grading and 288 cases below 60° F. at the second grading.

Tables 9 and 10 gives a seasonal break down of the case temperatures. The first grading for the fall season showed the least quality decline. The spring grading showed a significant difference between the temperature ranges of 51° - 60° F. and 61° - 70° F. A possible reason could be that this is the period that roosters are often running with farm flocks. The resulting fertile eggs not needed by the hatcheries for baby chicks are marketed. The quality decline is greater in the fertile egg, particularly when above 68° F. since this is the point at which incubation starts.

Effect of Outside Temperature

It was thought that the outside temperature would give some idea of the temperature conditions under which these eggs were produced on the farm and handled at the assembler's place of business. Here again, there was a significant difference except for the ranges of 70° - 79° F. and 90° F. The group in the temperature range from 90° F. and up all came from one station. It should be remembered that the outside temperature did not necessarily indicate the actual holding temperature.

TABLE 9

Quality Change in Relation to Case Temperature at First Grading

	Temperature degrees	No. of Cases	Average Interior Quality Loss points*
Spring	41-50	7	5.143
	51-60	57	5.842
	61-70	66	10.955
Summer	41-50	5	11.8
	51-60	38	7.29
	61-70	94	7.9
	71-80	7	16.28
Fall	41-50	5	3.8
	51-60	65	4.215
	61-70	45	4.644

* One point equals one egg dropping one grade.

TABLE 10

Quality Change in Relation to Case Temperature at Second Grading

	Temperature degrees	No. of Cases	Average Interior Quality Loss points*
Spring	41-50	48	4.45
	51-60	55	11.58
	61-70	27	8.59
Spring	51-60	70	7.65
	61-70	72	8.1
	71-80	2	20.5
Fall	41-50	31	5.16
	51-60	84	4.08

* One point equals one egg dropping one grade.

Time as it Affects Egg Quality

Time has been shown to be a major factor in egg quality decline. Wilhelm (1939) reported a very definite change in quality when temperature was maintained constant. Lorenz and Newton (1944) also showed a quality loss due to the length of holding time of eggs. Table 12 shows the number of days between gradings correlated with the interior quality drop. There was a definite quality decline due to the length of time the eggs are held between gradings. There was a gradual increase in quality decline from an average of 3.63 eggs per 100 dropping one grade in a one-day period between gradings to a maximum of 17.18 eggs dropping one grade during the eight-day interval between gradings. The quality drop for the first three days was the most pronounced. The average decline was at the rate of 2.5 eggs for the first three days. The country assembler apparently realized the need for rapid handling of eggs - eighty-one percent of the eggs had a three-day or less lapse of time between gradings. The group that was held for four days does not follow the trend set by the other groups. This exception, it should be noted, was from one assembler. The others being composite samples were more significant.

Good Eggs Retain Quality Better Than Poor Eggs

It has been shown by Almquist and Lorenz (1935) that eggs having a high percentage of thick white stand up better than eggs having a smaller percentage of thick white. This does not agree with Wilhelm and Heiman (1938) who state "Eggs of varying quality stand up under storage conditions in proportion to their original quality, although the percentage loss may be the same." Almquist and Lorenz (1935) found that good eggs

TABLE 11

Quality Change in Relation to Outside Temperature at First Grading

Outside Temperature first grade (degrees)	No. of Cases	Average Interior Quality Loss (points)*
49 - below	29	4.4
50 - 59	107	6.3
60 - 69	111	7.5
70 - 79	56	5.7
80 - 89	74	11.
90 - up	10	5.

TABLE 12

Number of Days Between Gradings
Associated with the Change in Interior Quality

No. of Days Between Gradings	No. of Cases	Average Interior Quality Lost (points)*
1	75	3.63
2	150	6.76
3	90	7.53
4	10	4.90
5	28	8.50
6	8	8.75
7	28	17.18

* One point equals one egg dropping one grade.

lost less in quality percentage than poor eggs. Table 13 agrees with this latter point of view. Almost 90 percent of the eggs fell in the two classes from 61-80 percent and 81-100 percent A's. The change from 6.4 eggs to 9.2 eggs that dropped one grade between inspections is a 44 percent increase. The three groups below 60 percent A's or better do not show the agreement of the other two classes. There are two reasons for this; one, there was too small a sample in the lower groups, the total of three groups was only 10 percent of all the eggs inspected; and two, the nearer you get to zero percent A's the less chance there was of marked quality decline. It would appear that the drop from A's to B's seemed to be more likely than the drop from B's to C's. This was indicated by Howland (1946) when he stated that it was reported that less than two percent of the eggs sold in Detroit were Grade C eggs.

TABLE 13

Original Quality at First Grading Compared to Quality Lost Between Gradings

Percent A or Better**	No. of Cases	Total Interior Quality Drop	Average Interior Quality Lost (points)*
0- 20	20	161	8.1
21- 40	9	135	15.0
41- 60	15	86	5.7
61- 80	76	699	9.2
81-100	268	1721	6.4
	388	2802	

* One point equals one egg dropping one grade.
** This classification includes stained and dirty eggs of A and AA grade.

Effect of Egg Quality by Miles Traveled

Table 14 shows that the distance from country assembler to city receiver was not consistently related to the quality change between these two points. The distance varied from eight miles to two hundred and fifteen miles of travel. The cases identified with eight miles of travel could be ruled out because of the short distance. Furthermore, only four cases were inspected and the Fall grading was missed entirely. The relationships was true for both interior quality and shell damage. Part of the explanation for the limited relationship between distance and quality decline might be based on the relatively small range in distance traveled by most of the shipments that is from 90 to 215 miles.

TABLE 14

Quality Loss Due to Miles Traveled Between Grading

Miles Traveled	No. Cases	Average Quality Drop	Average Shell Loss		Average Total Loss
		points	points		points
8	4	4.7	3.8	Not in fall	8.5
90	25	3.4	2.6		6.1
92	14	4.5	2.0		6.5
95	23	6.2	2.0		8.2
97	10	10.7	1.8	Only in spring	12.5
102	60	8.9	1.5		10.4
103	25	9.1	3.0		12.1
103	16	9.4	4.0	Not in fall	13.4
103	19	17.1	7.0	Not in fall	24.1
107	21	2.3	.7		3.0
114	20	7.1	2.1		9.2
123	27	4.6	3.1		7.7
128	26	8.6	3.9		12.5
133	29	6.7	9.6		16.3
140	16	9.6	3.1		12.7
188	28	3.8	3.7		7.5
215	28	8.2	3.5		11.7

The Effect of a Combination of Four Factors on Egg Quality

As has been previously shown, egg quality was clearly affected by several factors. Every egg handler or channel may have some good and some poor points for the maintenance of egg quality. They may concentrate their attention on one or more possible quality maintenance factors to the neglect of others. For example, if the handler has refrigeration he may feel he can disregard the speed of handling or the original quality of the eggs. For this reason, it was considered desirable to examine the combined effect of four factors.

The four factors that influenced quality the most were - the number of days between gradings, the case temperature at the first grading, the percent of AA's and A's at the first grading, and the outside temperature at the first grading. These four factors were combined by assigning an arbitrary value, as shown in Table 15, to the good, fair, and poor conditions that each represent. The values assigned were as follows: for the number of days between gradings one day was considered good so a value of one was assigned, two days a value of two, three a value of three, etc. Since the most favorable case temperatures recorded were 40-49 degrees, this range was considered good and a value of one was assigned, 50-59 degrees a value of two, 60-69 degrees a value of three, etc. The total AA's and A's of 90 percent and higher was considered good and equal to one, 80-89 percent equal to two, 70-79 percent equal to three, etc. With outside temperatures, 40-49 degrees again was as low as the temperature went, so the same values were used as in the case temperatures.

After these values were assigned, the values for each case were

TABLE 15

Code Values* Assigned to Various Factors Associated with Maintaining Egg Quality

Time Between Gradings		Case Temperature at First Grading		Initial Quality		Outside Temperature at First Grading	
Days	Code no.	Degrees	Code no.	Percent A's	Code no.	Degrees	Code no.
1	1	40-49	1	90-100	1	40-49	1
2	2	50-59	2	80-89	2	50-59	2
3	3	60-69	3	70-79	3	60-69	3
4	4	70-79	4	60-69	4	70-79	4
5	5	80-89	5	50-59	5	80-89	5
6	6	90-100	6	30-49	6	90-100	6
7	7			10-29	7		
8	8			Less than 10	8		

* The lower code values represent the more favorable conditions, the higher values, the more unfavorable conditions.

totaled for the four factors. This total was then compared with the interior quality change as shown in Table 16. The outstanding observation from Table 16 was the relationship in which interior quality declined as the total of the four factors increased. This tendency was evident in each of the three seasons and even more evident when the data for the three seasons were combined. This gradual increase was from an average decline of about two to an average of about twelve points in the classes that had enough cases to be significant. The average quality loss for each of the seasons was 4.3 points in the fall, and 8.4 in both the spring and summer. The spring and summer were the two seasons that showed consistently higher quality losses when single factors were studied. One would expect the summer season to show the greatest loss due to generally higher temperatures. The fact that outside temperature does not always influence the actual holding temperature of the eggs may account for the fact that quality decline in the summer was the same as in the spring.

In interpretation of Table 16, it would readily appear that the egg handler in hoping to have a minimum of interior quality change, while eggs are in his possession, should attempt to provide conditions reflected by the lower code values. Furthermore, if the handler is faced with a particular handling condition that he is unable to correct for economic or physical reasons, he should concentrate upon the improvement of the other quality maintenance conditions.

TABLE 16

Interior Quality Loss Between Gradings Associated With
A Combination of Four Factors*

Total Rating of Four Factors	Fall		Spring		Summer		Three Seasons	
	Cases (no.)	Ave. Loss Interior Quality points	Cases (no.)	Ave. Loss Interior Quality points	Cases (no.)	Ave. Loss Interior Quality points	Cases (no.)	Ave. Loss Interior Quality points
5	4	2.8					4	2.8
6	9	1.3					9	1.3
7	22	3.8	2	3.3			24	3.8
8	36	5.7	15	5.6	9	2.4	60	3.9
9	22	4.0	31	6.3	13	5.3	66	5.4
10	7	6.3	21	5.9	18	5.9	46	6.0
11	1	7.0	19	7.0	9	6.3	29	6.9
12	9	9.2	8	16.0	21	4.4	38	8.2
13	2	6.0	10	12.7	19	10.7	31	11.0
14	3	5.3	5	14.0	12	9.0	20	9.5
15			7	12.1	6	11.6	13	12.0
16			5	11.2	11	9.5	16	10.0
17			4	2.0	8	13.0	12	9.3
18			1	1.0	15	14.8	16	14.0
19			1	38.0	2	23.0	3	28.0
20			1	35.0	2	2.5	3	13.3
Total	115	4.3	130	8.4	145	8.4	390	7.2

* The four factors combined were number of days between grading, case temperature at first grading, number of AA's and A's at first grading, and outside temperature at first grading.

SUMMARY

Farmers were apparently responsible for more of the egg quality change than were the country assemblers. The actual comparison was 76.1 percent A's or better during the first grading at the country assemblers as compared to 69.4 percent A's or better during the second grading, at the city receivers. The quality loss attributable to the handling practices of the farmer was a little over 20 percent in the number of A's. The practices of the country assemblers accounted for 6.7 percent reduction in number of A's.

The fall season showed better egg quality delivered to country assemblers than in either of the other two seasons. The actual figures were 80 percent A's in the fall compared to 74 percent for both of the others.

There were a larger number of cracked and leaker eggs during the summer grading than the average for all three seasons. During the summer grading 5.03 percent of the eggs were cracked or leakers. The average for all seasons was 3.7 percent.

The increase in number of cracked and leaker eggs between the gradings and the country assemblers and the city receivers amounted to 1.1 percent of the eggs.

The economic loss incurred by the farmer was 55 cents a case. Of this, 28 cents were for change in interior quality and 27 cents in shell damage. Likewise, the loss presumably sustained by the country assembler was 22 cents per case of which 12 cents were interior quality and 10 cents for shell damage.

Eggs delivered to country assemblers by producers were 59 percent A's as contrasted with truck route delivered eggs that were 74 percent A's.

This does not conform with the popular belief that producer delivered eggs are of better quality than those obtained from truck routes.

Brown and white eggs were delivered to the country assemblers at almost identical qualities, 81.3 percent A's or better for whites and 82.2 percent for browns. Similarly, the quality change between gradings was 10.6 points for white eggs and 10.4 for browns.

Case temperature at the first grading, indicative of the farmers' holding conditions, influence the interior egg quality change. This was also true of the second grading. The average case temperature was 60.5 degrees at the first grading and 55.9 degrees at the second. An explanation of this difference in case temperature might be that all ten city receivers had mechanical refrigeration as compared to 9 out of 17 of the country assemblers.

The spring grading showed the greatest interior quality change when compared to case temperature during the first grading. This might have been due to the large proportion of fertile eggs produced during this season of the year.

There was a direct relationship between outside temperature and interior egg quality change. An average of 4.4 eggs per 100 eggs dropped one grade when held at 40-49 degrees while an average of 11 eggs per 100 declined when held at 80-89 degrees.

The number of days eggs were held between gradings also affected egg quality. A rather steady increase was evident from 3.6 points decline for one day to 17.1 points for eight days between gradings.

Good eggs, 80-100 percent A's or better, retained interior quality better than poor eggs, 60-79 percent A's or better.

Miles traveled did not appear to affect the egg quality change between the assembler and the city receiver's place of business.

The combined affect of the four factors seemed to have more influence on the quality change than any single factor.

SUGGESTIONS

The Producer

It would seem that the producer could recognize that according to this data, he is not doing as good a job as the country assembler in handling market eggs. The farmer could improve his position by insisting that the chicks he buys be selected from hens that are known to be producers of good eggs. Hens with good inherited characteristics lay eggs that have a high percentage of thick white, a strong, shell, and an ability to retain their quality. After the eggs are laid the farmer should gather the eggs frequently, at least three times a day, and cool them to remove the animal heat.

Farmers should arrange to market their eggs more than the usual once a week. Time is an important factor in egg quality decline. The shorter the time from hen to market the better the egg quality. Speeding up the marketing of eggs from the farm is probably more practical than having the producer buy artificial refrigeration, especially since refrigeration is not usually necessary throughout the entire year.

The Country Assembler

The two main points that country assemblers could do is to put in refrigeration and speed up the handling of eggs. The average farmer can not afford to buy refrigeration equipment to cool his eggs. The country assembler can not afford to endanger the quality of the eggs he buys. A reputation for good eggs is built by the quality delivered to the city receiver and not on what the eggs grade at the time of grading at the country point. Some assemblers think that they can pay the farmer on the basis of a grade and turn around and sell to the receiver on the basis of the same grade. A glance at the receipts of a large receiver

will show very different prices paid for the same U. S. Grades of eggs on a given day.

Egg quality as delivered by country assemblers to city receivers is affected by their philosophy of grading. For example, some assemblers candle their eggs so that they will fall within the tolerance of the grade specified when delivered to the city receiver. Others candle their eggs to the minimum specifications at the country point. Temperature control will also help to maintain the egg quality. Delivery at night is advisable particularly in summer months since most buyers do not have refrigerated or insulated trucks.

The country assembler can speed up the handling of eggs through his plant. There is no excuse for holding the eggs for eight days as recorded in this study. Assemblers should attempt to make three days the maximum period for holding eggs. This allows him to ship twice a week to his outlet. This means once at the first and once at the middle of the week. If volume is large enough, shipments should be made oftener. Small volumes can often be shipped motor freight and quality saved.

Some assemblers may claim that the expense of more frequent deliveries would be excessive. They may also feel that during certain seasons holding the eggs is justified due to an anticipated price raise. In either or both instances, the loss in quality may very likely exceed the anticipated gain or savings. This is especially reflected in year-round quality egg reputation of the assembler.

This data did not include the conditions of the city receiver or the retail store. The effects of time and temperature should be recognized by these two types of agencies.

Limitations of This Study

The experience obtained in making this study indicates the need for further and more refined research on this problem. Some of the limitations of this study are:

1. Genetics -- The hen has been ignored as an individual. It has been demonstrated by several investigators that there are several things in the genetic make-up of a hen that influence egg quality. One of these things is that the percentage of firm white is an inherited characteristic. A relatively large percentage of firm white is, of course, recognized as a requirement for high quality eggs.

2. Age of Bird -- Jeffrey (1941) has demonstrated that egg albumin is correlated with the age of the bird. The older the pullet, the poorer the albumin index. Early hatched birds would be laying good quality eggs in the summer when just starting to lay. These same birds the next spring would lay relatively poorer quality eggs. Late hatched birds would do just the opposite and this study did not have data concerning the age of the birds.

3. Production Practices -- Skoglund and Tomhave (1941) demonstrated that a change in the length of time between gatherings of eggs has a definite influence upon their albumin score, albumin height, and percent of firm albumin which are desirable for good eggs.

4. Humidity -- Humidity was another important thing that was overlooked. Wilhelm (1939) showed that as humidity decreased, the average percentage index loss increased.

5. Candling Rooms -- The inspections to be entirely comparable should be made in candling rooms of the same light intensity. Eggs look

different even if the same candling light is used when there are varying amounts of light in the room.

6. Eggs were not Identified -- It would be a good idea to identify the individual eggs instead of in groups of one hundred eggs. Things should not be done in the large and rought, but more controlled, experiments are better. It was not known which individual eggs went down in quality.

7. Inspection Reports -- The inspector should not have access to the first inspection report at the time of the second inspection of any particular lot of eggs. The plan of having the results of the first inspection before the inspector when the second inspection was being made, was likely to bias the results. Nichols and Larzelere (1949) have found that up-grading by the same grader is a definite possibility in inspection work done while following eggs from a country assembler to the city receiver.

8. Temperature of the Eggs -- The temperatures of an egg when it is candled also might have some affect on the result of the grade. It has long been an observation in egg candling rooms that chilled eggs grade lower than the same eggs when they have come back up to room temperature, at least for a short time.

9. Broken Out Scores - The broken out scores on eggs are much more reliable indications of egg quality than candled grades. Therefore, candling reports should be frequently checked by the broken out scores on some of the eggs.

10. Egg Size -- Size was another thing that was not considered as being separate. If the inspectors had a choice they chose large eggs. In most cases, particularly in fall, spring and most of the summer, eggs were probably large eggs.

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APPENDIX

Measurement of Quality Decline

The procedure for determining egg deterioration used in this study is the same as the one used in the North Central Regional Study, 1949. The drop in egg quality was determined for the interior quality, the shell quality, and the total of both or the overall deterioration. The quality decline was measured by arbitrarily assigning a value of one point for each drop in quality grade. In other words, if an egg dropped from AA to B it had an egg quality decline of two, one from AA to A plus one from A to B. The samples were worked on the basis of one hundred eggs and as a result the actual scoring for deterioration was more complicated. This is more easily explained by the illustrations or examples which follow.

AA's and A's first grading	60		35	
AA's and A's second grading	55 - 5	- 5	33 - 2	- 2
B's first grading	20		42	
B's second grading	23 + 3	- 2	43 + 1	- 1
C's first grading	15		15	
C's second grading	17 + 2	0	14 - 1	- 2
Checks first grading	0		7	
Checks second grading	0		6 - 1	- 3
Leakers first grading	0		1	
Leakers second grading	0		4 + 3	0

Loss first grading	0		0	
Loss second grading	0		0	
Overall deterioration		- 7		- 8

Example one shows that five (5) eggs dropped from AA's and A's to B's. Maybe two (2) of these same AA's or A's dropped from B to C. This gives a total of a drop of 7 quality points.

The second example is one in which the equivalent of two eggs went down from A's to B's, there was only one more B; one dropped from C's, one dropped from checks and leakers gained 3 eggs. The overall quality loss was 8 quality points. A separation of shell damage was made from the interior quality decline. This was done by multiplying the number of cracked eggs by three and the leakers by four. The reason was that a drop from A to B is 1, B to C is 2, C to Checks is 3, and Checks and Leakers or Loss is 4. The shell damage can not of course equal more than the total quality change. The change in example one was 7 points all interior quality. The shell damage in example two could not go over 8. It could have been 15 points if there had been that many to cancel.

TABLE 17

Prices Used to Determine Economic Losses*

1948	U.S. Grade A Large Cents Per Dozen	U. S. Grade B Large Cents Per Dozen	Chex Cents Per Dozen
January	53.45	49.03	36.03
February	52.17	49.11	35.40
March	53.70	50.35	33.99
April	52.69	43.10	34.32
May	51.41	47.55	33.74
June	53.86	49.65	34.77
July	59.21	53.61	35.54
August	64.55	58.59	37.53
September	68.50	61.80	---
October	72.62	64.68	38.58
November	71.13	65.86	38.28
December	58.00	53.71	38.13
Average	59.27	53.92	36.03

* Data taken from U.S.D.A. Market News Service Detroit Office for 1948. Averages are straight numerical averages not weighed.

The test for significance used in this study, suggested by W. D. Baten, was the differences in proportions. This is presented in theorem eleven* which resolves itself into the equation --

$$t = \frac{W}{} \quad \text{or} \quad t = \frac{x_1/n_1 - x_2/n_2}{\sqrt{pg\ (1/n_1 + 1/n_2)}}$$

An example of the use of this formula is presented here for a part of a table of case temperatures at the first grading.

case temperature	no. of eggs	quality change points
$41^\circ - 50^\circ$	1,700	114
$51^\circ - 60^\circ$	16,000	880

$$t = \frac{.067 - .055}{\sqrt{.056 \times .944 \left(\frac{1}{1700} + \frac{1}{16000}\right)}}$$

$$t = \frac{.012}{.0058} = 2.06$$

$$t = .96$$

This means that the probability of the differences in the probability of occurrence as large as 0.012 or larger, given $n_1 = 1{,}700$ and $n_2 = 16{,}000$ is equal to or more than .96 or 96 times out of 100 this will happen. We can therefore say that there is a significant relationship between the temperature ranges of $41^\circ - 50^\circ$ and $51^\circ - 60^\circ$ and egg quality change in the above table. Where reference is made to significance, in the body of this study, this method was used.

* Mathematics of Statistics, Part 2, Kenny, J.F.