An Analysis of Egg Handling Costs and Efficiency

by

Kermit Bird

Department of Agricultural Economics

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Extension leaflets covering certain aspects of egg handling may be obtained at Oklahoma County Agent's offices or by writing to the Agricultural Extension Service, Oklahoma State University, Stillwater, Oklahoma. They include L-51, Inplant Labor and Equipment; L-52, Selecting and Training Egg Candlers; L-53, Costs Fixed Labor; L-56, Fixed Costs Buildings and Equipment, and L-57, Inplant Total Costs. All of these are free.

Agricultural Experiment Station
Oklahoma State University
Stillwater, Oklahoma
and
Marketing Economics Research Division
Agricultural Marketing Service
U. S. Department of Agriculture

CONTENTS

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Egg handling costs are of concern to consumers who eventually pay them; they help set the price to producers; and to egg handlers they can spell the difference between profit and loss. To the individual egg handler efficiency means reducing physical inputs and thereby lowering costs. By lowering costs an egg handler may maintain or increase his share of the market, and remain competitive. He is in a position to pay better prices to producers and sell at lower prices to retailers. The research reported in this bulletin should give egg handlers ideas on how to lower their in-plant costs.

This report presents results of a study of costs and efficiency in the operation of plants candling and packing shell eggs. This study is based upon observations obtained from existing plants, and is directed toward improvements of efficiency within existing plants. It does not attempt to establish maximum efficiency conditions which would be obtained with newly constructed plants utilizing only latest equipment. In direct contrast, reports by the Agricultural Marketing Service, now in press, will present estimates of efficiencies based upon engineering designs utilizing the most recent equipment.

Most Oklahoma eggs are candled and packed in one dozen cartons. The cartons are packed in cases, stored until needed, and then delivered to retail stores or other outlets. Cartons are expensive, candling and packing labor requirements are high, and overhead contributes to the relatively high cost of handling eggs. This study shows analysis of these costs and presents ways of reducing them. Included are the effects of yearly hours of operation, quality of eggs handled, wage rates, multiple shifts, and plant capacity. Labor standards for candling and case handling are detailed.

Table I shows that most Oklahoma firms handling eggs are small—91 percent of them handle less than 10,000 cases of eggs annually. The 21 firms handling 10,000 or more cases per year are the firms considered of

*In cooperation with Marketing Economics Research Division, U. S. Department of Agriculture.

Table I.—Oklahoma Firms Actively Engaged in Handling (Candling, Grading, Packaging) Eggs

Cases Handled Per Year	Firms		Eggs	
	No.	Percent	Cases	Percent
0 to 9,999	205	91	277,100	29
10,000 to 19,999	8	3	99,964	11
20,000 to 39,999	7	3	194,900	21
40,000 to 79,999	4	2	206,596	22
80,000 to 99,999	2	1	165,151	17
Total	226	100	943,711	100

Source: Marketing Economics Research Division of AMS, USDA, 1959.

commercial size. They handle 71 percent of the state's output of eggs. This publication, although written for managers of commercial firms, may be of interest to operators of smaller firms who wish to change from small family-operated to hired-labor type enterprises.

Previous studies of egg handling have analyzed costs[1] and investigated materials handling systems.[2] Other studies have compared alternative methods of candling and handling eggs.[3] None of these specifically identify volume as an important factor influencing egg handling costs. Several studies have been made describing poultry processing scale relations,[4] but so far as can be determined few have been made on egg handling scale relations.[5]

This study emphasizes volume as an important determinant of egg handling costs. Economies of scale studies are particularly useful at times when an industry is in a state of change. This describes the United States egg industry at present.

[1]Candling and Cartoning Eggs at Country Plants. Robert Conlogue. Marketing Research Report No. 366. Marketing Research Division, AMS, USDA, Washington, D.C., December, 1959.
Cost of Marketing Eggs and Labor Output of Selected Cooperatives, Part I Northeast, Part II Northcentral, and Part III Western States. General Reports 59, 72 and 75, Harry E. Radcliffe. Farmer Cooperative Service, USDA, Washington, D.C., May 1959, May 1960 and July 1960.
Costs of Candling and Cartoning Eggs. C. E. Trotter and C. A. Becker, Paper No. 1812 Journal Series, Department of Agricultural Economics and Rural Sociology, The Pennsylvania State University, University Station, Pennsylvania, August, 1953.

[2]Candling, Sizing, Packing, and Materials-Handling Equipment and Methods Used in Egg Assembly Plants. Norman Paulhus and Frank P. Delle Donne. Marketing Research Report 47, AMS, USDA, Washington, D.C., June 1953.

[3]Electronic Bloodspot Detection in Commercial Egg Grading. John Hamann, Evans Winter, Robert Stoyanoff and O. C. Hester. Marketing Research Report 239, Marketing Research Division, AMS, USDA, Washington, D.C., June, 1958.

[4]Factors Affecting the Output, Size, Costs and Location of Poultry Plants in Southern New England, R. O. P. Farrish and S. K. Seaver, Bul. 342, Storrs Agricultural Experiment Station, Storrs, Connecticut, September 1959.
Economies of Scale in Chicken Processing. George Rogers and Edwin Bardwell, Bul. 459, Marketing New England Poultry—Economies of Scale in Chicken Processing, University of New Hampshire, Durham, New Hampshire, April, 1959.

[5]Improved Designs for Egg Grading and Packing Plants, John Hamann and Thomas Todd of the Transportation and Facilities Research Division, Agricultural Marketing Service will soon be printed. This publication uses the economies of scale principle as one of the major influences affecting recommendations.

Objectives of the Study

The general purpose of this study was to provide information so owners and managers of egg handling plants can reduce costs of candling and packing eggs. Specific objectives included (1) a determination of the effects on short-run costs of wage rates, multiple shifts, quality of eggs, candling method used, and yearly hours of operation, and (2) effect on long-run costs of plant size.

Costs Involved

Costs analyzed and discussed in this report are only those incurred within an egg handling plant. Labor and truck costs in procuring and delivering eggs are not included. Neither egg breakage nor inspection costs are included. Included as costs are supplies such as cartons, cases, and flats and fillers. Equipment costs are given for both egg handling and refrigeration equipment. Building and land costs are reported together. Worker costs are in two categories: labor and salaried employees. The former group, labor, is considered a variable cost and comprises the workers handling eggs or cases. The latter group, salaried employees, is fixed and includes office workers and the foreman. Other costs are utilities, office expense, and miscellaneous.

Cost figures used were originally gathered from actual plants in every day operation. These figures were adjusted. Then they were fitted in models. As such they are synthetic figures, meaning that they don't apply to any particular plants. The cost functions used for comparisons and illustrations are minimum ones for the particular use to which they are applied. Minimum, as used here, does not mean they are least cost. Rather it means they are low, but attainable by most firms now in operation.

Source of Data

Cost estimations and labor and equipment standards came from an economic-engineering study in five fairly efficient Oklahoma egg handling plants. In the summer of 1959 a work-sampling study was conducted. Man hours of labor and wait time were determined for all operations. Delays were noted and sources of delay were accounted for. In each plant studied two analysts spent two full days collecting work and delay tallies. Standards for individual machines or items of equipment were

obtained with stop-watch measurement in these same plants and in other plants. With information thus obtained labor and equipment standards were calculated. These standards were later checked and verified in a larger group of plants.

Other data on building requirements, land needs, refrigeration space needs, and equipment use came from a second group of plants. These plants were located in Kansas, Minnesota, Indiana, Ohio, and Virginia. Costs of cartons and rental rates on carton-setup machines, carton-closers, and turntables were obtained from carton companies. Case manufacturers supplied data on case and filler costs. They also estimated the expected life of these supplies. Various equipment companies supplied data on equipment prices, depreciation, and repair costs.

Refrigeration room cost estimates were supplied by a national refrigeration manufacturer. Refrigeration equipment ownership and operational cost estimates were made by an Oklahoma firm.

Fork truck costs and capacities were estimated by a national firm. Building and land costs for the models were estimated by local contractors and real estate agents.

Instructions to engineers, contractors, and other persons providing estimates specified that least cost machines or items be used in calculating costs.

Definitions

A **Plant** is one egg handling facility. It consists of the land, building, equipment, salaried workers, laborers, and supplies necessary to perform the functions of grading, candling, and storing of shell eggs.

An **Input** is a factor of production as an hour of labor, use of a machine or building for a period of time.

An **Output** is a measure of achievement of a plant. In egg handling plants, output is measured in terms of cases of eggs for a given length of time. It is a measure of product flow.

Volume is the same as output; it is the achieved flow of cases of candled and packaged eggs.

Capacity is the potential volume of a plant, where scale is specified. It is the most economical operation using a one-crew setup.

Efficiency denotes the relation of physical inputs to physical out-

puts. In a given plant if inputs decrease while output stays the same, a degree of efficiency has been achieved.

Production Standard is a unit of time applied to a given job. A standard is not the average time needed to do the job, nor is it the least time. Rather it is an attainable time, using good methods and efficient labor. Many times these standards are called input coefficients or labor requirements.

Scale is size of magnitude of a fixed plant. It is measured in capacity per unit of time. A plant with a capacity of 12 cases per hour is twice as big as a plant with a capacity of six cases per hour. Here scale has doubled. A plant adding a second shift has not changed its scale, even though output per day, per week, and per year have doubled. Here scale is the same since the fixed plant is the same.

Short-run Cost Curves are those of particular plants of a given size or scale. Fixed factors are not free to vary. These curves show that as a plant increases its volume it is able to spread its fixed costs over more units and average costs decline. During this stage fixed units of production are getting into better balance relative to the variable units. But as volume increases, more and more variable units are combined with the fixed units and eventually the plant gets out of balance the other way and average costs increase.

A **Long-run Cost Curve** shows the level of costs, with fixed factors free to vary. This curve is tangent to the short-run curves mentioned above and may be thought of as the cost curve for a number of plants of different scales at any one time. This curve is useful for planning; it shows the cost advantages or disadvantages for prospective plants of various sizes.

Economy of Scale Curve is the same as the long-run curve described above. It shows the level of costs that may be expected from operations of various size plants when these plants are organized and operated as efficiently as possible under given conditions.

Assumptions

Costs used in this study are fitted into models. These models are described in a later section, but the simplifications and specifications used in constructing the models are given here.

1. GEOGRAPHICAL LOCATION. Models designed for study are similar to plants now operating in Oklahoma. These plants are

close to procurement areas and also are close to distribution areas. In egg surplus areas eggs are packed in flats rather than in cartons. However, in the models identified here, eggs are packed in retail cartons.

2. QUALITY OF EGGS. The egg quality standard used is 75 percent Grade A or better. For comparison purposes eggs 90-95 percent Grade A or better are used. No estimates are made of costs except for eggs of these two qualities. The five firms, studied in detail, had eggs 90 percent A's or better, 89 percent, 88 percent, 75 percent, and 70 percent.

3. LENGTH OF SEASON. In this study egg handling is considered a full year job, i.e., eggs are packed every week of the year. For purposes of analysis this year is defined as 260 working days, 2080 hours. Unless otherwise specified the work week is 40 hours.

4. WAGE RATES. All employees, except salaried ones, get $1.25 per hour. For comparison purposes a $1.50 wage rate is used. This $1.25 rate is slightly higher than most Oklahoma plants are paying at present (1959-60), but it is anticipated that wage rates will increase to this rate during the next year or so. Both men and women, candlers and case handlers, receive the same wages.

5. STORAGE. Cold storage requirements depend upon the operation. In the models designed for study assumptions made concerning refrigeration room space needs were:
   a. All eggs stored in 30 dozen cases.
   b. All cases filled with eggs are stored on pallets.
   c. Refrigerator rooms large enough to store slightly more than a week's supply of eggs.

6. CARTONS. All eggs, except inferior grades, are packed in one dozen cartons. Cartons used are of one-color chipboard. Mention is made of the labor saving possibilities of using moulded cartons, but these are not used in the models. Inferior eggs are packed in cases and shipped to egg breakers.

7. CASES. These are assumed to be made up during working hours by case handlers. This function is closely integrated with getting cases out of storage.

8. MANAGEMENT. Each model plant is assumed to be independently owned, and not controlled by a firm other than itself. The manager provided for each plant has full responsibility and

makes all management decisions. The firm has no tie-in with sales agency, nor does it have a tie-in with a production agency. Thus the jobs of procuring and selling eggs are charged to the eggs handled, and not to some other enterprise.

9. FIXED COSTS. The costs of management, depreciation, interest, maintenance, property insurance, property taxes and some repairs are assumed to stay the same, independent of volume change, within the period of a year.

10. VARIABLE COSTS. Costs of labor, supplies, utilities, and some repairs are assumed to be directly related to volume changes.

11. ONLY EGGS ARE HANDLED in these plants. In actual plants, where other commodities are handled, the effect is to lower overhead costs.

Models

Measuring and comparing costs may be approached in a number of ways. The most efficient method depends upon the objectives of the study. In this study models are used. Basic data are derived using the economic-engineering approach outlined in detail in the July, 1956 issue of *Hilgardia*.[6]

Scale relations, costs, and efficiency may be determined in ways other than through use of models. Data could be obtained from a sample of plants of different capacities and variations in handling methods. These data could be analyzed to determine effects of particular changes on average costs. A statistical procedure such as this would involve a fairly large sample of plants, and these plants would have to vary in capacity and in other desired characteristics. Such a procedure also assumes that the needed plants for study exist and the necessary knowledge is present to choose appropriate plants. It also means that capacity in egg handling plants has to be defined before the sample of plants is chosen. Defining capacity is not so easy as it might first appear. Questions arise as to whether it should be in terms of volume per hour, per day, per week, per month, or per year. Here it is defined in terms of output per hour. Another problem is what actual volume levels should be chosen for study.

Also in choosing an adequate sample of plants it is necessary to

[6]French, B. C., L. L. Sammet, and R. G. Bressler, Economic Efficiency in Plant Operations with Special Reference to the Marketing of California Pears, Volume 24, Number 19, *Hilgardia*. University of California, Berkeley, California.

have clearly in mind the factors to hold constant if sample size is delineated before the specified data are collected. To overcome such difficulties the synthetic or budgetary approach is used here to determine scale and efficiency relations. This approach, using models, gives control over variables affecting efficiency. Construction of models not only provides a basis for determining cause and effect relations, it also provides some insights into underlying physical input-output relations which, with prices, determine average cost curves and other relevant cost functions.

Basic labor data were obtained using work-sampling techniques. Sometimes called ratio-delay, this method provides estimates of proportions of time spent by various workers on various jobs. When related to total-manhours and outputs, it yields estimates of time requirements for detailed elements of each job. These time requirements were used to estimate physical input-output and cost relations for the labor called work standards. Work standards are expected outputs per worker hour. Combined with standards of machines, these become building blocks for model plants.

The model plants designed for this study, and used in the description and analysis of costs, are a result of deliberately synthesizing costs. This is a common engineering technique used by architects in designing actual buildings. First the building is designed on paper. In the case in point, labor requirements were added to equipment and building estimates. The first step in designing these models was to determine actual costs at various sized plants. Then a decision had to be made concerning what sized plants to design as prototypes. Here it was felt desirable to have plants of the following sizes: 6, 12, 24, 36, 48, and 96 cases per hour capacity. Then for each capacity operation, building, land, equipment, labor, and salaried workers were combined to make a complete synthetic model.

Plant capacities used in the models are similar to commercial plants currently in operation in Oklahoma, except that model F is about double the size of the largest Oklahoma plant. With the change in size of plants now evolving at the national level, it is expected that Oklahoma plants will experience some growth.

Details in the construction of one model may serve as an explanation of the general methods used in constructing all of them. Model A has two candlers and one case handler. Two candlers were used because the standard for candling at this size plant is three cases per candler per hour. Standards had been derived using the work-sampling techniques described above. Even though less than one case handler was needed, it

is difficult to hire less than a full-time man, so one man is assigned to this job. He also doubles as carton packer, case labeler, case maker, and assists with clean-up work. The salaried work force consists of one man, the manager.

A plant of this size needs a building of 2000 square feet. This building is placed on a lot of appropriate size. Building costs were estimated on a per square foot basis. Here again the reader should keep in mind this is all done on paper; no buildings were actually built.

Within the buildings was installed adequate refrigeration room and equipment. In addition, equipment needs for handling the volume of eggs were estimated. Finally other cost components such as utilities, office expense, advertising, and supplies were estimated and introduced into the model. Prices were applied to the physical input factors. For example labor was charged at $1.25 per hour, the manager was assigned a salary of $5,200 per year, building costs were $6.00 per square foot, and each of the other items was given a dollar cost value.

Models, when accurately constructed, become useful tools in determining the effects of different ways of operating a plant. By dividing the costs into two categories, fixed and variable, it is easy to calculate the effect of working the plant at various levels of capacity, at varying number of hours per year, with several egg qualities, and with several shifts per day.

The models used in this study, although varying in capacity, are all essentially the same. Eggs are candled by hand. Cases are moved around the plant on pallets, by fork trucks.

Following is a description of the facilities in the model plants. First is given the items they have in common, and then differences are pointed out. Equipment includes a carton-former, a carton-closer, and a turntable. Other items are a candling light, a bench and scales for each candler. Pallets and a fork truck are provided for each plant. Each candler station has a roller cross-conveyor; the group of candlers has a belt conveyor to provide empty cartons and take away filled cartons.

The building common to all models is one story. Lots for all buildings are 140 feet deep. Width depends on size of building.

Model A has a capacity of six cases of eggs per hour. The manager is a "jack-of-all-trades," serving as clerk, janitor, buyer-seller, and foreman. He is assigned $5,200 per year. The labor force includes two candlers and one case handler.

The building has an initial cost of $12,000. The lot cost $4,000. Installed within the building, the refrigeration room contains 2,085 cubic feet.

Because of the low annual volume of 12,500 cases, this plant cannot take advantage of lowest prices on cartons. One-color chipboard cartons cost $.753 per case of eggs. Case and filler-flat costs add another $.03 per case. Miscellaneous costs are $300 per year. Total costs per case, with 75 percent Grade A eggs, are $2.14. All these costs are detailed in the section entitled "Description of Costs."

Model B plant has a capacity of 12 cases per hour. With an annual volume of 25,000 cases, it is double the size of model A. The work force consists of four candlers and one case handler. Salaried employees include a manager at $6,000 per year and his assistant at $2,860 per year. The building contains 3,700 square feet and the lot is 124 feet wide.

This model has only slightly higher total fixed costs than model A, but since it has double the volume, fixed costs per unit are considerably less. Total costs per case are $1.88, twenty-six cents per case less than model A. (A breakdown of costs for model B are illustrated in Table IV.)

Model C is double model B in size, having a capacity of 24 cases per hour. Equipment is similar except the fork truck has a hydraulic lift. The refrigeration rooms have an eight foot ceiling instead of the seven foot ceiling in the two smaller models. Refrigeration equipment, air cooled in smaller models, is water cooled in this and larger model plants.

Three full-time salaried employees cost the plant $15,000 per year. The nine workers include six candlers, one case handler, one case packer, and one other worker. This crew is for 75 percent Grade A eggs. For 90-95 percent, three fewer employees are needed. (The reason for the greater candling speed with higher quality eggs is not quality per se. Rather it is uniformity. With uniform eggs a candler only has to look for eggs that are "different". The remainder of the eggs get only a cursory examination.) Costs per case are $1.71.

Model D, 50 percent larger than model C, has a capacity of 36 cases per hour. A major change in this plant, designed to handle 75,000 cases annually, is that it has two refrigeration rooms. One room holds 580 cases of eggs and the other holds 920 cases.

The only change in egg handling equipment, other than a proportionate increase, is that the case handler is provided with an electric fork truck.

Twelve workers handle the eggs. The manager of this plant is assisted by a full-time buyer-seller, a full-time foreman, a secretary-clerk, and a part-time accountant. Costs per case are $1.63.

Model E is equipped to handle 48 cases of eggs per hour. Fifteen egg handlers and five salaried employees compose the work force. Ceilings in the refrigeration rooms are 13 feet high. Pallets are stacked two high.

Two carton-setup machines feed cartons to the candlers and two carton-closers supply the turntable. Annual charges for these five rental items are $870. Average costs per case are $1.59.

Model F is the largest plant designed in this study. It handles 96 cases per hour, 200,000 cases annually. Twenty-eight egg handlers and nine salaried employees compose the work force. The salaried personnel includes manager, buyer-seller, assistant buyer-seller, foreman, assistant foreman, full-time accountant, clerk, assistant clerk, and cleanup man. Annually $51,000 is spent on these salaried workers.

Two fork trucks are employed--one rider high-piler and a non-electric "walkie".

A comparison of the number of workers and the magnitudes of investment for the model plants is summarized in Table II. This shows investment for the small plant to be $21,000, and $163,000 for the largest model. Number of workers vary from four in the small plant to 37 in the largest plant.

The above gives a picture of the six model plants. They have little equipment, relative to many plants currently in operation, but are efficient. Other models, more mechanized, could be designed to illustrate the ideas portrayed here, but it is felt these simple model plants have advantages for illustrative purposes. The six model plants are least cost

Table II.—Comparison of Number of Workers and Investments in Various Items, Six Model Plants

Model	Number of Workers	Salaried Employees	Land and Building Investment	Refrigeration Investment	Egg Handling Equipment Investment**
A	3	1	$16,000	$ 2,750	$ 2,469
B	5	2	25,384	4,445	3,436
C	9	2 11/12	43,848	6,295	4,839
D	12	4 1/5	60,500	9,616	8,186
E	15	5 1/5	76,718	10,599*	11,600
F	28	8 2/3	129,200	16,400	17,006

*Investment in refrigeration is low in this plant relative to the smaller plants mainly because a higher ceiling is employed.

**Egg handling equipment investment includes one year's rent on leased items.

for the given quality of eggs and the given wage rate. If eggs were of better quality, if wages were higher, or if labor were less efficient—these models would not be least cost operations.

In comparing Oklahoma's egg handling plants with these synthetic models, eight are about the size of model A. Seven are the size of model B. Two are the size of model C. Two are comparable to model D, and two others are slightly smaller but similar in size to model E. None are so large as Model F. The remainder of the egg handling plants in Oklahoma are smaller than model A.

Work Standards

Labor standards have been calculated in this study for each job in egg handling. Standards have also been derived for items of equipment used. Data used to compute these standards were gathered from actual plants in operation, from equipment companies' engineering files, and from other publications[7] in the field of egg handling.

For candling labor, five cases per candler per hour was used as a standard for labor requirement in constructing the models. However, this applies only to plants where the candlers can spend full-time candling. This is true in the two largest models, E and F. In the smaller models, candlers are forced to stock their own empty cartons, count manually rather than automatically, assist in making cartons, and help in packing. This is desirable and necessary because of lack of specialization, but does cut down on rate per candler hour. Thus standards or input coefficients for candling are five cases per hour in models E and F, 4.5 cases per

Table III.—Candler Labor Standards* Used in Constructing Models; Two Egg Qualities

Size Plant	Grade A or Better	
	75 Percent	90-95 Percent
	(cases per candler per hour)	
Model A (6 cases/hr)	3.0	3.0
Model B (12 cases/hr)	3.0	4.0
Model C (24 cases/hr)	4.0	5.0
Model D (36 cases/hr)	4.5	6.0
Model E (48 cases/hr)	5.0	6.8
Model F (96 cases/hr)	5.0	6.8

*Labor standards used here mean coefficients of inputs or labor requirements.

hour in model D, four in model C, and three in the two small plants. These labor standards are for eggs that are 75 percent Grade A or better. Table III illustrates labor requirements for candling eggs that are 75 percent and 90 to 95 percent Grade A or better. Results from this and other studies show candlers work faster and are more productive with higher quality eggs.[8] (Table XVI shows labor standards for all egg handling jobs).

Description of Costs

Costs of handling eggs depend upon many factors: efficiency, accuracy, and speed of labor; amount and type of machinery; quality and uniformity of eggs; wage rates; geographical location of plant; combination of input factors; and capacity of plant. Table IV illustrates cost of egg handling in model B plant. Total costs are $47,096 exclusive of egg breakage and inspection fees. On a per case basis these costs are $1.88. Primary among costs are cartons, labor, salaries, and building expenses. Little can be done to reduce carton expenses, other than ordering in larger quantities, so they are discussed only briefly in this report. Labor and salaries are large. They comprise 29 and 20 percent respectively, of total egg handling expenses. Because of cost cutting opportunities, considerable space is devoted to these two items.

Few costs are fixed, if the time period involved is long enough. In this study a cost is considered fixed if it does not change with changes in volume, within the period of one year. It is apparent that property taxes and interest on investment are fixed. Depreciation, maintenance, and repairs are not so easily categorized. Maintenance is arbitrarily defined as being independent of volume and is fixed. Repairs are classified as fixed or variable, depending on the item in question. Depreciation is considered as fixed even though "wear" depreciation is associated with the extent of use.

Table V draws together the rates used in determining ownership costs. These rates are applied to initial costs and are used in determining yearly fixed charges.

[7]The publication cited in footnote 3 shows labor standards derived for egg handling in a California plant. See pages 58 to 65 of that report.

[8]To be more accurate, it is not the high quality of eggs so much as the uniformity of eggs that lowers candling costs. It would be just as simple to mass-candle eggs that were 95 percent undergrade as it is to mass-candle eggs that are 95 percent Grade A. In either case the few eggs that are different would immediately show up under lights. Realistically, however, uniformity is not present in any eggs except the high quality ones.

Table IV.—Costs of Grading and Handling Eggs Within Model B Plant (Synthetic Data)*

Items of Expense	Annual Costs	Costs Per Case	Percent
Carton (chipboard), delivered, one-color	$18,575	$ .743	40
Filler flats, delivered, assuming 50 return trips	175	.007	
Cases, delivered, collapsible, 200-lb. strength, assuming 16½ trips	600	.024	1
Building and land	2,264	.091	5
Refrigeration rooms	371	.015	1
Refrigeration equipment, adequate for the rooms above	201	.008	
Refrigeration operation costs	350	.014	1
Egg handling equipment, minimum automation but adequate for hand operation	1,012	.040	2
Egg handling labor, includes candlers, case handlers, carton packers, and laborers.	13,850	.554	29
Fixed salaried employees, includes manager, clerk foreman, janitor, and buyer	9,298	.372	20
Utilities (not included in equipment described above), supplies and services	400	.016	1
Totals	$47,096	$1.88**	100

*Cost assumptions are as follows: The plant is built to operate at 12 cases per hour and is operating at capacity. It operates 8 hours per day, 260 days per year for a total of 25,000 cases per year. Eggs are assumed to be 75 percent Grade A or better in quality.

**Other costs not included in this study are loss-off (egg breakage) and inspection fees. These amount to about $.20 and $.075 per case, respectively.

Table V.—Percentage Rates Applied to Initial Costs, Used in Determining Ownership Costs

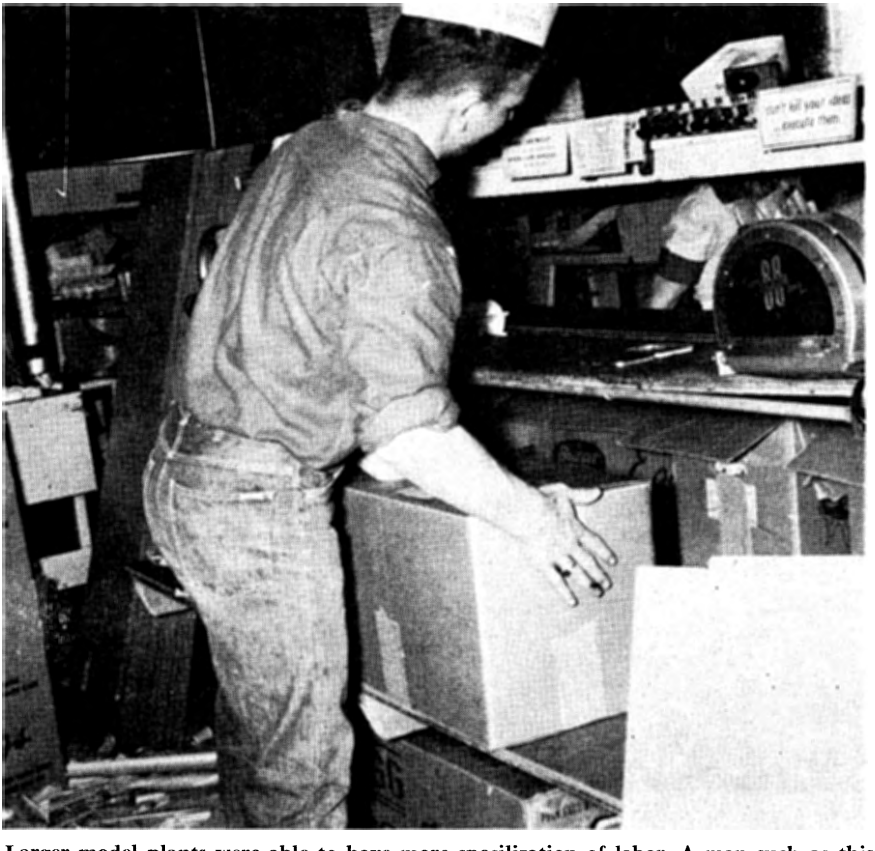
	Buildings	Land	Refrigeration Rooms	Equipment	
				Refrigeration	Egg Handling
Depreciation	2	0	5	10	5, 10, 20
Interest	2 ½	2 ½	2 ½	2 ½	2 ½
Taxes, insurance, maintenance	5	4	4	4	4

The following paragraphs describe costs studied for the six model plants.

Labor Costs

Labor is defined as workers handling cases, cartons, or eggs within an egg handling plant. Truck drivers, loading and unloading personnel are not included in this study. Foremen, clerks, and cleanup men are classified as salaried employees, not labor. The laboring force consists of candlers, case handlers, case packers, empty carton suppliers, and case labelers. All labor costs are variable.

In small model plants jobs are done by unspecialized workers. For example, a case handler doubles as the case packer, case labeler, carton



Larger model plants were able to have more specilization of labor. A man such as this one, who does nothing but close and label cases, would be found in only the larger models.

supplier, and so on. In fact he may do any or all of the jobs except candle eggs. In larger plants there is more specialization, and a rise in output per man generally ensues. In a large operation instead of the case handler performing all the above mentioned functions the work is divided so one man conveys cases to and from the cooler. Another worker packs cases, another labels cases, another makes up and supplies empty cartons. The larger the plant, the more specialization possibilities there are.

Table VI illustrates labor requirements and costs. In addition to wages, other costs charged to labor include Social Security payments of three percent of the first $4,800 annual wage, unemployment insurance of 1½ percent, and workmen's compensation of $2.04 per $100 of wages.

Labor costs are 66 cents per case at the smallest plant and 39 cents per case in the large model plant.

Table VI.—Labor Inputs and Costs for Six Model Plants, Egg Quality 75 Percent A's or Better

	Model Size					
Workers	A (6/hr)	B (12/hr)	C (24/hr)	D (36/hr)	E (48/hr)	F (96/hr)
Candlers*	2	4	6	8	10	20
Case handlers**	1	1	1	1	1	2
Case packers**			1	1	2	3
Carton suppliers**			1	1	1	2
Case labeler**				1	1	1
Total	3	5	9	12	15	28
Yearly wages† at $1.25/hr.	$7,800	$13,000	$23,400	$31,200	$39,000	$72,800
FICA, unemployment insurance, and Workmen's compensation	510	850	1,530	2,040	2,550	4,761
	$8,310	$13,850	$24,930	$33,240	$41,550	$77,561
Cost/case	$ .665	$ .554	$ .499	$ .443	$ .416	$ .388

*The candlers' jobs are quite different in the various sized plants. In small capacity models candlers stack their cartons, assist in making cartons and in packing. In larger plants candlers specialize more and do fewer "non-candling" jobs.

**In the two small plants all "materials-handling" functions are performed by one man, the case handler. As plants get larger more specialization is possible and in model C three men do these same functions.

†Vacation pay is included in the total. Even though the plant operates 52 weeks per year an individual worker works less than this.

Fixed Salaried Employees

Salaries of yearly personnel account for about 20 percent of total costs in handling eggs. These are fixed since, in a given capacity plant, they are independent of volume of eggs packed.

The manager, in the smaller volume plants, performs many duties. However, he does no actual egg or case handling jobs. As plant capacities get larger the manager becomes more a decision-maker and less a salaried worker. And also as plant capacities increase, the manager is supplied with more help in the form of buyers, sellers, foremen, clerks, and accountants.

Table VII shows the number of salaried workers and minimum yearly wage rates. Fractional figures in total employees are possible through giving one man several jobs, using part-time help, or using services of a firm on a contractual basis. In model C, for example, the buyer works half-time as the foreman. The clerk-secretary is working six hours per day (¾ time). The accountant costs the firm $800; he is the equivalent of one-sixth of a full-time man and his services are pro-

The study shows one of the important expenses in egg handling concerns is fixed labor. Salaried employees including office workers, manager, foremen and janitors have costs amounting to 20 percent of total costs in egg handling plants.

Table VII.—Fixed Labor Expenses, Six Model Plants

Expense item	Model Size					
	A (6/hr)	B (12/hr)	C (24/hr)	D (36/hr)	E (48/hr)	F (96/hr)
Manager	$5,200	$6,000	$ 6,000	$ 6,800	$ 8,000	$10,000
Buyer-seller		2,860	2,900*	5,500	6,500	7,200
Assistant buyer-seller						6,500
Foreman			2,900*	4,200	6,000	6,500
Assistant foreman						5,200
Accountant			800**	1,100**	1,100**	5,200
Clerk-secretary			2,020†	2,700	2,800	3,800
Assistant clerk					2,800	2,800
Cleanup						1,800†
Total Salaries††	$5,200	$8,860	$14,620	$20,300	$27,200	$40,000
Social security, unemployment insurance, and workmen's compensation	$ 268	$ 438	$ 603	$ 948	$ 1,097	$ 2,059
Total expense	$5,468	$9,298	$15,223	$21,248	$28,297	$51,059
Total employees	1	2	2 11/12	4 1/5	5 1/5	8 2/3
Cost/case	$ .437	$ .372	$ .304	$ .283	$ .283	$ .255

*Buyer-seller spends ½ time as foreman.

**Accounting firm provides part-time service.

†Part-time worker.

††Vacation pay is included in the total. No bonuses are included even though this is recognized as a fairly common incentive procedure.

vided by an accounting firm.

Within one year volume does not affect these fixed costs. Although fixed labor expenses increase as plant size increases, these expenses do not increase proportionately. Model B has twice the volume capacity of model A, but has fixed labor expenses only 70 percent higher.

Buildings and Land

Building and land costs are fixed. They include depreciation, interest, property taxes, insurance, and maintenance. Calculated as cost percentages, these rates are applied on initial costs. Refrigeration rooms and equipment are not included with buildings and land. These are treated separately in the following sections.

In planning buildings for the model plants, volume flow determined building size. The area, based on plants now in operation, provides more than adequate space for equipment, dry storage, cold storage of eggs, office, restrooms, and unloading and loading areas. An allowance in building space is included for extra load periods. Planning for future expansion, to save major renovations later, is a wise move if volume increases are anticipated. This, however, does not provide minimum short-run building cost information even though long-run costs may be minimized by making such an allowance. The more-than-adequate building space allowances provided in these models are not included as an expansion provision. Rather they furnish temporary space for overtime or seasonal high volume periods.

Buildings have concrete block walls, concrete floors, steel casing windows and doors, and insulated ceilings. A minimum of interior finishing is included. Wiring is provided, as is plumbing. Table VIII building costs include furniture and fixtures.

Initial costs of buildings ranged from $6.00/sq. ft. for the smallest plant to $4.40 for the largest volume operation. Costs assigned to land were $40 per frontage foot.

With plants operating at capacity, and using rates shown in Table

Table VIII.—Building and Lot Sizes and Costs, Six Model Plants

	Model Size					
	A (6/hr)	B (12/hr)	C (24/hr)	D (36/hr)	E (48/hr)	F (96/hr)
Size of building needed (feet)**	2,000 (40x50)	3,700 (60x62)	7,400 (80x93)	11,000 (100x110)	14,600 (128x114)	26,000 (141x185)
Size of lot, frontage feet	100	124	186	220	228	370
Building cost per sq. ft.	$ 6.00	$ 5.52	$ 4.92	$ 4.70	$ 4.63	$ 4.40
Initial cost of building	$12,000	$20,424	$36,408	$51,700	$67,598	$114,400
Initial cost of lot	$ 4,000	4,960	7,440	8,800	9,120	14,800
Annual cost of land and building*	$ 1,400	2,264	3,943	5,484	7,015	11,830
Cost/case, land and building	$ .112	.091	.079	.073	.070	.059

*Two percent depreciation, 2½ percent interest, 4 percent taxes and insurance, and 1 percent fixed repairs. No depreciation on land.
**Rounded to nearest (100) feet.

VIII, costs for ownership of buildings and land are 11 cents per case for model A and six cents per case for model F.

Costs of building materials, construction, structural requirements, and land vary from area to area. The costs presented here are based on Oklahoma estimates and may not be applicable to other areas. However, the relative comparisons will probably hold, even though the absolute values may vary.

Refrigeration Rooms

Because of their importance and depreciation rates that are higher than for buildings, refrigeration room costs are estimated separately from buildings. Annual costs of these rooms are 16½ percent of initial costs. These costs are all assumed to be fixed, although it is recognized that some maintenance costs should be considered as variable.

For each model plant, refrigeration rooms were designed large enough to hold slightly more than one week's supply of eggs. Model A plant, with a weekly capacity of 240 cases, has 250 case storage space. An allowance of six inches around each pallet load of eggs provides air circulation. In the three small models, one room is used for both incoming and candled eggs. This is done to keep initial and operating costs at a minimum, even though two rooms are more desirable for good flow patterns. The three large plants have separate rooms for incoming and candled eggs.

Table IX.—Refrigeration Room Sizes and Costs, Six Model Plants

Model	Case Capacity of Rooms	Size of Rooms	Initial Cost	Annual Cost*	Cost Per Case**
A	250	2,085	$1,850	$ 213	$.017
B	500	3,552	3,225	371	.015
C	1,000	6,552	4,900	564	.011
D	1,500	3,648 5,740	2,722 4,360	814	.011
E	2,000	4,618 6,910	3,235† 4,736†	917	.009
F	4,000	9,041 13,720	5,100 7,300	1,426	.007

*Depreciation at 5 percent, interest at 2½ percent, insurance, taxes, and repairs at 4 percent of initial cost.

**These figures are for rooms only. Equipment costs, ownership and operating, are shown in Table X.

†Investment cost is low relative to the next smaller size plant because of use of a 13 foot instead of an 8 foot ceiling.

Refrigeration rooms are designed in height to approximate a cube. This keeps both initial and operational costs at a minimum. The two small plants, A and B, have rooms with seven-foot ceilings. Models C and D have eight-foot ceilings. In all four of these plants cases are stacked five high on the pallet. Pallets are stacked one high. Rooms in model E plant have 13-foot ceilings and pallets are stacked two high. The lower pallet has cases five high, and the upper pallet has cases four high. Model F plant has rooms with 14-foot ceilings and cases are stacked 10 high, five high on each of the two pallets.

All nine refrigeration rooms described in Table IX have two doors each, except the largest room in plant F which has four doors. Plant F has four doors even though additional doors are wasteful of refrigeration and storage space. However, four doors do permit two aisles and easy

In models E and F pallets are stacked two high in the refrigeration rooms. High-piler fork-trucks are needed for the stacking, but refrigeration ownership and operating costs are lowered through use of high ceiling rooms.

access to the cases of eggs. Within a plant, rooms are located so they are adjacent to the loading and unloading docks. Entering eggs come in one door of the cooler, and leave through the other door to go to the candling line. Thus a circular flow pattern for cases of eggs is established within the plant.

Specifications of the rooms include four-inch cork insulation in walls, ceilings and floor. Portland cement plaster is on the walls and Monoplast on the ceilings. Cold storage doors are 4'6" by 6'6" in size. Refrigeration room costs per case of eggs range from less than two cents to one-half cent per case. This latter figure pertains to model F plant.

Refrigeration Equipment

Refrigeration equipment fills the required cooling needs detailed in the previous paragraphs. Each model has capacity to cool one day's supply of eggs, and keep cool slightly more than four day's supply of eggs. In the case of model A plant, having a volume flow of six cases per hour, the equipment will cool to 40 degrees 50 cases of eggs daily. It will maintain 40° temperatures for holding 200 cases. It will do this

Table X.—Refrigeration Equipment Ownership and Operational Costs, Six Model Plants

Model	B.T.U. Per Hour of Operation	Initial Cost of Equipment	Equipment Cost*		Operating Cost**	
			Per Year	Per Case†	Per Year	Per Case†
A	13,807	$ 900	$148	$.012	$ 263	$.021
B	22,700	1,220	201	.008	350	.014
C	34,600	1,395	230	.005	617	.012
D	22,430 24,290	1,220 1,314	418	.006	867	.012
E	27,000 38,255	1,314 1,314	434	.004	876	.009
F	58,400 66,927	2,000 2,000	660	.003	1,314	.007

*Depreciation is 10 percent, maintenance 2 percent, interest 2½ percent, insurance and taxes are 2 percent of initial cost.

**Electrical use costs calculated from h.p. of motors times yearly hours of operation times rate per kwh (assuming 1 h.p. per kwh). Rates were: $.03/kwh for the A, B, and C plants, $.025 per kwh for the D and E plants, and $.0225 per kwh for the largest size plant. Plants A and B are air cooled. Plants C and D are water cooled, but water is wasted and is charged at $91.00 and $137 per year. Plants E and F are water cooled, but have water towers. Water towers for plants C and D would cost $300 and $400, if used in place of waste water.

†Per case costs are calculated by dividing annual costs by yearly output of cases. Model A has a yearly output of 12,500, model B 25,000, model C 50,000, model D 75,000, model E 100,000, and model F 200,000. Both ownership and operating costs are high in model D, relative to smaller plants, because of its two rooms.

running 16 hours per day, or two-thirds of the time. The 50 percent excess capacity provides for defrosting, emergency loads, and for long life.

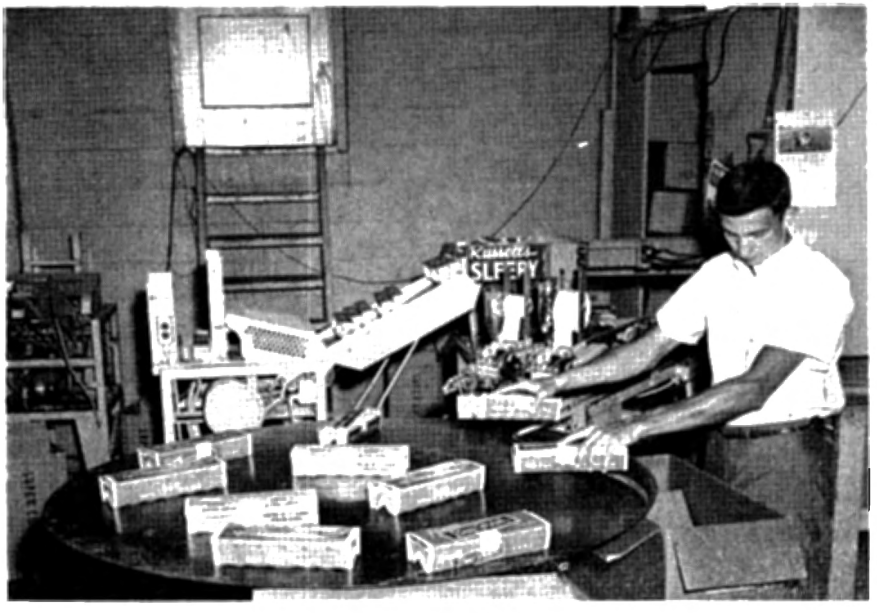
Table X shows refrigeration equipment specifications and costs for six model plants. Combined ownership and operational costs are 3.3 cents per case for model A, and one cent per case for model F.

Egg Handling Equipment

Equipment used for egg handling in the model plants is sometimes described as the "push-pull" system. Basically a hand candling operation, it is supplemented by fairly efficient materials handling techniques.

Using a fork truck, the case handler brings pallets of ungraded eggs to a location near a cross-feed conveyor. This gravity conveyor, when

All six model plants have this type candling bench arrangement. Candler pulls in ungraded case and pushes out empty case.



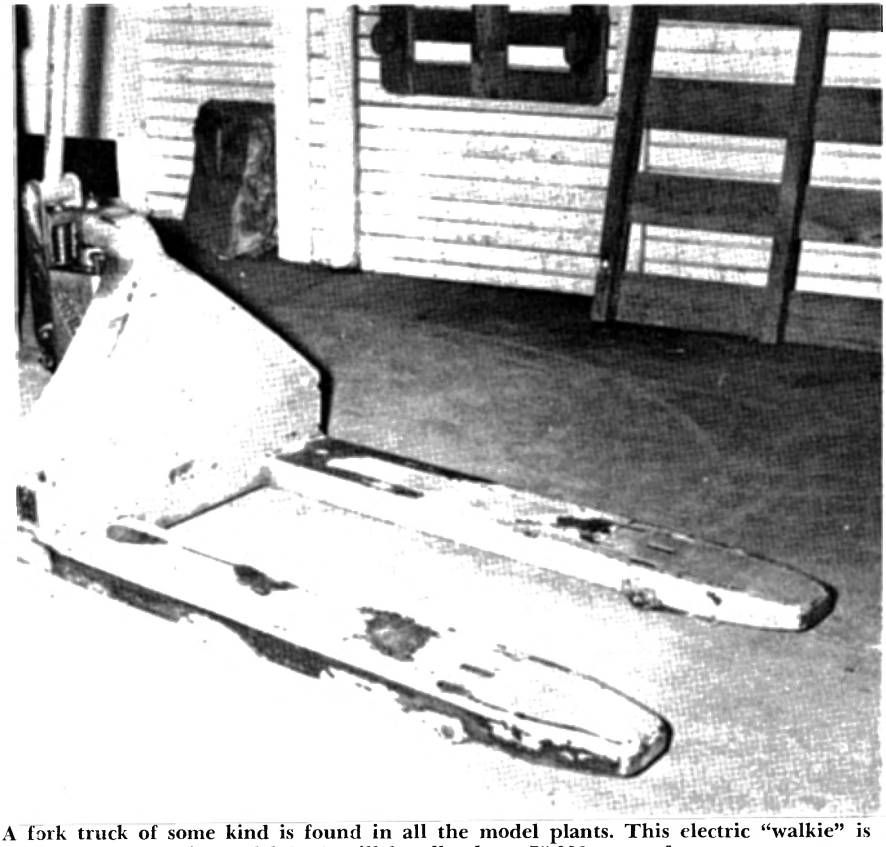
Each of the six model plants was equipped with a turntable such as this one. It facilitates packing cartons into cases.

loaded with cases of ungraded eggs, moves the cases to the candlers. Each candler pulls an ungraded case into the candling area and pushes out the empty case. She candles, sizes, and places the eggs into the appropriate carton. When full, the carton is pushed onto a moving belt. This takes the carton to the carton-closer, and then to the turntable. Cartons are packed in cases from the turntable. Full cases of graded eggs are sealed, labeled, and stacked on pallets. Pallets, when loaded, are taken to the cooler and the cases are kept there until they are shipped out. Undergrade eggs are packed in cases and are handled in similar fashion except they go to egg-breakers. More labor is involved in handling these eggs and the labor standards for the several egg qualities reflect this difference.

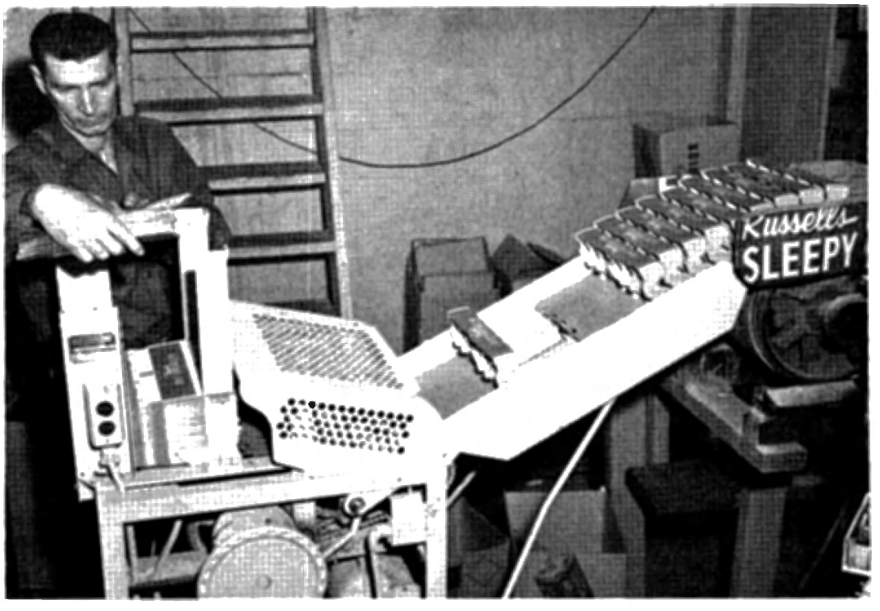
Each candler has a cross-feed conveyor to supply full cases of ungraded eggs. Each has a candling bench, a candling light, a pair of scales and adequate room to move about. The same conveyor that supplies empty cartons also moves full cartons away. At least one carton-setup machine, one carton-closer, and one turntable are provided for the group of candlers. The larger model plants have several carton-setup machines and closers.

Fork trucks in the plants vary from a small mechanical hand model to large high lift rider types. Pallets are three feet by four feet. Cases are piled six per layer and usually 30 on the pallet. Number of layers of cases varies somewhat, depending on the ceiling height in the coolers. Each model plant is provided with enough pallets to handle a week's supply of eggs plus a 10 percent allowance for pallets to be used for supplies and another 10 percent allowance for out-of-service repairs. It is also assumed pallets will be filled, on the average, 75 percent full in storage.

Equipment costs are described in Table XI. Fixed costs, except for rental items, are based on initial costs. Depreciation is calculated at 20 percent for pallets, 5 percent for metal conveyors, and 10 percent for all other items. Interest is 2½ percent on initial cost. Taxes, insurance, and fixed maintenance costs total four percent. Operating costs include



A fork truck of some kind is found in all the model plants. This electric "walkie" is similar to the one in model D. It will handle about 75,000 cases of eggs per year.



Carton-setup machines similar to this one were provided in each of the model plants. This machine may be rented from carton companies and costs $140 per year.

electricity at $.03 per kwh. Repair expenses are estimated for individual items.

Egg handling equipment costs, including both ownership and operating costs, range from seven cents per case for the small plant down to two cents per case in the largest model. The main reason for higher costs in the small plants is that with low volumes they are not using equipment to capacity. As an example, annual rental fee is $486 for the three rental items in plants A, B, and C. Yet volumes of these three plants differ considerably. In model A plant, rental expense for these three items is four cents per case. Model B plant has rental costs of two cents per case. Model C plant has double the volume of model B and rental costs are only one cent per case.

Supply Costs

Even though supplies are the most important single cost element in handling eggs, they are not analyzed in this study. The manager of an egg handling plant is faced with certain carton prices, and except for ordering in larger quantities, there is little he can do to reduce these costs.

Table XI.—Egg Handling Equipment Ownership and Operating Costs, Six Model Plants

Model and Equipment	Ownership Cost: Initial	Ownership Cost: Depreciation Insurance, Taxes and Int.	Ownership Cost: Rent	Operating Costs: Power	Operating Costs: Maintenance	Operating Costs: Total Costs
Model A						
1 carton-setup 1 carton-closer 1 turntable	--	----	$486	$13.00	$31.00	$ 530.00
2 cross-feed conveyors	$ 80	$ 9.20	--	--	1.00	10 20
2 grading benches	850	140.25	--	6.00	5.00	151.25
14 pallets	56	14.84	--	--	1.10	15.94
1 hand mechanical lift fork truck	300	49.50	--	--	3.00	52.50
Miscellaneous equipment costs	697	69.66	--	1.90	4.11	75.67
Total per year		$769.45				$835.56
Cost per case						$ .067
Model B						
1 carton-setup 1 carton-closer 1 turntable	--	----	$486	$13.00	$31.00	$ 530.00
4 cross-feed conveyors	160	18.40	--	--	3.00	21.40
4 grading benches	1,550	255 75	--	10.00	20.00	285.75
27 pallets	108	28.62	--	--	2.10	30 72
1 hand mechanical lift, fork truck	300	49 50	--	--	3.00	52.50
Miscellaneous equipment costs	832	83.19	--	2.30	5.91	91.40
Total per year		$921.46				$1,011.77
Cost per case						$ .040
Model C						
1 carton-setup 1 carton-closer 1 turntable	--	----	$486	$35.00	$31.00	$552.00
6 cross-feed conveyors	320	36.80	--	--	2.00	38.80
6 grading benches	2,250	371.25	--	27.00	30.00	428.25
53 pallets	212	56.18	--	--	3 40	59.58
1 fork truck (non electric hydraulic lift)	550	90.75	--	--	6.00	96.75
Miscellaneous equipment costs	1,021	102.08	--	6.20	7.20	115 48
Total per year		$1,143.06				$1,290.86
Cost per case						$ .026

Table XI.—(Continued)

Model and Equipment	Ownership Cost: Initial	Ownership Cost: Depreciation Insurance, Taxes and Int.	Ownership Cost: Rent	Operating Costs: Power	Operating Costs: Maintenance	Total Costs
Model D						
1 carton-setup 2 carton-closers 1 turntable	--	----	$586	$55.00	$55.00	$696.00
8 cross-feed conveyors	320	36.80	--	--	4 00	40.80
8 grading benches	2,950	486.75	--	36 00	40.00	562.75
80 pallets	320	84.80	--	--	5.00	89 80
Fork truck (electric "walkie" hydraulic lift)	2,200	363.00	--	60.00	50.00	473.00
Miscellaneous equipment cost	1,810	181.00	--	15.10	14.90	211.00
Total per year		$1,738.35				$2,073.35
Cost per case						$ .028
Model E						
2 carton-setups 2 carton-closers 1 turntable	--	----	$870	$60.00	$60.00	$990.00
10 cross-feed conveyors	$400	$46.00	--	--	5.00	51.00
10 grading benches	3,200	528.00	--	45 00	45.00	618 00
120 pallets	480	127.20	--	--	7.40	134 60
Fork truck (electric "walkie" hi piler, hydraulic lift)	4,400	726 00	--	75.00	100 00	901.00
Miscellaneous equipment cost	2,250	225.00	--	18 00	21.74	264.74
Total per year		$2,522.20				$2,959.34
Cost per case						$ .030
Model F						
2 carton-setups 3 carton-closers 1 turntable	--	----	$1,005	$70.00	$70.00	$1,145.00
20 cross feed conveyors	$800	$92.00	--	--	10.00	102.00
20 grading benches	5,700	940 00	--	60.00	60.00	1,060.00
214 pallets	856	226.84	--	--	10.72	237 56
1 rider fork truck hi piler, hydraulic lift)	5,000	825.00	--	100 00	100 00	1,025.00
1 non-electric "walkie" fork truck (hydraulic lift, non hi piler)	550	90.75	--	--	6.00	96.75
Miscellaneous equipment costs	3,095	309.48	--	36.00	42.00	387 48
Total per year		$3,489.07				$4,053.79
Cost per case						$ .020

Table XII shows the supply costs of cartons, cases, and filler flats. All of these are on a per case of eggs basis. Together, these three supply items total 78 cents per case of eggs for the small plant. They are 76 cents per case of eggs for the large model. Supply costs are variable. They depend on volume of eggs handled.

Miscellaneous Costs

Miscellaneous costs include telephone, telegraph, heat, water, electricity for lighting, advertising, and office expenses. All these costs are considered fixed even though some like telegraph and advertising should be classified as variable.

Table XIII shows a listing of the miscellaneous expenses for the six model plants. Although minor, they amount to two cents per case for the small model A plant. They are only one-half cent per case in the larger model F plant.

Table XII.—Carton, Case and Filler Costs, Six Model Plants

	Model					
	A	B	C	D	E	F
Carton Costs						
Price of 1,000 cartons*	$22.60	$22.30	$22.10	$22.00	$21.95	$21.80
Carton cost/case	$ .753	.743	.737	.733	.732	.727
*Case Costs***						
Price per case	$ .39	.39	.37	.37	.35	.35
Cost per case of eggs†	$ .024	.024	.022	.022	.021	.021
Filler Costs						
Price of filler flats per case††	$ .33	.33	.33	.33	.33	.33
Cost of filler flats per case of eggs	$ .007	.007	.007	.007	.007	.007
Cost of Carton, Case, and Filler Per Case of Eggs	$ .784	$ .774	$ .766	$ .762	$ .760	$ .755

*One color, chipboard. This price includes delivery in Oklahoma.
**Collapsible, knocked down, 200 lbs. strength.
†Assuming cases are returned and each case averages 16½ trips.
††14 filler flats needed per case. 50 return trips are assumed. Price is $2.35 per 100.

Table XIII.—Miscellaneous Egg Handling Plant Costs, Six Model Plants

	Model					
	A	B	C	D	E	F
Total per year	$ 300	$ 400	$ 600	$ 700	$ 800	$1,000
Cost per case	$.024	.016	.012	.009	.008	.005

Analysis of Costs

Increases and decreases in output of the model plants may be accomplished in the short run by (1) changing the rate of speed eggs are handled, and (2) changing hours of operation—per day, per week, or per year. The first part of the following discussion considers only time changes—changes in hours worked per year—not changes in rate per hour. In other words the **time** a plant is operated is considered and not the **rate.** This comes under the heading of Yearly Hours and Costs. Rate changes are considered later in the section called Labor Efficiency and Costs. Both of these changes are short-run changes since the fixed factors remain the same.

The latter part of the analysis deals with long-run changes. Long-run changes are those occurring in time periods longer than one year, and fixed assets as well as the variable inputs are allowed to vary. Discussed in this section are scale curves and their implication to the industry.

In all the analyses presented here, egg quality is assumed to be 75 percent Grade A. The exception to this is in the section showing effect of egg quality on costs.

Short-run Changes

Reducing or increasing hours of operation is easier and generally more desirable cost-wise than making reduction in the plant output per hour. The difference is that when time changes take place, the plant still runs at capacity. Here the short-run cost curves do not turn upward as yearly volume is changed because variable inputs are not allowed to get out of balance relative to the fixed inputs. A different situation exists when changes in rate are allowed to take place. Here a change in the rate per hour decreases efficiency since the plant moves away from capacity levels. This assumes the plant is so set up that it operates more efficiently at capacity[9] levels of operation.

Other factors considered in this section under short-run changes are quality of eggs, wage rates, and candling method used. All of these have a definite effect on egg handling costs.

Yearly Hours and Costs

The model plants are designed to operate 2,080 hours annually; i.e., 52 forty-hour weeks. In this particular instance assume less volume is desired. Here the production rate per hour is kept constant and the plant is operated at capacity. The number of days of operation per week or per year are decreased and volume adjustments are taken care of in this manner. Such reductions are assumed possible. Figure 1 shows costs of operating the six plants. The 2,080 hour per year figure shown on the horizontal axis indicates one shift, full-time operation. Costs for the six model plants are indicated by reading upward from the 2,080 figure. They range from $2.14 for model A to $1.50 for model F.

Costs of operating the plant at 1,560 hours are calculated using the same yearly fixed costs, plus the variable costs incurred at this volume.

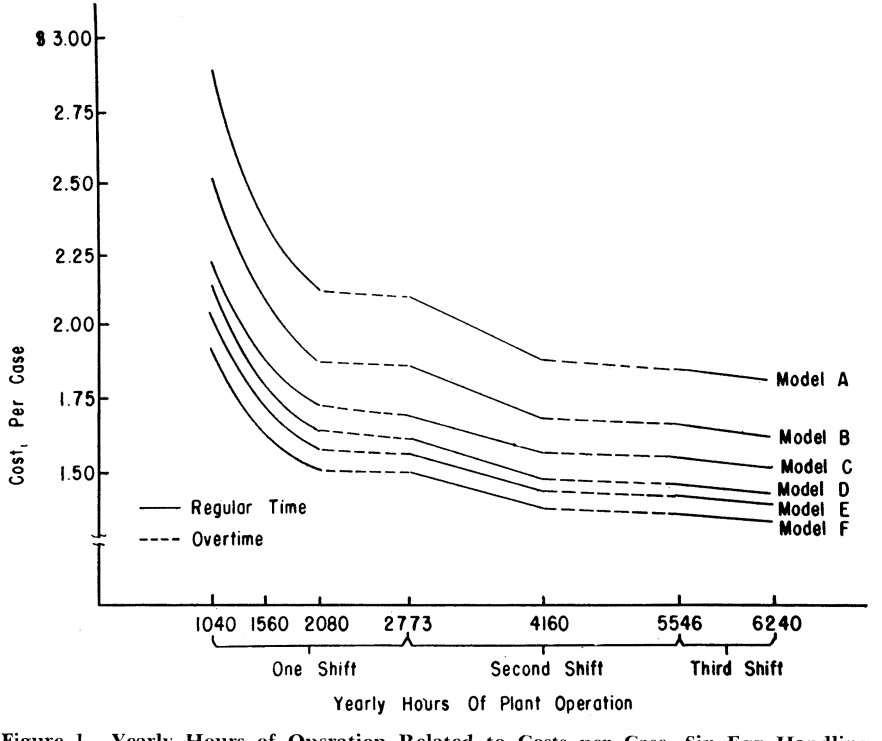


Figure 1.—Yearly Hours of Operation Related to Costs per Case, Six Egg Handling Plant Models.

Table XIV.—Costs Per Case of Operating Six Model Plants at Capacity,* at 1,040, 1,560, 2,080, and 2,773 Hours for One Shift, and Operating Two and Three Shifts

Volume Operation	Model Size A (6/hr)	B (12/hr)	C (24/hr)	D (36/hr)	E (48/hr)	F (96/hr)
One Shift						
1,040 hours	$2.91	$2.52	$2.23	$2.14	$2.05	$1.92
1,560 hours	2.38	2.08	1.88	1.80	1.73	1.63
2,080 hours	2.14	1.88	1.71	1.63	1.59	1.50
2,773 hours	2.09	1.85	1.70	1.62	1.56	1.48
Two Shifts						
(4,160 hours)	1.88	1.68	1.56	1.47	1.43	1.37
Three Shifts						
(6,240 hours)	1.80	1.61	1.51	1.42	1.38	1.32

*Capacity is defined as operating one full crew to get maximum rate per worker per hour. With this definition all the costs except the two lower lines are capacity costs.

Similarly, costs of operating the plants 1,040 hours include the full annual fixed costs, plus the variable costs at this one-half year level. Costs for model A are $2.38 per case operating 1,560 hours and $2.91 per case at 1,040 hours.

Table XIV shows costs per case for the three levels mentioned, and also for 2,773 hours per year. This latter level, one-third overtime, is possible, still using one crew, but paying the crew overtime wages for hours over 2,080. The costs at this overtime labor rate are shown in Figure 1 by the broken line. Costs per case are slightly lower at 2,773 hours than at the 2,080 hour operation, even though labor is paid time-and-a-half for overtime. This shows the increase in wage payments is not so much as the decreases in fixed costs. In model A costs are $2.14 per case at 2,080 hours compared with $2.09 per case at 2,773 hours of operation.

From 2,773 hours to 5,546 hours of annual operation, a second shift is in use. This second shift is employed since it is undesirable for fatigue reasons to work one crew more than one-third overtime. Costs per case decline through this area, but cost reductions are small after the plant

[9]Capacity is defined as operating a plant so as to achieve maximum efficiency with one full shift. It will be shown later than this definition does not provide least-cost solutions for costs may be reduced by working overtime or more shifts. Nor does this definition show points of maximum profits. It merely sets a standard whereby other volume rates per hour may be compared.

is operated 4,160 hours, a full two-shift operation.

Also shown are costs per case associated with working the plant up to 6,240 hours per year, a full three-shift operation. Model A costs are $1.80 at three full-shifts, $1.88 for two full-shifts, and $2.14 for one full-shift. Model F, with much larger capacity, has costs of $1.32, $1.37, and $1.50 for corresponding yearly hours of operation. No data are available to show costs per case beyond 6,240 hours, even though it would be theoretically possible to operate the plant even more hours per year.

In summing up this section on yearly hours, it is seen that for any given sized plant costs per case may be reduced by working more hours per day, more days per week or per year. This hold true for small increases where the same crew can be worked a longer work week (and paid time-and-a-half for overtime hours). Adding a second crew materially lowers costs, and working both crews overtime or hiring a third crew lowers costs still further.

Egg Quality and Costs

Egg quality affects plant labor costs as well as the demand for eggs. Table XV shows the effect on labor requirements and costs of two levels of egg quality. In model D, eight candlers are needed for grading 36 cases of eggs per hour with 75 percent Grade A eggs. In this same plant,

Table XV.—Effect of Egg Quality on Candling Labor Costs, 75 Percent and 90-95 Percent Grade A Eggs, 2,080 Hours Per Year Operation, Wages $1.25 Per Hour

	Model Plants					
	A (6/hr)	B (12/hr)	C (24/hr)	D (36/hr)	E (48/hr)	F (96/hr)
75 Percent Eggs						
Candlers needed*	2	4	6	8	10	20
Candling labor cost per case**	$.42	$.42	$.31	$.28	$.26	$.26
90-95 Percent Eggs						
Candlers needed*	2	3	5	6	7	14
Candling labor cost per case**	$.42	$.31	$.26	$.21	$.18	$.18

*Candlers in the various sized plants do not perform the same functions and are not entirely comparable. In smaller plants figures show the candlers to be inefficient, relative to candlers in larger plants, but actually part of the higher labor input is due to more duties performed by the small plant candlers.

Unemployment Insurance.

**This cost is wages only and does not include costs of F.I.C.A., Workmen's Compensation, and

still handling 36 cases per hour, only six candlers are needed if the eggs are 90 to 95 percent Grade A. No differences are apparent for labor other than candlers. Synthetic data, derived from observations of actual plants, are the basis for the figures presented here.

Costs are correspondingly low in plants with better eggs. Model D has candling labor costs of 28 cents per case for the poorer eggs and 21 cents per case for the eggs of higher quality. Based on these labor cost savings egg handlers can afford to pay more for better eggs. This would be a premium in addition to a premium based on selling prices of eggs.

It should be noted here that cost savings resulting from candlers being able to increase their rate, are not so much a result of egg quality as of egg uniformity. It is conceivable that uniformly poor eggs would have as low labor costs as uniformly good eggs. The hitch here is that eggs that are uniform are also high in quality.

Labor Efficiency and Costs

Workers vary in their productivity and sometimes whole crews are inefficient. Table XVI shows labor standards for handling eggs. These figures were derived from real plants in actual operation. The column headed "achievable standards" is not to be considered a high goal; rather these are standards *easily* attained by any well-managed crew. The figures are in terms of labor hours per 100 cases of eggs, and these are easily convertible to cases per hour by dividing the standard figure into 100. The columns headed "inefficient" and "efficient" contain figures derived from egg handling concerns in daily operation. The "efficient" column shows what may actually be done, with highly trained workers, in a well-organized plant. These figures are not easily obtained and efficiency must be highly stressed to achieve them.

The achievable standard for candlers is 20 man hours of labor per 100 cases of eggs. This is five cases per man hour. Although too general a standard for precise use, it gives some indication of what output to expect. The achievable standard for case handlers is 10 cases per man hour, but a plant striving for maximum efficiency should aim for efficient plant's rate of 16 cases per man hour. This case handler goal of 16 cases per man hour has been achieved by actual plants under operating conditions.

For the whole plant, the standard is 30.2 man hours of labor per 100 cases of eggs. This is 3.3 cases per worker per hour. Some Oklahoma plants operate continuously at a rate of 4.9 cases per man hour.

Table XVI.—Labor Standards in Candling and Case Handling Jobs, "Push-Pull" Handling Method

	Man Hours of Labor Per 100 Cases of Eggs		
	Inefficient* Plant Example	Efficient** Plant Example	Achievable† Standards
Candlers			
Candling	25.0	9.9	13.3
Handling cases, flats and fillers	8.6	.7	1.8
Handle cartons	3.3	1.2	2.5
Record keeping	8.8	.5	.9
Miscellaneous work	2.7	.1	.3
Personal off-time	1.8	.2	.8
Wait for work	1.9	.1	.4
TOTAL CANDLER LABOR	48.8	14.2	20.0
Case Handlers			
Handle cases, ungraded	1.3	.4	.8
Handle cases, graded	1.3	.3	.6
Handle cases, empty	1.1	.5	.9
Pack cartons	7.8	1.1	2.5
Make cartons, carton supplying, closing	3.6	.8	1.0
Flat transferring (vacuum lift)	4.2	2.9	3.3
Handle flats and fillers	.5	.3	.5
Record keeping	2.5	.2	.4
Walk empty	2.7	.5	.8
Miscellaneous work, make cases, etc.	1.2	.3	1.0
Personal delays	4.2	.1	.7
Wait for work	3.0	.1	.7
TOTAL CASE HANDLERS	24.2	6.3	10.2
TOTAL, BOTH CREWS	73.0	20.5	30.2

*These are figures derived from a plant in actual operation. The plant was selected for study and is presented as an example here because of its low rate of efficiency. Egg quality was 70 percent Grade A, and plant volume was low, 5.3 cases per hour.

**These figures were derived from several highly efficient plants in actual operation, with most of them coming from one plant. They show rates that may be achieved if efficiency is highly stressed.

†These are standards and are synthetic figures in the sense they don't represent any actual plant. They are achievable by most plants as indicated by those plants that have made recommended changes.

Figure 2 compares two levels of efficiency in the model plants. In the one case the labor is fairly efficient, comparable to the achievable standards described above. In the second case the workers produce just three-fourths as much per hour as in the first group. Model E output is 48 cases per hour with the efficient crew and 36 cases per hour using the inefficient crew. Costs per case are 82 cents for the efficient crew and $1.16 for the inefficient crew. (Supplies are not included in this cost comparison.) In other words, if a crew is 25 percent less efficient than achievable standards, costs are 25 to 44 cents per case higher than in a plant obtaining rates similar to the standards.

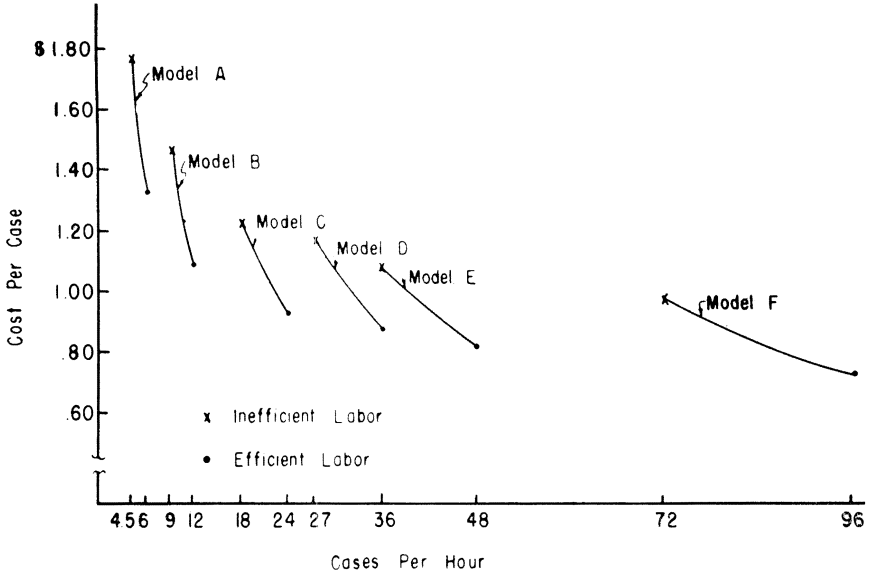


Figure 2.—Comparison of Costs per Case with Two Levels of Labor Efficiency, Six Egg Handling Plant Models.

Wage Rates and Costs

Throughout this study wages have been assigned at $1.25 per hour. This rate fairly well represents present Oklahoma wage rates. However, with more and more industries being unionized, and with the general trend upward in wage levels, it may be that in a few years egg handlers will have to pay higher wages. Therefore, to illustrate the change in costs, $1.50 per hour is compared with the present $1.25 per hour.

With the $1.50 wage rate compared to the $1.25 wage rate, costs are seven cents per case higher in the model F plant, and 13 cents higher in the small model A plant (Figure 3).

Efficiency of labor, in the larger capacity plants, makes wage rates relatively less important. In the smaller plants, with their lower level of efficiency, wage rates are more important as a cost element. Therefore, it is likely that the larger plants will be leaders in future wage increases. The effect of this may be to put more of an economic squeeze on small firms. and thus encourage them to increase their volume and efficiency.

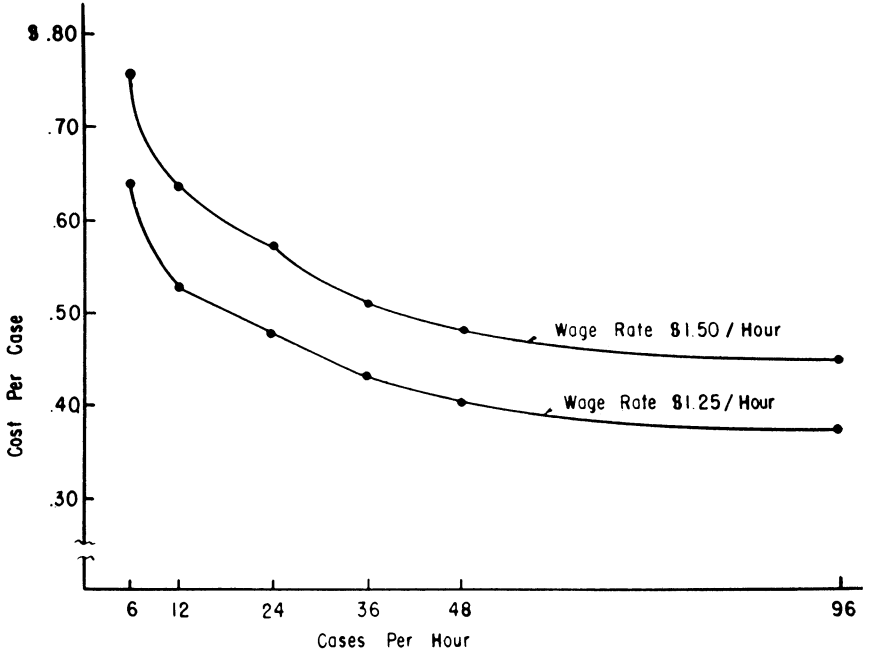


Figure 3.—Comparison of Two Wage Rates on Costs per Case, Six Egg Handling Plant Models.

Candling Methods and Costs

The models presented in this study are designed as hand operations. This means eggs are hand-candled and hand-packed. There are other ways of doing the candling and packing jobs and this section compares costs of an alternative with the system in common use. This comparison is made to show if costs might be reduced through use of other systems.

The method commonly used in Oklahoma, and described for the models, is called "push-pull". It is described in detail in the section entitled "Egg Handling Equipment". The method used here for comparison purposes is a newer one; eggs are removed from cases and packed into cartons by vacuum lifts. One person operates a lift and removes all the eggs from the cases for a given team or group. Other team members mass-candle, pack cartons in cases, and so on. A team is based on two units of the machine. This team includes one lifter, two candlers, one case handler, two turntable packers, and one person closing and labeling cases. This is a total of seven workers and team volume is 36 cases per hour. With four units, using two teams, a plant uses 10 workers and output is 72 cases per hour. Each unit costs $23,200, so equipment costs

Mechanical lifters such as this one, and vacuum lifters of a similar type, are used in mass-candling operations. They quickly and easily move a layer of eggs from the case.

are high relative to the other system described.

In mass-candling, revolving eggs pass over candling lights. Candlers merely remove other than Grade A eggs. Automatically sized, the eggs are packed in cartons by vacuum lifters. This semi-automatic machine, designed to be used with high quality eggs, would not be suitable for use with many eggs now being handled in Oklahoma plants. It is estimated that most Oklahoma plants do not have the egg quality found in the plants analyzed in this study. The comparison of costs presented in the following paragraphs applies only to the two methods compared, under the conditions specified. Conclusions reached regarding the two methods apply only to the two methods compared, and to no others.

One of the cost comparisons explored in this study was hand-candling versus mass-candling. Mass-candling operations such as this one are well adapted to eggs of high, uniform quality. In low volume plants, particularly where eggs are not uniform and wage rates are relatively low, lowest cost may be achieved with hand-candling.

Both mass-candling and push-pull methods use carton-setup machines. Both use conventional carton-closers and turntables for carton packing. The main difference between the two methods is that in using mass-candling methods, machines are used for taking eggs out of cases, for sizing, and putting eggs in cartons. With eggs of a high quality, it is thus possible to eliminate candling of individual eggs. However, it should be pointed out that even when fine quality eggs are handled, occasional lots of irregular quality call for candling of individual lots. Further, strict quality control measures such as breakout tests are necessary to back up a mechanical grading and packing operation.

Figure 4 compares costs of the two methods. Using $1.25 wage rates, hand methods have lower costs up to volumes for which data are available. Extension of the data shows the two methods would have equal costs at about 120-130 cases per hour. In plants with larger capacities than these, or with higher wage rates, mechanized methods would have lower relative costs. (The only costs compared in Figure 4 are labor and equipment, since these are the only ones affected in comparing the two methods.)

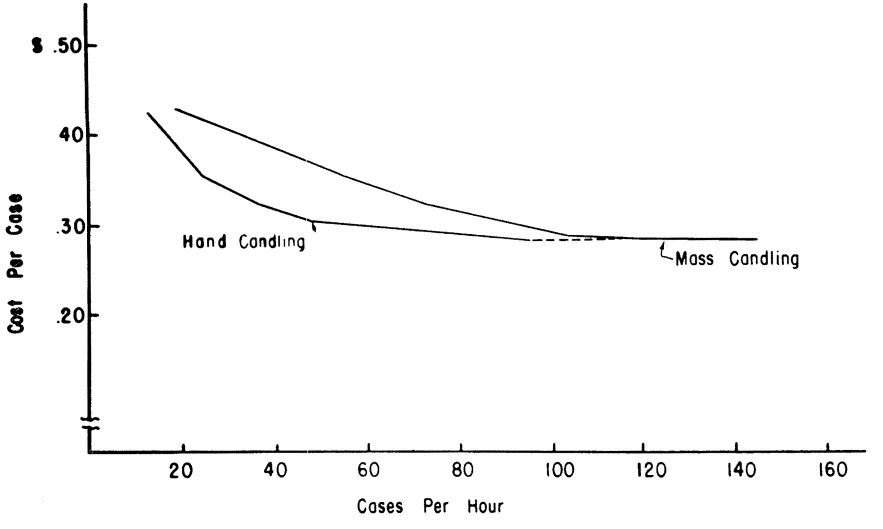


Figure 4.—Comparison of Two Handling Methods on Costs per Case, Six Egg Handling Plant Models.

Higher wage rates would have the effect of raising both lines shown in Figure 4. But since more labor is involved in the hand method, this line would be raised relatively more. Then the break-even point would occur at a lower volume. A $1.50 wage rate would probably make the breakeven point at a volume of about 110 cases per hour, rather than at the 120-130 cases per hour indicated for the $1.25 wage rate.

As indicated previously, quality of eggs affect the cost relations of the two methods of egg candling. The poorer the eggs, the greater relative advantage of the hand method. In fact, with eggs of poor quality (or low uniformity), the semi-automatic machine would be virtually unusable for its designed capacity.

A third factor affecting the relative costs of the two handling methods is the number of hours the plant operates per year. A plant with a high proportion of fixed costs would find average costs considerably lowered if more hours were worked per year. This would characterize the semi-automatic method. A plant with a relatively low proportion of fixed costs would find average costs lowered somewhat, but not nearly so much as in the higher fixed cost plant. The hand method would be an example of the low fixed cost plant.

An alternative eliminating the "either-or" choice is a compromise between the hand method and the newer mechanized methods. Most mechanized systems can be purchased or leased in units. If one or more of these units were used for high quality lots of eggs and the "push-pull"

benches kept for poorer quality lots, probably a plant manager could utilize many of the advantages of both systems. Some managers using mass candling feel it has the additional advantage of a predictable hourly output. In summary:

1. Hand methods are better for poor or variable quality eggs. Highly mechanized methods are not suitable for these eggs.

2. Hand methods are advisable in areas where labor is plentiful and wage rates are low. With higher wage rates, machine methods become much more competitive cost-wise.

3. Plants with high volumes can benefit from machine methods. At a wage rate of $1.25 per hour, volume needs to be about 125 cases per hour for machine methods to be justified. At a wage rate of $1.50, volume needs to be only 110 cases per hour for machines to be advantageous. With high quality eggs, volume can be much lower to justify machine operations.

4. Multiple shifts per day can lower machine and building costs. Two shifts per day can cut fixed costs per case approximately in half. Three shifts can cut fixed costs per case to about one-third.

Long-run Changes

Economics of Scale[10]

The previous discussion focused on the operation of the six model plants, where many of the factors of production were fixed. In some situations, however, it will be advantageous to consider all production factors as variable, and to determine long-run costs. Similar in everything except size, the six plants range in capacity from six to 96 cases of eggs per hour. Short-run cost curves of this type are illustrated in Figure 5 by the broken lines. Here are seen estimates of what average costs would be if the model plants were operated at various levels of capacity from 50 to 133 percent. Note the downward slope as capacity volume is reached, and then the upward turn as over-capacity volumes are encountered. Higher costs at over-capacity levels result from input factors getting out of proportion, relative to fixed factors.

The heavy line in Figure 5 shows the scale curve. This curve, sometimes termed the industry or envelope curve, is drawn tangent to the six individual plant curves and shows lowest average costs that may be achieved at various volumes. Individual plant curves show the changes in costs accompanying variations in volume. The long-run envelope, or

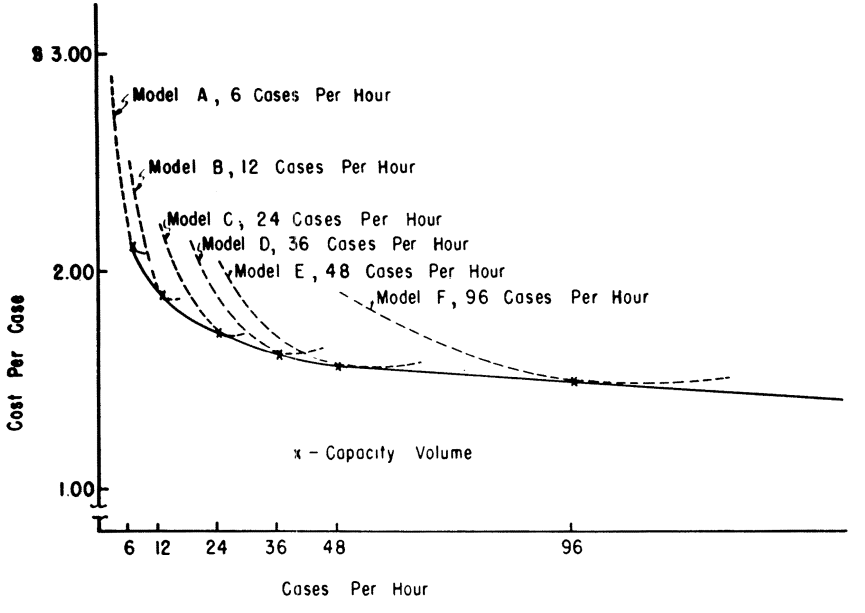


Figure 5.—Short Run Cost Curves and Scale Curve, Six Egg Handling Plant Models.

economies of scale curve, shows the cost changes accompanying changes in size of plant when plants are operated efficiently and with little or no excess capacity. This curve, like the plant curves, slopes downward and to the right. It indicates lower costs in the larger capacity plants.

One might ask the question, "Why are costs lower in the larger plants since the six plants are the same except for size?" There are several answers to this question: An important one is that there is excess capacity at various places in the small plants. Some of the machines, notably the carton-closer, carton-former, and turntable are used at about one-fourth their capacity in the smallest plant. But there are neither smaller nor cheaper machines to install in this size plant. Secondly, management is used inefficiently in the small plants. Fixed salary costs are 44 cents per case in the model A plant, but only 26 cents per case in the large model F plant.

A third reason for higher costs in the small capacity plants is building and land costs. Small buildings cost more per given area than large buildings. Building costs were $6.00 per square foot for the small plant, and $4.40 per square foot in the large plant. A fourth reason for lower

[10]Bressler, Ray, Research Determination of Economies of Scale. *Journal of Farm Economics*, August 1945. This article gives a clear theoretical discussion of long-run cost curves.

costs at the larger capacity volumes is economies in buying supplies. Cartons cost the small plants 2.6 cents per case more than the same cartons cost model F plants.

Still another reason for economies in the larger plants is the affording of larger type machinery. Small plants have to be satisfied with hand-operated fork trucks. The larger plants can afford, and use to advantage, rider, high-lift fork trucks. Not only are these larger fork trucks more efficient since they are faster, but they also pile pallets two high. This permits construction of high ceiling refrigeration rooms, and rooms that approximate a cube are more economical both to build and maintain than other shaped rooms.

A final major point concerns use of labor. In small plants labor cannot specialize. A case handler in the six case per hour plant not only hauls cases to and from the candling line, he also packs cartons into cases, provides candlers with empty cartons, and is the cleanup man. Speed and accuracy come about through specialization and this is possible through limitation of activities in larger plants. Not only this, but in larger plants there is more of an opportunity to use personnel where most adapted. If the larger plant is located in a metropolitan area, rather than a small town, management may have more opportunity to select the persons most suitable or qualified when hiring new labor. Thus labor efficiency is better, and costs per hour of labor lower, in larger plants.

As noted in the previous paragraphs, all cost items do not contribute equally to economies resulting from size of plant. Some items like refrigeration and utility costs stay at about the same rate per case as plant capacity increases. It is also possible that other items would **increase** in cost per case as plant size increases, but none of these were noted in this study.

A point that should be mentioned is that larger plants are not necessarily lower cost operations if different levels of capacity are compared. If 48 cases of eggs per hour were to be candled, one would **not** build a 96-case per hour plant and run it at 50 percent capacity. Average costs would be $1.92 per case. Rather, a plant owner would build a 48-case per hour plant and run it at or near capacity. Average costs would be $1.59 per case. These examples can be seen in Table XVII.

An interesting point to consider is the cost comparison of operating a large plant with one crew, or operating a plant with half the capacity with two crews. In both instances the yearly output would be the same. Taking plants E and F, model E with a capacity of 48 cases per hour,

and model F with a capacity of 96 cases per hour, we find costs in model E with two crews are $1.43 per case. Model F costs per case are $1.50, using one full-time shift. Here the smaller plant with two shifts had lower costs. A comparison of model C (24 cases per hour) operating

Table XVII.—Egg Handling Costs Per Case at Four Levels of Capacity, Six Model Plants

Plant Size and Cost Group	Percent of Capacity			
	50	75	100	133
Model A (6 cases/hr capacity)				
Labor	$ .767	$ .682	$ .665	$ .750
Supplies	.784	.784	.784	.784
Equipment operating	.035	.032	.026	.026
Fixed	1.320	.880	.644	.528
Total, cost per case	2.906	2.378	2.139	2.088
Model B (12 cases/hr capacity)				
Labor	.639	.568	.554	.625
Supplies	.774	.774	.774	.774
Equipment operating	.029	.023	.018	.017
Fixed	1.078	.719	.539	.431
Total, cost per case	2.520	2.084	1.885	1.847
Model C (24 cases/hr capacity)				
Labor	.575	.511	.499	.563
Supplies	.766	.766	.766	.766
Equipment operating	.027	.025	.015	.023
Fixed	.859	.573	.433	.344
Total, cost per case	2.227	1.875	1.713	1.696
Model D (36 cases/hr capacity)				
Labor	.511	.455	.443	.499
Supplies	.762	.762	.762	.762
Equipment operating	.022	.019	.016	.017
Fixed	.850	.567	.405	.341
Total, cost per case	2.145	1.803	1.626	1.619
Model E (48 cases/hr capacity)				
Labor	.479	.426	.416	.469
Supplies	.760	.760	.760	.760
Equipment operating	.022	.018	.013	.014
Fixed	.785	.525	.404	.315
Total, cost per case	2.046	1.729	1.593	1.558
Model F (96 cases/hr capacity)				
Labor	.448	.398	.388	.436
Supplies	.755	.755	.755	.755
Equipment operating	.017	.013	.010	.010
Fixed	.696	.464	.350	.279
Total, cost per case	1.916	1.630	1.503	1.480

two shifts and model E (48 cases per hour) operating one shift shows costs to be in favor of the small plant, $1.56 per case. The large plant with one shift had costs of $1.59 per case. In comparing A model and B model we find costs are the same, $1.88 per case. Apparently at high capacity levels it is more desirable to consider multiple shifts. The figures quoted above may be checked using Table XIV.

In returning to the scale curve in Figure 5, the economies of scale curve applies only to egg handling plants as specified. These are **hand** operations. Here the greatest slope of the curve occurs at low volumes indicating this area to be most important in cost reductions. The curve is fairly flat and has less slope after a volume of 48 cases per hour has been reached.

Cost differences between the small six case per hour plant and the large 96 case per hour plant are 64 cents per case (Table XVII). This is with both plants operating at capacity. Much of this difference, 55 cents, has been attained by the 48 case per hour plant. From 48 cases per hour capacity on to 96 cases per hour, savings of only nine cents per case are possible. In other words, after a plant has attained a size of 48 cases per hour, and is efficient at this level, costs cannot be reduced materially at greater capacities. This statement would not be true for a more mechanized plant, for the curve flattens out at greater volumes in these plants.

The statements mentioned above apply only to inplant cost saving possibilities. In looking at the whole plant undoubtedly there would be other savings resulting from larger scale. Examples of this would be assembly and distribution.

Implications of the Scale Curve

Briefly, the economy of scale curve shows levels of costs that may be expected through operating plants of various sizes, when operations are organized as efficiently as possible under the conditions given. The particular curve for egg handling plants shows costs to be lower at larger volumes. As a planning guide this indicates that industry costs may be lowered by having fewer egg handling plants. Using Oklahoma as an example, the state's production of one million cases of eggs, cited in Table I, could be handled by ten firms the size of model E. Cost savings would be around $350,000 annually. If these same one million cases of eggs were handled by five firms the size of model F, cost savings would be about $430,000 per year. These statements do not imply that

consolidation of firms **should** take place. Rather it shows cost savings to be important factors determining size of firms in an industry.

Summary

The purpose of this study was to determine the relations of size of operations in egg handling plants to costs of handling eggs. Only inplant handling costs are included. Costs omitted from the study are egg breakage (loss-off) and inspection fees. Container costs are included since they are somewhat dependent on volume handled.

Cost relations given here are based on economic-engineering methods of analysis. Model plants have been synthesized or constructed on paper. Data used in making the models were collected from actual plants in operation in Oklahoma and other areas of the country. In these actual plants work measurement studies were used to gather detailed labor and equipment performance standards. These data, plus cost information from other plants, equipment companies, and engineering firms, constitute the basis for cost estimates.

From the analysis presented it is apparent there are two pronounced types of economies possible in the operation of egg handling plants: (1) those associated with changing the size or scale of the plant, and (2) those associated with internal cost factors in a given size of plant. Considering scale first, economies are most pronounced as plants get larger in the range from six to 48 cases per hour. After plants get to a size of 48 cases per hour, economies are still possible, but of less importance. By increasing size from six to 48 cases per hour it is possible to lower costs 56 cents per case. From 48 to 96 cases per hour, costs are lowered eight cents per case.

Internal factors found important in affecting egg handling costs are: quality of eggs, yearly hours or days of operation, number of shifts per day, efficiency of labor, wage rates, and egg handling methods. Some of these factors are interrelated. For example it was found that egg quality has an important bearing on output per man hour. With high quality eggs, it is possible to introduce a new type of candling method (mass candling). This allows use of vacuum lifters and other labor saving items of equipment. New equipment substitutes capital for labor, fixed costs for variable costs. With a higher proportion of fixed costs, an egg handler is forced to acknowledge volume as an important method of reducing costs per case. Ways of increasing volume are more shifts per day, more hours per year, and so on. In addition, in-

creasing size of plant or capacity rates of operation is considered. Thus, a decision to handle higher quality eggs can affect the whole plant and many long-run decisions may have to be considered at the same time.

Specifically, it was found that costs were lowered by: handling quality controlled eggs, operating two or more shifts per day, working the plant more hours per year even though overtime had to be paid, and seeing that workers are efficiently employed. Newer techniques of handling and candling eggs were not found especially advantageous at low volumes, but at volumes of 120 to 130 cases per hour they showed lower costs. As quality of eggs improves, or as wage rates rise, these newer handling techniques will be more and more applicable to Oklahoma conditions.

11-60/2½M