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Egg Grading MANUAL

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CONTENTS

	Page
Introduction	1
Formation of the egg	1
Formation of the yolk	2
Formation of the white	2
Formation of the shell membranes	4
Formation of the shell	4
Structure and composition of the egg	4
Physical structure	4
Composition of the egg	6
Abnormalities	6
Grading	7
Advantages of grading	7
General application	7
General quality factors	8
Exterior quality factors	8
Interior quality factors	11
United States Standards, Grades, and Weight Classes for Shell Eggs	17
United States standards for quality of individual shell eggs	17
United States consumer grades and weight classes for shell eggs	17
United States procurement grades and weight classes for shell eggs	18
United States wholesale grades and weight classes for shell eggs	19
Grading eggs	20
Classification of interior quality	20
Classification of exterior quality	22
Weight classification	25
Candling and weighing facilities	25
Candling room	26
Candling bench	27
Candling light	27
Weighing equipment	27
Shell egg grading laboratory	28
Candling technique and grading-room practice	28
Classifying as to weight	28
Classifying by shell factors	29
Classifying by air cell	29
Classifying by white and yolk	30
Classifying by all factors	31
Federal-State grading programs	32
Regulations governing grading of shell eggs	33
Prerequisites to packaging eggs with grade identification labels	35
Costs of service	35
The USDA licensed grader	36
General qualifications	36
Specific qualifications	36
Duties and responsibilities	37
Services to the applicant	38
Mechanics of grading	38
Legislation affecting grading and marketing of eggs	40
Federal laws	40
State egg laws	41
Production and maintenance of egg quality	41
Breeding	42
Hatching	42
Brooding and raising	42
Production of high quality eggs	42

Page

Production and maintenance of egg quality--Continued

Housing	42
Care of eggs on the farm	42
Cleaning eggs on the farm	43
Marketing	43
Station care	43
Distribution	44
Planning grading schools	45
Location and time	45
Equipment and facilities	45
Suggested programs	46

EGG GRADING MANUAL

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INTRODUCTION

This manual was prepared as an aid in teaching beginners as well as experienced egg graders the correct interpretation and application of the United States standards, grades, and weight classes for shell eggs. It is intended to serve as a guide in short courses or grading schools and its use should be supplemented with lectures, group discussions, and demonstrations as the needs of any particular group demand. Although designed primarily for those entering egg-grading work, this manual should also prove useful to those teaching the marketing of eggs in high schools and colleges.

Descriptions of the various qualities of individual eggs should assist the student grader in understanding egg quality. But it is imperative that the word pictures of the different qualities be compared with eggs before the candling light and that the quality interpretations be checked by experienced graders. The importance of practice in candling cannot be stressed too much. Although it is essential that the student grader become thoroughly familiar with the descriptions of the different qualities, the final measure of a grader's ability is the accuracy of his interpretation of quality before the candling light. Occasional comparisons of broken-out appearance with candled appearance are also very important in developing grading skill. With continued practice the student grader's ability to make accurate decisions will increase rapidly. Accurate quality interpretation at normal commercial candling speed is what is desired in an egg grader.

This manual not only provides instruction in egg grading, but also gives information on the formation and structure of the egg, on production practices that affect quality, on Federal-State grading programs, and on the duties and responsibilities of licensed graders of the United States Department of Agriculture.

It is essential that the licensed grader know about eggs, egg quality, and grading procedures. Such knowledge of the "what" and "how" of the job, coupled with reasonably good judgment, practice, and guidance, should enable one to acquire the necessary skill to determine rapidly the proper classification of shell eggs according to official standards of quality.

To be a little better than average, the grader should have background information on the reasons why grading of eggs is necessary. This includes information about the formation, structure, and composition of the egg, and the production and conservation of egg quality. Such information has therefore, been included in this manual. Although some of this material is only indirectly related to the actual grading function, a knowledge of egg formation, composition, and structure will help the grader do a better job in handling eggs and in maintaining their quality. Such information will help the grader, particularly the grader-in-charge of an egg-candling room, to have a better appreciation and understanding of his job, and will aid him in acquiring a reputation for competence and in gaining the respect of his fellow workers.

FORMATION OF THE EGG

The egg, it should be remembered, is a biological structure intended by Nature for reproduction of the chicken. It protects and provides a complete diet for the developing chick embryo and serves as the principal source of food for the first few days of the baby chicken's life. The egg is one of the most nutritious and versatile of human foods. As chickens now produce eggs in abundance, this source of food has become extremely important throughout the world, nutritionally as well as economically.

The reproductive system of the hen is divided into two main parts: Ovary and oviduct. Most female animals possess both a right and a left functioning ovary but in the hen, the right ovary and oviduct normally remain dormant and the left ovary and oviduct develop the egg.

The ovary--a cluster of developing yolks, each separate from the others--is attached to the middle part of the back about midway between the neck and the tail (fig. 1). This organ is fully formed, although very small, when the chick is hatched. It contains approximately 3,600 to 4,000 minute ova (future yolks) each within its own sac or follicle.

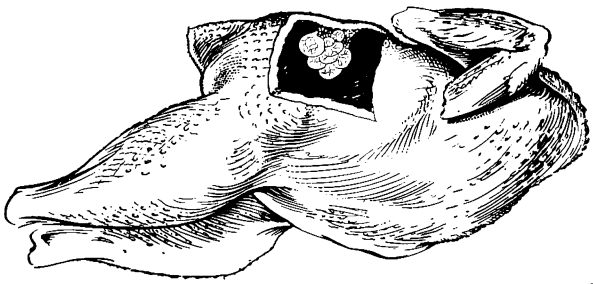

FIGURE 1.--Position of ovary in hen.

Formation of the Yolk

The three recognized stages of yolk (ovum) formation (fig. 2A) are:

First, which is concluded before hatching.

Second, which begins before hatching and ends 8 to 10 days before sexual maturity.

Third, the accelerated stage, which occurs 8 to 10 days before ovulation. This stage is initiated by the stimulating hormone of the pituitary gland. The hormones secreted by the ovary in turn stimulate the oviduct to activity. The rate of yolk secretion increases rapidly from the 9th to 2d day before ovulation (0.5 to 2.8 grams of yolk per day) and decreases thereafter.

The yolk grows by the gradual addition of yolk fluid. Fat soluble dyes--normally xanthophyll--are transferred rapidly from the digestive tract to the blood stream and then to the yolk. Occasionally, what appears to be concentric layers of alternate dark- and light-colored yolk fluid may be observed. However, modern feeding and production practices have reduced the frequency of this occurrence.

The yolk within the ovary develops as follows:

Starts as a single cell (female reproductive cell or germ) with the vitelline membrane around it.

Grows slowly at first as food material is added.

Matures as the yolk fluid is added, the germ stays at the surface of the yolk, leaving a tubelike structure, the latebra, extending to the center of the yolk (fig. 3).

Ovulation is the release of a mature yolk (ovum) from the ovary. Each developing yolk is enclosed in a yolk sac in which many blood vessels are profusely distributed. These blood vessels carry yolk-building substances to the developing yolk. One particular area of the yolk sac is free of blood vessels (stigma or suture line) and it is normally in this area that ovulation or release of the mature yolk takes place. However, the rupture of the yolk sac and release of the yolk sometimes occur at other than the stigma, with the result that one or more blood vessels are ruptured and blood spots occur on the yolk, or the white becomes bloody.

Sometimes blood vessels break before ovulation and blood is released within the yolk sac. If this occurs several days before ovulation the blood spot may degenerate and change in color to reddish brown, brown, tan, or white, and when the egg is laid, what is commonly called a meat spot is the result. Microscopic examinations show that meat spots are not sloughed-off pieces of tissue, but generally are composed only of blood cells.

Ovulation occurs again about 30 minutes after an egg is laid, during the laying clutch of a good producing hen.

Formation of the White

The oviduct (fig. 2B) is a long, tubelike organ lying along the backbone and attached to it loosely between the ovary and the tail. This organ, which is approximately 25 to 27 inches long, may be divided into five areas which perform certain functions in completing the formation of the egg. It is in the oviduct that the white, shell membranes, and shell are secreted.

The first part of the oviduct, usually 3 or 4 inches long, is the infundibulum commonly called the funnel. It opens into the body cavity. When ovulation occurs, the funnel engulfs the yolk and starts it on its way down the oviduct. Although the main function of the funnel is to pick up the yolk, it also serves as a reservoir for male sperms which, if present, fertilize the germ and set up embryonic growth. The yolk moves through the infundibulum or funnel to the magnum in about 15 minutes. Movement is brought about by peristaltic action.

The magnum area is about 15 inches long and the time required for the yolk to travel through its length is about 3 hours. It is here that the thick white, which comprises approximately 55 percent of the albumen and practically all the protein in the albumen, is secreted. The quality of the white is

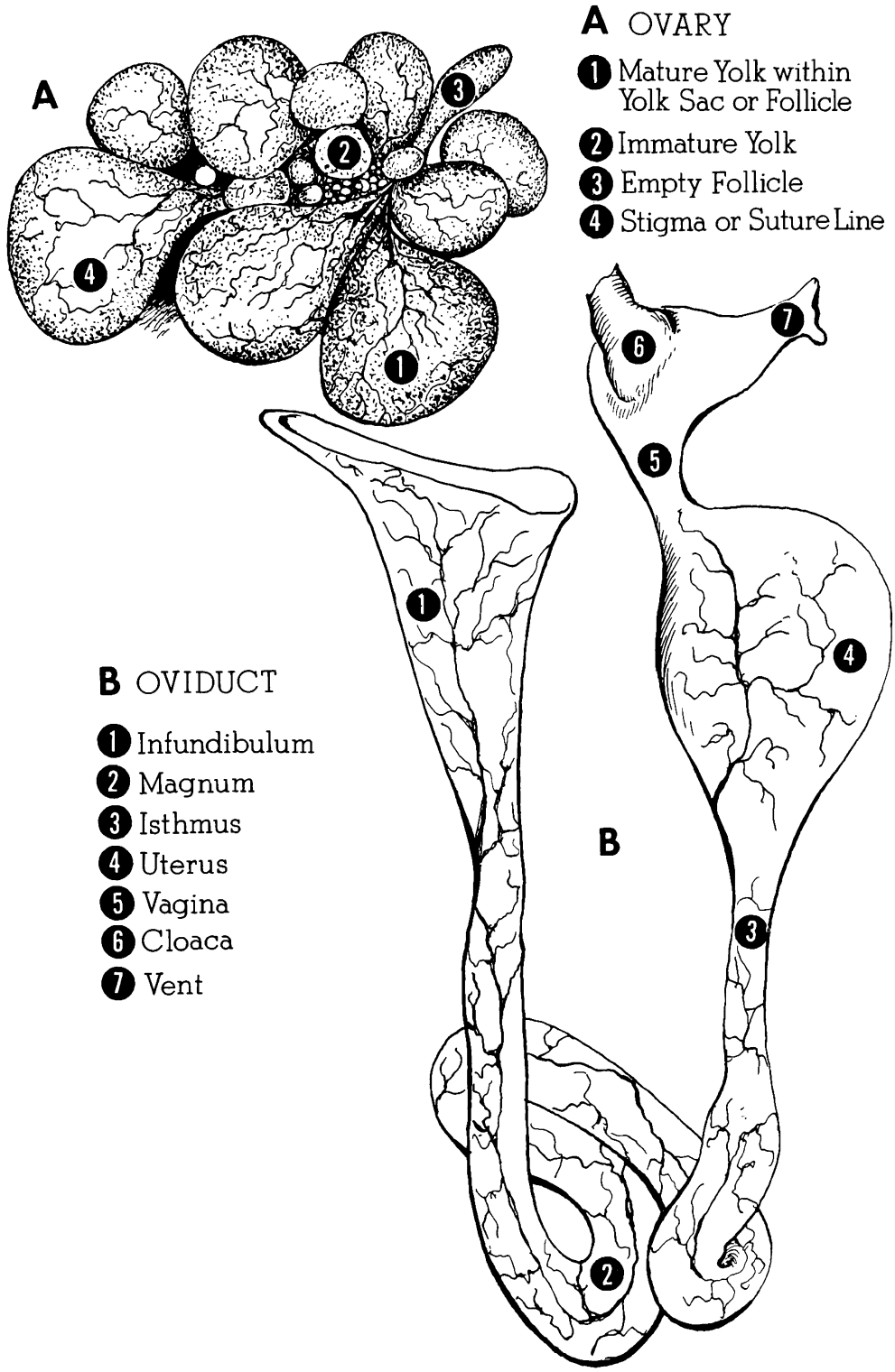

FIGURE 2.--Enlarged drawings of A, ovary; B, oviduct.

largely dependent on the amount of ovomucin secreted by this part of the oviduct.

The isthmus is a constricted area of the oviduct about 4 inches long, through which the developing egg passes in about 1-1/4 hours. Here some water and mineral salts are added and the two shell membranes are deposited.

The uterus, a heavy-walled part of the oviduct and approximately 4 inches in length, supplies the final complement of white and minerals (which pass through the shell membranes by osmotic pressure) and then the shell, shell pigment, and cuticle are added. The developing egg spends about 21 hours in this area.

Moving finally into the vagina, a 2-inch area, the fully formed egg enters the cloaca and the vent, and is laid. The entire time from ovulation to laying is usually slightly more than 24 hours. About 1/2 hour after a hen has laid an egg, she releases another yolk (ovulation), and it will likewise travel the length of the oviduct.

The albumen (fig. 3) secreted by the magnum is a homogenous gel. The mucin (secreted as fibers) is responsible for the gel. The portion of the gel immediately adjacent to the yolk undergoes partial liquefaction before the egg leaves the magnum. The spiral movement of the developing egg as it passes through the oviduct causes the mucin fibers to draw together. From these strands the chalaziferous layer and the chalazae are formed. The twisting and drawing together of these mucin strands tend to squeeze out thin albumen to form the inner thin white. Thus three layers of albumen are formed from the homogenous gel., as follows: (1) Chalaziferous layer continuous with the chalazae, (2) the inner thin white, and (3) the thick white. The outer thin white (4th layer) is added in the uterus through the shell membranes. The water and solids content of the white ultimately become equally distributed in the various layers of the white.

Formation of the Shell Membranes

The shell membranes (fig. 3 and 4) are added as the partly formed egg enters the isthmus. The membranes are a closely knit lacelike nitrogenous compound of a substance similar to that present in chicken's toe nails.

Formation of the Shell

The shell fig. 3 and 4 is formed in the uterus and is composed of three layers:

Mammillary or inner layer consisting of calcite crystals over the surface of the outer shell membrane in knoblike formations set perpendicular to the surface of the shell.

Spongy layer consisting of small calcite crystals that are not arranged in any order except in the outer portion of the layer where crystals are set at right angles to the shell surface.

Cuticle which is sometimes erroneously referred to as "bloom" and which is of a chemical composition similar to the shell membrane.

Calcium carbonate comprises about 94 percent of the dry shell. A hen may use as much as 47 percent of her skeletal calcium for egg shell formation.

Pores are formed through the spongy layer connecting some of the space between the knoblike mammilla with the surface. When the egg is laid, the pores are filled by the matrix material and covered by the cuticle.

The egg, as laid, normally has no air cell. It forms as the egg cools, usually in the large end of the egg, and develops between the shell membranes. The air cell is formed as a result of the different rates of contraction between the shell and its contents.

STRUCTURE AND COMPOSITION OF THE EGG

Physical Structure

Yolk

The yolk (fig. 3) consists of the latebra, germinal disc, concentric rings of yolk material and the vitelline membrane (a colorless membrane) which surrounds and contains the yolk. The yolk constitutes approximately 31 percent of the total weight of the egg.

White

The white consists of several layers of albumen which together constitute about 58 percent of the weight of the egg.

The Chalaziferous layer immediately surrounds the yolk and is continuous with the chalazae. (Pronounced Kah-lay-za.) This is a very firm but very thin layer of albumen. It makes up 3 percent of the total albumen.

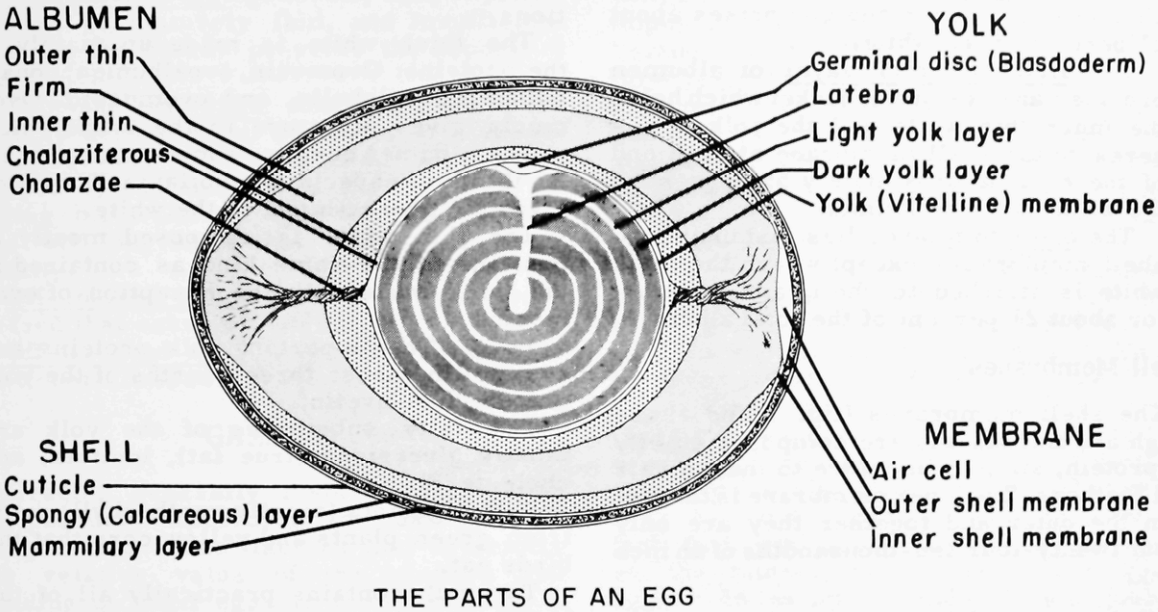

FIGURE 3.--The parts of an egg.

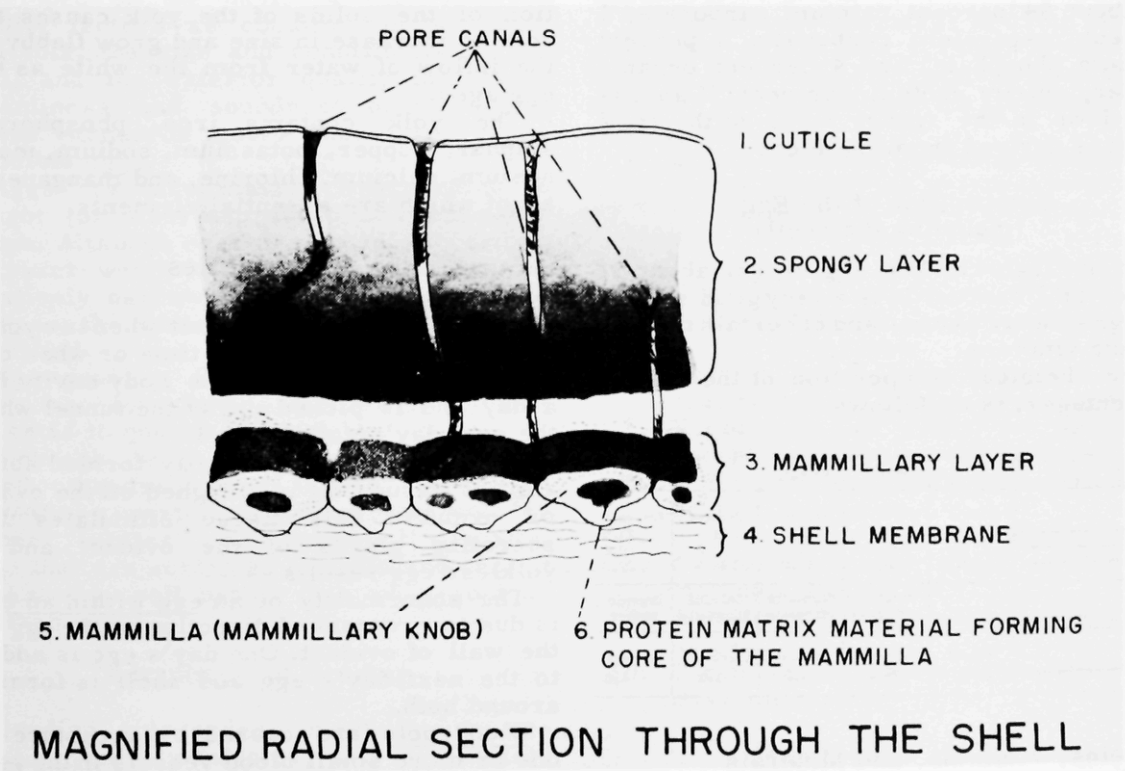

FIGURE 4.--Magnified cross section of shell of an egg.

The inner thin layer surrounds the chalaziferous layer and comprises about 21 percent of the white.

The firm or thick layer of albumen provides an envelope or jacket which holds the inner thin white and the yolk. It adheres to the shell membrane at each end of the egg. Approximately 55 percent of the white is firm albumen.

The outer thin layer lies just inside the shell membranes except where the thick white is attached to shell, and accounts for about 21 percent of the total albumen.

Shell Membranes

The shell membranes (fig. 3 and 4) are tough and fibrous and are composed chiefly of protein, similar in nature to that in hair and feathers. The inner membrane is thinner than the outer and together they are only about twenty-four ten-thousandths of an inch thick.

Shell

The shell (fig. 4) constitutes approximately 11 percent of the egg and is composed of about 94 percent calcium carbonate, 1 percent magnesium carbonate, 1 percent calcium phosphate, and 4 percent organic matter, chiefly protein. Pigment, if any, is laid down in the spongy layer of the shell and it is derived from the blood.

Composition of the Egg
(including the shell)

An average chicken egg weighs about 57 grams or 2 ounces. It is a very good source of high-quality protein and of certain minerals and vitamins.

The chemical composition of the egg, in percentages, is as follows:

		Water	Protein	Fat	Ash
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Whole egg	100	65.5	11.8	11.0	11.7
White	58	88.0	11.0	0.2	0.8
Yolk	31	48.0	17.5	32.5	2.0
		Calcium carbonate	Magnesium carbonate	Calcium phosphate	Organic matter
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Shell	11	94.0	1.0	1.0	4.0

Proteins, Vitamins, and Minerals
(edible portion, not including the shell)

Albumen.--The protein of egg is complete; it contains all of the indispensable amino acids in well-balanced proportions.

The thick white is made up mainly of the proteins: Ovomucin, ovoalbumen, conalbumen, ovoglobulin, and ovomucoid. Ovomucin gives structure to the thick white.

The albumen contains some water-soluble B vitamins, especially riboflavin. The latter gives the greenish tint to the white.

The thin white is composed mostly of proteins of the same kind as contained in the thick white with the exception of ovomucin.

Yolk.--The important yolk proteins are ovovitellin (about three-fourths of the yolk protein) and livetin.

The fatty substances of the yolk are mostly glycerides (true fat), lecithin, and cholesterol.

Yolk pigments (mostly xanthophyll) come from green plants and yellow corn that the birds eat.

The yolk contains practically all of the known vitamins except vitamin C. The vitelline membrane is mostly protein similar to that of the shell membranes and is fairly permeable to water. The higher concentration of the solids of the yolk causes the yolk to increase in size and grow flabby by the inflow of water from the white as the egg ages.

The yolk contains iron, phosphorus, sulphur, copper, potassium, sodium, magnesium, calcium, chlorine, and manganese, all of which are essential elements.

Abnormalities

Double-yolked eggs result when two yolks are shed about the same time or when one day's yolk is lost into the body cavity for a day and is picked up by the funnel when the next day's yolk is shed.

Yolkless eggs are usually formed about a bit of tissue that is sloughed off the ovary or oviduct. This tissue stimulates the secreting glands of the oviduct and a yolkless egg results.

The abnormality of an egg within an egg is due to reversal of direction of the egg by the wall of oviduct. One day's egg is added to the next day's egg and shell is formed around both.

Bloodspots are caused by a rupture of one or more small blood vessels in the yolk follicle at the time of ovulation.

Meat spots are believed to be degenerated blood spots which have changed, mostly in color, as a result of chemical action.

Soft-shelled eggs generally occur when an egg is prematurely laid, and insufficient time in the uterus prevents the deposit of the shell.

Thin-shelled eggs may be caused by dietary deficiencies, heredity, or disease.

Glassy-and chalky-shelled eggs are caused by malfunction of the uterus of the laying bird. Glassy eggs are less porous and will not hatch but may retain their quality.

Off-colored yolks are due to substances in feed that cause off-color.

Off-flavored eggs may be due to disease or to certain feed flavors.

GRADING

Grading generally involves the sorting of products according to quality, size, weight, and other factors that determine the relative value of the product. The grading of shell eggs is the classifying of the individual egg according to established standards. United States Standards for Quality of Individual Shell Eggs have been developed on the basis of such interior quality factors as condition of the white and yolk, the size and condition of the air cell, and the exterior quality factors of cleanliness and soundness of the shell. These standards cover the entire range of edible eggs.

Eggs are also classified according to weight (or size) expressed in ounces per dozen. Although eggs are not sold according to exact weight, they are grouped within relatively narrow weight ranges or weight classes, the minimum weight per unit being specified.

Egg grading, then, is the grouping of eggs into lots having similar characteristics as to quality and weight.

Although color is not a factor in the U. S. Standards and Grades, eggs are sometimes sorted for color and sold as either "whites" or "browns." Usually, eggs that are sorted as to color and packed separately, sell better than when sold as "mixed colors."

Advantages of Grading

Grading aids orderly marketing by reducing waste, confusion, and uncertainty with respect to quality values. Standards are developed to satisfy the need and desire of producers, dealers, and consumers for a uniform yardstick with which to measure important differences in quality. The term "standardization" implies uniformity. However, unless the same standard is used and unless it is applied accurately in all instances, uniformity in interpretation will not result. The egg production pattern and the marketing system in the United States are such that interstate trading and shipment occur constantly and in large volume. This situation creates a need for uniform standards throughout the United States so that marketing may be facilitated and the efficiency of distribution increased. To aid in this situation officials of the U. S. Department of Agriculture and State and industry leaders have for a number of years been encouraging the use of uniform standards and grades for eggs. That progress has been made is evidenced by the fact that practically all the eggs traded on the futures market and most of the eggs sold in other wholesale and jobbing channels are graded on the basis of United States standards. Many of the eggs reaching the consumer are graded and marked according to U. S. standards and grades.

The principal advantage in using official standards and grades for eggs is that they furnish an acceptable common language in trading and marketing the product, thus making possible:

1. Impartial official grading which eliminates the need for personal inspection of the eggs by sellers, buyers, and other interested persons.
2. Pooling of lots of comparable quality.
3. Development of improved quality at producer level through "buying on grade" programs.
4. Market price reporting in terms understood by all interested parties.
5. Negotiation of loans on generally accepted quality specifications.
6. A basis for settling disputes involving quality.
7. A basis for paying damage claims.
8. A standard upon which advertising may be based.
9. A uniform basis for establishing brand names.
10. Establishment of buying guides for consumers.

General Application

Standards of quality are used as a basis for establishing grades. Standards of quality

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apply to the individual eggs; grades apply to lots of eggs such as dozens, 30-dozen cases, and carloads. As egg quality is unstable and grading procedures are largely subjective, it is necessary to provide tolerances in grades for small percentages of eggs of a quality lower than that comprising the major part of the grade. The tolerances are provided to allow for errors in judgment, differences in interpretation, and normal deterioration in quality from the time of grading during a reasonably short period until the eggs are sold to the consumer.

The United States Standards for Quality of Individual Shell Eggs serve not only as a basis for establishing U. S. grades, but also for developing State standards and grades and "commercial" grades. The U. S. standards and grades are permissive, that is, they may or may not be used by individual producers or handlers.

Many of the State departments of agriculture adopt the United States standards and grades as a part of their programs for regulating the marketing of eggs within their States. Grade specifications in some States vary somewhat from the U. S. grades, but the standards of quality are rather uniformly used throughout the country. United States standards are often used by commercial firms as a basis of buying and selling eggs or in settling controversies that may arise in such transactions. Other firms develop their own standards and grades, although many of these are based on the U. S. standards. The principal change from the U. S. standards that commercial buyers make in establishing their bases of buying and selling is the practice of combining several qualities of eggs into one grade in order to reduce the total number of grades. For example, several of the lower qualities, such as C, dirties, and checks, may be combined into one commercial grade which may be given a name such as "number two's," or "under grades."

As previously indicated, there is broad general use of the U. S. standards and grades; however, the uniformity of their application within the States and between commercial firms may vary considerably. Official grading programs sponsored by the U. S. Department of Agriculture in cooperation with the States are intended to bring about uniformity in the application of the standards throughout the country. The work of graders is continuously supervised to assure correct interpretation of egg quality according to the official standards.

GENERAL QUALITY FACTORS

Quality may be defined as the inherent properties of a product which determine its degree of excellence. Those conditions and characteristics which consumers want and for which they are willing to pay are in a broad sense factors of quality. Certain properties, such as size and shell color, are not considered as factors in most standards of quality; they, nevertheless, are important considerations in the minds of consumers.

Standards of quality have been developed as a means of classifying individual eggs according to various groups of conditions and characteristics that experience and research have shown to be wanted by consumers and for which they are willing to pay. Grades are nothing more than specified combinations of various qualities in dozen or case lots.

Quality factors may be divided into two general groups: Exterior quality factors, apparent from external observation; and interior quality factors, which involve the contents of the shell.

Exterior Quality Factors

Shell Shape and Texture

The normal egg has an oval shape with one end larger than the other, and it tapers toward the smaller end. These ends of an egg are commonly called the large end (air-cell end) and the small end. Measurements of both strength and appearance of many eggs by investigators resulted in the development of the "ideal" egg shape. This ideal egg shape is illustrated in figure 5. The shape of an egg can be considerably different (fig. 6) from the "ideal" but may still be considered practically normal. The grader must keep in mind a mental picture of the normal or usual shape of an egg and compare each egg as he grades it with that picture.

Eggs that are unusual in shape, such as those having ridges, rough areas, or thin spots, are placed in the lower grades (fig. 7 and 8). Shells of such eggs are usually weaker than normal shells and the danger of breakage en route to the consumer lowers the utility value of the egg.

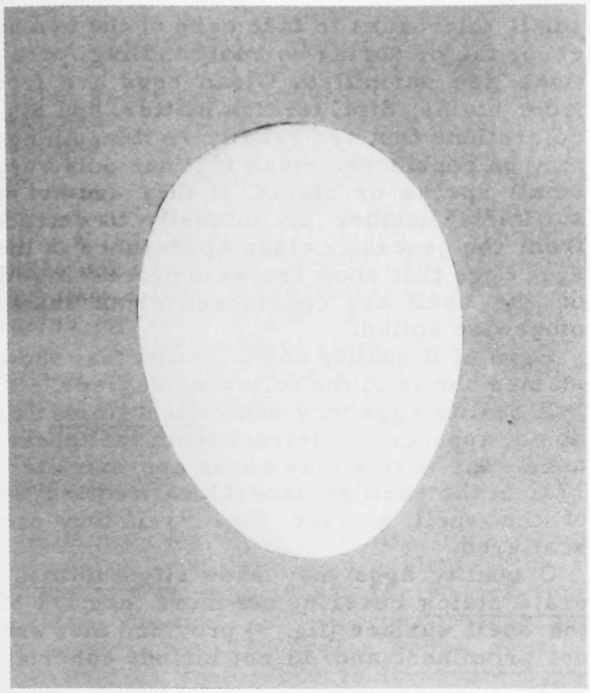

FIGURE 5.--Ideal egg shape, usually found in AA or A quality.

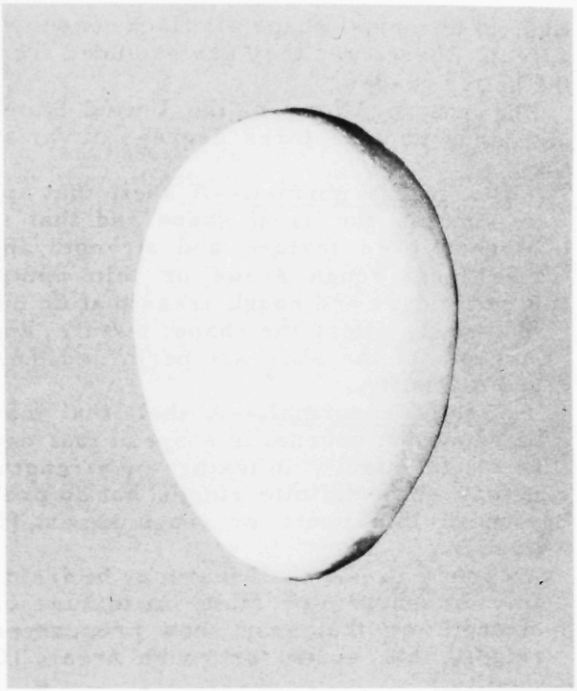

FIGURE 6.--Practically normal shape which may be found in AA or A quality.

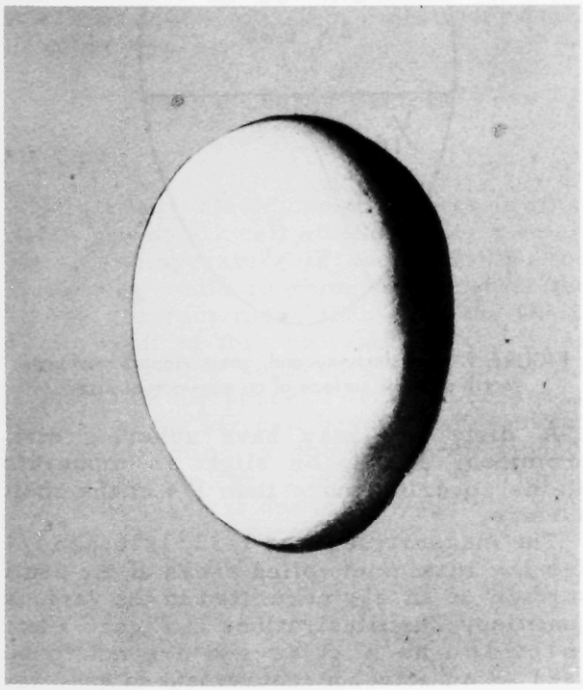

FIGURE 7.--Slightly abnormal shape, showing definite ridges and rough shell permitted in B quality.

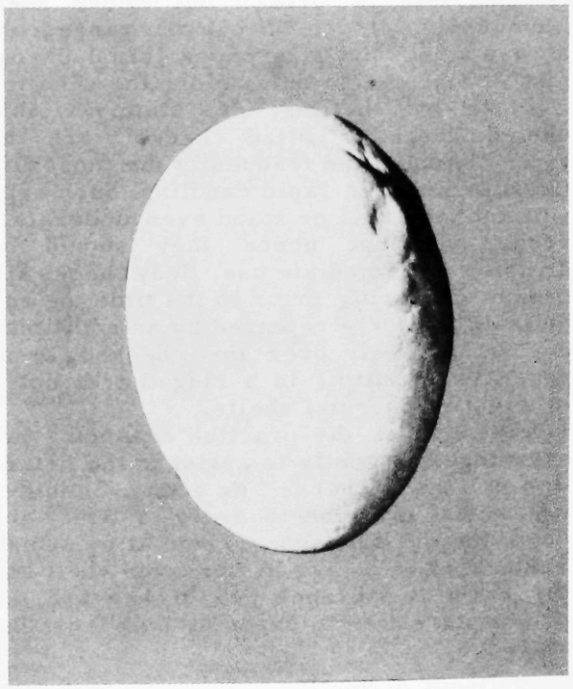

FIGURE 8.--Abnormal shape having pronounced ridges permitted in C quality.

Eggs of abnormal shape also lack consumer appeal. Therefore, they are excluded from the better grades.

The specifications of the United States standards provide three degrees of variation:

Practically normal.--A shell that approximates the usual shape and that is of good even texture and strength and free from rough areas or thin spots. Slight ridges and rough areas that do not materially affect the shape, texture, and strength of the shell are permitted. (AA and A Quality.)

Slightly abnormal.--A shell that may be somewhat unusual in shape or that may be slightly faulty in texture or strength. It may show definite ridges but no pronounced thin spots or rough areas. (B Quality.)

Abnormal.--A shell that may be decidedly misshapen or faulty in texture or strength or that may show pronounced ridges, thin spots, or rough areas. (C Quality.)

Soundness of Shell

A sound-shelled egg is one whose shell is unbroken. A checked or cracked shell is one that is broken but whose shell membrane is intact. Checks may range from a very fine, hair-like check (blind check) that is discernible only before the candling light or by "belling," to plainly visible dented checks. "Blind checks" are the most common and frequently the most difficult to detect in rapid candling. Such eggs will not keep well or stand even moderately rough handling, hence they should be diverted to immediate use. Body checks are checks occurring prior to the time the egg is laid. They are repaired by an additional deposit of shell over the checked area, generally resulting in a ridged area noted in slightly abnormal shells.

"Belling" is the practice of tapping two eggs together gently to assist in the detection of "blind checks" by sound. Candlers follow this practice in order to verify and complete the findings arrived at by sound.

A leaker is an egg in which the shell and the shell membranes are broken and the contents are free to exude or leak from the shell.

Cleanliness of Shell

Eggs of AA quality and A quality must have clean as well as sound shells. However, small tolerances to take care of the human error factor during normal candling operations are permitted. Clean eggs are free from stains, dirt, foreign matter, and discolorations that are readily visible. An egg may be considered clean if it has only very small specks or stains, if they are not of sufficient number or intensity to detract from the generally clean appearance of the egg. Eggs that show traces of processing oil on the shell are considered clean unless otherwise soiled.

Eggs of B quality and C quality may show stained shells in the following degrees:

B quality eggs may show slight stains that do not appreciably detract from the appearance. The stains may cover approximately 1/32 of the shell surface if localized or 1/16 of the shell surface (fig. 9) if they are scattered.

C quality eggs may show slight to moderate stains covering not more than 1/4 of the shell surface (fig. 9) provided they are not prominent and do not include adhering dirt.

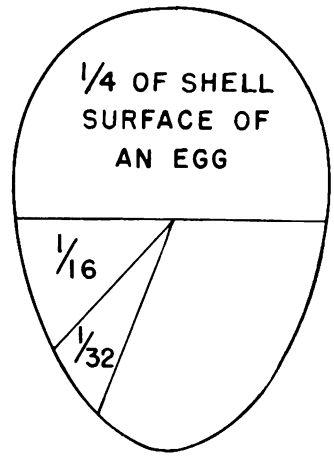

FIGURE 9.--One thirty-second, one-sixteenth, and one-fourth of shell surface of an egg--actual size

A dirty egg may have adhering dirt, prominent stains, or slight to moderate stains covering more than 1/4 of the shell surface.

The measurements of 1/32, 1/16, and 1/4 are the maximum soiled areas of the shell surface of an egg permitted in the various qualities. The illustrations in Figure 9 are intended as a guide and are not to be used as an actual measurement in grading. Graders should learn to determine the area that constitutes these measurements and then judge eggs having soiled

shells against this mental picture. It is difficult to visualize the gathering together of soiled areas and apply them against a scale. However, if the grader keeps in mind that the total area of a normal 2-ounce egg is about 10-1/2 square inches, 1/32 of the shell surface of a 2-ounce egg would measure approximately 3/5" x 3/5"; 1/16 would measure about 4/5" x 4/5"; and 1/4 would measure a little more than 1-1/2" x 1-1/2".

The terms "slight" and "moderate," describing intensity of stain, may be interpreted as barely detectable for "slight" and readily noticeable but not prominent for "moderate."

Color of Shell

Although the U. S. specifications do not recognize shell color as a quality factor, it is actually an important factor in marketing. Certain markets pay higher prices for white eggs; others prefer brown eggs. If the market preference is for white eggs, they should be chalk white--not tinted or creamy colored. Most markets prefer either all white eggs or all brown eggs--not mixed colors packed in the same container.

The color of the shell, an inherited characteristic, does not affect the interior quality of the egg.

Interior Quality Factors

Air Cell

As already stated, when the egg is first laid it has no air cell at all or only a small one. Its temperature is about 105° F. and as the egg cools to room temperature the liquids contract more than does the shell. As a result of this contraction, the inner shell membrane separates from the outer to form the air space. Further increase in the size of the air cell beyond that resulting from contraction is due to evaporation of water from the egg. The rapidity with which this takes place is due to many factors, such as age, shell texture, temperature, and humidity. The air cell is normally at the large end of the egg and is one of the first factors observed in candling.

The air cell is perhaps the one quality factor that is easiest to evaluate as it can be judged objectively by a simple measuring device--the air-cell gauge. In candling, the air cell is considered by many as a relatively unimportant quality factor for determining the broken-out quality of an egg. However, the air cell is one of the factors of the U. S. standards and, therefore, it can be the determining factor in classifying the individual egg as to quality. There are two measurements of the air cell to be considered, namely, the depth and the amount of movement. The practically regular air cell required in eggs grading AA and A is one that maintains a practically fixed position in the egg and shows a fairly even outline, with not more than two-eighths inch movement in any direction as the egg is rotated.

The size and movement of the air cell which are permitted in the various qualities are as follows:

Quality	Depth	Movement
AA	1/8 inch	2/8 inch
A	2/8 inch	2/8 inch
B	3/8 inch	May be free but not bubbly
C	No limit	No limit

The air-cell gauge may be used by the beginner until he can learn to judge the size of the air cell accurately at a quick glance while candling. More experienced candlers occasionally use the gauge to check the accuracy of their determinations.

The depth of the air cell is measured at the point of greatest distance between the top of the cell and an imaginary plane passing through the egg at the lower edge of the air cell where it touches the shell (fig. 10). Air-cell movement is the distance the air cell moves away from its normal position when the egg, with the air cell uppermost, is twirled.

Among the air cell defects are:

Tremulous air cells which are in relatively fixed positions but have a slight movement from side to side as the egg is moved.

Free air cells in which the shell membranes are intact, but the air cell moves freely around between them.

Bubbly air cells in which the inner shell membrane is broken, causing one or more air bubbles to move about in the white when the egg is rotated.

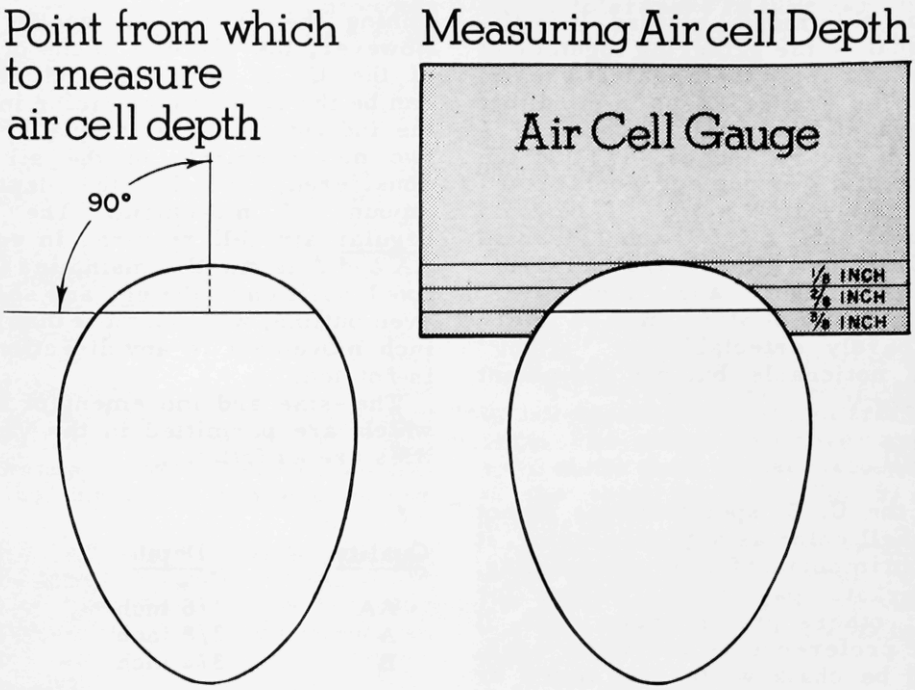

FIGURE 10.--Gauge for measuring depth of air cell.

Yolk

The appearance of the yolk as the egg is twirled in candling is one of the best indicators of the interior quality of shell eggs. The characteristics of the yolk are determined by the shadow that it casts upon the shell before the candling light. The appearance of the yolk is dependent on the condition of the albumen; however, there are four factors about the yolk itself that are considered in judging egg quality by the yolk. These are:

- Position of yolk
- Distinctness of yolk shadow outline
- Size and shape of yolk
- Defects and germ development

Position of the yolk. Normally the yolk in a new laid egg of high quality occupies a central position within the egg--vertically as well as horizontally. The distance the yolk moves away from the center of the egg as it is properly twirled, indicating the viscosity of the white, is a measure of the interior quality. There are three types of movements that can be detected (fig. 11). The vertical or up-and-down movement, the movement or swing of the yolk to either side around the inside of the shell, and the spinning motion of the yolk on the axis formed by the chalazae. This latter spinning movement allows all sides of the yolk to be seen and thereby permits observation of spots, germ development, and blemishes on the yolk.

The horizontal movement or centering is more difficult to measure than is the vertical movement. The former is measured by the distinctness of the yolk outline shadow and is dependent largely on the viscosity of the white or albumen.

In order to make observations on a uniform basis, the amount of twirling given the egg as it is placed before the candling light should be standardized.

The terms used to describe yolk centering are as follows: Well centered--A yolk that occupies the center of the egg and moves only slightly from that position as the egg is twirled (AA Quality). Fairly well centered--A yolk that is not more than one-fourth of the distance from its normal central position toward the ends of the egg and swings not more than one-half of the distance from its normal position toward the sides of the egg as it is twirled (A Quality). Off center--A yolk that is distinctly above or below center and swings

close to the sides of the egg as it is twirled (B and C Quality).

The approximate distances given above--not more than one-fourth the distance, and so on--are intended as an aid to candlers. They are not to be considered as specific measurements requiring the use of a ruler or other measuring device, but are designed to help the candler form his opinion of each egg--whether the yolk is well centered or off center (fig. 11).

Distinctness of yolk shadow outline. The distinctness of the yolk outline or shadow outline is governed by three factors:

(1) The thickness and consistency of the albumen. The thicker the albumen the less distinct the outline appears, because the yolk is prevented from moving close to the shell.

(2) Condition of the yolk. This condition is determined by the presence of blemishes that show up before the candling light as dark shadows in the yolk, or the absence of these blemishes; and the presence or absence of an off-colored yolk appearance which shows as a grayish or greenish shadow.

(3) Color of the yolk. It is difficult to determine the color of the yolk before the candling light except off-color. However, extremes in yolk color may influence the candler's judgment of egg quality. An extremely deep-colored yolk, under some conditions, would cast a darker shadow before the candling light than would a lighter yolk. By concentrating on the yolk outline instead of the depth of the yolk shadow, therefore, the grader will minimize the influence of yolk color on his quality determinations. The color of the yolk and the firmness of the albumen are two interacting influences that affect the distinctness of the yolk shadow outline; therefore, a grader cannot be even reasonably certain which is the more important factor in any specific case. The distinctness of the yolk shadow is the important factor in determining the horizontal centering of the yolk. The principle of judging distinctness of the outline rather than the depth or darkness of the shadow can be illustrated by holding a ball close to a wall so its shadow falls on the wall, and then holding it a little farther away from the wall; at the greater distance, the outline of the shadow is less distinct.

The terms used to define the four degrees of distinctness of yolk shadow outline in the U. S. standards of quality for shell eggs are: Outline slightly defined--A yolk outline that is indistinctly indicated and appears to blend into the surrounding white as the egg is twirled (AA Quality). Outline fairly well defined--A yolk outline that is discernible but not clearly outlined as the egg is twirled

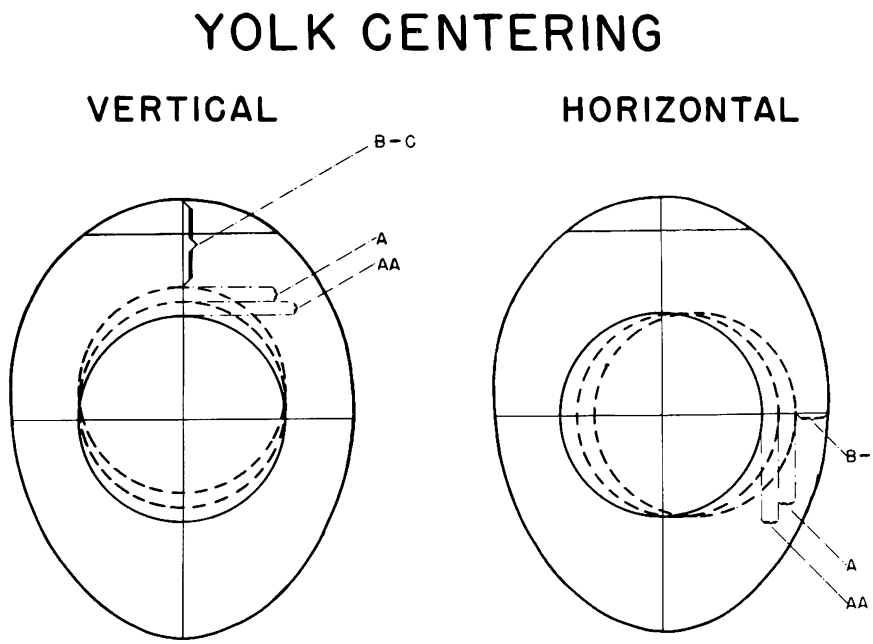

FIGURE 11.--Diagram showing the position of yolk for each quality.

(A Quality). Outline well defined--A yolk outline that is quite definite and distinct as the egg is twirled (B Quality). Outline plainly visible--A yolk outline that is clearly visible as a dark shadow as the egg is twirled (C Quality).

Size and shape of yolk--The yolk in a new-laid egg is round and firm. As the yolk ages it absorbs water from the albumen which increases its size and causes it to stretch and weaken the vitelline membrane and to assume a somewhat flattened shape on top and an "out-of-round" shape generally, resembling a balloon partially filled with water. Yolk size and shape are mentioned only in the lower quality classifications for eggs--B and C--where these factors become apparent. The terms used in the U. S. standards of quality for shell eggs to describe yolk size and shape are: Slightly enlarged and slightly flattened--A yolk in which the yolk membranes and tissues have weakened somewhat causing it to appear slightly enlarged and slightly flattened (B Quality). Enlarged and flattened--A yolk in which the yolk membranes and tissues have weakened and moisture has been absorbed from the white to such an extent that it appears definitely enlarged and flat (C Quality). Occasionally the yolk will sag and produce two well-defined shadows, the edges of which overlap.

Defects and germ development. Relatively little is known about the exact causes of most yolk defects other than those due to germ development. Some of the causes which have been advanced are: Irregular deposits of light and dark yolk; blemishes from rubbing; and development of accumulations or clusters of the fat and oil in droplets. The relative viscosity of the albumen has a direct bearing on the accurate determination of defects on the yolk before the candling light. Unless yolk defects are very prominent, detection of them is difficult particularly when the egg has a thick albumen. Germ development is visible before the candling light and can generally be detected as a circular dark area near the center of the yolk shadow. If blood is visible, the egg must be rejected as inedible.

The terms used to describe yolk defects are: Free from defects--A yolk that shows no spots or areas on its surface indicating the presence of germ development or other defects (AA Quality). Practically free from defects--A yolk that shows no germ development but may show other very slight defects on its surface (A Quality). Definite but not serious defects--A yolk that may show definite spots or areas on its surface but with only slight indications of germ development or other pronounced or serious defects (B Quality). Other serious defects--A yolk that shows well-developed spots or areas and other serious defects, such as an olive yolk, which do not render the egg inedible (C Quality). Clearly visible germ development--Development of the germ spot on the yolk of a fertile egg that has progressed to the point where it is plainly visible as a circular area or spot with no blood in evidence (C Quality). Blood due to germ development--Blood caused by development of the germ in a fertile egg to a point where it is visible as definite lines or as a blood ring. Such an egg is classified as inedible.

White

Practically all new-laid eggs contain four layers of albumen--inner thin, chalaziferous, thick, and outer thin. The appearance of the egg before the candling light is governed largely by the relative proportions of the thick and outer thin layers of albumen. The white and yolk are very closely associated and any discussion of either factor, of necessity, involves the other. However, there are two important considerations about the white which are included in standards of quality: Condition or viscosity, and clarity.

Condition of the white.--The condition of the white is determined in candling by the yolk position, the intensity of the yolk shadow, and the relative freedom of movement of the yolk away from its central position when the egg is twirled before the candling light. The grader must judge from the behavior of the yolk, how the white will appear when the egg is broken out. The appearance of the albumen in broken-out eggs is illustrated in (fig. 14).

In classifying eggs for quality according to the U. S. Standards of Quality for Individual Shell Eggs, four groupings are made with respect to the condition of the white.

A firm white is sufficiently thick or viscous to permit only limited movement of the yolk from the center of the egg, thus preventing the yolk outline from being more than slightly defined or indistinctly indicated when the egg is twirled.

A reasonably firm white is somewhat less thick or viscous than a firm white. A reasonably firm white permits the yolk to

move somewhat more freely from its normal position in the center of the egg and approach the shell more closely. This would result in a fairly well-defined yolk outline when the egg is twirled.

A slightly weak white is lacking in thickness or viscosity to an extent that permits the yolk to move quite freely from its normal position in the center of the egg. A slightly weak white will cause the yolk outline to appear well defined when the egg is twirled.

A weak and watery white is thin and generally lacking in viscosity. A weak and watery white permits the yolk to move freely from the center of the egg and to approach the shell closely, thus causing the yolk outline to appear plainly visible and dark when the egg is twirled.

Clarity.--The albumen must be clear if the egg is to be classified as AA, A, or B. The viscosity or firmness of the white of new-laid eggs often influences the correct appraisal of the clarity factor insofar as small blood spots are concerned. Small spots that may be entwined with the chalazae or that adhere to the well-centered yolk may often be undetected. Whites that are not clear because they contain small blood spots or meat spots (not over 1/8 inch in diameter) are included in C quality. Whites that are not clear because of other foreign material or because of decomposition are classed as loss or inedible.

The U. S. Standards of Quality contain the following descriptive terms relating to the clarity of the white.

A clear white is free from discoloration or from foreign bodies floating in it. (Prominent chalazae should not be confused with foreign bodies such as spots or blood clots.)

Blood clots or spots (not due to germ development) are sometimes found on the surface of the yolk or floating in the white. These blood clots may have lost their characteristic red color and may appear as small spots or foreign material commonly referred to as meat spots. Such blood clots or spots are incorporated in the egg during its formation, sometimes even before the yolk leaves the ovary. If they are small (aggregating not more than 1/8 inch in diameter) the egg may be classed as "C Quality." If they are larger or show diffusion of blood in the white surrounding them, the egg is classified as loss.

An egg, the white of which has blood diffused through it, is called a bloody white. Such a condition may be present in new-laid eggs. Eggs with bloody whites are classed as loss.

Loss and Inedible Eggs

The U. S. Standards of Quality also define certain eggs as "loss."

"Loss.--An egg that is inedible, smashed, or broken so that the contents are leaking, cooked, frozen, contaminated, or containing bloody whites, large blood spots, large unsightly meat spots, or other foreign material."

Inedible eggs. Inedible eggs are described in the U. S. standards to include black rots, white rots, sour eggs, eggs with green whites, musty eggs, and moldy eggs. These types of inedible eggs are usually caused by the growth of bacteria or mold on or in the egg. Other types of inedible eggs are those showing blood rings, and those containing embryo chicks (at or beyond the blood ring stage) which result from germ development in fertile eggs. Two additional types of inedible eggs are mixed rots and eggs with stuck yolks.

The freshly laid egg is usually free of bacteria on the inside and is well protected from bacteria by the shell, shell membranes, and several chemical substances in the egg white. If subjected to warm temperatures or moisture, or both, bacteria are able to penetrate the egg and overcome the egg's defense. When bacteria grow inside the egg they may form byproducts or cause the contents of the egg to decompose, or both. These conditions result in the characteristic colors, appearance or odors from which the rots take their name.

Stuck yolk occurs when the yolk membrane becomes attached to the shell membrane. It generally occurs in older eggs that have been left in a fixed position for a long time. When the thick white becomes thin, the yolk floats close to the shell and becomes attached to the shell membrane. Before the candling light the yolk appears attached to the shell and snaps back to its attached position when the twirling motion of the egg is stopped. If loosened from its position, the yolk membrane usually breaks, permitting the yolk content to seep into the white. The first stage of this condition is generally referred to as "seeping yolk"; later "mixed rot" or "addled egg."

Mixed rot (addled egg) occurs when the vitelline membrane of the yolk breaks and the yolk mixes with the white, resulting in a

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murkiness throughout the interior of the egg when viewed before the candling light.

Sour egg is not readily detected by candling because the evidence of the breakdown of the content is noted only by the sour odor given off. Generally, eggs in this condition show a weak white and murky shadow around an off-center, swollen yolk. Frequently the content of this type of egg fluoresces under ultraviolet light.

Eggs with green whites are very difficult for the inexperienced grader to detect with the standard candling light. The experienced grader can detect advanced stages of green white with a considerable degree of accuracy. The adoption of ultraviolet light in candling (black light) has made the detection of this type of loss easier. The bacteria causing green white belong to a group named Pseudomonas. These organisms produce a material which fluoresces under ultraviolet light, giving off a green sheen that makes possible the detection of this type of loss. When an egg is broken out under ultraviolet light, the fluorescence can be noted even more readily. Frequently the content of this type of loss egg gives off a sour odor. In advanced stages of spoilage the white under ordinary light has a green color, but many appear perfectly normal in other respects.

In early stages the white rot may be detected by the presence of threadlike shadows in the thin white. In later stages the yolk appears severely blemished when viewed before the candling light, and when broken shows a crusted appearance. The content frequently gives off a fruity odor.

Musty eggs frequently appear clear and free from foreign material when viewed before the candling light and can generally be detected only by the characteristic musty odor emanating from the egg. It might have been caused by exposure to must odor in the case or in nesting material. Another source of contamination may be the presence of this odor on the shell itself from previous contamination. It is said that certain bacteria that occasionally invade the egg give off this characteristic odor also. Due to the fact that this type of loss is impossible to detect by visual observation, it is of utmost importance that the grader note the odor emanating from the case and packing material immediately upon opening the case.

Moldy eggs may be detected by observing mold spots on the shell or by mold growth in checked areas of the shell, or by mold growths (the odor of mold or must may or may not be present) inside of the egg itself when viewed before the candling light. The use of dirty water for washing eggs and dirty processing oil cooler than the egg, and the storage of the egg in unusually high humidity encourage mold growth and mold penetration through the shell. Advanced stages of mold growth throughout the entire egg might have an appearance similar to that of black rot.

Black rots are generally opaque (with the exception of the air cell) when viewed before the candling light. When broken the content has a muddy brown appearance and gives off a repulsive, putrid odor. The bacteria most frequently causing this type of loss belong to a group named Proteus. However, when any rot is at an advanced stage it may appear "black" before the candling lamp.

Blood rings and embryo chicks are caused by germ development, occurring in fertile eggs held at incubation temperatures. At a rather early stage in incubation (after 24 hours) the embryo develops a circulatory system. If at this stage the embryo dies the blood drains to the outer edge of the germ disc, causing the blood ring. Before the candling light, it appears as a brilliant blood-red circle from one-eighth to three-eighths inch in diameter, depending on the stage of development. If incubation temperatures are maintained for a longer period, the embryo chick is formed by about the third day and eventually fills most of the egg. This can be observed before the candling light as an actual outline of the embryo, in the early stages.

In addition to the inedible eggs described above, eggs showing severe shell damage and the presence of large blood spots or diffused blood in the white, are classified as loss.

Smashed or broken eggs are classified as loss. When damage to the shell and membrane of an egg permit the content to flow out of the shell, the egg is "loss."

The origin of large blood spots and bloody whites has already been explained. They appear as brilliant red in color or as a dark gray in so-called meat spots, in contrast to the surrounding lemon-to-orange colored tinge of the yolk, observed before the candling light.

Eggs not classified as loss but as "no grade" include eggs of possible edible qualities that have been contaminated by smoke, chemicals, or other foreign ma-

terial which has seriously affected the character, appearance, or flavor of the eggs.

Earlier in this manual reference was made to eggs that give off an offensive odor due to disease or feed flavors. It has been found that some hens inherit the characteristic of producing eggs that give off a characteristic fishy odor. In other instances diseased laying organs may impart an off odor to the broken-out eggs. High concentrations of fish oil or garlic fed to hens impart their flavor to the eggs. Eggs exposed to foreign odors after they have been laid, may give off these odors. Eggs stored near kerosene, carbolic acid, mold, must, fruit, and vegetables, for example readily absorb odors from these products.

UNITED STATES STANDARDS, GRADES, AND WEIGHT CLASSES FOR SHELL EGGS

The United States Standards for Quality of Individual Shell Eggs are applicable only to eggs of the domesticated chicken that are in the shell.

United States Standards for Quality of Individual Shell Eggs

AA Quality.--The shell must be clean, unbroken, and practically normal. The air cell must not exceed 1/8 inch in depth and must be practically regular. The white must be clear and firm so that the yolk will appear well centered and its outline will be only slightly defined when the egg is twirled before the candling light. The yolk must be free from apparent defects.

A Quality.--The shell must be clean, unbroken, and practically normal. The air cell must not exceed 1/4 inch in depth and must be practically regular. The white must be clear and at least reasonably firm and the yolk at least fairly well centered and its outline only fairly well defined when the egg is twirled before the candling light. The yolk must be practically free from apparent defects.

B Quality.--The shell must be unbroken, may be slightly abnormal, and may show slight stains but no adhering dirt. Approximately 1/32 of the shell surface may be slightly stained when the stains are localized and 1/16 of the shell surface may be stained if stains are scattered. The air cell must not exceed 3/8 inch in depth, may show unlimited movement, and may be free but not bubbly. The white must be clear and may be slightly weak so that the yolk may appear off-center, with its outline well defined when the egg is twirled before the candling light. The yolk may appear slightly enlarged or slightly flattened and may show other definite, but not serious defects.

C Quality.--The shell must be unbroken, may be abnormal and may have slight to moderate stained areas covering not more than 1/4 of the shell surface. Prominent stains and adhering dirt are not permitted. The air cell may be over 3/8 inch in depth and be free or bubbly. The white may be weak or watery so that the yolk may appear off-center and its outline plainly visible when the egg is twirled before the candling light. The yolk may appear dark, enlarged, and flattened, and may show clearly visible germ development but no blood due to such development. It may show other serious defects that do not render the egg inedible. Small blood clots or spots may be present.

Dirty.--The shell must be unbroken but has adhering dirt or prominent stains, or slight to moderate stains covering more than 1/4 of the shell surface.

Check.--Individual egg that has a broken shell or crack in the shell but with no leakage of the contents.

Leaker.--Individual egg that has a break or crack in the shell and shell membrane, with contents exuding or free to exude through the shell or an egg that has 1/4 inch square of shell missing with the shell membrane intact.

United States Consumer Grades and Weight Classes for Shell Eggs

These grades are applicable to edible shell eggs in "lot" quantities rather than on an "individual" egg basis. A lot may contain any quantity of 2 or more eggs. Reference in these standards to the term "case" means a case holding 30 dozen eggs as used in commercial practice in the United States.

Terms that are defined in the United States Standards for Quality of Individual Shell Eggs have the same meaning in this part as in those standards.

An aggregate tolerance of 20 percent is permitted within each consumer grade. This tolerance is to take care of differences in the efficiency of graders, normal changes in the product under favorable conditions during reasonable periods between grading and inspection, and reasonable variations in interpretations of graders.

Substitution of higher qualities for the lower qualities specified in a grade is permitted.

Summary of U. S. Consumer Grades for Shell Eggs

U. S. consumer grade	At least 80 percent (lot average)[1] must be—	Tolerance permitted[2]	
		Percent	Quality
Grade AA	AA Quality	15 to 20	A.
		Not over 5[3]	B, C, or Check.
Grade A	A Quality or better.	15 to 20	B.
		Not over 5[3]	C or Check.
Grade B	B Quality or better.	10 to 20	C.
		Not over 10[3]	Dirty or Check.
Grade C	C Quality or better.	Not over 20	Dirty or Check.

[1]In lots or two or more cases, no individual case may fall below 70 percent of the specified quality and no individual case may contain more than double the tolerance specified for the respective grade (i. e., in lots of Grade A, not more than 10 percent of the qualities in individual cases within the sample may be C or Check, provided the average is not over 5 percent).

[2]Within tolerance permitted, an allowance will be made at receiving points or shipping destination for 1/2 percent leakers in Grades AA, A, and B, and 1 percent in Grade C.

[3]Substitution of higher qualities for the lower qualities specified is permitted.

U. S. Weight Classes for Consumer Grades for Shell Eggs

Size or weight class	Minimum net weight per dozen	Minimum net weight per 30 dozen	Minimum weight for individual eggs at rate per dozen
	Ounces	*Pounds*	*Ounces*
Jumbo	30	56	29
Extra large	27	50-1/2	26
Large	24	45	23
Medium	21	39-1/2	20
Small	18	34	17
Peewee	15	28	

Minimum weights listed above for individual eggs at the rate per dozen are permitted in the various size classes only to the extent that they will not reduce the net weight per dozen below the required minimum.

United States Procurement Grades and Weight Classes for Shell Eggs

Procurement grades are applicable only to shell eggs in lot quantities. They are designed primarily for Government and institutional procurement. A lot may contain any quantity of one or more cases.

Summary of U. S. Procurement Grades for Shell Eggs

U. S. Procurement Grade	A quality or better (lot average) at least[1]	Maximum tolerance permitted[2] (lot average)	
	Percent	Percent	Quality
I	80	15 to 20	B.
		Not over 5	C, Check, Dirty, Leaker, and Loss.
II	60	30 to 40	B.
		Not over 10	C, Check, Dirty, Leaker, and Loss.
III	40	48.3 to 60	B.
		Not over 11.7	C, Check, Dirty, Leaker, and Loss.
IV	20	68.3 to 80	B.
		Not over 11.7	C, Check, Dirty, Leaker, and Loss.

[1]Individual cases may contain not over 10 percent less A Quality eggs than permitted for the lot, provided the average for the lot is not more than the tolerance permitted in any grade. In lots of 200 cases or more, one case in each 10 examined may contain not over 20 percent less A Quality eggs than is permitted in any grade.

[2]Within each tolerance for qualities below B, each of the grades may contain not over 3 percent Checks, and a combined total of not over 3/10 percent Dirties, Leakers, and Loss. Individual cases may contain not over 18 percent of qualities below B, provided the average for the lot does not exceed the tolerances permitted in any grade.

Weight Classes for United States Procurement Grades

Weight classes	Average net weight on lot basis 30-dozen case	Minimum net weight individual 30-dozen case	Minimum net weight of individual eggs at rate per dozen	Maximum average percent of individual eggs below minimum weight lot average[1]
	Pounds	*Pounds*	*Ounces*	*Percent*
Extra large	50.5	50	26	3.33
Large	45	44.5	23	3.33
Medium	39.5	39	20	3.33
Small	34	33.5	17	3.33

[1]Individual cases may contain not over 10 percent of individual eggs below minimum weights specified in any weight class but such eggs shall weigh not less than the minimum specified for the next lower weight class.

United States Wholesale Grades and Weight Classes for Shell Eggs

Wholesale grades are applicable only to shell eggs. The meaning of all terms used in this part, is the same as that defined for these terms in the United States Standards For Quality of Individual Shell Eggs.

Substitution of higher qualities for the lower qualities specified in a grade is permitted.

The term "refrigerator eggs" means eggs that have been held under refrigeration for a period of 30 days or more.

Summary of United States Wholesale Grades for Shell Eggs

Wholesale grade designation	Minimum percentage of eggs of specific qualities required[1]				Tolerances in terms of maximum number and percentage of eggs, for each 30 dozen of eggs									
	AA Quality	A Quality or better	B Quality or better	C Quality or better	B Quality, C Quality, Dirties, and Checks		C Quality, Dirties, and Checks		Dirties and Checks		Checks		Loss[4]	
					Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
U. S. Specials—% AA Quality[2]	20	Balance	None permitted except for tolerances		27	7.5	—	—	—	—	—	—	6	1.7
U. S. Extras—% A Quality[2]	—	20	Balance	None permitted except for tolerances	—	—	42	11.7	—	—	—	—	8	[3]2.2
U. S. Standards—% B Quality[2]	—	—	20	Balance	—	—	—	—	42	11.7	—	—	10	[3]2.8
U. S. Trades—% C Quality[2]	—	—	—	83.3	—	—	—	—	42	11.7	—	—	18	5
U. S. Dirties	—	—	—	—	—	—	—	—	—	—	42	11.7	18	5
U. S. Checks	—	—	—	—	—	—	—	—	—	—	—	—	18	5

[1]Substitution of eggs possessing higher qualities for those possessing lower specified qualities is permitted.
[2]The actual total percentage must be stated in the grade name.
[3]For the period beginning on August 1 of one year and extending through January 31 of the next year, the permitted tolerance for loss with respect to "refrigerator eggs" is 12 eggs (3.3 percent) and 15 eggs (4.2 percent) for U. S. Extras—% A Quality and U. S. Standards—% B Quality, respectively.
[4]Effective January 1, 1956, the percentage of Loss eggs permitted in U. S. Specials—% AA Quality, U. S. Extras—% A Quality, and U. S. Standards —% B Quality, will be 2.0, 3.0, and 4.0 percent, respectively and will thereupon supersede the present requirements with respect to Loss.

Weight Classes for United States Wholesale Grades for Shell Eggs

Weight classes	Per 30 dozen eggs		Weights for individual eggs at rate per dozen	
	Average net weight on a lot[1] basis	Minimum net weight individual case[2] basis	Minimum weight	Weight variation tolerance for not more than 10 percent, by count, of individual eggs
	At least—			
Extra large	50 1/2 pounds	50 pounds	26 ounces	Under 26 but not under 24 ounces.
Large	45 pounds	44 pounds	23 ounces	Under 23 but not under 21 ounces.
Medium	39 1/2 pounds	39 pounds	20 ounces	Under 20 but not under 18 ounces.
Small	34 pounds	None	None	None.

[1]Lot means any quantity of 30 dozen or more eggs.
[2]Case means standard 30 dozen egg case as used in commercial practice in the United States.

GRADING EGGS

A skilled grader must be able to determine the interior quality of an egg by candling, to appraise the condition of the shell, and to judge the individual egg weight.

The appraisal of interior egg quality by candling is a skill that requires manual dexterity and the ability to make frequent split-second decisions over long periods of time. The experienced egg grader, in the average grading room, is primarily concerned with interior egg quality when candling shell eggs, but he is also concerned with soundness, cleanliness, and color of the shell, and the weight or size of the egg. These three primary considerations cannot for all practical purposes be disassociated; however, in this section they will be treated separately and in order of degree of difficulty with which each is mastered rather than in the order they are used in the grading operation.

Classification of Interior Quality

In determining interior quality by candling it is customary to hold two eggs in each hand. Supporting one egg by the tips of the thumb and index finger and holding the other against the palm with the other fingers. The small ends of the eggs should point toward the palm of the hand (fig. 12). After one egg in the hand has been candled, it is shifted back in a rotating motion to the palm of the hand and the second egg is brought into candling position. The eggs are viewed alternately before the light. The uppermost egg in the right hand is examined first, then the uppermost egg in the left hand, and this procedure is repeated after the position of the eggs in each hand has been shifted. After the first egg is candled and the hand is dropped slightly back and downward, the third and fourth fingers are relaxed, letting the uncandled egg roll downward slightly. At the same time the thumb and index and

FIGURE 12.--The way to hold eggs while candling.

second fingers guide the candled egg into the palm of the hand. The third and little finger then roll the uncandled egg into candling position between the thumb and index finger; meanwhile the little finger (fourth) and third finger hold the candled egg in the palm. The position of the eggs is changed in one hand while one of the eggs held in the other hand is being candled.

The ability to quickly rotate two eggs in each hand makes for more rapid work and should be practiced until reasonable dexterity is acquired. In manipulating eggs before the candling light, it is important that the rotation of eggs in each hand, and the twirling motion before the light become mechanical. Dexterity in this rotation operation permits the grader to concentrate entirely on placing the egg before the light rather than on changing its position or rotating the two eggs and frees him from concern over dropping the eggs. It also helps him to develop a rhythm which improves uniform timing of judgment, thereby making possible greater proficiency.

In order to obtain a proper view of the egg while candling, it is necessary to have the contents spinning within the shell at the time of viewing. This can best be achieved by having the hand that holds the egg to be viewed arrive at a point near the candling aperture palm down. Then by turning the hand with a snap of the wrist in an arc of 180° the shell and its contents are started in motion. Stopping the hand motion at the end of the arc without moving the arm or body permits the contents to spin within the shell. The long axis of the egg should be at about a 45° angle to the candling aperture. The thumb and index finger should be on opposite sides of the shell without obstructing the grader's view (fig. 12). After gaining some experience in the candling operation, the grader will learn to have the egg content spinning at the exact instant the egg is placed before the candling aperture.

The Factor of Judgment

Even under the most favorable conditions, egg quality is relatively unstable. The interior quality of the egg deteriorates from the time it is laid until it is consumed. Sometimes quality changes render eggs useless for food before they reach consumers. However, when eggs are properly cared for, the quality decline can be minimized and the period of time between original high quality and uselessness can be lengthened materially. Quality decline is illustrated graphically in figure 13.

In grading eggs, and more specifically in classifying them according to internal quality, the grader is merely trying to group the eggs according to where each is located on "quality hill."

Edible eggs are divided into four groups or qualities as shown in figure 13. All clean eggs whose candled characteristics fall between the top line and point 1 on the chart are in the best quality class or AA, those between 1 and 2 are in the next quality or A, between 2 and 3 are in B, and between 3 and 4 are in C, and those at and below point X are inedible or loss.

It is relatively easy to place eggs properly if they are midway between the various points on "quality hill," but judgment and skill are required to place in the correct group the eggs that are at or near the quality division points. It becomes increasingly difficult when brown eggs or mixed white and browns are being candled. The real knack in candling is to have a clear mental picture of the dividing line between the various quality classes, so that the eggs may be properly placed in their respective quality groups.

In acquiring skill in judging egg quality it is helpful to break the classification down into steps, considering separately the various quality factors--shell, air cell, yolk position and condition, and condition of the white. The operator can concentrate with greater ease when each factor is considered separately. Later, all factors should be considered in combination.

Good judgment in determining albumen and yolk condition can be developed and maintained by having the grader break out an egg occasionally and check his estimate of the candled quality with the broken-out appearance as compared with the chart for scoring broken-out appearance (fig. 14).

As soon as the grader has acquired a working knowledge of the standards of quality and reasonable dexterity in manipulating individual eggs, candling speed will increase. The accuracy of interpretation of quality standards depends on the ability to develop judgment of correct classification. In efficient commercial operations, each grader must make 7,200 decisions or more a day. It is, therefore, essential that the grader develop an ability to make instant decisions. It has been said that the greatest frequency of error occurs in instances of repeated

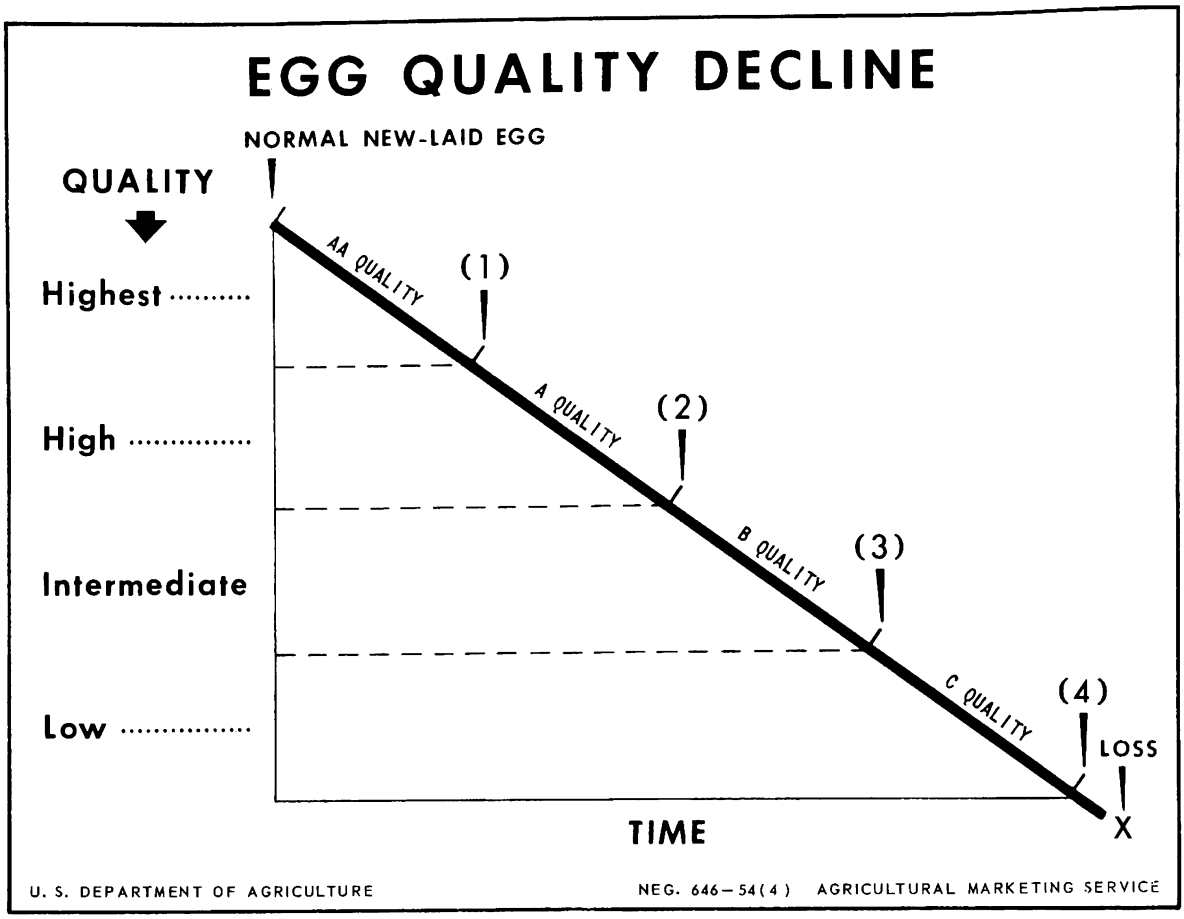

FIGURE 13.–Range of quality in official grades.

indecision as to the placement of individual eggs. It should be pointed out that mistakes due to oversight, minor errors in decision, and differences of opinion between graders or between graders and supervisors or inspectors are factors that are taken into consideration in the U. S. grades by providing for tolerances. However, errors beyond the permitted tolerances result in the incorrect grading of the entire lot of eggs. It is most important, therefore, that each grader's decision of egg placement be as nearly correct as possible.

Speed and accuracy in grading should be accompanied by constant careful handling of the product. When eggs are placed into a carton or filler they should be placed carefully, not dropped. The egg should always be packed small end down. Cartons of eggs should be placed on the conveyor belt carefully, not dropped. Eggs should not be placed into dirty or torn fillers and flats or in packing materials giving off foreign odors. Eggs received in cases or packing material giving off foreign odors should not be graded unless the egg content is carefully checked for flavor. It is desirable to grade eggs when their internal temperature is between 50° and 70° F., but it is imperative to avoid handling eggs for grading when they are "sweating" (when there is condensation of moisture on the shell) in order to avoid smearing and staining of the shell. Eggs from a very cool environment should be tempered in the candling or other room with as moderate a temperature as necessary before candling to avoid "sweating" when the eggs are candled.

Classification of Exterior Quality

Shell Factors

The external factors of the egg--color, condition, and cleanliness of the shell--can be determined without using the candling light, but soundness of shell should be veri-

INTERIOR QUALITY OF EGGS

(Recommended standards for scoring the quality of broken-out eggs)

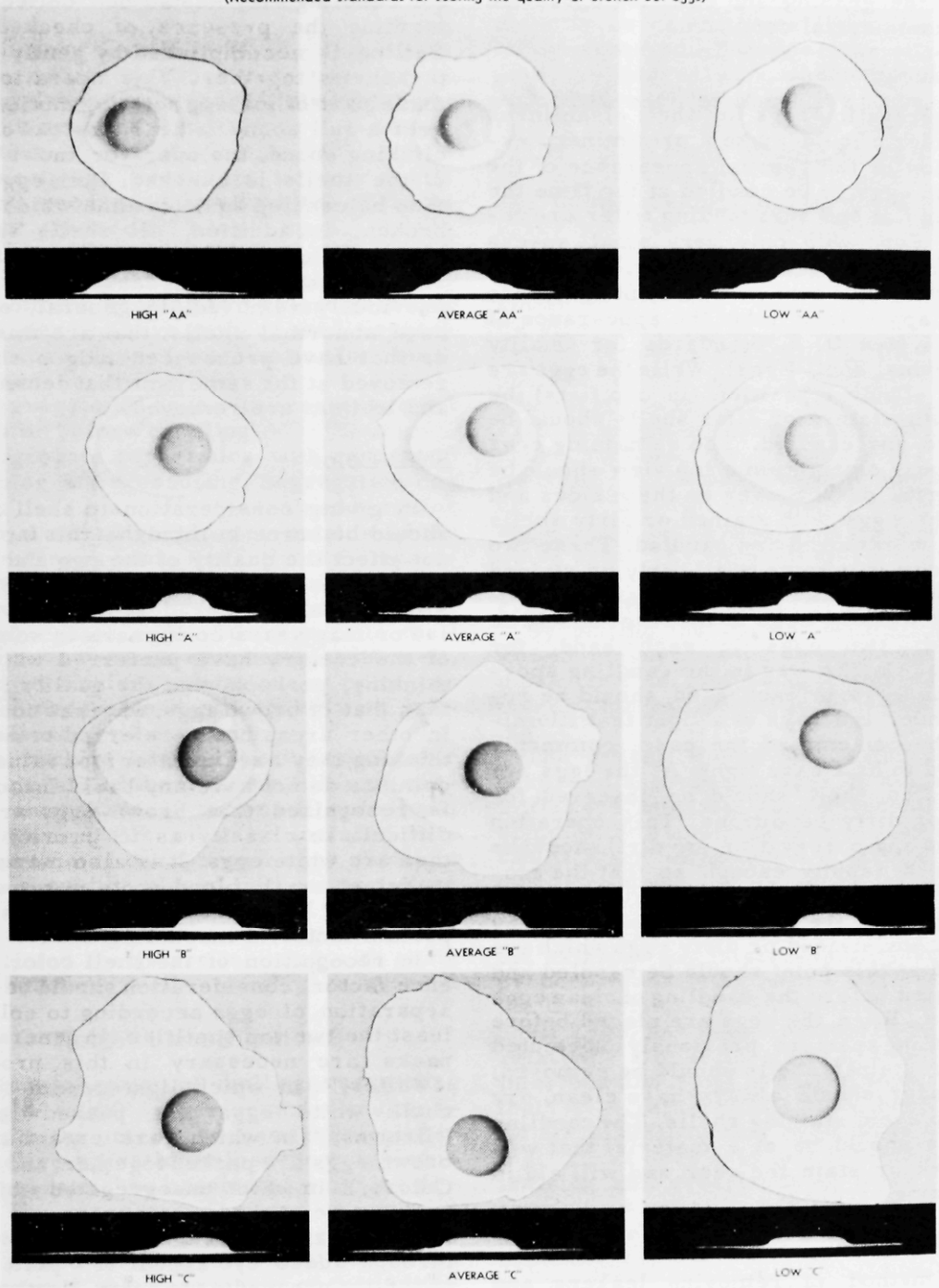

FIGURE 14.--The pictures on this chart show the interior quality of eggs that meet the specifications of the U. S. Standards for Quality of Individual Shell Eggs with respect to albumen and yolk quality. Quality factors dealing with the shell, air cell, and defects are not included. Scores 1, 2, and 3 represent the appearance of broken-out eggs of high, average, and low AA Quality; 4, 5, and 6 represent high, average, and low A Quality; 7, 8, and 9, high, average, and low B Quality, and 10, 11, and 12, high, average, and low C Quality.

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fied by candling. All these factors become a part of the grading and candling operation under commercial conditions.

Shell Cleanliness

In segregating eggs for shell cleanliness the grader should make a preliminary examination of the general appearance of the layer of eggs to be candled at the time the covering flat and surrounding filler are removed. Eggs with only very small specks or stains may be considered clean if such eggs are not present in sufficient number to detract appreciably from the appearance of the eggs (see U. S. Standards for Quality of Individual Shell Eggs). While the eggs are still in standing position (in cup flats) the eggs with stained or dirty shells should be removed and candled. The remaining eggs that appear clean from a top view should be then gently pushed over on their sides and again the eggs with stained or dirty shells should be removed and candled. These two operations will remove all dirty or stained eggs that are noticed at first glance.

The remaining eggs in the filler should be removed, two eggs in each hand, for candling. On the way to the candling aperture, the eggs in each hand should be rotated under the rays of a light that illuminates the contents of the case, commonly referred to as a case light. As the eggs are rotated the shell should be observed for stains or dirty conditions. This operation (rotation and observation for dirt) should be performed rapidly enough so that the motion of the hand from the case light to the candling aperture is made in one sweeping motion. Any stained or dirty eggs which are detected at this point should be candled and segregated before the candling of clean eggs is begun. When the eggs are placed before the candling aperture, previously undetected dirty or stained shells should be removed. The grader should always have clean, dry hands to avoid staining shells. The candling aperture should be of a material that will not mark or stain the shell and will aid in minimizing breakage.

Shell Soundness

The method of removing leakers and dented checks need not be emphasized, except to say that it is necessary to remove such eggs from the lot carefully to avoid doing further damage to them and dripping liquid from leakers onto clean eggs.

As the eggs are removed from the case for candling they should be "belled" to determine the presence of checked shells. Belling is accomplished by gently touching the shells together. This operation can be made part of the egg rotating motion. Whenever a dull sound is heard instead of a clear clinking sound, the operator knows that one of the shells is checked. Both eggs should then be candled to determine which shell is broken. In addition, all shells should be observed before the candling light for possible checks or thin areas that have not been previously removed. In general, eggs that have abnormal shells, that are misshapen, or that have pronounced ridges should be removed at the same time that dented checks and leakers are removed.

Shell Color

In giving consideration to shell color, it should be borne in mind that this factor does not affect the quality of the egg and for this reason it is not considered in the U. S. standards of quality or grades.

For may years consumers in some areas of the country have preferred white eggs, thinking, perhaps, that the quality is better than that of brown eggs, whereas consumers in other areas have preferred brown eggs, thinking they have greater food value. These opinions do not have any basis in fact, but it is recognized that brown eggs are more difficult to classify as to interior quality than are white eggs. It is also more dificult to detect small blood spots in brown eggs. Then, too, consumer preference is an important factor in marketing.

In recognition of the shell color preference factor, consideration should be given to separation of eggs according to color in at least the two top qualities. In general, three packs are necessary in this procedure: "Whites," in which light cream-tinted to chalk white eggs are packed together; "Browns," in which dark cream and dark brown eggs are packed together; and "Mixed Colors," in which unsegregated whites and browns are packed together.

Much can be said for the sales value through added eye appeal of a pack of eggs carefully grouped as to color. Furthermore, a carton or case of eggs in which white and brown eggs (even though of high quality) are mixed tends to give the impression to the uninitiated that the lot is heterogeneous in other respects as well as color.

There are a number of ways in which segregation with respect to shell color can be handled.

At producer level:

1. Encourage producers to pack brown eggs separately from white eggs when both are produced in appreciable quantities.
2. Encourage producers to have flocks that produce only all white, or flocks that produce all brown, eggs.

At grading station:

1. Provide bench space in the candling room for packing two colors of the top grades and have graders handle segregation at time of examination for cleanliness.
2. Segregate all eggs with respect to shell color before candling.
3. Segregate top grades with respect to color after candling. Segregation can be done manually by a trained operator in a well-lighted area outside of the grading room. Recently the Department of Agriculture has designed an experimental model of a machine that segregates eggs with respect to shell color by means of a photoelectric cell, in which fine gradations of color can be made at a rapid speed with consistency and accuracy.

When packing brown eggs it is desirable to confine all of them in one filler or carton to one shade of brown. If occasional light-brown shells must be included in a filler containing dark-brown eggs, the light browns should be placed in the outer edges of the filler or at either end of the carton. The same arrangement is suggested when cream tinted shells are included with chalk white shells.

Weight Classification

The classification of shell eggs according to weight (size) is performed simultaneously with the other processes performed in the candling operation unless the weighing is done separately by automatic weighing devices. The experienced grader can usually pick out eggs of different weight classes from a mixed lot of eggs without more than an occasional check-weighing of the individual eggs. This skill is acquired by developing the ability to evaluate size visually and by a sense of comparative weight and size. To assist in acquiring this skill for accurately classifying eggs with respect to weight, the following procedure is suggested: The end of the case to be worked should be placed directly under the case light, the top flat being removed. The operator should then note the degree with which the individual eggs fill each of the filler cells. An egg falling into the large weight class will generally touch three or four sides of the cell and will be standing erect in the cell. An egg in the medium weight class will have space between it and the fourth side (filler cell) and will be leaning slightly away from the side it is not touching. An egg in the small weight class will be lying almost on its side. It should be borne in mind that the degree to which the cell is filled and the position of the egg in the cell are only guideposts to help the grader in acquiring skill in weight classing. On the basis of the above method, the grader picks out the medium or small eggs if most of the eggs in the lot are large; and the large eggs if the lot is mostly of medium-weight class eggs. The eggs should be checked, as necessary, on the individual egg scale whenever the grader is in doubt about the weight.

By getting the eggs of obvious different weight classes sorted first, the grader has more time to give to determining quality, thereby increasing the accuracy of his grading.

The grader should not confine the procedure of segregating eggs by weight to the initial operation but should frequently check some of the remaining eggs until he acquires skill. After experience is gained the required frequency of weight checking may be reduced.

Skill in grading eggs, and in evaluating the external and internal quality factors and properly classifying them in accordance with the U. S. Standards for Quality of Individual Shell Eggs, has been considered by some as relatively simple to acquire. Those who are informed about egg candling, however, know that it is rather difficult to become proficient in determining egg quality by candling. It has been said that it takes a year of training and experience to learn to candle properly, 2 years to become a good candler and grader, and many years to become an expert.

CANDLING AND WEIGHING FACILITIES

In order to grade eggs with maximum efficiency it is essential that adequate facilities be provided.

Candling Room

The candling room should be darkened to the extent necessary to do an adequate and efficient job. The extent of darkness will vary depending on the type of candling light and other equipment used. There should be no cross beams of light between the grader and the candling light, except those emanating from his candling light. The candling light aperture should be so placed that rays of light coming from it will not shine directly into the grader's eyes when he is in a position for candling.

It is desirable that the walls and ceiling of the candling room have smooth, washable surfaces and be painted with a dark-colored flat-finish paint to avoid light reflection.

The linear space provided for each grader depends largely on the number of grades being packed and the general packing setup (fig. 15). Sufficient candling bench and shelf space should be provided for efficient grading and record control. Consideration should be given to: Provision for maximum concentration by graders (by installing shallow partitions between candling benches) and for minimum movement of graders; ease of case movement; care and cleanliness of packing materials; ease of removing empty cases; convenience to supply of packing materials; and ease of disposing of damaged packing materials and loss eggs. Sufficient space should be provided behind the grader to assure open aisle space at all times. It is recommended that suitable locker space be provided for grader's outer garments in an area or room other than the grading room. The locker room may serve as a lunchroom.

The floors should be of smooth concrete, coved into wall intersections and pitched to trapped floor drains. This construction will make possible floor wash-down and will help reduce off odors. If foot mats for graders are used, they should be of a material that can be washed without moisture penetration; and consideration may be given to artificially heated foot mats.

Sufficient overhead lights should be provided to facilitate cleaning up the room.

It is recommended that the grading room be equipped with a forced-air ventilator that provides cool air in warm weather and heated air in cool weather. Additional facili-

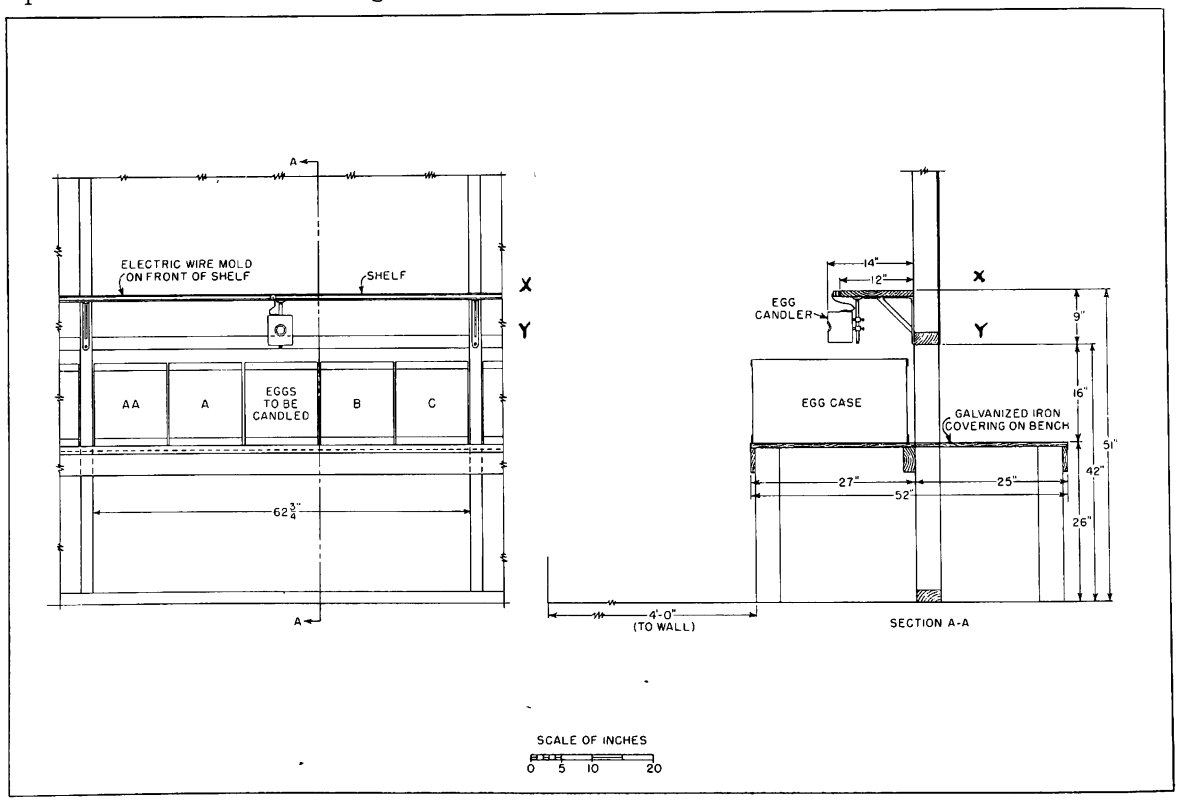

FIGURE 15.--Diagram of a candling bench.

ties might include a humidifier and year-round air conditioner. It is essential that the forced-air inlet deflect incoming air so that it will not blow directly on the workers and that the control switch be located outside the grading room, accessible only to the foreman of the candling room.

Candling Bench

The candling bench, or grading bench, may be one of a number of designs suited to fit various packing needs. The example shown in figure 15 illustrates its use for bulk packing of eggs in 30- or 15-dozen cases. If a cartoning operation is added, a supply of one-dozen cartons could be kept on the shelf above the candling light and an egg case such as that marked "A" in figure 15 could serve as a table for filling cartons. If a mechanized cartoning operation is considered for this type of bench, the part of the partition above point Y (fig. 15) could be suspended from the ceiling and serve as a hanger for a conveyor belt carrying inbound empty cartons to the grader's bench at "level X". The belt could return along "level Y" (fig. 15) and serve as a conveyor for filled cartons.

Basically, the dimensions should remain as shown in figure 15. An individual egg scale should be installed over the candling light. A gravity-roller conveyor for packing materials may be installed under the candling bench or along the wall in back of the grader.

In some large operations today, intricate tabulating systems automatically compute the weight and quality count for each lot of eggs graded. This type of operation requires a type of bench constructed to fit the specialized equipment and room layout.

Candling Light

There are many styles and types of candling lights commercially available in which the light intensity and the size of the candling-light opening vary considerably. Most of these candling lights, however, are satisfactory, if they are adjusted to provide comfort and proper illumination for the job. It is largely a matter of becoming accustomed to the type of light in use. The accuracy of the candling results can be checked by breaking out an occasional egg and comparing the broken-out quality with the quality determined by candling.

The opening into which the egg is placed for examination should be no larger than 1 1/8 inches in diameter.

The opening at the bottom of the light should be no larger than necessary to provide sufficient light to detect dirty eggs and to observe the condition of the packing material.

The light should be adjusted so that the aperture of the candling light is approximately on the level of the grader's elbows.

The interior of the candling light should be kept clean and free from dust to assure maximum light efficiency.

If a lens and a reflector are used, they should be freed periodically of the film-like coating. The reflector should be kept in adjustment and the surface silver should be intact.

In selecting a candling light, it should be borne in mind that the grader might adjust his quality interpretation slightly according to different types of lights or varied adjustments of the same light. It is best, therefore, to select one type of light and keep it clean and properly adjusted. Once a grader has adjusted his candled interpretation to a reasonably close correlation with the broken-out appearance of eggs, uniform grading can be maintained with moderate supervision.

Weighing Equipment

Individual Egg Scale

Each candling bench should be equipped with an individual egg scale.

In manual grading in commercial plants, every egg is not weighed. However, after check-weighing many individual eggs, the grader becomes rather proficient in accurately determining weight of eggs by sight, and touch. The scale should be handy on each bench to verify the weight of occasional eggs about which there is a question. The scale should have its moving parts enclosed to prevent "fouling" due to dust. It is recommended that the weight indicator be of a single-beam type so that "making weight" is accompanied by a click as the scale beam comes down. The grader hears this click, therefore he does not have to wait for his eyes to become adjusted in the semidarkness in order to read the scale, nor does he have to wait for a pendulum counter balance to come to rest before weight is determined.

Automatic Egg Scale

There are many types of automatic and semi-automatic egg-weighing devices that can be installed in the egg-grading line. The weighing operation can precede or follow the candling operation. If it precedes the

candling operation it is important to group the eggs in each weight class. Weighing before candling has some distinct advantages: (1) The grader is more inclined to ignore the weight factor in candling and thus to devote more attention to the rest of the grading job; (2) checked eggs that might develop during the weighing operation are subject to detection; (3) gross errors by mechanical weighing equipment can be detected.

Weighing after candling has its advantages too: (1) Loss eggs are not handled twice and are less likely to be broken; (2) badly dented checks or leakers are removed and the danger of fouling the scales with egg liquid is thereby reduced.

The weighing accuracy of automatic equipment should be checked at the beginning of each shift and periodically during the shift. When the weighing is done by electric contact at the scale balance, care against fouling of contact points by dust and moisture is important. When weighing is done by having the egg stop its forward motion just before the scale beam is automatically released, it is important that the egg come to rest completely before weighing commences, because the added weight imparted by the stopping motion of the egg may result in inaccurate segregation as to size.

SHELL EGG GRADING LABORATORY

The laboratory procedure should include demonstrations of grading-room practice, correct candling technique, classification with respect to quality factors for individual eggs, and segregation with respect to weight class. In order to reduce confusion and fix the standard for each factor in the beginner's mind, each quality factor should be considered separately for a number of lots. Each student should classify various lots of eggs as the instructor corrects or adjusts interpretation and technique. After the student becomes reasonably accurate in his interpretation of each quality factor considered separately, a trial lot or two should be considered for all factors simultaneously. The broken-out egg quality should be compared with the quality interpretation by candling, and misinterpretations adjusted.

Candling Technique and Grading-Room Practice

1. Demonstrate the transfer of 3 dozen eggs in filler and flat.
   Student practice
2. Describe the candling light.
   Adjustment and maintenance.
3. Demonstrate the use of the individual egg scale.
   Check for accuracy and adjusting.
4. Demonstrate classification for weight.
5. Demonstrate classification for stain and dirt.
6. Demonstrate "belling" for soundness of shell.
7. Demonstrate rotation and candling with two eggs in each hand.
   Student practice--(4), (5), (6), and (7).

Classifying as to Weight

Laboratory Work Sheet No. 1

Lot No.	Extra Large	Large	Medium	Small

Classifying by Shell Factors

Laboratory Work Sheet No. 2

Shell Factors

Lot No.	Clean	B (Stain)	C (Stain)	Dirty	Texture and shape			Checked
					Normal	Slightly Abnormal	Abnormal	

Classifying by Air Cell

Laboratory Work Sheet No. 3

Air Cell

Lot No.	AA	A	B	C

Classifying by White and Yolk

Laboratory Work Sheet No. 4

White and Yolk

Lot No.	AA	A	B	C	Loss

Bloody White	BW	Black Rot	Black
White Rot	WR	Blood Rings	Br
Mixed Rot	MR	Large Meat or Blood Spots	B
Stuck Yolk	SY	Leakers	L
Moldy Eggs	MLDY	Smashed	S

Classifying by All Factors

Laboratory Work Sheet No. 5

All Factors

Lot No.	AA	A	B	C	Dirty	Checks	Leakers	Loss	Percentage under____oz.

Bloody White	BW	Black Rot	Black
White Rot	WR	Blood Rings	Br
Mixed Rot	MR	Large Meat or Blood Spots	B
Stuck Yolk	SY	Leakers	L
Moldy Eggs	MLDY	Smashed	S

FEDERAL-STATE GRADING PROGRAMS

For more than 25 years the U. S. Department of Agriculture in cooperation with the various States has conducted a voluntary Federal-State egg-grading service. The legislation authorizing these programs provides that they be conducted on a self-supporting basis financed from fees charged the applicants for the service.

The grading service is based on the U. S. Standards for Quality of Individual Shell Eggs and the U. S. Grades and Weight Classes for Consumer Grades, for Procurement Grades, and for Wholesale Grades of Shell Eggs. In addition, contract purchase specifications serve as another basis for performing grading or inspection of lots of eggs tendered for delivery under purchase agreements. The various purchase specifications are, of course, based on the U. S. Standards for Quality of Individual Shell Eggs.

In the early days of the Federal-State grading service for poultry and eggs, the work consisted largely of examining eggs and poultry purchased by the U. S. Navy, to determine compliance with procurement specifications. Grading and inspection service of this type gradually was extended to other governmental agencies and private institutions that purchased eggs and poultry products.

Grading offices were established at the important terminal markets along the East and West Coasts as well as in the inland terminal markets, such as St. Louis and Chicago. These offices, in addition to providing grading service for eggs, poultry, and poultry products, handled the market news reporting activities, which began at about the same time.

The growth of the service was slow at first, but expansion continued at a steady pace during the thirties. The most rapid expansion occurred during World War II in connection with Government-buying programs for the Armed Forces and lend-lease activities (fig. 16). The use of the services and the volume of products inspected and graded continued to expand after the cessation of hostilities. This expansion was due in part to the price-support programs that followed and to the fact that firms had had experience with Federal-State grading and inspection programs and were continuing to use them in their processing and marketing programs.

It was during the war period that resident grading and inspection programs developed into major importance. Under these programs a qualified USDA licensed grader or inspector, whose duties included the grading of shell eggs in accordance with U. S. standards and grades, and the supervision of egg-breaking and drying operations, was placed in the processing plant. With the advent of the "resident grader" type of service the volume of products graded and inspected on a "fee basis" became (proportionally) less important, considering the overall volume officially graded and inspected. Resident graders are used in the producing areas as well as in the distribution centers. The resident type of grading service offers several advantages over the terminal market or fee type of grading service:

(1) Grader is constantly available to grade and certify the pack, whether in cartons or loose.
(2) Grading is likely to be more uniform because the grader is continuously available to check the accuracy of the various candlers in the egg-grading room.
(3) Cost of resident grading service is less per unit than for intermittent fee grading, when a substantial part of the eggs handled is graded. In addition, the resident grader quite often serves in the capacity of a candling-room foreman as well as a USDA licensed grader.

Sometimes the term "inspection" is used synonymously with "grading." This is perhaps a proper use of the term in referring to gradings at terminal markets, as in most cases that work consists of examining a representative sample of either graded or ungraded lots. Thus, it can be said one "inspects" for grade. This meaning is not properly associated with the term "inspection" used for poultry. Inspection of poultry, of course, pertains to the examination of poultry and its internal organs during the evisceration process to determine its wholesomeness or fitness for food. And the term "inspection" does not apply to programs in which eggs are graded under the continuous supervision of resident graders and packed in either 30-dozen cases or in 1-dozen cartons bearing official grade marks (fig. 19). When the resident grader checks the work of licensees working under his

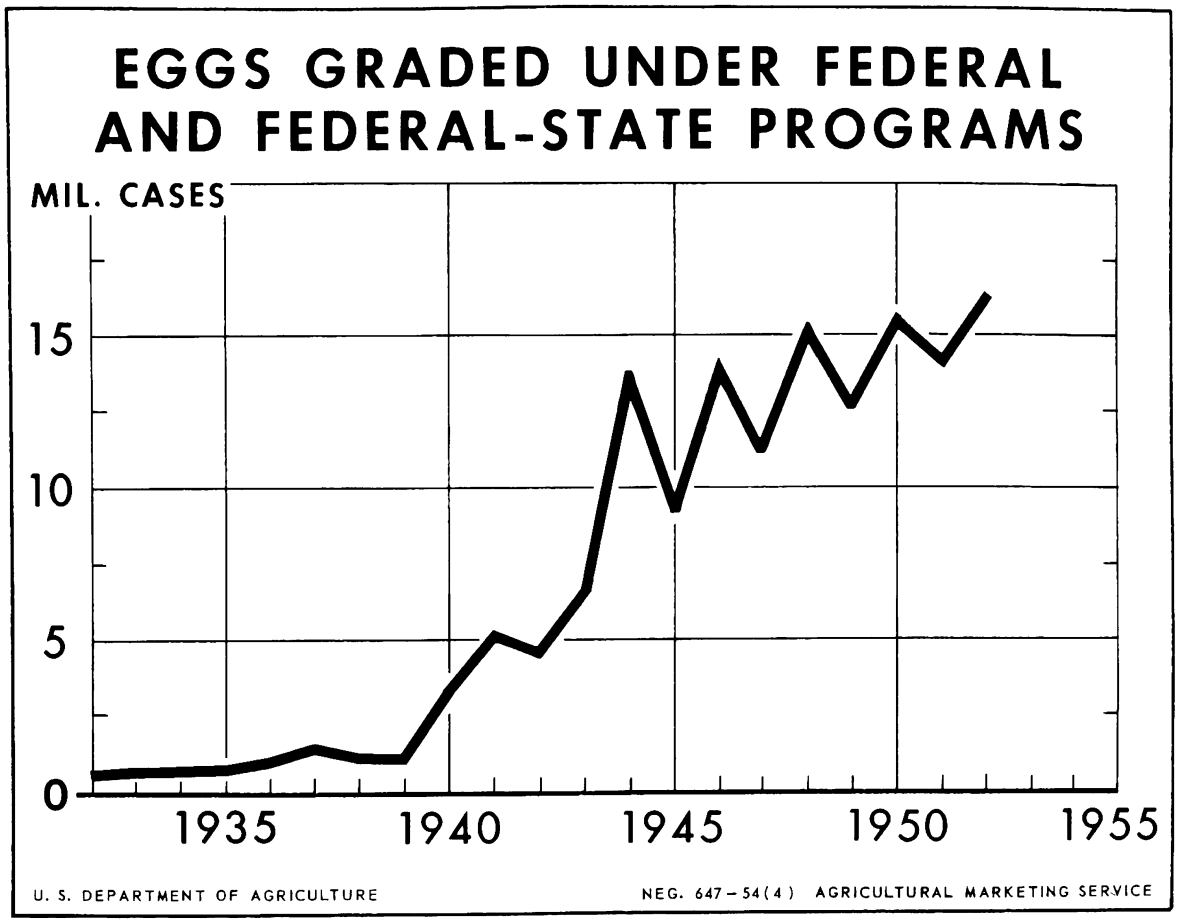

FIGURE 16.--The quantity of shell eggs graded under Federal and Federal-State programs increased from one-half million cases in 1932 to more than 16 million cases in 1952.

direction, the work is more properly classified as check-grading.

Regulations Governing Grading of Shell Eggs

Grading services of the U. S. Department of Agriculture for shell eggs are permissive, in that individuals, firms, or governmental agencies that desire these services may request them on their own volition. Services are performed on the basis of the "Regulations Governing the Grading and Inspection of Shell Eggs and United States Standards, Grades and Weight Classes for Shell Eggs." These regulations, like other regulations governing marketing service programs, were developed in cooperation with the industry, including all affected groups, such as marketing and regulatory officials, producers, handlers, and consumers, as well as on the advice of inspection and grading officials throughout the country.

The regulations explain how interested persons may apply for grading service, including appeals and regradings. Application for intermittent grading service on a fee basis is usually made by telephoning the local USDA grading office, by personally contacting a grader in the vicinity, or by contacting the State supervisor's office. Prospective applicants for egg-grading service may also contact the Poultry Division, Agricultural Marketing Service, U. S. Department of Agriculture, Washington 25, D. C., regarding the availability of grading service in their areas.

Application for resident grading service is made on special forms which specify the responsibilities of the applicant and the Department in connection with the performance of grading service on a continuous basis. The application form also prescribes the fees

and charges that the applicant must pay for the service.

Federal-State grading service is performed by USDA licensed graders who are supervised by the State, area, and national supervisors of the service. Graders may be either State or Federal employees or licensed individuals, trained and qualified to grade, whose employment status is not specified. In addition, the regulations provide for the issuance of limited licenses to persons qualified to candle and grade eggs under the U. S. Standards for Quality of Individual Shell Eggs, applying to eggs purchased from producers or eggs to be packaged with official grade labels.

Cooperative Agreements

The Federal-State egg grading service is conducted under cooperative agreements between the Department and one or more cooperating parties within each of the States where service is available. The agreements are usually made with State departments of agriculture and State extension services, or State colleges. Occasionally, experiment stations are cooperators, and in exceptional cases, trade associations serve as cooperating agencies.

Usually the responsibilities of State colleges and the extension services apply to the educational aspects of the grading program, under which they provide training for prospective graders and explain the Federal-State program to producers, handlers, and consumers.

State departments of agriculture are usually responsible for the administrative phases of the program within their States. The cooperative agreements vary from State to State from the standpoint of leadership and other responsibilities.

There are two main types of agreements--State Trust Fund and Federal Trust Fund agreements. Under the State Trust Fund agreement, the fees charged are collected by the State and held in trust by the State. The contracts for service are between the State and the individual firms, and the resident graders are State employees or USDA licensees employed by the firm. The Department is reimbursed by the cooperating agency periodically from the trust fund to cover the cost of the Federal supervision of the program. Under the Federal Trust Fund agreement, the contracts for services are between the Department and the individual firms, and the fees are collected and held in trust by the Department. The employees doing grading work are generally Federal employees or licensed employees of the firms, and the State is paid periodically out of the trust fund an amount to cover the costs and expenses incurred by it in performing grading and supervisory work.

Although two types of cooperative agreements are in effect, most of the agreements are of the Federal Trust Fund type.

Grade Labeling

Under the Federal-State grading program provision is made for the grade identification of the packaged product, whether packed in a 30-dozen case or a 1-dozen carton. Usually the grade mark is applied to 30-dozen cases by means of a rubber stamp (fig. 17). The stamp also marks the date the eggs were graded. In many instances when eggs are packed for delivery on purchase contracts to institutions, a paper tape must be placed around each half case and sealed at the top of the case. In these instances the grade or acceptance stamp (fig. 18) is usually applied to the tape at the point of sealing. Many carload and truck shipments of officially graded eggs are not stamped with a grade mark. In these cases, the buyer and seller rely on the grading certificate to give the grade and percentages of the various qualities in the lots.

Perhaps one of the greatest values of the grading program is the grade labeling of individual cartons of 1-dozen eggs to inform consumers of the quality. The regulations

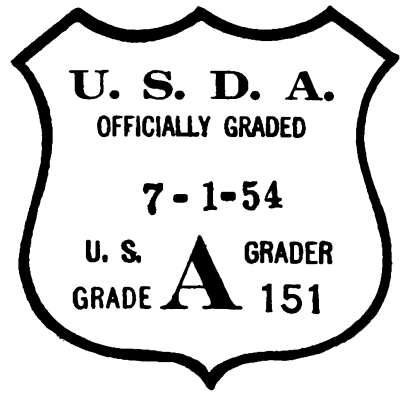

FIGURE 17.--Official grade stamp for use in terminal markets.

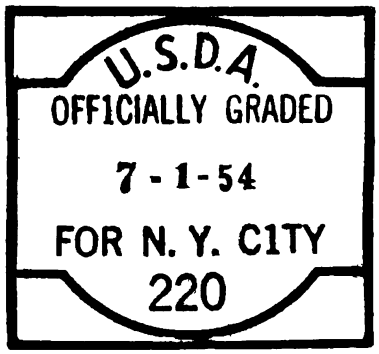

FIGURE 18.--Official mark to indicate acceptance under institutional purchase contracts.

provide for the approval of cartons and grade labels that are used in the labeling program for consumers. The grade mark used on official grade labels is contained in a shield design. It contains the following information: (1) The letters USDA, (2) the U. S. grade and size, and (3) a phrase such as "Graded Under Federal-State Supervision" or "Graded Under U. S. and (State) Supervision" (fig. 19). The grade mark may be printed on the carton, or on the sealing tape. If the egg size appears on the main panel of the carton, the size designation need not be shown on the seal (fig. 20). The date of grading must be placed on the seal or elsewhere on the carton. It is expressed as the month and day or as the consecutive day of the year.

FIGURE 19.--Official grade mark for cartons or seals on cartons holding 1-dozen eggs.

Prerequisites to Packaging Eggs with Grade Identification Labels

Several requirements must be met before

FIGURE 20.--Official grade mark for use on carton seals when size is shown on carton.

cartoned eggs may be grade marked:

1. The eggs must be graded by and identified under the supervision of a licensed grader. The actual grading may be performed by a limited licensed grader. (A limited licensee is a grader qualified and licensed to classify eggs according to United States grades but not authorized to issue certificates), but must then be check graded by the supervising grader. 2. If officially identified eggs are held in excess of four days after official grading, they shall be again check graded in addition to the previous check grading. 3. Eggs to be packed in consumer packages and grade marked U. S. AA or U. S. A must be packed from eggs of current production. 4. After January 1, 1956, establishments packing eggs with official marks in consumer packages must meet the facility and operating requirements set forth in the U. S. D. A. regulations.

Costs of Service

As the legislation which authorizes Federal-State egg-grading programs provides that the costs of the service be covered by fees charged persons who apply for grading and inspection services, schedules of charges have been established to cover these costs. Included as cost items are the salaries of the graders who perform the service, travel costs incurred in connection with grading activities, clerical assistance in typing certificates and maintaining necessary office records, supervisory costs at the field level, and the administrative and overhead costs at the Washington level. The charges for grading shell eggs on an intermittent or "fee basis" are based on the number of packages graded. Fees for grading

service performed on a resident or continuous grading basis are set forth in the contract form and are based on the costs to the Department in furnishing the grader or graders to the plant plus an overhead administrative charge, based on the volume of the product handled in the plant, to cover supervisory and other costs.

Salaries of resident graders are based largely on the wages paid for comparable work in the area where the grader is stationed. The fee schedules applicable to terminal market or fee grading vary from time to time as costs change. Whether the grading is done on a fee basis or a resident basis, the cost will average only a very small fraction of a cent per dozen eggs.

THE USDA LICENSED GRADER

In plants using the Federal-State egg grading service, the representative of the U. S. Department of Agriculture is the licensed USDA grader. He is largely responsible for the success of the grading programs.

General Qualifications

A licensed resident grader must have a combination of qualifications. He must have technical knowledge of and practical experience in the egg business and the stamina to do a physically tiring day's work cheerfully and effectively. He should be able to maintain good relationships between the industry and the Department.

The technical knowledge and experience requisite for this job call for familiarity with the Federal standards of quality for individual eggs, weight classes, and grades of eggs, and the ability to apply this knowledge at the grading bench at a rate of speed that is normal in commercial grading. Additional qualifications that the grader should have include the ability to instruct and then correct as necessary, the work of the egg candlers under his supervision, in order to insure accurate interpretation of the standards without upsetting the rate of production of the grading room. He should have sufficient background information on egg formation, structure, production, and care to be able to explain quality defects authoritatively in technical or nontechnical terms to managers, candlers, producers, or buyers.

The physical work involved in serving as a USDA resident grader is not arduous by nature, but standing (generally on a concrete floor) in a comparatively fixed position for long periods is tiring. Unless the grader is in average or better than average physical condition, his judgment and speed will be impaired before the work day is completed.

Maintenance of good relationships is necessary because the grader must be an unbiased observer and reporter of his findings at all times and should have the good will of management even when rendering decisions that are adverse to its interests. Some individuals are not psychologically suited for this type of work because of the strain. Others find it a stimulating challenge.

Specific Qualifications

To do the best job, a licensed grader must have certain specific qualifications.

Experience

Experience in candling and grading is essential. The lack of extensive commercial grading experience can be overcome, in part, by intensive training, including much closely supervised practice. The skill required to candle eggs at normal commercial operating speed and the ability to grade accurately for quality can be acquired only through practice. The amount of experience required will vary with different individuals, depending on their aptitudes for the work.

Education

Although the amount of formal education is not too important, the prospective licensee should have a high school education or the equivalent. The average grading assignment requires the preparation of reports and certificates and the ability to understand semitechnical detailed instructions.

Age

The age (preferably between 21 and 40) of the individual is secondary in determining the qualifications for egg-grading work. Maturity is desirable and frequently a requisite to satisfactory performance as a licensed grader.

Sound judgment and accuracy of decisions are usually associated with maturity. Hence, at times when an adverse decision is re-

quired, management is inclined to accept it more willingly from a mature individual.

If an individual possesses a practical knowledge of egg-grading operations and is a skillful egg candler, age is not so important. On the other hand, if an individual 40 or more years old has never candled and graded eggs, he may have difficulty in acquiring the necessary skill. The rapid coordination between eye and hand and the dexterity required in manipulating eggs in candling are acquired more slowly by an older person. It is therefore desirable to select a younger individual (under 40) for this type of work. Confidence is essential in a good grader.

Physical Fitness

Normal good health of the average grader is sufficient if the tiring effect of standing in one position for long periods of time does not detract from the accuracy of good judgment by the end of a normal work day. Individuals bothered by ailments such as varicose veins and flat feet might find the long hours of standing on hard floors harmful to their condition. This is equally true if lifting moderate weights (up to 60 pounds) and frequent turning of the torso aggravate other ailments. The individual who is very much overweight might develop foot and leg ailments.

Freedom from Red-color Blindness

Although total red blindness is not very common, an individual so affected should not endeavor to grade eggs for quality. The determination of the various qualities in eggs presupposes the ability on the part of the grader to classify various shades and intensities of red into fine gradations. Total red blindness makes this impossible.

Duties and Responsibilities

An official grader of the U. S. Department of Agriculture should receive complete instruction about his duties and responsibilities. Such indoctrination should cover two fields: The broad general scope of the overall job, and the specific and detailed responsibilities as they pertain to any particular part of the job.

The broad general responsibilities and duties of the egg grader are to observe and record accurately the class, quality, and condition of shell eggs in accordance with U. S. standards and grades, and to prepare the necessary memorandums, certificates, and reports in connection therewith, according to the regulations and instructions. The grader's conduct on and off the job shall befit the dignity of a representative of the Department. Official decisions shall be rendered in a manner that will be a credit to the Department and will simultaneously hold and encourage the good will of the user of the service.

Specific responsibilities include:

Keeping all official supplies, grade stamps, and equipment under lock and key.

Maintaining a handy reference file of instructions and regulations.

Correcting egg candlers' misinterpretations of official grades and supervising the work of candlers as necessary in a manner that will not disrupt candling-room production and will obtain the closest possible relationship between official quality standards and candlers' versions.

Maintaining permanent records of findings in supervisory check gradings.

Drawing samples personally in a manner prescribed in the procedure instructions.

Performing check gradings on cartoned eggs bearing the official mark.

Examining samples in the sequence and manner prescribed in the instructions.

Performing an official inspection on each lot of eggs bearing the official mark.

Personally taking and recording temperatures of case, storage holding room, truck, and car.

Personally preparing and signing all grading memorandums at time of grading.

Carefully checking memorandum totals and averages when assigning the grade.

Using official terminology when referring to official standards in certificates or official correspondence.

Issuing on request of applicant an official memorandum and a certificate for lots of eggs examined.

Including all necessary detail on all certificates.

Personally handling, or closely supervising, the neat application of the official grade mark.

Either typing certificates personally or carefully checking someone else's typing against memorandums.

Signing all original certificates and initialing all copies.

Arranging for distribution of certificates in accordance with instructions.

Defacing, removing, or causing to be defaced or removed, any incorrect official identification on any packages containing eggs packaged in the plant.

Preparing all reports on schedule and in accordance with instructions.

Reporting to the immediate supervisor any misuse of official identification.

Assisting management whenever possible by calling attention to any factors that are causing the "down grading" of a lot of eggs.

In addition to the responsibilities just outlined it has frequently proved helpful for the egg grader to:

Suggest to management methods of handling, processing, packing, storing, and shipping of graded eggs in a manner that will conserve quality.

Contact the supervisor immediately regarding difficult technical, personnel, or public relations questions that might become serious problems.

Services to the Applicant

The official grader furnishes the grading service stipulated in the terms of the contract between the applicant and the Department. In order to fulfill these requirements most effectively it is essential that the grader's activities be confined to the performance of grading service or related work.

One of the most valuable services rendered by the official grader is the issuance of a grading certificate that is accepted as prima facie evidence in a court of law. In addition to this service other important services are:

Providing an unbiased grading service for producers of quality eggs.

Providing factual information with respect to quality which will assist producers in improving the quality of eggs delivered.

Providing an unbiased grade for buyers.

Providing an authentic grading-room check control on quality.

Providing skilled supervision to the grading room.

Providing training for new and inexperienced graders.

Providing grading-room supervision that does not yield qualitywise under sales pressure.

Providing qualified personnel to pack products according to official grade requirements.

Placing management in a position to bid intelligently on deliveries requiring Federal grading by always drawing adequate samples on lot gradings.

Making it possible for management to supply grading certificates for such deliveries.

Mechanics of Grading

The procedures to follow when performing official grading are set forth in detail in the instructions issued to officially licensed graders.

The actual mechanics of grading of a lot of shell eggs can best be covered by setting forth the steps to follow for each of the two types of gradings. (1) Check grade eggs carrying official grade marks, continuously as they are being packed and also examine a portion of the lot after packing is completed. (2) Determine the grade of product on the basis of a representative sample.

In checking the grade of eggs packed by limited licensed graders a sampling procedure has been developed that includes drawing and examining samples from each grader's work during the day. The determination of when and how frequently a grader's work is to be sampled is based on the general quality of the eggs being graded and the proficiency of the grader. It should be assumed that important check periods are: At the beginning of the day; shortly after the grader returns from a rest period or lunch; at the beginning of grading a new lot of eggs; when a lot contains unexpected or variable qualities or conditions that are not generally prevalent in incoming eggs or with which the grader has not had recent experience (such as stains, small size, blood rings, mixed colors, or brown shells if white eggs only have been handled in the past). Obviously the work of all graders cannot be checked at all of these stages but keen observation and regularly prepared graders' performance records maintained by the official (USDA licensed) grader will be of great assistance in determining the sequence and

timing of the check against each grader's work. Care should be exercised not to develop a pattern of inspection that is familiar to everyone. The checking should be handled in a manner that will convey a spirit of helpfulness on the part of the official grader--not as if he were policing the work. Constructive results can be achieved only when the work is checked in a manner that does not imply the passing of a test at each check inspection.

In addition to regular check inspection of the individual grader's work an inspection should be made of a representative sample of the product drawn from the pack as it is completed each day. This inspection should be made to verify findings of periodic checks made during the day. At the same time a check should be made on the application of the official mark, the correctness of wording on the package, condition of the containers, and the product, packing temperature, and breakage that may have occurred in packing operations. Records of all check gradings should be made part of the official grader's permanent record.

When determining the grade of the product on the basis of percentages of qualities found in the random sample, it is essential that an adequate cross-section sample be drawn. The size of the sample and the position of the sample in the case, as required by the Federal-State grading service, have proved satisfactory and workable. It should be pointed out, however, that these quantities are minimum and the grader must decide whether or not they truly represent a cross-section sample. Additional samples must be drawn when any doubt exists.

Generally, the best procedure to follow after deciding on the size of sample is to draw from the truck, railroad car, or warehouse one case per stack and per layer, or, if several such lots are involved, a number of sample cases from each in proportion to the size of the lot. As each sample case is drawn, it should be numbered and initialed and one of the adjoining cases in the stack should be given the same number. The latter practice enables the grader to return to the same location in the lot for a larger sample if any one of the samples drawn is found to be of an unusual character.

While drawing the sample, the grader should try to detect any odors in the storage area. The presence of any foreign odor should be recorded on the grading memorandum. At this time the grader should also lay his thermometer on the lot of eggs or hang it nearby to obtain storage temperature.

The general condition of the egg cases in the lot should be observed and the condition of the sample cases should be noted on the memorandum.

After the entire sample has been accumulated and identified by the grader, examination should begin. The half of the case to be examined should be placed under the candling light so that ample case light is provided for detection of dirty or stained eggs. A thermometer should be placed under the second filler in the opposite end of the case in order to obtain case temperature while grading.

Out of each sample case, 100 eggs should be examined; that is, all but the 8 eggs in the third layer if the eggs are packed in fillers, or all but the 20 eggs in the fourth filler-flat, if that type of package is used. The eggs should be examined as follows: In the first case the 3 top fillers; in the second case, the 2d, 3d, and 4th fillers; in the third case, the 3d, 4th, and 5th fillers; in the fourth case, the 1st, 2d, and 5th fillers; and in the fifth case, the 1st, 4th, and 5th fillers. It is felt that 100 eggs is a large enough number to reflect the quality level of each sample. Each egg can be considered as 1 percent of the sample.

In order to improve counting accuracy, 4 empty fillers with flats should be conveniently placed for filling; 3 of them should be used for eggs of the principal qualities found and 1 for eggs of qualities occurring infrequently.

After candling and check-weighing the eggs, as described in an earlier section, the grader should tally up individual egg qualities and enter the figures on a memorandum. Data on light-weight eggs should not be recorded in the quality tally. They should be totaled and listed separately on the memorandum. The eggs examined should be put into three fillers and theses fillers should be so placed in the end of the case from which the eggs were taken that they will always appear as fillers one, two, and three, regardless of the original position of the eggs in the case.

At this point the case temperature reading should be recorded.

The net weight per case should be determined by transferring all eggs, fillers, and flats from the half of the case examined to a platform scale. (Scale should be checked for accuracy before each inspection.) The

weight should be multiplied by 2, and 3-1/2 pounds should be deducted as tare, if fillers and flats are used, or 1-3/4 pounds, if combination filler-flats are used. The difference is the net weight of the case. The reason for this rather involved procedure is to eliminate variations in the weight of individual empty cases. The filler and flat weights at 3-1/2 pounds and filler-flats at 1-3/4 pounds are seldom in significant variation.

The inexperienced grader may find "transferring" 3 dozen eggs at a time rather difficult but practice develops proficiency. Before attempting to pick up a layer of eggs, the grader should make sure that the filler and flat are in good condition. He should grasp the filler and flat in both hands, as near the ends of opposite corners as possible. The first two joints of the fingers of each hand should hold the corners of the flat on the under side and the thumbs should be pressed securely on the top of the filler. The corners of the filler and flat should then be lifted and tipped toward each other slightly, making sure that the filler remains securely pressed against the flat. Proper transfer procedure may be checked at this point: The shape of the filler cells has changed from square to diamond, the top of the filler between the hands has become concave, and the eggs in the center of the filler have not slipped downward. Now the filler and flat containing the eggs should be raised out of the case, the position just described being retained until the flat has been brought to rest outside the case. To return the filler and flat to the case, the grader should insert one of the filler's corners not being held by him into the nearest corner of the case, then should settle into place the diagonally opposite corner of the filler, after which he should release the corners being held in his hands. The development of dexterity in this technique is not absolutely necessary, but most experienced graders can "transfer" proficiently. The knack, therefore, helps the grader's prestige and it speeds up his output of work without egg breakage.

The detailed findings of the grading should be reviewed for accuracy, the case percentages should be totaled and averaged. The accuracy of the figures can be checked by determining whether the totals in the quality columns (not including figures for case weight or light-weight eggs) equal the number of cases multiplied by 100, and the averages of all quality columns equal 100.

Before affixing his signature to the certificate, the grader should check to make sure that the data have been accurately transferred to the certificate from the memorandum. A covering certificate should be issued on the day the grading is made, if at all possible. The certificate and memorandum file should be kept under lock and key.

Grading certificates are negotiable instruments in trading. It is, therefore, of utmost importance that the grader realize that he is accountable for all blank certificates issued to him and that he must keep records to show what was done with each certificate.

As in any legal document, erasures or strike-overs should be avoided. Minor corrections that can't always be avoided must be initialed in ink by the grader. Original certificates that contain many errors or that are mutilated must be marked void and recorded and attached to the list of certificates that is mailed to the supervisor each month.

LEGISLATION AFFECTING GRADING AND MARKETING OF EGGS

Much legislation has been enacted to regulate the sale of shell eggs. The laws apply to the edibility of the product and to its quality and grade. Both Federal and State laws are applicable to eggs, but practically all of those pertaining to candling and grading have been enacted by the States.

Federal Laws

The Farm Products Inspection Act of 1917 provided the original authority for establishing grades and grading service for voluntary use. Since 1925, the annual Appropriation Act of the Department of Agriculture has continued to provide for the inspection of agricultural commodities including eggs.

The Federal Food, Drug, and Cosmetic Act and the regulations for its enforcement thereunder apply to all food products in interstate commerce including shell eggs. This act is designed to prevent the shipment of adulterated and misbranded foods. In applying this act to shell eggs a small tolerance for loss eggs is permitted, as it would be rather difficult, costly, and impractical to eliminate all loss eggs from wholesale quantities of eggs.

The Packers and Stockyards Act is designed primarily to protect producers and

consumers against unfair, deceptive, and fraudulent practices and devices in interstate and foreign commerce. The act and the regulations promulgated thereunder apply to egg handlers only if the handler is also engaged in the meat packing business, or operates a stockyard, or is a dealer, or market agency for livestock products. The larger meat packers who also handle eggs are subject to the provisions of the Packers and Stockyard Act, whereas an operator engaged exclusively in the egg and poultry business is not.

STATE EGG LAWS

Egg laws have been enacted in 46 of the 48 States. The laws differ materially as to their provisions but in recent years, as new laws have been written and old ones revised, there has been a tendency toward more uniformity. Some of the earlier egg laws were probably intended to protect and promote the egg industry of the particular State and tended to serve as trade barriers. Most of the recent laws and the revisions of the older laws, however, are concerned more with grading, grade labeling, and accurate representation of the product to the consumer at the retail level. Most of the enforcement effort is directed toward retail outlets, although eggs are also inspected at the wholesale and jobbing levels.

A survey of State egg laws was made several years ago which indicated that progress was being made in obtaining uniformity by use of U. S. Standards for quality and grades for shell eggs. A few of the facts contained in the report are as follows:

(1) The quality groups specified in egg standards used by various States ranged from 1 to 8. However, the most generally used terms in a majority of the States are: Grade AA, Grade A, Grade B, and Grade C. A few States use such terms as Fancy, Special, Fresh, Extras, Standards, and Trades to designate grades.

(2) The survey disclosed that fifteen States have voluntary grades and 25 States have mandatory grades; 6 other States have laws regulating the sale of eggs, but they have not promulgated grades or standards. Only 2 States have no laws, grades, or standards regulating the sale of eggs.

(3) Twenty-four of the State laws include provisions with regard to fresh eggs. The use of the term "fresh" or other terms that imply freshness in connection with the advertising or selling of eggs or the labeling of egg containers is usually prohibited unless the eggs conform to minimum specifications of A Quality as provided by law.

(4) Provisions for candling of eggs are included in the laws of 35 States. In 3 States, egg candling is voluntary; in 28 States, it is required; 3 States require candling during specified times of the year; and 1 State requires candling of all out-of-State eggs before reselling.

(5) The sale of inedible eggs is prohibited in 34 States.

(6) Six States require out-of-State eggs to be marked as such. Labeling eggs which have been shell-treated is required in 12 States and 15 States require storage eggs to be labeled as such when offered for sale.

(7) In 37 States, all or part of the size and weight specifications are the same as those in the weight classes for consumer grades of eggs issued by the Department of Agriculture in 1947 (revised in 1948). The terms used to designate size or weight classes in the State standards and grades are much the same as those of the United States standards and there is some variation in the weights assigned to individual size or weight classes.

(8) Twenty-six States now designate grades by the same terminology (Grade AA, Grade A, Grade B, and Grade C) as used in the U. S. grades.

PRODUCTION AND MAINTENANCE OF EGG QUALITY

The production of eggs has become a major agricultural industry in this country. Total production in the United States in 1952 was about 65-1/3 billion eggs. Producing and marketing this large volume of eggs have been accompanied by an increasing awareness of the need for quality conservation and in a trend toward specialization. Breeding, hatching, and raising chickens, and producing eggs and poultry meat as a combination commercial operation are seldom practiced today. This fact is evidenced by the many specialized production and marketing operations that have come into being in the poultry industry.

Breeding

Shell color and thickness, egg size, quantity of thick white, quantity of eggs produced, and to some extent blood spots are hereditary factors and can be bred into the egg-laying flock. The baby chicks or pullets for the initial flock or flock replacement should be procured from a source that can give reasonable assurance that these factors have been carefully considered in the breeding program.

Hatching

In order to assure improved breeding and production qualities and to reduce losses from pullorum disease in poultry, the industry established the National Poultry Improvement Plan in 1935.

The Plan is administered jointly by the Agricultural Research Service of the Department and an official State agency in each of the cooperating States. It operates according to regulations and standards under which birds classified with respect to specific breeding qualities and freedom from pullorum disease, and hatching eggs, may be produced and marketed by poultrymen. Procurement of baby chicks from "Plan" hatcheries assists the producer in the selection of desirable young stock.

Brooding and Raising

The brooding and raising of baby chicks to laying age may be done by one who raises poultry for the eggs or by specialists in the pullet-raising field. Egg producers in a number of areas today follow the practice of culling their flocks carefully or entirely replacing them with laying-age pullets after their flocks have completed their first year of production. This practice eliminates for the specialized egg producer an outlay for additional space and labor, as well as the hazards of raising additional birds.

If brooding and raising his own flock replacements are considered by the egg producer, it is necessary that thought and careful planning go into the following:

(1) Selection of the source of baby chicks
(2) Providing separate quarters with sufficient space for raising birds to pullet age
(3) Providing sufficient land to permit rotation of each flock to new soil (not used for chicks for a year)
(4) Management know-how regarding handling, feeding, watering, vaccination, and sanitation

Production of High-Quality Eggs

Feeding shares the limelight with breeding in the production of high-quality eggs.

Shell.--The breaking strength of an egg is affected by the hen's feed, breeding, age, and freedom from disease, and by hot weather. Nowadays the average commercial feed supplemented with "grit" (calcium carbonate) usually has sufficient calcium, phosphorus, manganese, and vitamin D to produce sound shells. Therefore, the source of shell trouble is more frequently found in some of the other factors mentioned.

Yolk--Dark pigmentation in the yolk affects the acceptability of the egg in the top qualities. Rations high in yellow grains and green feeds produce dark yellow to orange-colored yolks. Rations high in green grasses, silage, and cottonseed meal (gossypol not removed) will cause the yolks to acquire a reddish or olive color.

White--To be of fine quality, eggs must have a high percentage of thick white. A lack of this factor can be attributed to breeding and disease of the chickens, and improper care of the egg after production.

Housing

To produce eggs with fine quality shells, yolks, and whites adequate housing of the birds and care of the eggs after they are produced, is essential. Adequate housing should include sufficient floor, feeding, and nest space, and nests having soft clean nesting material or means for mechanically removing the egg from the nest space.

Clean Eggs--The use of the "roll-away" nest is becoming popular and is effective in reducing the number of eggs dirtied in the nest. The yard area surrounding the laying house should be free from standing water. Runways to or along the nests for access to the nests help remove dirt from hens' feet.

Wire-screened dropping pits reduce the number of eggs dirtied from soil on the hens' feet, and tend to reduce loss due to breakage.

Care of Eggs on the Farm

Immediately after it is laid, an egg begins to lose quality even if it is removed from

the nest, cooled, packed, and marketed promptly. (See fig. 13.)

Keeping temperature and humidity conditions at an optimum level retards this loss in quality to a large degree. The necessary steps are:

1. Gather eggs frequently (at least 3 times a day)
2. Use a clean receptacle with ventilated sides and bottom, preferably a rubber-coated wire basket
3. Place eggs in basket carefully
4. Never fill basket more than three-fourths full
5. Place basket of eggs into cool, humid storage room
6. Do not pack eggs in cases until laying or nest temperature of eggs is reduced to storage room temperature. A clean basement or an insulated room equipped with an evaporative cooler (home-constructed) will serve as a good storage room
7. Pack eggs in clean, cool packing materials
8. Pack clean eggs separately from dirty eggs
9. Dry-clean slightly dirty eggs

Cleaning Eggs on the Farm

Even with good farm-management practices and careful handling a small percentage of dirty eggs will be produced. Producers must bear in mind that dirty eggs are covered with bacteria that will cause spoilage if they enter the egg. Farm cleaning, therefore, must be performed in a manner that will minimize the chances of bacterial penetration of the shell. However, if these important facts are forgotten, and accidental or wilful careless washing is carried on, more damage can be done than by leaving the dirt on the shell.

Dry Cleaning

Eggs may be satisfactorily and easily cleaned with a dry abrasive, such as emery cloth or fine sandpaper mounted on a shoe buffer. Select only those eggs that are moderately or slightly dirty or stained for cleaning and "touch them up" lightly. Do not attempt to clean extremely dirty eggs. They cannot be cleaned well enough to be classified as clean eggs, and the chances are they will become broken during the energetic buffing required. Furthermore, the percentage of such eggs should be very small if dirt sources have been kept at a minimum.

If a mechanical dry-cleaning unit is used, care should be taken to see that the abrasive strips are intact and not worn to a nonabrasive or dirty point. Eggs should be run through the unit once only. Otherwise they will acquire a shine that is objectionable in the market place. No attempt should be made to dry clean extremely dirty eggs because they will come out with stained shells.

Wet Cleaning (Washing)

Wetting a dirty shell provides moisture in which bacteria may breed and assist their growth and their penetration into the shell. A washing solution colder than the egg causes the egg content to contract and thus allows polluted water to be drawn into the shell. Therefore, if the washing method is used to clean dirty eggs the following precautions should be followed:

1. Wash eggs with water warmer than the eggs
2. Select a detergent sanitizer that is compatible with the wash water (varying degrees of hardness of water causes unfavorable reactions with different quaternary ammonium compounds), and one that will retain its sanitizing ability longer than its washing power.
3. The detergent should be one that will not give off foreign odors that may be imparted to the egg.
4. Keep wash water as clean as possible.
5. Rinse by spray or in running warm water (slightly warmer than the wash water).
6. Drain dry and case. Do not case wet eggs.

Marketing

Eggs from farms should be marketed 2 to 3 times a week in clean containers protected from transportation shock, wind, and heat or cold. Transportation should be furnished either by the producer or receiving station at regular intervals.

Station Care

It is wise to select a marketing firm that pays the producer on the basis of quality and not on the basis of one price

for all qualities. The latter practice makes it necessary to lower the price for top quality to compensate for lots having a high percentage of low-quality eggs. The Department has established grades and provides grading services that are used effectively by establishments buying on grade. In addition, the producer should satisfy himself that the receiving station is equipped to handle his product efficiently. The well-equipped receiving station should have refrigerated truck service for farm pickup of quality eggs during the summer and insulated or possibly heated trucks for use during severe winter weather.

When received at the plant and before they are graded, eggs should be put into a cool (50° to 65°F.), humidified room.

Grading

Grading should take place in a cool, darkened room properly equipped and operated by trained and carefully supervised graders. In some plants grading rooms are now air conditioned. The grading bench and room should be arranged to enable minimum lost motion by graders and grading room helpers. A combination of roller and belt conveyors to serve the graders with eggs to be graded and to move the graded product away from their benches has been worked out satisfactorily. The use of conveyors and shock-absorbing hydraulic lifts are helpful in reducing shocks normally caused by careless or accidental rough handling.

In order to reduce variations in grade in cases of eggs as a result of staleness due to overnight holding in the grading room, it is advisable to combine part cases of graded eggs each night. It is necessary to develop and maintain a receiving, handling, and shipping supply control of ungraded and graded eggs.

After eggs are graded and packed in cases they should immediately be moved to the shipping room cooler and held there until ready for distribution. If they are distributed direct to the retail store, a refrigerated truck should be used for summer deliveries and an insulated truck for winter deliveries. This practice will not only help to deliver the quality of eggs, as graded, to the retailer but also will stress the need of proper care of the product to the retailer.

Packing

Packing is normally carried on in conjunction with the grading operation. Clean packaging materials should assure adequate protection of the product in the handling required in the receiving station, distribution channels, and in the retail store. Cases for retail distribution should always have complete tops.

Distribution

Retail

Fine-quality eggs that have been properly cared for and packed in attractive cartons are sometimes handled carelessly by the retailer.

The wise operator of a receiving station packing and grading room knows that proper care of his product in the retail market will assure repeat sales. He will make suggestions to the retailer regarding stock control and care, including volume delivered, rotation of supply, refrigeration (50° to 65°F.), and humidity. Bulk stocks should be stored only under refrigeration in space that is free from volatile odors of fruits, vegetables, coal oil, mustiness, and mold.

Wholesale

Products for wholesale outlets, should be packaged in good cases having complete tops and with good packing materials. If deliveries are by truck the truck should be refrigerated by a self-contained refrigerator unit and insulated on all surfaces and doors for warm weather shipments. For deliveries in extreme winter weather, the truck should be equipped for heating with warm air free from foreign odors that might contaminate the eggs. Truck beds should be equipped with racks to provide adequate air movement around the load. The load should reach to the closed doors, but if this is not possible, end bracing should be used to avoid shifting of the load in transit. The shipping of small lots in trucks built for carrying heavy loads should be avoided.

Before shipping by rail the interior of the refrigerator car (with door closed) should be examined for any obvious insulation breaks. The floor racks should be in place and the drain plugs in the ice bunkers open. It is best to use a car that has just sufficient space to permit a snug fit for

each stack of cases. Loading from either end provides for working space when installing bracing between center rows. Bracing should be sturdy and fit snugly to avoid load shift in transit. For shipments requiring 48 or more hours at a time of year when temperatures are 70° F. or higher, the bunkers should be loaded to capacity with chunk ice and provision should be made for reicing in transit. For short hauls or where maximum daytime temperatures are below 70° F., smaller quantities of ice can be used or none at all.

During extremely cold weather refrigerator cars should be lined with building paper or other insulating material and the bunker hatches should be closed after bunker and hatch plugs are in place. The car should be heated to not more than egg holding-room temperature while loading.

Precautions against exposure, extreme heat, cold, and rain should be taken at the time of loading by using tarpaulin to cover the loading platforms.

Before cars or trucks are loaded, they should be checked for the presence of foreign odors. Cars or trucks used for fish, potatoes, citrus fruit, apples, or cabbage, should be rejected for use in shipping eggs if the carrier cannot remove the odor of these products. Cars showing breaks in the ceiling, walls, or floor surfaces sufficient to admit daylight when doors are closed, should also be rejected.

When both fiber and wood cases make up the load, the wood cases should always be on the bottom, and rows of wood cases should appear on either side of the bracing point.

PLANNING GRADING SCHOOLS

As is the case in most successful undertakings, good planning is a highly important phase in conducting an egg-grading school. The planning should cover ways and means of financing the school as funds will likely be needed for supplies of eggs, packing materials, rentals, manuals, and other equipment. Consideration might well be given to charging a laboratory or registration fee to cover the necessary expenses in conducting the school. An adequate number of instructors and staff assistants should be provided to help with the instruction and to assist in setting-up laboratory classes and demonstrations. Carefully developed plans coupled with energetic follow-through will usually result in a well-organized, smooth-running school that serves as an effective means of teaching the proper methods and practices of grading and related subjects. This part of the manual is intended as a guide to those who wish to organize and conduct egg grading schools.

Location and Time

The school should be held as nearly as possible in the center of the section or region from which the students are drawn. It should be held in a place where the essential equipment and facilities are available and where there is adequate space for classes and laboratory practice sessions. Consideration should be given to locating the school near a place where board and lodging facilities are available at reasonable rates.

Egg-grading schools can be held at any time during the year, but it is desirable to schedule a time when the regular work of the prospective students is not too pressing and when there is a minimum of conflict with other meetings, expositions, and special schools. Generally, it is desirable to hold school in the late winter or early spring months, although other times of the year may be equally as desirable. Refresher egg grading schools may be held just before or during the beginning stages of the "spring drop" in egg quality or when hot weather eggs or storage eggs are prevalent. In conducting a series of schools for an area over a period of several years it would be desirable to schedule the schools so that students can become familiar with the general quality of eggs and quality defects typical of the various seasons.

Equipment and Facilities

Facilities and equipment of a size and in quantities sufficient to accommodate the number of students and instructors attending the school, should be provided as follows:

1. A room equipped with tables and chairs, for lectures and demonstrations.
2. A room for laboratory sessions and demonstrations. An egg-grading or an egg-breaking plant that is not in current use would be a desirable place to hold the school if a room suitable for the lecture sessions is also available.

3. A supply of fillers, flats, filler-flats, and egg cases.
4. An adequate supply of candling lights mounted so as to provide ample bench space, candling light apertures at correct height, and adequate case light. These must be located in a room that can be darkened.
5. An adequate supply of shell eggs. At least 15 and preferably 30 dozens of eggs should be available for each student in attendance. The working stock of shell eggs must include the entire range of quality, including various types of loss and inedible eggs. It is desirable to have eggs which cover the complete range of quality in each of the quality factors. These are necessary for laboratory practice sessions as well as for testing and examination purposes.
6. Individual egg scales and scales for weighing 15 or 30 dozens of eggs.
7. Slide and film strip projectors, motion picture projector (if to be used), blackboard, opaque projector, and other similar facilities.
8. Other materials, such as egg quality slides, manuals, a supply of specifications of standards and grades, pads, pencils, and examination papers.
9. Registration blanks, supply of programs, and laboratory forms.
10. Certificates for those who successfully complete the school.

Suggested Programs

Suggestions for 2-, 3-, and 5-day schools for egg graders are given in the pages that follow. With variations and rearrangement, these suggestions could be used for planning the program to cover a 4-day school or even a 1-day refresher school for egg graders.

It may be desirable to supplement the program with appropriate slides[1], films, and other visual aids. It may also be helpful to introduce occasional technical lectures on one or more of the subjects covered.

It should be remembered that the more practice sessions in candling that are provided, the better understanding the student will have of egg grading. The instructors responsible for setting up the laboratory classes should include a wide variety of qualities within the various lots of eggs used in instruction. The selection and arrangement of the lots for student practice and testing is quite important and will influence considerably the success of the school.

[1] The Department of Agriculture has egg quality slides available for this purpose.

Suggested 2-day Program for a School for Egg Grading

First Day of School

Morning
- Registration
- Purpose and plan of the school
- Function, advantage, and general application of standards (Manual)
- Formation, structure, and composition of the egg (Manual)

Lunch

Afternoon
- General quality factors (Manual)
- Egg quality slides
- Candling room technique and grading practice (Manual)
- Demonstration and student practice (Laboratory)
  1. Transferring eggs out of and into cases
  2. Weight classing
  3. Segregation of stains and dirties
  4. Candling and quality determination

Second Day of School

Morning
- Review of standards of quality
- Laboratory practice--Factor grading
  1. External factors
  2. Air cell
  3. Yolk
  4. White
- Comparison of broken-out appearance with candled appearance

Lunch

Afternoon
- Laboratory period -- Candling for all factors
- Review -- Question-and-answer period
- Practical examination
- Written examination
- Adjournment

Suggested 3-day Program for a School for Egg Grading

First Day of School

Morning
- Registration
- Purpose and brief outline of course

Egg grading, advantages and general application (Manual)
Formation of the egg (Manual, supplemented with film, if possible)
Structure and composition of the egg (Manual)

Lunch

Afternoon
The general quality factors for individual eggs (Manual, Egg Quality Slides)
Candling room technique and grading practice (Manual)
Laboratory practice
1. Transferring out of and into cases
2. Weight classing
3. Segregating of stains and dirties
4. Candling and quality determination

Second Day of School

Morning
The production and maintenance of egg quality (Manual, supplemented with slides, film strip, or movies)
Laboratory practice--weight classes, review of shell factors (Manual and Egg Quality Slides)
Reviewing air-cell requirements
Laboratory practice--classifying eggs as to air-cell factors

Lunch

Afternoon
Review of quality specifications for yolks and whites
Laboratory practice--classifying eggs on the basis of the yolk factor and albumen factor
Laboratory practice, candling eggs considering all factors
Comparison of broken-out appearance with candled appearance
What's new in egg-quality research

Third Day of School

Morning
Federal-State grading programs for shell eggs
Laboratory period--candling practice according to all factors
Federal and State Laws applicable to egg grading and marketing--Relationship to Federal-State grading programs

Lunch

Afternoon
Question-and-answer period
General review
Written examination
Practical examination
Adjournment

NOTE: The school may be extended into the fourth day, if desirable and practical, by devoting more time to laboratory practice in classifying eggs for all factors, and shifting the examination, general review, and practical tests to the fourth day.

Suggested 5-day Program for An Egg Grading and Marketing School

First Day of School

Morning
Registration
Purpose and plan of the school
The formation of the egg (Manual, film)
The structure and composition of the egg (Manual)

Lunch

Afternoon
New trends in egg marketing
The grading of eggs--Advantage of grading; general application of standards and grades
What is egg quality--Lecture and demonstration of broken-out quality of eggs
General quality factors (Manual)
Laboratory demonstration and student practice
1. Transferring eggs out of and into cases
2. Weight classing
3. Segregating of stains and dirties
4. Candling and quality determination

Second Day of School

Morning
U. S. Standards for Quality of Individual Shell Eggs
Laboratory practice
1. Weight classes and review of shell factors (Manual, Egg Quality Slides)

2. Classifying eggs as to shell factors
3. Review of air-cell requirements
4. Classifying eggs as to air cell factors

The production and maintenance of egg quality (Manual, supplemented with slides, film strip, or movie)

Lunch

Afternoon

What's new in egg-quality and egg-marketing research

Laboratory practice--Factor grading
1. External factors
2. Air cell
3. Yolk
4. White

Candling technique and grading-room practice (Manual)

Third Day of School

Morning

What the consumer wants in shell eggs (Preference for weight and quality; package; label information)

Laboratory practice--Candling; all factors

Delivering to the consumer eggs of the quality represented on label

Lunch

Afternoon

Federal-State grading programs

Proposals for changes in standards, grades, and regulations

Federal and State Laws that relate to egg marketing

Panel discussion--Interrelationship of Federal-State grading and State law enforcement programs

Fourth Day of School

Morning

Laboratory practice--Candling; all factors

Demonstration and laboratory practice--comparison of broken-out appearance with candled appearance

U. S. grades of eggs--Consumer, Procurement, Wholesale

Practice in assigning U. S. grades to lots of different quality levels

Lunch

Afternoon

Review of standards and grades (Manual and slides)

Grading and inspection procedures (Manual)

Laboratory practice--Establishing the grade on a lot of eggs (1-, 2-, or 3-case lot)

Cleaning dirty eggs

Fifth Day of School

Morning

Shell treatment of eggs

Sanitation requirements and operating procedures applicable to grading and packing

Laboratory period--Review of standards of quality--Candling practice; all factors

Lunch

Afternoon

Practical examination--Candling tests

Review and question-and-answer period

Written examination

Award of certificates of completion

Adjournment

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