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Design, Operation, and Feasibility of a Small On-the-Farm Egg Grading and Packing Plant



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Summary

The purpose of this study was to develop a layout and operating methods for a 35-case-per-hour egg-grading and packing plant located close enough to the production houses to facilitate conveying the eggs into the plant to minimize handling costs and maximize quality. This location eliminates the transportation, labor, and other costs normally incurred in the assembly of eggs to a central grading and packing plant. Since the assembly function is eliminated, losses from egg breakage may be reduced through less handling of the eggs.

Economic competition and economies resulting from expanded scales of operations during the past decades have resulted in many egg producers expanding the size of their laying flocks to the extent that they are considering the feasibility of on-site grading, packing, and marketing of their eggs. Significant technological changes in egg production, handling methods, quality control, grading, and cartoning have all contributed to the feasibility of on-the-farm grading and packing plants. Another contributing factor is the growth in volume of many production units.

A recommended layout for an on-the-farm egg-grading and packing plant is described and illustrated in this report. The plant was designed to efficiently handle the eggs produced by 108,000 hens at first, with capability for expanding the facility to handle the eggs produced by 180,000 hens. The layout features a retail salesroom for selling some of the eggs directly to consumers, with a majority being delivered to retailers and institutions. Each area of the plant is discussed, along with recommended methods of operation.

Estimated annual ownership and operating costs are presented, as is potential income at the two production levels. Estimated income is based on the average 1975-77 retail price of 80.9 cents per dozen and a price to the retailer of 68 cents per dozen, as reported for the 10-city average during that period when the average farm price was 51.5 cents per dozen. Income from undergrade and underweight eggs is estimated at 58 cents per dozen. Because egg-grading plants normally receive less than full retail price for the eggs they sell directly to consumers, the average price per dozen is estimated at 74.5 cents for 5 percent of the plant volume and 68 cents for the remaining 87 percent being marketed. Some producer-packers sell many of their undergrade and small eggs directly to consumers.

Producers should use the expected cost and return data appropriate for their individual situations to determine the feasibility of such a plant. In situations where the price spreads are less than presented above or when operating costs exceed those presented in this report, such a plant might not be feasible.

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Introduction

The transition within the egg industry from small farm flock production to large automated operating units has created different egg processing and marketing needs throughout the industry. When small farm flocks were prevalent, centralized egg grading and packing plants were the most efficient system for processing and marketing eggs; but as the production units increased in size it became advantageous to perform many of the processing, packaging, and marketing functions on the farm. The trend toward moving the processing, packaging, and marketing functions to production areas has extended through much of the food industry.

Improved methods and equipment for maintaining egg quality, along with a uniform, standardized grading program, contributed to making on-the-farm processing and marketing both practical and advantageous. As production units get larger, it becomes economically feasible to acquire equipment, facilities, and personnel for adequate and efficient processing at the farm level. It is also no longer necessary to accumulate eggs for several days at the farm to constitute a sufficient quantity to transport to the next stop in the marketing chain. Thus, the eggs can be moved to market sooner, giving the consumer fresher eggs.

With eggs moving from hen to consumer in a short period of time, and with adequate refrigeration and other improved quality control techniques and facilities, the grading and cartoning functions can be moved from the urban consumption area to the farm. Larger units also make feed delivery, waste disposal, and supervision more efficient.

Egg producers are usually interested in ways to increase the return on their investment, or to find a better market for their products. On-the-farm egg processing and packaging is being considered by many producers as a means of increasing their income.

An effective marketing program is essential to a successful on-the-farm egg processing operation. Most firms which grade and pack eggs market them by mutual agreements or contracts with retail stores or distributors. Many pack their eggs under the retailer's brand name. Direct retailing of eggs can be a market outlet for some or all of the eggs; however, the location of the plant and other factors can greatly influence the success of direct marketing.

Economic feasibility and facility planning studies of representative egg-processing and marketing operations indicate that egg producers with laying flocks of sufficient size can usually increase their income by processing and marketing their own eggs through a properly planned and operated plant. This report presents a description and layout of an on-the-farm egg processing plant, designed to handle 35 cases of eggs (30 dozen per case) per hour, along with a cost analysis for construction and operation of the plant. The facility would be operated 7 days per week, since the hens produce each day of the week and eggs must be removed daily from the laying house.

Description of Facilities

Initial Production Houses

The three initial production houses (fig. 1) have sufficient capacity for 36,000 hens each. The production houses are equipped with either flat deck, stairstep, or multitiered cages with conveyORIZED egg collection systems. Eight or more 2- to 4-inch belt conveyors run the length of each production house. With stairstep or multitiered cages, more than eight belt conveyors are required to bring the eggs to the end of the production houses, where elevators lower the eggs to a wider belt conveyor running across each house. Wide belt conveyors transport the eggs from each production house to the plant. Eggs from the three production houses are not commingled until they are on the belt conveyor just before reaching the accumulator in the grading and packing plant. This arrangement should minimize egg breakage during the assembly process and facilitate the keeping of production records by individual houses. If equipment were to be temporarily shut down, the eggs could be gathered from the belts either in the production houses or in the plant.

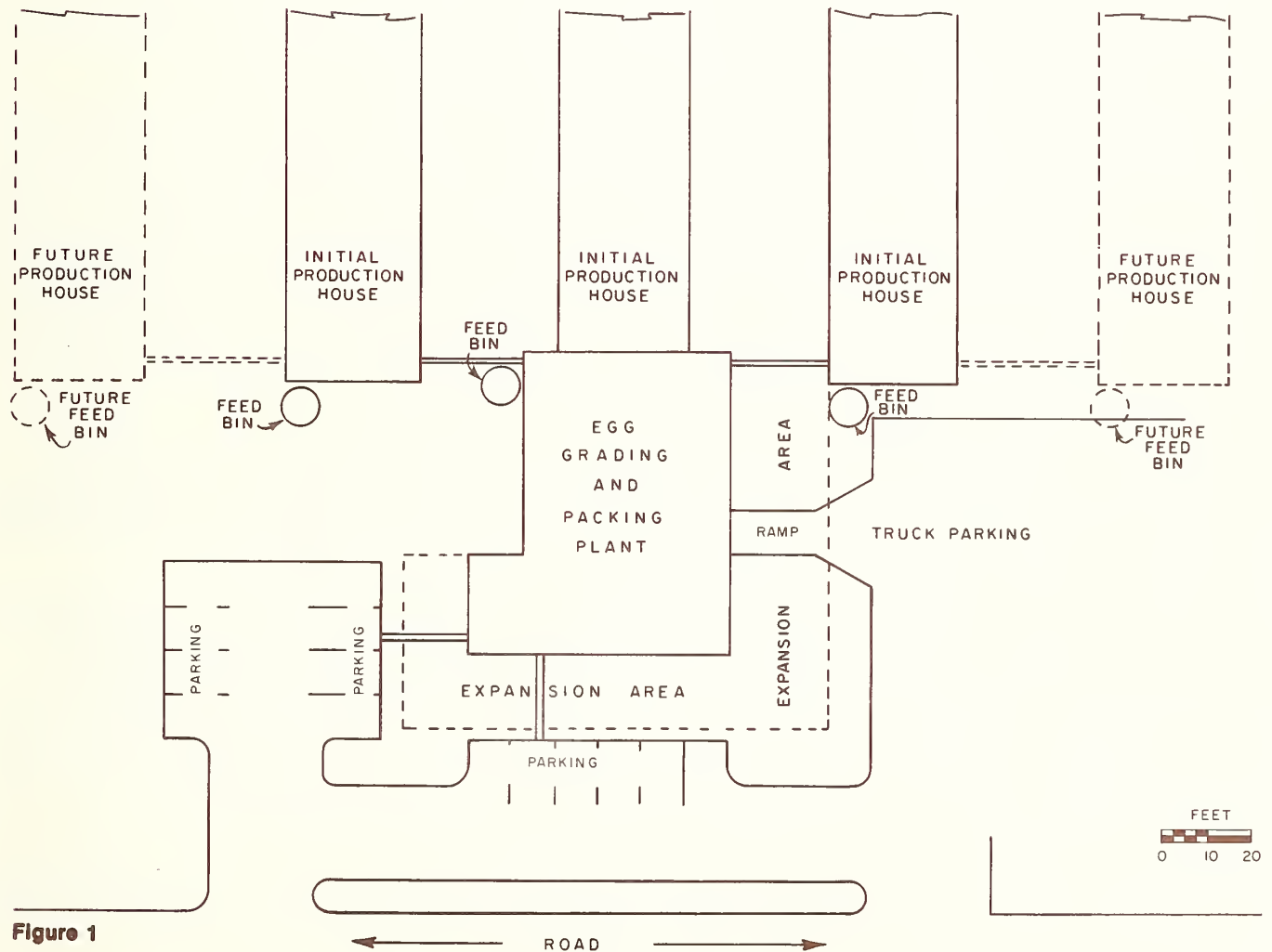


Figure 1

The egg collection belts are powered by electric motors, which can be controlled from a master switchboard located at an easily accessible place near the egg accumulator in the egg grading and packing room of the plant. This arrangement allows the grading personnel to control the flow of eggs through the plant. Switches for operating the conveyor belts in each production house are located there to facilitate servicing and emergency shutoff. The belts are located within an enclosure between production houses to ensure the safety of the eggs to protect them from inclement weather and predators. Egg escalators may be used to raise or lower the eggs when the floor level in the production houses and the plant is appreciably different.

As illustrated in figure 1, the egg-grading and packing plant is attached to one of the three initial production houses. Space for two other production houses is shown by dotted lines on either side of the initial production houses in figure 1.

Egg Grading and Packing Plant

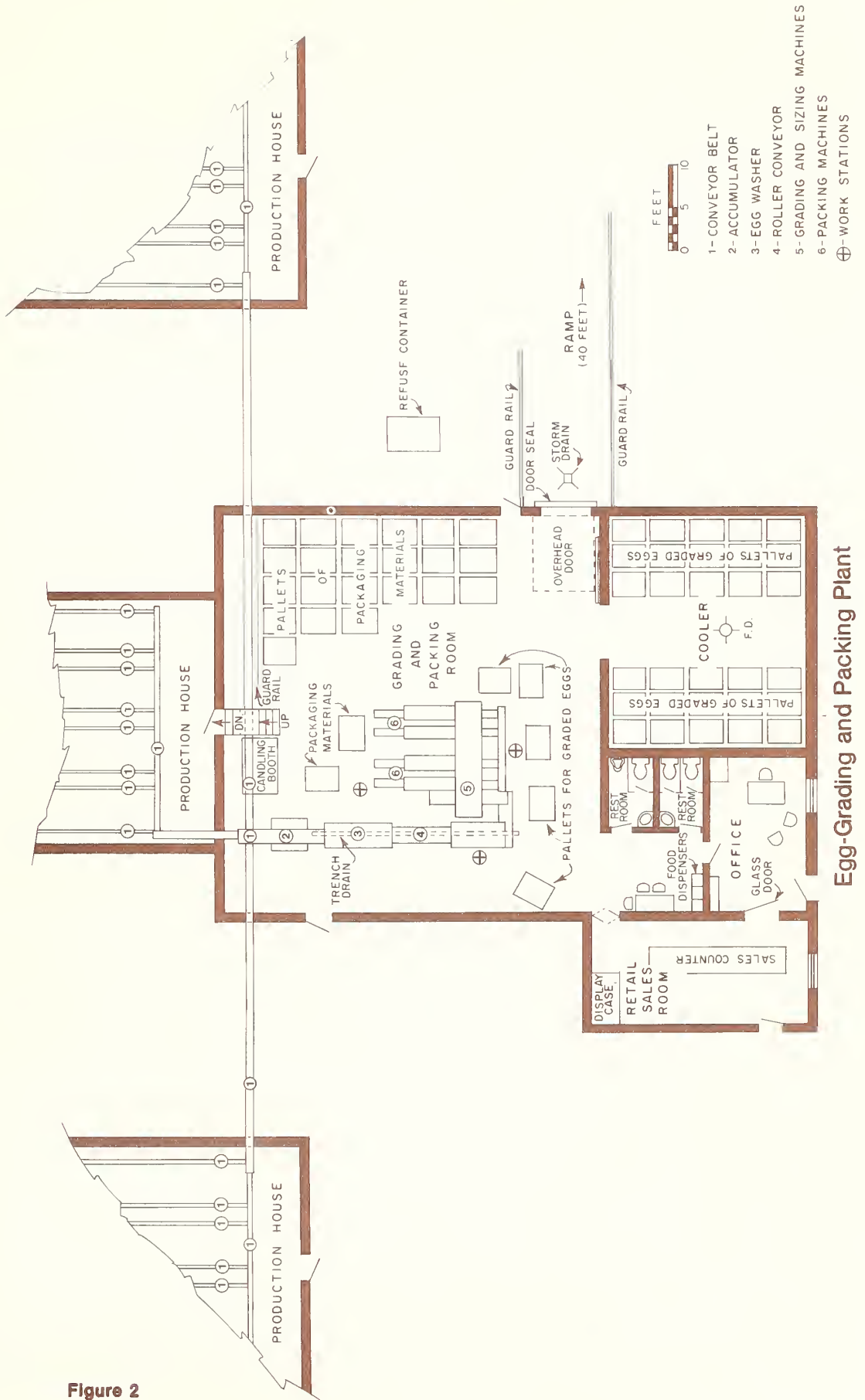
The egg grading and packing plant is rectangular in shape except for a retail salesroom containing about 300 square feet (fig. 2). The remainder of the plant contains about 3,350 square feet of floorspace. It is a one-story, concrete block, wood, and steel structure with a 12-foot ceiling.

Dotted lines are used in figure 1 to designate areas for future plant expansion. Figure 2 shows that open areas are left adjacent to the retail store, the office, the cooler, and the area for storing packaging material to allow for future expansion. The area designated for storage of packaging material in the layout (fig. 2) could be used for expanding the egg-grading and packaging operation when additional facilities are built for storage of packaging material. The cooler could be extended in length or width. Expansion may be necessary if the eggs from more production houses are added to the system or if more hens are added to the present houses.

Arrangements of facilities within the plant allow for future growth, while providing for a good flow pattern, with accumulation, washing, grading, sizing, orientation, packaging, and storage of eggs in sequence to simplify operations and to minimize costs.

Eggs roll by gravity onto conveyors in the production houses. Belt conveyors move the eggs from the production houses to the plant, where they are assembled and deposited on a roller conveyor which carries them through washing, drying, and candling operations. Then the eggs are placed on scales, sized, and conveyed by size to packaging machines or stations. Packaged eggs are palletized and transported either to the cooler, directly into a properly cooled truck parked at the overhead door, or to the retail store.

The retail salesroom is located near the egg-grading and packing room and adjacent to the office. This location makes it convenient for moving eggs from that room to the refrigerated display cases in the retail salesroom.



Egg-Grading and Packing Plant

Figure 2

This arrangement also makes it convenient for plant personnel to assist retail customers in addition to performing office functions.

The building site should be reasonably level and well drained, with ample space for constructing and operating the plant as well as parking vehicles. Utilities for the grading and packing plant are provided by the same sources as those for the production houses. However, additional electrical service may be required for the plant.

An approved water supply must be available. Wastewater treatment facilities are needed to handle the effluent discharged from the plant and the production houses.

Before construction starts, all regulatory agencies (Environmental Protection Agency, Occupational Safety and Health Administration, local health inspectors, building inspectors, etc.) must be consulted to assure compliance with their specific requirements for the operation of an egg-grading and packing plant. Safety features must be incorporated into the plant design for protection of employees. Adequate lighting, heating, air-conditioning, ventilation, plumbing, and electrical wiring must be provided throughout the plant. Hot and cold water outlets and handwashing facilities must be located where needed.

Other considerations that must be complied with in the design and operation of the plant include the following:

- (1) Floors must have relatively smooth surfaces that are impervious to moisture and easily cleaned, yet have enough traction to minimize skidding when wet;
- (2) Floors must be sloped sufficiently to facilitate adequate drainage;
- (3) Walls and ceiling must be smooth, washable, light in color, impervious to moisture, with outside walls and ceiling insulated, (more insulation for walls and ceiling of cooler); and
- (4) Construction materials should absorb sound and minimize noise.

Walls throughout the processing and storage areas are concrete block to a height of 4 feet, resting on footings extending below the frost line. The concrete floor in the egg-grading and packing room slopes to a 6-inch wide, 24-foot long trench drain located under the egg washer. The bottom of the trench drain slopes to the center, where the trench drain discharges into a trapped drain. A trapped floor drain 6 inches or larger is needed in the cooler.

The plant is designed and equipped to handle about 35 cases (30 dozen each) of eggs per hour, 7 days a week. This capacity is based on an initial flock of 108,000 birds with approximately a 67-percent rate of lay, requiring about 6 hours (5.7 hours) to grade and pack the daily production. The volume would fluctuate depending on the rate of lay, downtime in replacing flocks, age of flock, and flock mortality. If the size of the flock is expanded to 180,000 birds,

with approximately a 67-percent rate of lay, then about 9½ hours would be required per day to grade the production.

However, with many of the grading machines available today, the speed can be increased to wash and grade about 40 cases per hour, which would reduce the time required to grade the eggs produced by 180,000 birds to about 8½ hours per day. The above production hours do not include time for employee breaks or downtime, which may constitute an hour or more per day.

The entire volume is washed, candled, and sized, and about 80-90 percent is cartoned either under the producer-packer brand name or the brand name of a wholesale or retail customer.

The following sections present descriptions and evaluations of the various areas of the plant and the major functions that would normally be performed in each area. Usable floorspace by individual areas is as follows:

	Square feet
Grading and packing	2,024
Cooler	628
Retail salesroom	300
Office	208
Lunchroom	110
Restrooms	80
Total	3,350

Grading and Packing Room

The egg-grading and packing room is adjacent to one end of the middle production house, with direct access between the two through a doorway. The door is equipped with a self-closing device to keep it closed, except when in use, to reduce the amount of dust and air passing between the two areas. The common wall should be fireproof and constructed of materials and in a manner that will minimize the transmission of odors.

About 25 percent of the 2,024 square feet of floorspace in the room is allocated to the storage of packaging material. This area can accommodate 22 or more 3- by 4-foot pallets of packaging materials with single stacking, or 44 or more with double stacking. The 12-foot ceiling is sufficient to accommodate double stacking with pallet racks. The packaging material consists of various types of egg cartons, cases, baskets, filler flats, labels, pallets, and other items. For convenience, the packaging materials are stored near points of use. Cartons are used at the cartoning machines, and the cases are used at the opposite end of the grading machine, where the filled, closed cartons are ejected and packed in cases. Baskets are filled at the same place. Cases or baskets of eggs are placed on pallets at the positions labeled “pallets for graded eggs” in figure 2.

Eggs are brought into the plant by belt conveyors, accumulating on a belt conveyor (1)¹ wide enough to accommodate six eggs or more abreast. This belt transports them to the accumulator (2), where they are picked up by the roller conveyor of the egg washing machine (3). In the washing machine, the eggs are washed and air-dried, after which they pass across candling lights (4), where undergrade eggs are removed.

Eggs meeting the quality requirements go to the sizer (5) for separation according to size—pee wee, small, medium, large, extra large, and jumbo. The packing machines (6) place each egg in either a carton or filler flat with the small end down. The packaged eggs are moved under the packaging machines and the sizer to the case packing station, where an operator packs them into baskets or cases and stacks them on nearby pallets. Palletized eggs are transported to the cooler, directly into a waiting truck, or to the retail sales-room.

The 44-by-46-foot grading and packing room has a relatively smooth concrete floor that slopes approximately 1/8 inch per foot to a 24-foot trench drain running parallel to the side walls. The walls are concrete block to a height of 4 feet for ease of cleaning and to minimize the probability of wall damage by pallet transports and other equipment. The ceiling is 12 feet above the floor to allow for double stacking of palletized materials.

A ventilation system consisting of a hood, exhaust duct, and fan is located over the egg washer, and a ventilation duct is connected to the candling machine. This ventilation system removes much of the heat generated by the equipment.

Sufficient space is provided in the grading and packing room to house and operate the equipment, to store packing materials, to hold products temporarily, and to move palletized products and packaging materials to locations as required. The area around the overhead door is left unobstructed for ease of movement of a product into the cooler or into a truck.

A guard rail is installed adjacent to the belt conveyor to prevent pallet transporters and pallets from damaging the belt conveyor or the eggs. Steps are provided for getting across the belt conveyor and into the production house. The room is equipped with smoke and fire detectors and a sprinkler system with sufficient capacity to control burning stacks of packaging materials.

A 6- by 7½-foot doorway equipped with an electrically operated overhead door is provided for loading trucks. A truck seal is attached to the outside wall to

¹Numbers in parentheses refer to equipment identification numbers in fig. 2 and + represents work stations.

facilitate loading and unloading of trucks while minimizing the quantity of air exchanged with the outside.

A 10-foot-wide ramp—4 feet below the plant floor level—along with a bridge plate, enables the operator of a pallet transporter to load and unload pallet units of eggs and packaging material. A storm drain in the bottom of the ramp provides drainage. Where practical, the truck loading area should be located on the lower side of the plot and should be graded to eliminate the need for a ramp. In localities with frequent snow and ice, it is highly desirable that the truck loading area be covered.

Cooler

A 23- by 27-foot, 4-inch walk-in cooler provides about 628 square feet of floor space. It is equipped with a refrigeration unit. A humidifier capable of maintaining the relative humidity at 70-80 percent is suspended from the 12-foot ceiling. The walls, ceiling, and door are insulated to limit refrigeration losses. Baseboards are installed on each wall to protect them from damage by pallets and pallet transporters. The walls and ceiling are washable, since a buildup of mildew can be a problem when it is necessary to maintain high humidity.

The cooler has sufficient space for storing thirty 48- by 36-inch pallets of eggs with single stacking and 60 pallets of eggs with double stacking, leaving space for an aisle at least 8 feet wide extending the length of the cooler. Also, there is sufficient room for 6 inches of space between each pallet to give adequate air circulation—a necessity if the temperature of the product is to be lowered rapidly to preserve product quality. Drive-in pallet racks can be installed in the air space to facilitate double stacking of pallets, which may be necessary if egg production is expanded.

Data in table 1 represent a schedule of expected refrigerated storage requirements for a 108,000-bird production unit, and a 180,000-bird production unit, with shipments twice a week. Even with this limited number of shipments per week, the maximum number of cases on hand at any given time is 1,333, which amounts to 54 (53.3) pallets. The cooler has space for storing 60 pallets with double stacking. Since 1,333 cases of eggs is more than a truck load, and since eggs are usually moved to the market place as soon as feasible to insure quality, a firm with a production unit of 180,000 birds would probably ship more than twice a week. Firms marketing eggs locally would probably deliver 4 or 5 days per week, with two deliveries per customer. However, for distant markets, deliveries would probably be confined to two a week for the 108,000-bird production unit, since this volume constitutes less than 2 trailer loads.

Lunchroom

The lunchroom, 9 feet, 6 inches by 11 feet, is between the grading and packing room and the office and the restrooms. It serves as a vestibule for the restrooms, so that the restrooms do not open directly to the grading and packing room. The facility is designed for prepackaged items normally

dispensed by food and beverage machines. A table and chairs are provided, and the concrete floor is covered with tile.

Restrooms

The restrooms, each 5 by 8 feet, are next to the lunchroom. Mechanical ventilation to the outside and self-closing doors are required. The number of lavatories, toilets, and other sanitary facilities required is based on guidelines prescribed by U.S. Department of Agriculture regulations governing the inspection of eggs and egg products.²

Retail Salesroom

A retail salesroom, measuring about 12 by 26 feet, is provided to house a direct sales program for the plant. The room is located convenient to the road as shown in figure 1, yet it is designed to route retail customers away from the production houses and the processing, loading, and unloading operation in the plant. A parking lot located near the retail salesroom for the convenience of customers has a sidewalk leading from it to the salesroom. Doorways also open to the grading and packing room and to the office. Eggs can be transported on pallets from either the grading and packing room or the cooler into the retail salesroom. A pallet of eggs can be moved through the doorway with the swinging doors, to a point just inside the room from which eggs can be removed and displayed for sale.

Another door connects the retail salesroom to the office. This door is equipped with a one-way glass to allow one person working in the office to oversee retail salesroom activities while providing some privacy for the office. At times when direct or retail sales are frequent, additional help may be needed in the salesroom.

The retail salesroom is equipped with a 3- by 16-foot sales counter and a 3-foot, 6-inch by 6-foot refrigerated display case. The plant cooler is used for bulk and long-term storage. Sufficient space is provided in the retail salesroom for marketing other products besides eggs; however, other products are not discussed in this report because of the wide variation in products that might be handled in such a facility.

²Regulations governing the inspection of eggs and egg products. (7CFR Part 2859). Food Safety and Quality Service.

Table 1. Refrigerated storage requirements for eggs from 108,000 and 180,000 hens with a shipment each Monday morning and Thursday afternoon¹

Item	Schedule													
	Sunday		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday	
	Cases	Pallets	Cases	Pallets	Cases	Pallets	Cases	Pallets	Cases	Pallets	Cases	Pallets	Cases	Pallets
108,000 hen unit														
Days production	200	6.7	200	6.7	200	6.7	200	6.7	200	6.7	200	6.7	200	6.7
Hold over	400	13.3	0	0	200	6.7	400	13.3	600	20.0	0	0	200	6.7
Total storage	600	20.0	200	6.7	400	13.4	600	20.0	800	26.7	200	6.7	400	13.4
Plus 20% allowance for partially filled pallets		24.0		8.0		16.1		24.0		32.0		8.0		16.1
180,000 hen unit														
Days production	333.3	11.1	333.3	11.1	333.3	11.1	333.3	11.1	333.3	11.1	333.3	11.1	333.3	11.1
Holdover	666.6	22.2	0	0	333.3	11.1	666.6	22.2	999.9	33.3	0	0	333.3	11.1
Total storage	999.9	33.3	333.3	11.1	666.6	22.2	999.9	33.3	1,333.2	44.4	333.3	11.1	666.6	22.2
Plus 20% allowance for partially filled pallets		40.0		13.3		26.6		40.0		53.3		13.3		26.6

¹Based on a maximum of thirty (30) dozen cases per pallet

Cost Benefit Analysis

An analysis of farm-to-consumer price spreads indicates the revenue potential which may be realized from a grading and packing operation with sales made to both wholesale and retail customers. During 1975-77, the 10-city average farm price for large eggs was 51.5 cents per dozen, the price to the retailer was 68 cents per dozen, and the average retail price was 80.9 cents per dozen. This resulted in a price spread of 29.4 cents per dozen between the farm and retail price and a spread of 16.5 cents between the farm price and the price to retailers.³ These prices and price spreads are for large eggs.

A nationwide study conducted by a private egg-marketing organization of 36 firms reporting processing and cartoning costs for 65 plants⁴ reported the following average costs:

packing materials	5.06 cents/dozen
plant operating costs	3.91 cents/dozen
administration and overhead	1.60 cents/dozen
grade yield and size loss	3.44 cents/dozen
Total	14.01 cents/dozen

The value of cases and packaging materials received from trade was placed at 1.7 cents per dozen. The producer who can process and market eggs directly to the retail consumer can expect to receive part or all of the normal spread. When the producer can grade, package, transport, and market the product for less than the spread, he may have an opportunity to realize a profit between the farm price and the retail price. Many egg producers are turning to this marketing method to increase their income. The feasibility of such a venture is dependent upon many factors that could influence the amount of additional return that producers might receive from direct marketing of eggs.

Factors that influence the number of retail customers that a producer can expect with a direct marketing operation at the processing plant include such things as the quantity of the traffic passing near the plant, the type of road, the population in the area, other businesses in the area, competition, prices, advertising, visibility, and other products sold by the firm. Some other factors that may influence the feasibility of direct marketing of eggs include availability of sales personnel, wholesale markets for eggs, appearance of the facility, and hours of operation.

Initial Investment Cost

About 1.5 acres of land are required for the egg-grading and packing plant, and the vehicle maneuvering and parking area (fig. 1). However, almost as much land would be required for packing and storing the eggs for shipment to a centralized grading plant. Also, a building would be required for assembling,

³U.S. Department of Agriculture 1978, Poultry and Egg Situation, March, PES-297-267 Table 19.

⁴Poultry and Egg News, Inc. 1978, The Poultry Times, December 1978, page 8, Gainesville, Ga.

washing, packing, and storing eggs for shipment to a centralized grading plant.

Many producers do not wash their eggs. It is estimated that about one-half the size of the egg-grading and packing plant, or 1,675 square feet of floor space, would be required without grading or retail sales. The additional acreage required is estimated at one-half of an acre. The production houses and acreage requirements would be the same with or without the grading operation and facilities.

Estimated construction cost of the egg-grading and packing plant is \$76,155, excluding equipment. Cost by area is shown in table 2. The facility is designed with sufficient capacity to handle the volume of eggs produced by 108,000 hens, with expansion area for 180,000. Building costs are based on the recommended layout (fig. 2) in a pre-engineered building with a 4-inch thick concrete floor, floor drains, sewer lines, foundation, and concrete block walls to a height of 4 feet.

Delivery of materials, permits, landscaping, and construction labor costs are included in the weighted average cost of \$22.73 per square foot of floor space. These costs are based on a recent publication on a modular egg-grading and packing plant⁵ and another publication describing on-the-farm fluid milk plants⁶, with allowances for inflation. Cost estimates also were obtained from manufacturers of pre-engineered buildings for construction in rural areas and from equipment manufacturers. There will be some variation in construction and equipment costs for different areas of the country.

Equipment

Estimated equipment cost for the egg-grading and packing plant described in this report is as follows:

Belt conveyors (in plant only)	\$ 600*
Accumulator	5,000*
Washer-dryer	7,200*
Grading and packing machine	40,400*
Hot water heater	620*
Refrigeration equipment	3,400*
Pallets and transporter	1,950*
Display case (used)	300
Miscellaneous and transportation of equipment	3,000*
Total	62,570

*1979 manufacturer's suggested retail price, including transportation and installation where applicable.

⁵Goble, Jesse W. A Modular Shell Egg Grading and Packing Plant, MRR 1050, U.S. Department of Agriculture, Washington, D.C. 1976.

⁶Stewart, Charles F. Economic Feasibility of a Small On-the-Farm Milk Processing Plant, MRR 1087, U.S. Department of Agriculture, Washington, D.C. 1978.

Table 2.—Estimated construction cost of an egg-grading and packing plant

Facility	Area	Average cost per square foot ¹	Total cost
	Sq. ft.	Dollars	Dollars
Grading and packing room	2,024	21.00	42,504
Cooler	628	26.00	16,328
Retail salesroom	300	16.25	4,875
Office	208	16.25	3,380
Lunchroom	110	16.25	1,788
Restrooms	80	16.25	1,300
Miscellaneous (site preparation and sewer, water, and electrical systems)	—	—	5,980
Total or weighted average	3,350²	22.73	76,155

¹Based on 1978 cost of similar facilities built in areas with comparable construction cost, plus about a 10-percent-per-year inflation factor.

²Does not include area occupied by walls, doorways, and windows.

Table 3.—Estimated initial investment and total annual ownership and operating cost of the egg-grading and packing plant with retail salesroom

Cost item	Initial investment	Annual ownership and operating cost
	Dollars	Dollars
Facilities	76,155	12,947 ¹
Equipment	62,570	19,396 ²
Supplies	—	122,056 ³
Labor, utilities and transportation	—	90,840 ⁴
Administration, sales and overhead	—	35,040 ⁵
Grade yield loss	—	37,668 ⁶
Contingency	—	15,897 ⁷
Operating capital	41,784 ⁸	
TOTAL	180,509	333,844

¹Based on 15 years depreciation, 10 percent interest on investment, and 5 percent for taxes, insurance, maintenance, etc. Capital recovery formula used to compute cost:

$$\text{Depreciation: } \frac{\$76,155}{15} = \$5,077$$

$$\text{Average interest: } \$76,155 \frac{0.10}{(2)} \frac{16}{15} = \$4,062$$

$$\text{Taxes, insurance, etc: } \$76,155 (0.05) = \$3,808$$

²Based on 5 years depreciation, 10 percent interest on investment, and 5 percent for taxes, insurance maintenance, etc. Computed by above formula.

³Based on packaging material costs of 5.06 cents per dozen previously cited in 65-plant study and 200/thirty dozen cases per day, \$1.52/case × 200 cases/day × 365 days = \$110,960/year. Ten percent is added to cover other supplies.

⁴Based on usage rates and labor requirements of plants of similar size performing similar functions and 2 cents per dozen transportation costs.

⁵Based on data reported in 65-plant study discussed previously in this publication.

⁶Based on 65-plant study data, less estimated size loss.

⁷Based on 5 percent of total annual ownership and operating costs.

⁸Includes 2 weeks' egg production at 10 cents per dozen additional capital plus 10 percent of total annual ownership and operating costs.

Estimated cost for the equipment is based on the manufacturer's suggested retail price of new equipment plus transportation and installation. However, used equipment may be readily available. Many machines can be reconditioned to grade 35 cases per hour. A major equipment manufacturer's representative reports that a substantial market exists for used 35-case-per-hour grading machines in the \$20,000 price range and for used display cases suitable for eggs.

Most production units with 108,000 or more hens would need all the equipment listed above except the grading and packing machine for preparing and handling their eggs for shipment to a centralized egg-grading plant. In most production units that do not grade, the eggs are washed, dried, packed, and cooled before shipment. Equipment also is required to perform these functions efficiently.

Annual Ownership and Operating Costs

Estimated total annual ownership and operating cost in the plant, including a 5-percent contingency (table 3), is \$333,844, while the total initial investment is \$180,509. Initial investment includes the building, equipment, and the operating capital needed to get the business underway. Operating capital includes the additional cost of graded, cartoned eggs instead of loose nest-run eggs for about 2 weeks before the buyer's payment is received. Delivery vehicles are not listed since these might be rented.

Operating costs are based on the use of some part-time employees, especially during weekends, and much of the production work being performed by persons with administrative responsibility. Transportation costs are estimated at 2 cents per dozen⁷, which may vary from producer to producer. The operating and distribution costs amount to \$4.57 per case or \$0.152 per dozen for 73,000 cases per year.

Potential Benefits

By grading and packing the total annual production of 73,000 cases of eggs per year (108,000 birds x 66.6666% production rate ÷ 360 eggs/case x 365 days/yr.) and marketing 87 percent or 65,700 cases per year at an average of 68 cents per dozen, 8 percent as undergrades, or small eggs at 58 cents per dozen, and retailing the remaining 5 percent at an average of 74.5 cents per dozen, the annual sales would amount to \$357,518 per year more income than selling the entire production as ungraded eggs. The income calculations are: (73,000 cases/yr. x 87% x 30 doz./case x 68 cents/doz.) + (73,000 x 8% x 30 x 58 cents) + (73,000 x 5% x 30 x 74.5 cents) - (73,000 x 30 x 51.5 cents).

These income calculations are based on a farm price of 51.5 cents per dozen, price to the retailer of 68 cents per dozen, and a retail price of 80.9 cents per dozen presented previously in this report. The retailer-consumer price spread of 12.9 cents (80.9 less 68.0) is reduced by 6.4 cents per dozen for a retail

⁷Lederer, Bruce E. An Evaluation of Two Shell Egg Marketing Systems, MRR 1046, U.S. Department of Agriculture, Washington, D.C. 1975.

at-plant price of 74.5 cents per dozen. This price estimate of 74.5 cents per dozen was made because such plants do not usually receive the full retail price. The income would be less when direct retail sales account for less than 5 percent of total volume, and more when they exceed 5 percent. The retail sales estimate is based on the direct marketing program averaging 10 cases per day. Likewise, the income would be less if a quantity smaller than 87 percent of the production were sold to retailers at 68 cents per dozen, or if the price were less than 68 cents per dozen. Some of these eggs might have to be sold at nest-run prices, which would reduce the income. Brokerage firms might provide assistance in marketing cartoned eggs.

With annual ownership and operating costs of \$333,844 (table 3), the estimated return before taxes is \$17,104 per year more than if the entire volume of production were sold at farm price based on a 108,000-layer operation and the market conditions described above. Any costs of making sales should be deducted from the above return.

The total volume of eggs produced by 180,000 hens at a rate of lay of about 67 percent yields an annual volume of 121,667 cases. Marketing 87 percent to retailers, 8 percent as undergrade and small sizes, and 5 percent through direct marketing at the previously quoted prices would result in annual sales of \$584,914 more than selling the production as ungraded eggs.

$$(180,000 \text{ hens} \times 66.6666\% \text{ lay} \div 360 \text{ eggs/case} \times 365 \text{ days/yr}) = 121,667 \text{ cases/yr.}$$

$$(121,667 \text{ cases/yr} \times 87 \times 30 \text{ doz/case} \times 68 \text{ cents/doz}) + (121,667 \text{ cases/yr} \times 8\% \times 30 \text{ doz/case} \times 58 \text{ cents/doz}) + (121,667 \text{ cases/yr} \times 5\% \times 30 \text{ doz/case} \times 74.5 \text{ cents/doz}) = \$2,464,669 - (121,667 \text{ cases/yr} \times 30 \text{ doz/case} \times 51.5 \text{ cents/doz} \times 100\% \text{ at farm price}) = \$585,914 \text{ additional sales/yr.}$$

Based on the operating costs of \$4.57 per case or \$0.152 per dozen estimated above, the additional income from grading, packaging, and marketing the eggs would be \$28,896 per year before cost of sales for a 180,000-layer operation. $\$584,914 - (121,667 \times \$4.57) = \$28,896$.

However, if grading, packaging and marketing costs were to increase by 10 percent to \$5.03 per case, the plant would operate at a loss of \$27,071 per year. $\$584,914 - (121,667 \times \$5.03) = \$27,071$. As with many types of enterprises, maintaining a relatively high degree of efficiency is essential to profitability.

Likewise, if revenue from graded and cartoned eggs were to decline by 10 percent, while the nest-run price remained constant, then the plant would incur a loss of \$29,595 per year. $\$584,914 - 58,491 = \$526,423 - (121,667 \times \$4.57) = -\$29,595$.

The enterprise might experience a decline in the rate of lay below the projected 67% which would reduce income, even without the egg grading and packing plant.

Conclusions

By building and operating an on-the-farm egg-grading and packing plant for a flock of 108,000 laying hens rather than selling the eggs as ungraded (nest-run) at the farm for 51.5 cents per dozen, the producer can realize an annual profit of \$17,104 when the rate of lay is about 67 percent, 5 percent of the volume is sold at an average of 74.5 cents per dozen, 8 percent of the volume at 58 cents per dozen, and 87 percent is sold to retailers at 68 cents per dozen. The annual profit can amortize the initial investment in plant, equipment, and operating capital of \$180,509 in about 11 years.

With 180,000 hens, and the prices and production given above, the producer could realize an annual profit of \$28,896. However, the producer could receive less profit if operating costs increase or if sales decrease.

The payback makes the construction of an egg-grading and packing plant a sound economic investment in situations where a reliable egg market can be obtained. The spread between farm and retailer's prices should be at least 16.5 cents per dozen and between retailer and consumer prices at least 12.9 cents. Several sales outlets should be developed for the products; however, if only one outlet exists, a contractual agreement should be obtained stipulating the volume and minimum price with a provision to compensate for the changing price characteristics of the egg industry.

On-the-farm egg-grading and packing plants can help save energy through reduced transportation requirements; hold down the cost of food through more direct sales; promote fresher products through reduced time lapse between production and consumption; and provide an opportunity for small farmers to increase their income.

