COST-SIZE RELATIONSHIPS FOR SOUTH CENTRAL ARIZONA POULTRY RANCHES

by

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STATEMENT BY AUTHOR

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Robert C. Angus — Date

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ABSTRACT OF THESIS

COST-SIZE RELATIONSHIPS FOR SOUTH CENTRAL ARIZONA POULTRY RANCHES

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David Lester Schlechty

The principal objective of this inquiry is to determine if economies to size exist and the extent of these economies, if they do exist, in the production of table eggs in South Central Arizona. Input structures assuming above-average management and high efficiency in resource use are budgeted from cross-section survey data obtained by interviews with a sample of 54 producers. Costs are analyzed using the economic-engineering synthesis approach for six sizes of cage flocks from 3,000 to 65,000 layers and five floor-flock sizes from 3,000 to 30,000 layers.

Results of the analysis indicate substantial cost economies can be realized by flock expansion. Per unit cost is reduced 6.3 cents per dozen for cage flocks and 5.2 cents per dozen for floor flocks by expansion from 3,000 to 10,000 layers. Further economies, although only slight beyond a flock size of 10,000 birds, will favor the establishment of large laying flocks.

Arizona producers are in competition with California producers because California producers are presently filling an Arizona egg deficit. A comparison of Arizona and California production costs plus transportation charges revealed a cost disadvantage of 2.3 cents per dozen to Arizona producers. Higher feed costs in Arizona explains at least 50 percent of this disadvantage.

CHAPTER I

INTRODUCTION

Arizona shell egg producers are faced with the cost-price squeeze which embraces the majority of farmers in the United States. With production costs mounting relative to prices received (Figure 1), poultry ranchers[1] are seeking income-improving adjustments.

Shell egg production in the United States in recent years has been characterized by a trend toward larger and fewer ranches. This trend is even more pronounced in Arizona than in the nation. A comparison between U. S. and Arizona farms reporting chickens 4 months old and over and the number reported for select years from 1940 to 1959 is presented in Table 1. Even though the nation has experienced a 58 percent reduction in the number of farms reporting chickens 4 months old and over the chicken population actually increased 4 percent. During the same period of time, the number of ranches in Arizona reporting chickens decreased by approximately 71 percent while layer numbers increased 87 percent. The change in number of

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[1] In the context of this thesis, poultry rancher will be understood to mean a commercial table egg producer.

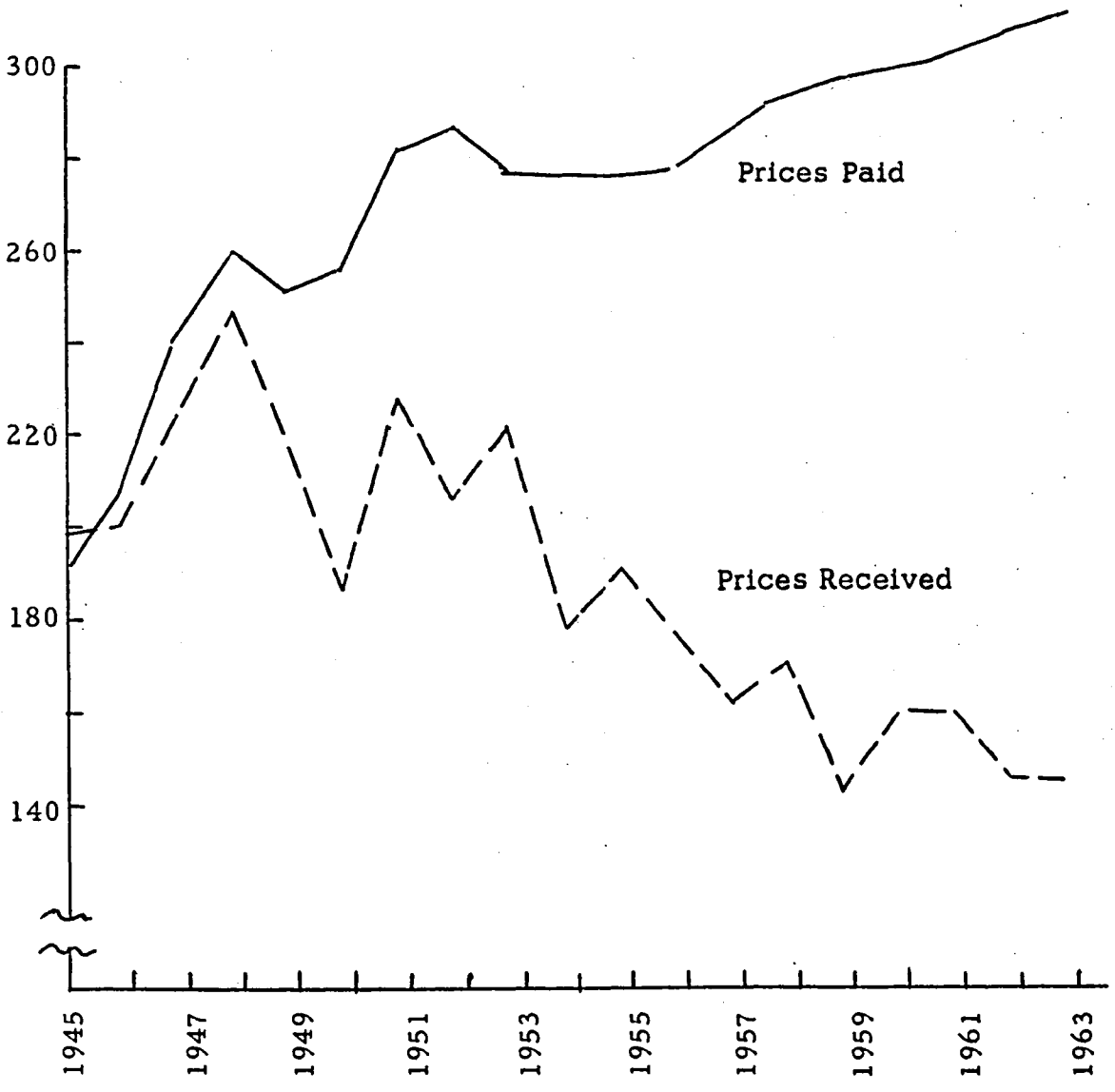

Figure 1.--Index of Prices Received by U. S. Farmers for Poultry and Eggs and Prices Paid from 1945 to 1963 (1910-14 = 100).

Source: Agricultural Prices, U. S. D. A., Statistical Reporting Service, Crop Reporting Board, Washington, D. C., September and May, 1963.

TABLE 1. --Comparison of U. S. and Arizona Farms Reporting Chickens Four Months Old and Over and Number Reported, for Selected Years, 1940 to 1959.

	1940	1945	1950	1954	1959
	Thousands				
United States[a]					
Farms reporting	5,152	4,901	4,219	3,418	2,172
Chickens four months old and over	338,240	433,111	342,956	375,800	351,029
Arizona					
Farms reporting	8	9	6	4	2
Chickens four months old and over	492	638	492	587	921

[a]Data for Alaska and Hawaii not included.

Source: U. S. Census of Agriculture, 1940, 1945, 1950, 1954, and 1959.

birds and ranches in Arizona resulted in an increase from 61 layers per ranch in 1940 to 359 layers per ranch in 1959.

The number of chickens in Arizona has increased annually reaching over one million in 1963.[1] In spite of this growth, in 1963 the state produced only 50 percent of the total number of eggs consumed. Arizona has historically had a deficit egg production. This deficit was filled by egg in-shipments from California, Iowa, Nebraska, Utah, Kansas, and Minnesota until 1960 (Table 2). Since 1960, approximately 98 percent of the in-shipments have originated in California (Figure 2). Transportation has become a relatively minor cost in getting California eggs to Arizona markets due to the proximity of the two states and to the well-developed transit systems between the areas.

Decreases in the relative importance of transportation costs for eggs was reported by A. D. Seale, Jr.[2] He concludes that "technological developments in the transportation industry have virtually eliminated the transportation cost advantages of location for the table egg industry." He states that the "future location of the egg industry

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[1] Rollins, Franklin D., Desert Cackles, Vol. V, No. 5-6, University of Arizona, Tucson, Arizona, p. 3.

[2] Seale, Jr., A. D., Equilibrium Prices and Movement of Eggs in the United States for 1958-60 and 1970, Mississippi Agricultural Experiment Station, Bulletin No. 690, June, 1964, p. 14.

TABLE 2.--Arizona Shell Egg In-Shipments by States of Origin from 1956 to 1964.[a]

	1956-58 average	% of total	1959	% of total	1960	% of total	1961	% of total	1962	% of total	1963	% of total	1964[b] (projected)	% of total
California	176,246	49.82	242,037	60.67	360,891	79.58	553,158	97.87	529,359	96.06	613,026	99.29	715,104	96.64
Iowa	27,743	7.84	64,335	16.13	46,197	10.19	---	---	---	---	4,074	.66	13,440	1.82
Nebraska	38,923	11.00	24,567	6.16	31,881	7.03	11,109	1.97	10,167	1.85	---	---	2,670	.36
Utah	39,039	11.03	13,716	3.44	402	.08	192	.03	2,175	.40	321	.05	120	.02
Kansas	27,882	7.88	21,903	5.49	---	---	600	.11	1,950	.35	---	---	---	---
Minnesota	19,718	5.57	15,561	3.90	---	---	---	---	2,160	.39	---	---	---	---
Colorado	8,898	2.51	8,583	2.15	1,425	.31	---	---	---	---	---	---	---	---
South Dakota	1,899	.54	8,229	2.06	9,279	2.05	---	---	2,268	.41	---	---	---	---
Illinois	2,188	.62	---	---	1,650	.36	---	---	---	---	---	---	---	---
Wisconsin	60	.02	---	---	---	---	---	---	---	---	---	---	4,140	.56
Texas	1,032	.29	---	---	---	---	---	---	3,000	.54	---	---	---	---
Washington	701	.20	---	---	---	---	---	---	---	---	---	---	---	---
Pennsylvania	---	---	---	---	1,800	.40	---	---	---	---	---	---	---	---
Missouri	1,721	.49	---	---	---	---	---	---	---	---	---	---	---	---
New Mexico	---	---	---	---	---	---	126	.02	---	---	---	---	---	---
Arkansas	5,231	1.48	---	---	---	---	---	---	---	---	---	---	4,452	.60
Mississippi	622	.18	---	---	---	---	---	---	---	---	---	---	---	---
Idaho	129	.04	---	---	---	---	---	---	---	---	---	---	---	---
New Hampshire	455	.13	---	---	---	---	---	---	---	---	---	---	---	---
Indiana	450	.13	---	---	---	---	---	---	---	---	---	---	---	---
Canada	809	.23	---	---	---	---	---	---	---	---	---	---	---	---
TOTAL	353,746	100.00	398,931	100.00	453,525	100.00	565,185	100.00	551,079	100.00	617,421	100.00	739,926	100.00

[a]Original data gathered four times annually in February, May, August, and November, by the Arizona State Highway Inspection Stations cooperating with the State Egg Inspector. Yearly totals represent the four monthly totals multiplied by times 3. Data shown in cases. Where original data were in pounds and it was necessary to convert it to cases, a standardized case of large eggs weighing 45 pounds was used. In all instances a case represents 30 dozen eggs.

[b]1964 projected yearly total obtained by adding first two months available, February and May, and multiplying by six.

Source: Calculated from unpublished data obtained from the Arizona State Egg Inspector.

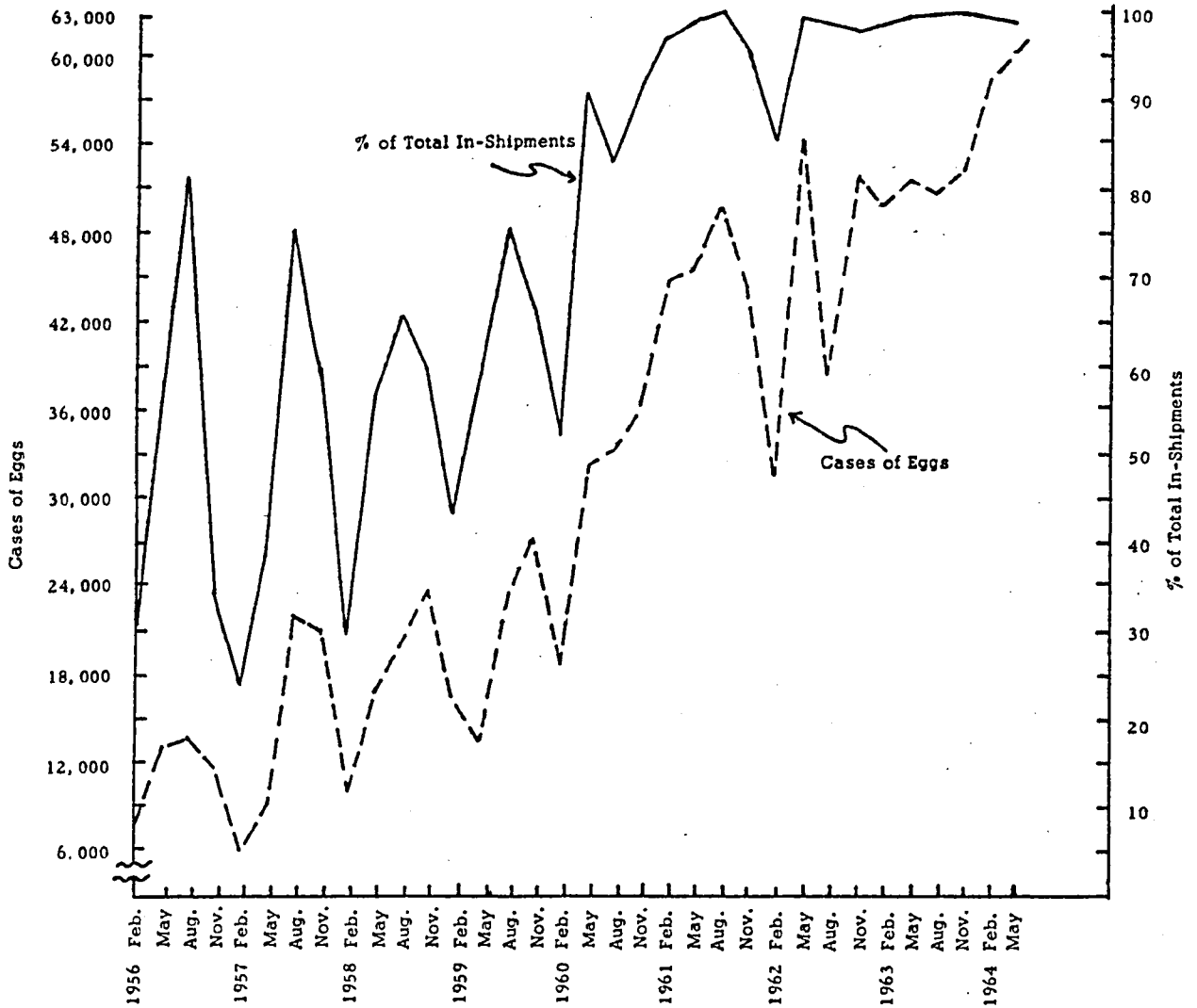

Figure 2. --Arizona Shell Egg In-Shipments from California, by Quarters from 1956 to 1964.

Source: Calculated from unpublished data obtained from Arizona State Egg Inspector.

will be highly dependent upon the technology employed in production and the corresponding cost." Further growth of the Arizona egg industry, therefore, is likely to be determined by the Arizona egg producers' ability to compete effectively with the California producer.

Competition at the present time is on the basis of price and cost of production. Arizona's trend to larger and fewer poultry operations may be viewed as an attempt to increase efficiency and gain a competitive advantage. This trend will result in increased production efficiencies only if economies to size exist. Economies to size are achieved by spreading fixed costs over increasing units of output, through specialization of labor and machinery and by receiving discounts and premiums for purchasing and selling items in quantity. At present, knowledge of the effect of size of enterprise is limited. Yet the question of the magnitude of the reductions in per-unit costs as size of the ranch increases is of importance to ranchers, feed and egg dealers, bankers, and policy makers.[1]

Objectives and Procedure

Economies to size information is needed to determine the size of operation required for egg producers to compete effectively

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[1] In this thesis the relationship between per unit costs of production and size of the poultry ranch (measured by number of layers) will be referred to as "economies to size."

in the long run. Operators may use additional information to plan changes in the physical components of production and to attain more efficient operation or expansion. Therefore, the principal objective of this study is to determine the extent to which flock size affects unit costs in the production of table eggs for the two types of laying flocks prevalent in Arizona (cage and floor flocks). This general objective is supported by the following specific objectives:

1. To determine the components of production costs[1] and their relative importance to total costs for floor and cage flocks.
2. To determine for floor and cage flocks the effect of size of operation upon costs of producing eggs.
3. To compare production costs between floor and cage flocks.
4. To determine current efficiencies and trends in commercial egg production for purposes of comparison with past and future data and for management decisions.
5. To explore the competitive position of the Arizona commercial egg producer by comparing costs of production in Arizona under optimum conditions with the costs of producing and transporting California eggs to Arizona.

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[1]This study is concerned only with costs associated with the production of eggs. Egg production, in this study, ceases when the eggs have been gathered and are placed in the egg cooler.

Cost economies will be examined assuming above-average management and relatively high efficiency in resource use. That is, cost-size relationships are approximated using production levels and production techniques reported by the better operators in Pima, Pinal, and Maricopa Counties. These relationships, then, are approximated under ideal or optimum resource use rather than actual or "typical" conditions. Structures combining "above-average" management and "above-average" layers more nearly depict the relevant cost relationships for decision-making in a long-run competitive framework, such as agriculture.

The remainder of this chapter consists of a review of literature pertaining to economies to size in egg production, followed by a discussion of the theoretical concepts which provide the basis for analysis of cost economies. Data sources and a description of the population are presented in Chapter II. Empirical analysis of cost relationships follows, with resulting conclusions from the analysis presented in Chapter IV. Detailed information as to assumptions and methodology used are presented in Appendix I. The interview schedule which was used in obtaining the necessary information for this study is shown in Appendix II.

Review of Literature

A review of the literature revealed three studies pertaining to economies to size in egg production.[1] However, recent studies conducted in California and Arizona investigated production economies for several other western farming enterprises and related them to size.[2] These studies, though not specifically related to economies associated with egg production, were of assistance in developing the methodology and general procedure. The three studies dealing with economies to size in egg production will be reviewed separately.

The procedure followed in the first phase of Stenberger and Jasper's study was to design hypothetical housing units as conventional

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[1] These studies are: Stenberger, A. P. and W. J. Jasper, Effects of Flock Size and Housing Density on Egg Production Costs, A. E. 110, Dept. of Agricultural Economics, North Carolina State University, Raleigh, Jan. 1964; Eisgruber, L. M., E. W. Kehrberg and J. W. Sacer, Effects of Flock Size on Egg Production Costs and Returns, Res. Bul. No. 688, Indiana Agr. Expt. Sta., Lafayette, Dec. 1959; Bailey, J. M., What Size Laying Flock? A. E. 10502, Dept. of Agricultural Economics, Cornell University, Ithaca, New York, Jan. 1957.

[2] Martin, William E. and William K. Goss, Cost-Size Relationships for Southwestern Arizona Cattle Ranches, Arizona Agr. Expt. Sta. Tech. Bul. 155, Nov. 1963; Martin, William E. and James S. Hill, Cost-Size Relationships for Central Arizona Dairies, Arizona Agr. Exp. Sta. Tech. Bul. 149, Sept. 1962; Carter, H. O. and G. W. Dean, Cost-Size Relationships for Cash Crop Farms in Imperial Valley, California, California Agr. Expt. Sta., Giannini Found. Mimeo Rep. No. 253, May 1962; Dean, G. W. and H. O. Carter, Cost-Size Relationships for Cash Crop Farms in Yolo County, California, California Agr. Expt. Sta., Giannini Found. Mimeo Rep. No. 238, Dec. 1960; King, Gordon A., Economics of Scale in Large Commercial Feedlots, California Agr. Expt. Sta., Giannini Found. Mimeo Rep. No. 251, March 1962.

facilities with two square feet of floor space per bird.[1] Costs of producing eggs were then estimated by budgeting techniques for each model housing facility and the effects of size noted. The second phase examined the association between bird density and costs of production for bird density rates of 3.0, 2.5, 1.5, 1.0, and .826 square feet of floor space per bird. Unit costs were compared for each house size as the level of housing density was varied. Throughout the study input-output levels were synthesized on the basis of production coefficients determined from engineering data and previous research results.

The authors concluded that definite economies existed as flock size increased and that economies were primarily a result of reduction in feed price, electricity cost, and equipment investment per bird. In their analysis, average total cost per dozen eggs produced declined from 31.6 cents for a 1,500 bird flock to 29.41 cents for a 14,000 bird operation with 2.0 square feet per bird. Similar economies were found for housing density levels of 3.0, 2.5, 2.0, 1.5, 1.0, and .826 square feet of floor space per bird.

Eisgruber,[2] et al., and Bailey's[3] studies utilized data obtained in a survey of sample egg producers in Northeastern Indiana and South

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[1] Stenberger, op. cit., p. 7.

[2] Eisgruber, et al., op. cit.

[3] Bailey, op. cit.

Central New York, respectively. Eisgruber's, et al., study includes various flock sizes ranging from 150 to 1,300 birds. Production costs decreased from 48 cents per dozen for flocks under 250 layers to 31 cents per dozen for flocks from 1,000-1,500 layers. Meaningful cost comparisons between Arizona and Indiana are impossible since the present study considers only flocks of over 2,000 layers while in Eisgruber's study the largest flock included was 1,300 birds.

Bailey utilized records from 64 poultry farms to develop group average for three size flocks. He determined that costs per dozen eggs produced decreases as flock size is increased. His conclusions were based on survey averages for the different size flocks observed. He found that farms with flocks averaging over 5,000 layers produced eggs for about 49 cents per dozen. This was 5.5 cents less per dozen than the average cost for the group of small flocks (under 3,000 layers) and about 2 cents less than that of the flocks from 3,000-5,000 birds.

The studies reviewed have limited application in Arizona, since none considered flocks larger than 14,000 birds, while commercial flocks in Arizona typically contain from 10,000 to 75,000 layers. In addition, the studies were carried out in regions having different climatic conditions which would result in differences in production relationships. These studies, at best, provide rough guides to economies to size for egg producers in Arizona.

Theoretical Basis for Analysis of Cost Economies[1]

Costs and Time

The basic goal for an economy to size study is to determine the nature of average unit cost curves. Consideration of the costs of producing any product is necessarily linked with a specific time period. The way in which the costs of producing a product varies as output level is changed will depend upon the length of the time period considered. Distinction between time periods is determined by the ease with which resources "tied up" in the production process can be transferred to other processes. This ease of transferrence is used to distinguish "short-run" and "long-run" periods.

The Short Run. --The short-run is defined by Jacob Viner[2] as "a period which is long enough to permit of any desired change of output technologically possible without altering the scale of plant,

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[1]Theoretical constructs of economies of scale are widely discussed in economic literature. For example see: Viner, Jacob, "Cost Curves and Supply Curves," Readings in Economic Analysis, Vol. 2, edited by R. V. Clemence, Addison-Wesley Press, Inc., Cambridge, Mass., 1950, pp. 8-34; Boulding, Kenneth E., Economic Analysis, Harper and Brothers Publishers, New York, Third ed., 1955, pp. 671-690; Stigler, George J., The Theory of Price, Macmillan Co., New York, revised ed., 1952, pp. 134-147.

[2]Viner, Jacob, "Cost Curves and Supply Curves," Readings in Economic Analysis, Vol. 2, edited by R. V. Clemence, Addison-Wesley Press, Inc., Cambridge, Mass., 1950, p. 11.

but which is not long enough to permit of any adjustment of scale of plant."[1] The short-run is characterized by the presence of one or more fixed resources. In the short-run all factors of production can be classified as either fixed (those factors of production which do not vary with and are not a function of output) or variable (those which vary with and are a function of output). Throughout the remainder of this thesis costs associated with fixed factors will be referred to as "fixed costs" and those associated with variable factors will be called "variable costs."

Individual firm short-run average cost (hereafter denoted SRAC) curves are basic to the theoretical presentation of economies to size curves. In the conventional theory of economies to size, the SRAC curves are "U" shaped. The traditional explanation for this shape is that average per unit costs of production decline in the short-run with expansion of output as fixed costs are spread over increasing units of output. The rise of SRAC at higher outputs is associated with the addition of variable factors which are increased in increasing proportion to the fixed factors as output proceeds beyond the least cost level. Thus, a SRAC curve traces out in effect an average cost

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[1] "Scale of plant" as used by Viner refers to the amount of the factors which are fixed in the short-run, and each scale will be quantitatively indicated by the quantity of output which can be produced at the lowest average cost possible at that scale.

as more of the variable inputs are applied to the fixed plant. For every combination of fixed resources there exists an SRAC curve. The size of a firm's plant[1] is determined by the quantity of fixed resources used in the production of a product.

Hypothetical SRAC curves for four sizes of firms are presented in Figure 3. A long-run average cost (hereafter denoted LRAC) curve or economies to size curve is then generated by constructing an envelope curve tangent to the average cost curves (Figure 3). A small size plant $SRAC_1$ operating at capacity is able to produce a small amount of output, Q_1, more cheaply than a somewhat larger size plant $SRAC_2$ operating at less than capacity (Figure 3). The vertical distance AB illustrates graphically $SRAC_1$'s cost advantage in producing output Q_1. However, as output is increased, larger size plants will result in lower per unit costs. It is also quite possible that two or more firms of equal size producing the same output may have different unit costs of production resulting from different levels of plant efficiency. $SRAC_1$ and $SRAC_4$ illustrate this (Figure 3).

Output beyond the point where each SRAC curve is tangent to the LRAC curve is not relevant in this study. This is because output

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[1]An increase (decrease) in size of plant refers to an increase (decrease) in amount of fixed resources in any given combination, whereas increase (decrease) in scale of plant refers to increasing (decreasing) all fixed factors in a constant proportion.

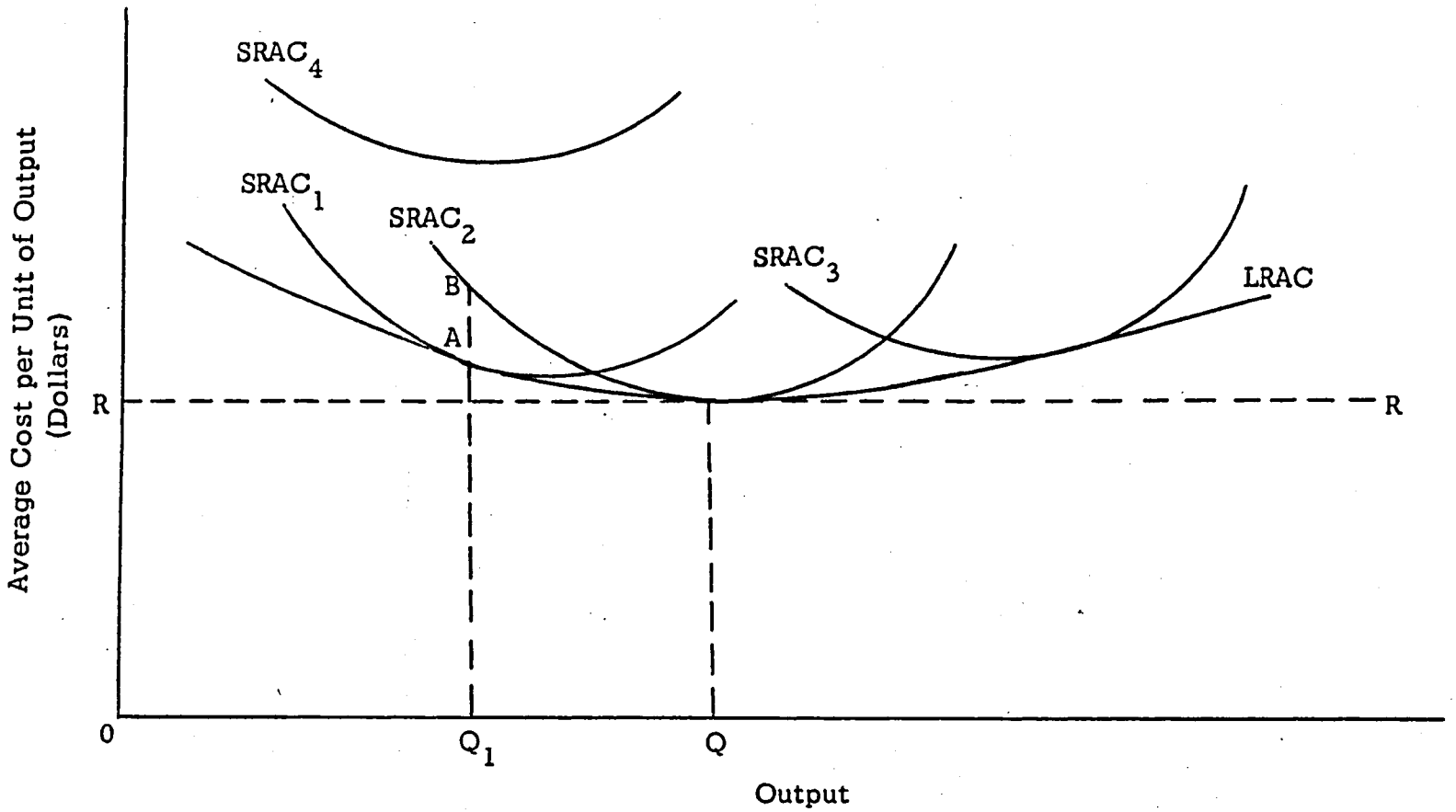

Figure 3. --Hypothetical Short-Run and Long-Run Average Unit Cost Curves for Different Size Plants.

at this point is defined as capacity for the given size plant, thus each of the SRAC curves becomes discontinuous at this point (Figure 4). Buildings, machinery, and poultry equipment are considered fixed resources in this study because they are not easily varied in the short run. Thus, as the number of laying hens varies the output is varied. $SRAC_1$ illustrates the average cost per dozen eggs produced given a small size laying house and a particular set of machinery and equipment, as the numbers of layers housed is varied (Figure 4). Curve $SRAC_2$ is a similar average unit cost curve, but for a set of fixed resources with a slightly larger output potential. Curve $SRAC_3$ has a similar interpretation.

The Long-Run. --The long-run as defined by Jacob Viner "is a period long enough to permit each producer to make such technologically possible changes in the scale of this plant as he desires."[1] There are no fixed resources in the long run, all resources are freely variable--land may be purchased, buildings may be built, and machinery and equipment may be acquired. The LRAC curve theoretically traces out the minimum cost of producing each level of output under the assumptions of specific levels of technology and factor costs.

Under these conditions any point on the LRAC curve indicates the least-cost combinations of inputs required to produce a specified

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[1]Viner, op. cit., p. 13.

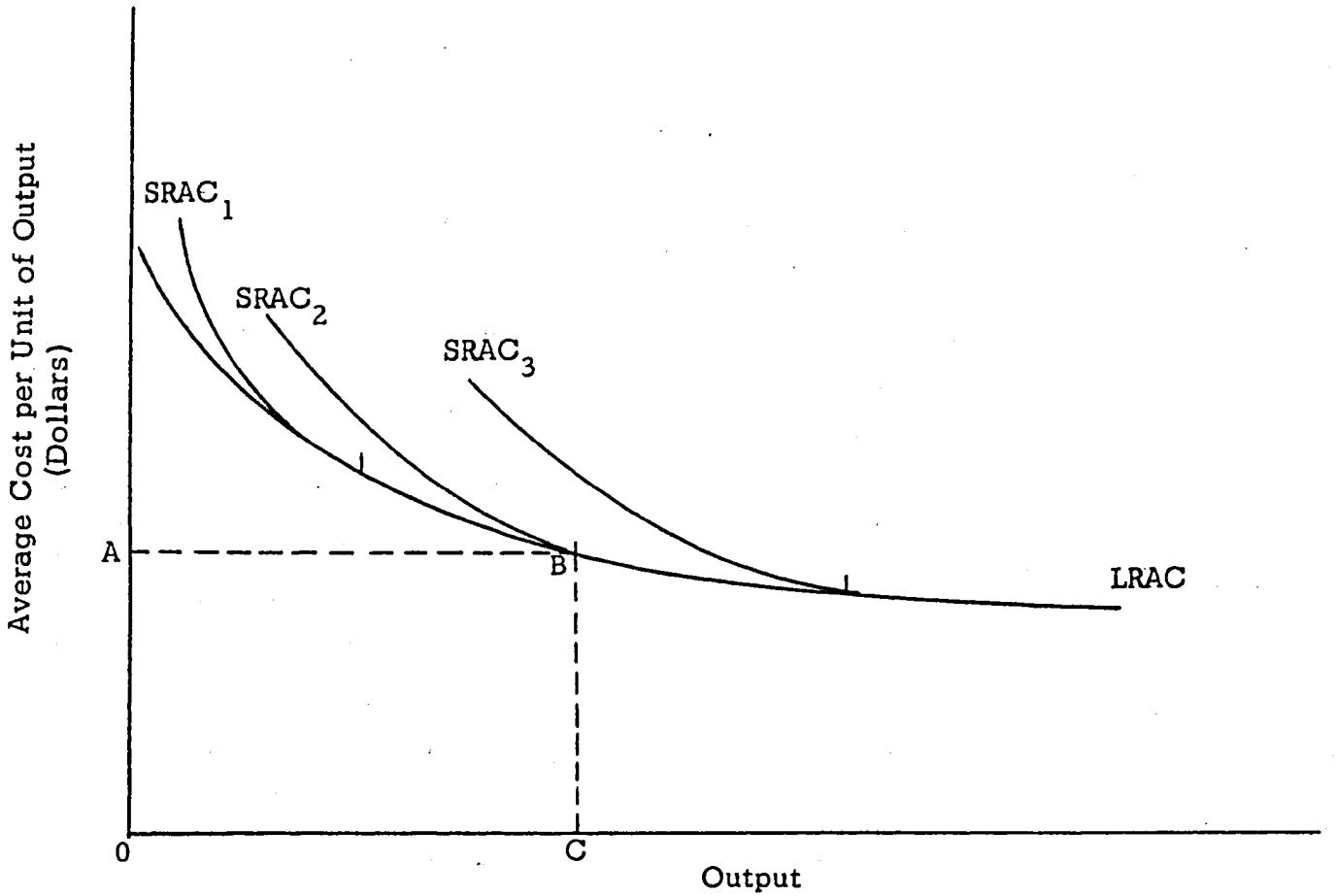

Figure 4. --Hypothetical Short-Run and Long-Run Average Unit Cost Curves for Different Size Plants of This Study.

output. Point B lies on the LRAC curve of Figure 4; consequently, OA is the lowest average cost for which output OC can be produced. In reality the LRAC curve is a "planning curve" because in long-run planning an entrepreneur could decide to produce any output level and organize his resources to produce at any cost per unit shown by the LRAC curve. Once a given output level is selected, it can in principle be determined which particular combination of buildings, machinery, equipment, and optimum number of layers yields lowest average cost per unit of output. However, once a particular setup is chosen the period and the entrepreneur are then restricted by the fixed resource combination he chose.

Size and Cost Economies

Adjustments in "size" of plant are possible by two alternative means. A firm may either increase or decrease in size through scale adjustments. This is defined to mean that all factors of production are changed in constant proportions. However, the majority of size adjustments observed were obtained by changing the factor mix rather than through scale adjustments. For example, a commercial poultry rancher raising his replacement pullets will require a brooder house whether replacement occurs once annually or several times annually. Thus, the size of flock may be varied without changing the fixed

resource combination. The factor which is most often not held in proportion as size is varied is management.

Throughout the remainder of this thesis the term "change" or "difference" in size will refer to different firm or plant capacities which are possible through expansion by either scale, proportionality, or some combination of the two.

Cost economies or diseconomies may appear with modification in the size of a plant. These refer to decreases or increases in per unit cost as size is varied and may be either internal or external to the individual producing unit. They may also be pecuinary or technological in nature.[1]

Internal Economies and Diseconomies. --The term internal economies refers to those economies realized from size adjustments within the producing unit. They are independent of the size of output of the industry. Technological (physical) internal economies are economies realized via reduction of technological coefficients of production. Savings in materials, equipment, or labor requirements per unit of output resulting from improved organization or methods of production made possible by a larger size operation would be considered technological internal economies. Cost economies of this

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[1] Heady, Earl O., Economics of Agricultural Production and Resource Use, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1960, p. 361.

type arise when the indivisibility of factors is overcome by firm growth and output expansion. For example, the egg producer with a relatively small laying flock may feed by hand while a rancher with a larger flock may employ automated feeding equipment. Automatic feeding equipment can be employed on small operations although the associated high fixed costs often prohibit it.

Internal pecuniary (market) economies are those associated with reductions in the prices paid for the factors as the result of increases in the amounts purchased. Economies of this nature grow out of advantages in buying. Quantity discounts and the ability to gain a premium for product sales due to large uniform sales are examples. Ranchers purchasing feed by the truck load will most certainly pay less per ton than an individual purchasing by the hundred weight.

Internal diseconomies in agriculture are largely of a technical nature. Beyond a certain size of plant, management and space become limiting factors resulting in diminishing productivity for other resources. An example would be the addition of more and more layers to a fixed set of buildings. Eventually disease, higher mortality, and other diseconomies would result, causing factor productivity to decline and the SRAC curve of the firm to rise.

Economic theorists disagree as to whether the long-run average cost curve ever rises. However, the rise of the LRAC curve is frequently

attributed to limitations of management. Since the LRAC curve has meaning only with reference to the long run and all resources are variable in the long run an inconsistency results. It appears correct to state that the emergence of the problems of coordination arising from increasing firm complexity causes the LRAC curve to rise. This is not to say that such problems do not arise until output is pushed past the LRAC curve's minimum point. As a rule, these coordination problems may appear at an early stage of plant expansion. But "in the early stages they are submerged by the overwhelming gains from further specialization and more efficient techniques. But since these latter tend to exhaust themselves with larger aggregates, whereas complexity steadily increases, it appears certain that the diseconomies must sooner or later outweight the economies, and beyond that point predominate. The forces making for economies and for diseconomies are in balance at the minimum point on the LRAC curve; the latter predominate to the right."[1]

External Economies and Diseconomies. --Reductions in unit costs not directly related to the size of individual operations but which result from expansion of the industry are known as external economies. External economies arise solely from the industry's output expansion

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[1]Chamberlain, Edward C., "Proportionality, Divisiblity, and Economics of Scale," Quarterly Journal of Economics, February, 1948, p. 249.

and are independent of any one firm's output. External economies like internal economies may be of either a technological or pecuniary nature. Illustrations of external economies in agriculture are not widespread. They are even of lesser importance in the poultry industry. One example of an external physical economy (although it might equally be considered as a market economy) would be a rancher who is able to purchase a share in a community water line rather than constructing his own water system. External pecuniary economies arise when the number and size of ranches increase to such an extent that feed mills, marketing outlets, etc., are built up to give a lower cost for the products produced.

External diseconomies accruing to a firm are, according to Jacob Viner, "of indisputable practical importance." He emphasizes this by asserting that, "pecuniary diseconomies will always tend to result from the expansion of output of an industry because the increased purchases of primary factors and materials which this entails must tend to raise their unit prices."[1] For example, a rancher producing eggs may find that as the industry expands it becomes increasingly difficult to obtain locally hatched replacement pullets, necessitating the purchase of out-of-state replacements either of an inferior quality or at an increased cost. Both represent external market diseconomies.

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[1]Viner, op. cit., p. 25.

An example of external technical diseconomies would be where one rancher by pumping additional water causes less to be available to his neighbor thus causing pumping costs to rise.

It is not the purpose of this thesis to present an analysis of the entire poultry industry in the area. Although external economies may be very important in egg production this study is primarily concerned with the internal type of economy, the relation of costs of production to the size of flock.

Net Economies and Diseconomies. --"Net" economies or diseconomies are introduced to emphasize that a change in output of a firm may result in economies and diseconomies simultaneously. For example it is quite conceivable that a ranch might be realizing economies to size in its use of buildings, equipment capacities, feed purchases, etc., while at the same time experiencing diseconomies in the employment of labor or some other resource. Throughout the remainder of this thesis reference to economies or diseconomies of size will refer specifically to "net" economies or diseconomies.

Adjustments

Poultry ranchers are generally interested in maximizing profits. $SRAC_2$ represents the optimum size plant, where unit cost is minimized (Figure 3). In a purely competitive economy returns would establish an equilibrium at R and only those firms producing

output Q from the size of plant corresponding to $SRAC_2$ would continue covering all production costs. If returns were greater than R profits[1] could be made by firms larger or smaller than optimum. Maximum profit occurs where marginal cost (additional cost of producing the last unit of output) equals marginal revenue (additional revenue derived from this unit). Marginal revenue is identical with price for the competitive firm since all firms receive the same price at a given time and no firm's expansion can affect price in a purely competitive market. If returns are above minimum unit cost R, at output Q in Figure 3, the additional or marginal cost of producing the last unit of output must be greater than the minimum cost when marginal cost is equal to marginal revenue. Thus the average unit cost of production must be rising. Under these conditions profit maximization will be as some output level greater than Q, in Figure 3.

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[1] Profit is herein understood to mean the residual accruing after all factors of production have been paid their market value.

CHAPTER II

DATA SOURCES AND DESCRIPTION OF POPULATION

Attainment of the thesis objectives required that costs of producing eggs be ascertained by construction of realistic synthetic models representing various size laying flocks. Before models could be developed, data on the physical resources of various sizes of laying flocks were necessary. These data were obtained by personal interviews with poultry ranch operators in South Central Arizona. The interviews were conducted during the spring and summer of 1964. These data were based on production records for 1963, [1] and were supplemented with engineering and cost data from individuals and firms supplying factors of production to poultry ranches. Secondary sources utilized includes publications of the Arizona Agricultural Experiment Station and other Agricultural Experiment Stations. Other secondary sources were unpublished materials in the files of the Department of Agricultural Economics and the Department of Poultry Science at the University of Arizona and the Arizona State Egg Inspector.

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[1] In most cases records were based on the 1963 calendar year; for some large ranches records were based on their 1963 fiscal year.

The three-county study area of South Central Arizona includes Pima, Pinal, and Maricopa Counties (Figure 5). A listing of all egg producers in the state, available from the Poultry Extension Specialist at the University of Arizona, showed that the area in this study incorporates approximately 79 percent of the state's total number of commercial poultry ranches.[1] This information is kept current by the State Egg Inspector. In 1963 over 89 percent of the state's total layers were included in the study area (Table 3). The other 11 counties of the state account for the remaining 21 percent of the commercial poultry ranches and 11 percent of the layers. Seventy-five percent of the poultry operations outside the study area were small flocks of under 7,000. In no instance was there a flock of over 20,000 layers outside the three-county area included in this study.

No attempt to sample randomly was made because the study area includes a total of only 74 commercial poultry ranches. A complete enumeration of "eligible" ranchers in the area was planned to avoid bias and to increase reliability.

Eligible ranches for the study were those meeting the following requirements:

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[1]For purposes of this study a commercial poultry ranch was defined as one having 2,000 layers or more.

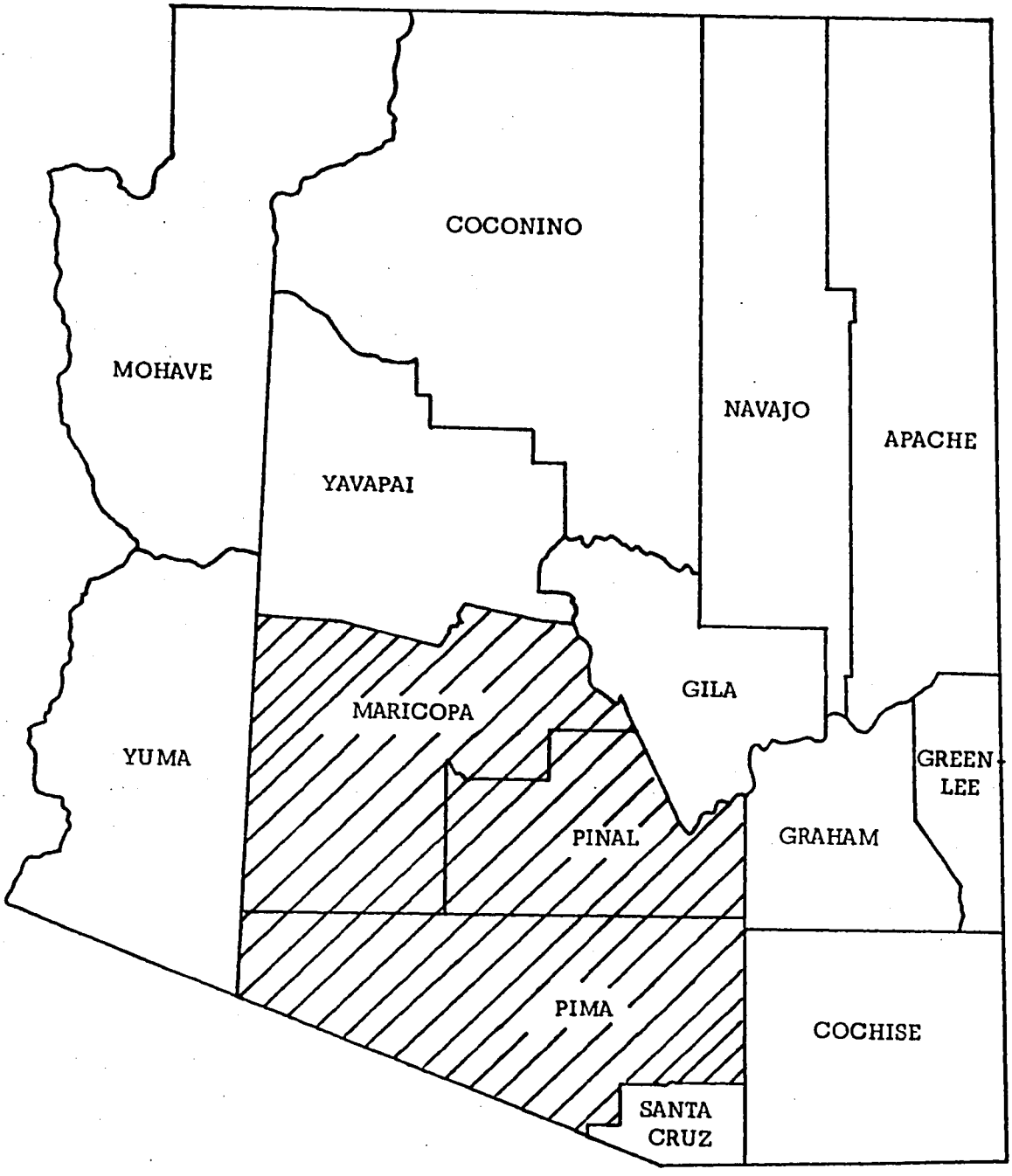

Figure 5.--State of Arizona Showing Three-County Study Area in South Central Arizona.

Legend: ▨ Area in Study

TABLE 3.--Sample Size Groups of This Study, Defined Relative to Laying Flock Size, Showing Disposition of Commercial Flocks[a] and Laying Hens in State, and in Study Area.

Size Group	Size of Laying Flock	Arizona				Pima				Pinal				Maricopa				11 Remaining Counties			
		Poultry Ranches[b]	% of State Total	Laying Hens[c]	% of State Total	Poultry Ranches[b]	% of State Total	Laying Hens[c]	% of State Total	Poultry Ranches[b]	% of State Total	Laying Hens[c]	% of State Total	Poultry Ranches[b]	% of State Total	Laying Hens[c]	% of State Total	Poultry Ranches[b]	% of State Total	Laying Hens[c]	% of State Total
		Number	%	Head	%	Number	%	Head	%	Number	%	Head	%	Number	%	Head	%	Number	%	Head	%
I	2,000- 3,999	34	36.17	85,600	8.47[d]	6	6.38	17,500	1.73	2	2.13	5,000	.50	18	19.15	44,100	4.37	8	8.51	19,000	1.88
II	4,000- 6,999	25	26.60[d]	130,300	12.90[d]	9	9.57	48,500	4.80	0	0	0	0	9	9.57	45,000	4.45	7	7.45	36,800	3.64
III	7,000-12,999	15	15.96	140,000	13.86[d]	7	7.45	66,200	6.55	0	0	0	0	4	4.26	36,000	3.56	4	4.26	37,800	3.74
IV	13,000-19,999	9	9.57	138,500	13.71	3	3.19	48,000	4.75	1	1.06	15,000	1.48	4	4.26	61,000	6.04	1	1.06	14,500	1.44
V	20,000-39,999	6	6.38	181,000	17.91	3	3.19	84,000	8.31	1	1.06	31,000	3.07	2	2.13	66,000	6.53	0	0	0	0
VI	40,000 +	5	5.32	335,000	33.15	4	4.26	270,000	26.72	1	1.06	65,000	6.43	0	0	0	0	0	0	0	0
	TOTALS	94	100.00	1,010,400	100.00[d]	32	34.04	534,200	52.86	5	5.32	116,000	11.48	37	39.37	252,100	24.95	20	21.28	108,100	10.70

[a]Commercial flock, defined as one having 2,000 layers or more.

[b]As of July, 1964.

[c]As of December, 1963.

[d]Additions across the row are off .01 percent due to rounding.

1. Location. --The ranch must be located within the boundaries of Pima, Pinal, or Maricopa County.
2. Commercial poultry ranch. --The ranch must be a commercial business operated primarily for profit, excluding experimental ranches, "hobby" or "show" ranches, and other similar operations. A commercial poultry ranch was defined as one having 2,000 layers or more during the 1963 production period.
3. Type of ranch. --To qualify as a poultry ranch, the flock must have been kept for purposes of table egg production. No ranches producing eggs for purposes other than table egg consumption were included in this study. To qualify as a cage flock operation all of the ranch's laying hens had to be housed in cages. A like qualification applied to floor flocks. A flock was classified as a mixed flock if any portion of the laying flock was on the floor while the remainder were in cages. The mixed flocks were then allocated to either the cage or floor flocks depending upon the management practice employed in housing the majority of the flock.

Records were obtained from each of the ranchers interviewed. Information was obtained from each on land, buildings, equipment and

machinery investment, labor use, bird inventory, rate of lay, ranch expenses, and related data (see Appendix II for a copy of the schedule used to obtain the necessary data for this study). Ranch records and income tax summaries proved to be the main source of data for individuals interviewed. In a few cases where verifiable information was not readily available memory of the operator was used.

A total of 67 interview schedules were obtained from poultry ranchers in the area. Of these, 54 were used in the analysis. Of the 13 schedules not used, 3 were excluded because of failure to meet the minimum laying flock size of 2,000 layers or more. The remaining 10 were not used because of inaccurate or incomplete information. The rate of "refusals" and "unable to contact" was reasonably low, totaling approximately 10 percent.

The final number of detailed cost interviews and average number of laying birds included in the study are compared with the number of ranches and the number of birds in the study area and the state (Table 4). Considering only commercial flocks, Table 4 shows that the sample of ranches obtained by interview includes approximately 72 percent of the laying hens and 73 percent of the poultry ranches in the three-county study area. On the state level the sample accounts for roughly 65 percent of the laying hens and 57 percent of the state's total commercial poultry ranches. A summary of the total number of

TABLE 4.--Sample Size Groups of This Study, Defined Relative to Laying Flock Size, Disposition of Commercial Flocks and Laying Hens in State, in Study Area, and in Sample.

Size Group	Size of Laying Flock	In State		In Study Area		In Sample	
		No. of Poultry Ranches[b]	No. of Laying Hens[c]	No. of Poultry Ranches[b]	No. of Laying Hens[c]	No. of Detailed Cost Interviews	No. of Laying Hens[d]
I	2,000- 3,999	34	85,600	26	66,600	19	57,001
II	4,000- 6,999	25	130,300	18	93,500	11	58,966
III	7,000-12,999	15	140,000	11	102,200	9	90,164
IV	13,000-19,999	9	138,500	8	124,000	7	111,149
V	20,000-39,999	6	181,000	6	181,000	5	145,444
VI	40,000 +	5	335,000	5	335,000	3	191,402
	TOTAL	94	1,010,400	74	902,300	54	654,126

[a]Commercial flock, defined as one having 2,000 layers or more.

[b]As of July, 1964.

[c]As of December, 1963.

[d]Sample averages.

usable schedules, by size and type of laying flock included in the study is shown in Table 5.

TABLE 5.--Summary of Usable Detailed Cost Interviews, by Size and Type of Flock, South Central Arizona, 1963.

Size Group	Size of Laying Flock	Number of Usable Schedules			
		Cage Flocks	% of Total	Floor Flocks	% of Total
I	2,000- 3,999	12	38.7	7	30.4
II	4,000- 6,999	3	9.7	8	34.8
III	7,000-12,999	6	19.4	3	13.0
IV	13,000-19,999	5	16.1	2	8.7
V	20,000-39,999	2	6.4	3	13.0
VI	40,000 +	3	9.7	0	0
TOTAL		31	100.0	23	100.0[a]

[a]Due to rounding, column addition does not total 100.0.

CHAPTER III

RESULTS OF EMPIRICAL COST ANALYSIS

The cost analysis, which follows, provides the empirical counterpart for the theoretical short-run and long-run average cost curves discussed previously in Chapter I. Presentation of the results is divided into four major sections: (1) cage laying flocks, (2) floor laying flocks, (3) unit cost comparisons between cage and floor flocks, and (4) Arizona and California unit cost comparisons. The general method of analysis is identical for both cage and floor flocks.

The development of a cost structure necessitates separation of the empirical observations into distinct size classes because cost behavior in both the short run and long run must be estimated. In this study, size classification is by average number of laying hens in the flock. The size groups are subdivided into cage and floor flock operations. This type classification facilitates comparison between type of flock as well as among the various size flocks.

Six poultry building inventories were developed on the basis of the respective samples. They represent optimum resource combinations for cage flocks in each of the six size groups. Optimum was used in the sense that the inventories were developed from the most efficient

firms observed. Five such resource combinations for flocks housed on the floor were developed. The cage flock group has one additional flock size at the extreme upper end of the survey data.

Costs assignable to the production imputs are determined by the synthetic economic-engineering process. The production levels and efficiencies used are typical of those attained by the better producers in the study area. Thus, the production coefficients are presented as representing the optimum in resource use and efficiencies for the study area. In general the flocks surveyed were experiencing some "excess capacity" in the utilization of their resources. Therefore each optimum resource combination was adjusted to eliminate excess resources. The laying house was used as the base unit. Other resources were adjusted in size and amount to fit the capacity of the laying house. Poultry buildings were assumed to be the limiting "fixed" factor in determining a short-run capacity for each synthetic resource combination. The capacities of the other fixed factors such as poultry equipment and machinery are not as sharply definable.

Cage Laying Flocks

The fixed resource combinations were assembled on the basis of the operations examined for each of the six cage flock size groups and are shown in Table 6. The "fixed costs" for this analysis include

TABLE 6.--Fixed Resources by Investment Group, South Central Arizona Cage Flocks, 1963.

Item	Investment Group					
	I (3,000)[a]	II (5,000)[a]	III (10,000)[a]	IV (15,000)[a]	V (30,000)[a]	VI (65,000)[a]
Buildings						
Labor housing				1, frame, 720 sq. ft.	1, frame, 720 sq. ft.	4, frame, 3,160 sq. ft. total
Livestock facilities						
Laying houses	1, frame, lath siding, metal roof, 5,760 sq. ft.	2, frame, lath siding, metal roof, 9,600 sq. ft. total	3, frame, lath siding, metal roof, 14,976 sq. ft. total	3, frame, lath siding, metal roof, 21,696 sq. ft. total	6, frame, lath siding, metal roof, 43,392 sq. ft. total	11, frame, lath siding, asphalt walkways, metal roof, 94,464 sq. ft. total
Replacement houses	1, frame, lath siding, metal roof, 1,080 sq. ft.	1, frame, lath siding, metal roof, 2,048 sq. ft.	combination replacement and brooder house--1, frame, metal and lath siding, metal roof, 6,000 sq. ft.	1, frame, lath siding, metal roof, 4,800 sq. ft.	2, frame, lath siding, metal roof, 6,816 sq. ft. total	3, frame, lath siding, metal roof, 24,000 sq. ft. total
Brooder houses	1, frame, metal siding, concrete floor, metal roof, 540 sq. ft.	1, frame, metal siding, concrete floor, metal roof, 1,040 sq. ft.		1, frame, metal siding, concrete floor, metal roof, 2,400 sq. ft.	2, frame, metal siding, concrete floor, metal roof, 5,760 sq. ft. total	2, frame, metal siding, concrete floor, metal roof, 12,880 sq. ft. total
Other facilities						
Egg house	1, concrete block, 192 sq. ft.	1, concrete block, 308 sq. ft.	1, concrete block, 600 sq. ft.	1, concrete block, 600 sq. ft.	1, concrete block, 750 sq. ft.	1, concrete block, 1,200 sq. ft.
Egg cooler room	walk-in box type, insulated, 288 cu. ft.	walk-in box type, insulated, 384 cu. ft.	walk-in box type, insulated, 960 cu. ft.	walk-in box type, insulated, 1,344 cu. ft.	walk-in box type, insulated, 2,048 cu. ft.	walk-in box type, insulated, 2,816 cu. ft.
Shops						1, frame, metal siding, metal roof, 864 sq. ft.
Machinery and equipment						
Tractor						1, utility, 40-50 H.P., with front end loader

TABLE 6--Continued

Item	Investment Group					
	I (3,000)[a]	II (5,000)[a]	III (10,000)[a]	IV (15,000)[a]	V (30,000)[a]	VI (65,000)[a]
Truck					1, 2-ton, stake platform, with rack	1, 2-ton, stake platform, with rack
Pickup and/or auto (poultry share)	1, 6-passenger station wagon	1, 1/2 ton	1, 1/2 ton	1, 1/2 ton	1, 1/2 ton	1, 1/2 ton
Feed tanks	1, metal, 290 cu. ft.	3, metal, 719 cu. ft. total	4, metal, 1,160 cu. ft. total	5, metal, 1,148 cu. ft. total	8, metal, 2,320 cu. ft. total	16, metal, 4,640 cu. ft. total
Feeders	metal, 28 (36" chick), 34 (60" pullet)	metal, 56 (36" chick), 67 (60" pullet)	metal, 120 (36" chick), 144 (60" pullet)	metal, 145 (36" chick), 174 (60" pullet)	metal, 334 (36" chick)	3 auto. type, 1,500 ft. total, 723 (36" chick),
Waterers	6, auto. 8', stand type	10, auto. 8', stand type	21, auto. 8', stand type	25, auto. 8', stand type	28, auto. 8', stand type	125, auto. 8', stand type
Brooders	3, gas, 6', 500 chick cap.	4, gas, 6', 500 chick cap.	6, gas, 6', 500 chick cap.	8, gas, 6', 500 chick cap.	15, gas, 6', 500 chick cap.	35, gas, 6', 500 chick cap.
Cages	1,530, wire, 10 x 18"	2,560, wire, 10 x 18"	2,520, wire, 16 x 18"	3,768, wire, 16 x 18"	5,796, wire, 24 x 18"	10,944, wire, 24 x 18"
Feed and/or egg carts	1, metal push, 3 wheel	2, metal push, 3 wheel	3, metal push, 3 wheel	1, elect. truck, 500 lbs. cap.	1, elect. truck, 500 lbs. cap.; 2, metal push, 3 wheel	1, elect. truck, 500 lbs. cap.; 5, metal push, 3 wheel
Egg room cooler	1, 1/2 H.P. refr. unit	1, 1/2 H.P. refr. unit	1, 1 H.P. refr. unit	1, 1-1/2 H.P. refr. unit	1, 2 H.P. refr. unit	1, 2 H.P. refr. unit
Small tools	general, misc. small tools	general, misc. small tools	general, misc. small tools	general, misc. small tools	general, misc. small tools	general, misc. small tools
Other	20 round egg baskets	30 round egg baskets	50 round egg baskets			

[a]Flock size most frequently encountered in the investment group. Flock size is varied for each investment group in the development of the short-run average cost curves.

insurance, taxes, repairs, depreciation, and interest on these fixed resources.

Values for all investment items are presented in Table 7. These values are considered to be an "average" investment. The items are assumed to have one half of their useful life remaining. Investment was computed in this manner because poultrymen must allow for adequate depreciation to replace worn-out resources under present (or future) cost conditions if they are to remain in business in the long run.

This study disregarded land as an investment item. Land in the study area was a negligible cost item in the production of table eggs.

All costs other than "fixed" costs are termed "variable" and are assumed to vary directly with the size of the laying flock. If an additional layer is of the same productive ability the addition of one more to the flock will affect total costs but not average variable costs. Egg production is increased in exactly the same proportion as are variable costs. Variable costs per one hundred layers for the different size groups are shown in Table 8. These costs were derived from survey data, excluding labor cost and assuming production techniques and efficiencies attained by the better producers. Certain variable costs (for example, feed purchased per one hundred layers) differ

TABLE 7.--Average Investment Value[a] of Fixed Resources by Investment Group, South Central Arizona Cage Flocks, 1963.

Type of Investment	Investment Group					
	I (3,000)[b]	II (5,000)[b]	III (10,000)[b]	IV (15,000)[b]	V (30,000)[b]	VI (65,000)[b]
Buildings						
Labor housing				2,250	2,250	9,875
Laying houses	3,024	5,040	7,862	11,390	22,781	51,011
Replacement houses	567	1,075	3,750	2,520	3,578	13,560
Brooder houses	405	780		1,800	4,320	9,660
Egg house	504	807	1,575	1,575	1,969	3,150
Egg cooler room	249	286	456	552	708	871
Shops						1,728
Total buildings	4,749	7,988	13,643	20,087	35,606	89,855
Machinery						
Tractors						2,700
Trucks					1,718	1,718
Pickups and/or auto	1,124	1,091	1,091	1,091	1,091	2,182
Feed tanks	180	520	720	860	1,440	2,874

TABLE 7--Continued

Type of Investment	Investment Group					
	I (3,000)[b]	II (5,000)[b]	III (10,000)[b]	IV (15,000)[b]	V (30,000)[b]	VI (65,000)[b]
Feeders	90	178	382	462	272	2,760
Waterers	54	90	189	225	252	1,125
Brooders	87	115	173	230	432	1,007
Cages	1,339	2,240	3,213	4,804	9,419	17,784
Feed and/or egg carts	40	80	120	350	430	550
Egg room cooler	312	312	394	500	603	603
Small tools	125	125	250	250	500	1,000
Other	18	26	44			
Total machinery	3,369	4,777	6,576	8,772	16,157	34,303
Total fixed investment	8,118	12,765	20,219	28,859	51,763	124,158

[a]Average investment over the life of the investment assuming 1963 prices and a zero salvage value.

[b]Flock size most frequently encountered in the investment group. Flock size is varied for each investment in the development of the short-run average cost curves.

TABLE 8.--Total Variable Costs,[a] Excluding Labor, per One Hundred Layers, by Type of Cost, for Six Cage-Flock Sizes, South Central Arizona, 1963.

Item	Size of Laying Flock					
	3,000	5,000	10,000	15,000	30,000	65,000
	dollars/100 layers					
Feed purchased	375.57	372.38	377.63	377.72	393.81	378.31
Utilities and power	7.75	7.75	7.75	7.75	7.75	7.75
General production expense	4.00	4.00	4.00	4.00	4.00	4.00
Replacement cost[b]	26.67	32.00	33.54	33.54	38.00	37.00
Interest on poultry (6%)	8.33	10.48	11.23	10.79	12.27	12.27
Flock depreciation[c]	13.92	16.70	17.09	17.09	18.88	17.88
TOTAL	418.24	443.31	451.24	450.89	474.71	457.21

[a]Includes costs of rearing replacements.

[b]Cost of day-old sexed pullets.

[c]Difference between initial laying flock value plus purchases and additions, and the closing value plus sales.

depending on egg production per layer. Average egg production per layer housed differs between size groups because the laying period a hen is kept in the flock varies with size group. The typical laying period and the rate of egg production for each size group used in the analysis are shown in Table 9. In all cases the egg production used in this analysis came from the upper level of the survey data and is based upon the number of layers housed. Costs such as utilities and power and general production expense were assumed to be constant per bird regardless of the layer's productive ability.

The shapes of the short-run average cost curves are determined by the spreading of fixed costs over increasing units of output. Additional layers and labor are added to each fixed plant up until the "capacity" of that plant is reached. The maximum number of layers that can be handled with each investment group was determined on the basis of the number of cages. For example, no more than 10,000 layers are considered possible with investment group III. Group III was defined as having 2,520 four bird (16 x 18") cages. While a few more than 10,000 layers could be handled with this number of cages the excess capacity arises due to the indivisibility of the cages.

Cost Structure for Cage Flocks

Short-run average total cost functions for six model cage flocks and the resulting "envelope" LRAC curve are presented in

TABLE 9.--Typical Production Period, Optimum Egg Production, Feed Requirement per Layer, and per Dozen Eggs Produced for Six Cage-Flock Sizes, South Central Arizona, 1963.

Size of Laying Flock	Typical Production Period[a]	Optimum Rate of Lay	Feed Requirement per Layer per Year[b]	Feed Requirement per Dozen Eggs
	Months	Eggs	Pounds	
3,000	18	222	82.21	4.44
5,000	15	234	83.93	4.30
10,000	14	238	84.50	4.26
15,000	14	238	84.50	4.26
30,000	12	246	85.64	4.18
65,000	12	246	85.64	4.18

[a]Modal value used in determining the typical production period.

[b]See Appendix I for estimating technique involved in calculating per layer feed requirement.

Figure 6. These curves assume optimum production levels and high efficiency in resource use. The production levels represent the current levels attained by the better commercial egg producers.

The cost curves shown in Figure 6 include all costs incurred in table egg production, except a charge for management. When the owner-operator contributes manual labor to the business, this labor is charged as a production expense at $1.50 per hour, approximately what these ranchers could expect to receive in alternative employment.

Management is assumed to be the residual claimant against income and the return to management is the difference between the average total cost of producing a dozen of eggs and the average price received for those eggs. The price line P shown in Figure 6 is a weighted average price based on the average percent production per layer of different size and grades of eggs and the price paid by the major egg dealers in Arizona. The estimating technique involved in calculating the weighted average price, P, is presented in Appendix I.

The relative importance of fixed and variable costs to total production costs for the various size flocks is illustrated graphically in Figure 6. For each of the six size flocks the short-run average "total" cost SRAC curve is obtained by vertical summation of the average fixed cost curve and the average variable cost curve (hereafter denoted AFC and AVC, respectively).

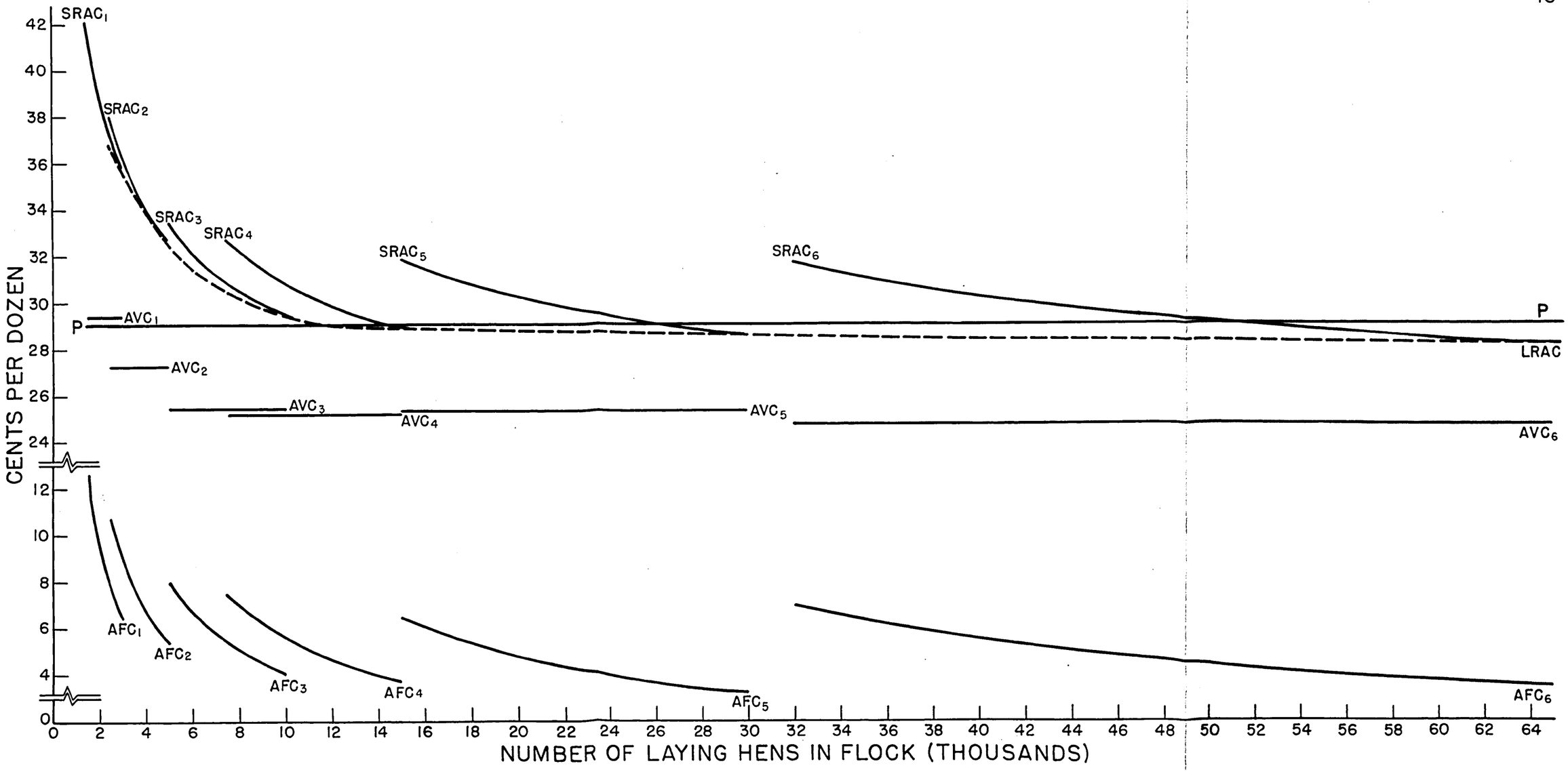

Figure 6.– Costs of Production per Dozen Eggs Produced, Cage Flocks, South Central Arizona, 1963.

Average variable costs per dozen eggs are constant within each size group but are successively lower for each larger size group, except size group V. The reason for this requires a brief explanation. Average variable cost items such as interest on the investment in poultry, flock depreciation, replacement costs, and feed costs vary with the length of time the layer is kept for production. Under the assumptions of this analysis, the typical production period of a layer varies for the different size groups (Table 9). The production period a layer is kept in size group V (30,000 layers) is shorter by two months from the preceding size group (15,000 layers). Since the production period varies by two months and because certain average variable cost items (previously listed) vary with the production period, AVC rises for size Group V (Figure 6). Although the production period varies between other size groups, the small flocks are able to gain "net" economies because efficiencies in labor gained by flock expansion more than offset the slight diseconomies of higher replacement costs, interest on poultry, and flock depreciation.

A long-run average cost curve is drawn as an "envelope" to the short-run cost curves (Figure 6).[1] The "envelope" (LRAC) curve

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[1] It is recognized that conceptually, an infinite number of short-run cost curves relating to successively larger fixed resource combinations are required to draw an "envelope" curve. Thus the LRAC curve of Figure 6 is only an empirical approximation to the "envelope" curve. For a stimulating discussion of the relevance of

shows the least cost of producing a dozen of eggs for the entire observed flock sizes. Production costs per dozen eggs produced decline sharply as the shell egg operation changes from a 3,000 layer family type operation to a more commercial operation with 10,000 layers. Throughout this size range there is a difference in production costs of 6.3 cents per dozen, dropping from 35.8 cents for the 3,000 layer flock to 29.5 cents per dozen for the 10,000 layer flock. Beyond the 10,000 bird flock only slight economies are possible. A savings of .5 cent is possible by expansion to a 15,000 bird flock. Beyond this size another .7 cent reduction in production cost is possible by expansion to the 65,000 cage layer flock. A flock of approximately 11,500 birds is necessary to cover all production costs. These empirical results indicate cost economies in capacity use of a given plant as well as cost economies in shifting to larger capacity plants.

It should be emphasized that the costs presented herein represent neither survey averages nor operations of the average shell egg producer included in the study. They represent the most efficient operations observed and can be essentially considered as standards for an efficient operation. Many operators interviewed reported higher per unit costs than are presented in this study.

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the individual plant curves to the development of the LRAC curve see: Chamberlain, Edward C., "Proportionality, Divisibility, and Economies of Scale," Quarterly Journal of Economics, February, 1948, pp. 234-235.

Floor Laying Flocks

An analysis of egg production costs for floor flocks will now be presented using the same method of analysis as was used in presenting production costs for the cage flocks. The five floor-flock size groups and their respective fixed resource combinations assumed for this analysis are presented in Table 10. All investment items associated with the raising of flock replacements are included. The cost items making up the "fixed" and "variable" costs of this analysis are the same as those for cage flocks. This facilitates comparisons between the two production techniques.

The values for all the investment items listed in Table 10 are shown in Table 11. The values presented represent an "average" investment (in other words, 1963 replacement costs of the items depreciated 50 percent).

Total variable costs, excluding labor, per one hundred layers for each of the five size groups, are shown in Table 12. An estimate of variable cost per bird can be readily attained by moving the decimal point two places to the left. The cost estimates presented were derived using the same assumptions that applied to the cage flocks.

The typical production period, optimum egg production, feed requirement per layer, and per dozen eggs produced for the five size floor flocks are shown in Table 13. Comparing Table 13 with Table 9,

TABLE 10.--Fixed Resources by Investment Group, South Central Arizona Floor Flocks, 1963.

Item	Investment Group				
	I (3,000)[a]	II (5,000)[a]	III (10,000)[a]	IV (15,000)[a]	V (30,000)[a]
Buildings					
Labor housing				1, frame, 720 sq. ft.	2, frame, 1,440 sq. ft. total
Laying houses	1, frame, lath siding, metal roof, 6,000 sq. ft.	2, frame, lath siding, metal roof, 9,900 sq. ft. total	3, frame, lath siding, metal roof, 19,800 sq. ft. total	3, frame, lath siding, metal roof, 28,080 sq. ft. total	3, frame, lath siding, concrete floor, metal roof, 55,500 sq. ft. total
Replacement houses	1, combination replacement and brooder house, frame, metal siding and metal roof, 1,500 sq. ft.	1, frame, lath siding, metal roof, 1,680 sq. ft.	1, frame, lath siding, metal roof, 3,900 sq. ft.	1, frame, lath siding, metal roof, 5,760 sq. ft.	1, frame, lath siding, concrete floor, metal roof, 10,000 sq. ft.
Brooder houses		1, frame, metal siding, concrete floor, metal roof, 840 sq. ft.	1, frame, metal siding, concrete floor, metal roof, 1,920 sq. ft.	1, frame, metal siding, concrete floor, metal roof, 2,880 sq. ft.	1, frame, metal siding, concrete floor, metal roof, 5,200 sq. ft.
Other facilities					
Egg house	1, concrete block, 192 sq. ft.	1, concrete block, 308 sq. ft.	1, concrete block, 600 sq. ft.	1, concrete block, 600 sq. ft.	1, concrete block, 750 sq. ft.
Egg cooler room	walk-in box type, insulated, 288 cu. ft.	walk-in box type, insulated, 384 cu. ft.	walk-in box type, insulated, 960 cu. ft.	walk-in box type, insulated, 1,344 cu. ft.	walk-in box type, insulated, 2,048 cu. ft.
Machinery and equipment					
Pickups and/or auto (poultry share)	1, 6-passenger station wagon	1, 1/2 ton	1, 1/2 ton	1, 1/2 ton	1, 1/2 ton, 1, 3/4 ton

TABLE 10--Continued

Item	Investment Group				
	I (3,000)[a]	II (5,000)[a]	III (10,000)[a]	IV (15,000)[a]	V (30,000)[a]
Feed tanks	1, metal, 290 cu. ft.	3, metal, 719 cu. ft. total	4, metal, 1,160 cu. ft. total	4, metal, 1,160 cu. ft. total	5, metal, 1,450 cu. ft. total
Feeders	metal, 28 (36" chick); 34 (60" pullet); 110 (96" hen)	2, auto. type, 640 ft. total, 53 (36" chick), 64 (60" pullet)	3, auto. type, 1,308 ft. total, 106 (36" chick), 127 (60" pullet)	4, auto. type, 2,094 ft. total, 134 (36" chick), 187 (60" pullet)	4, auto. type, 6,104 ft. total, 313 (36" chick), 375 (60" pullet)
Waterers	6, auto. 8'; 4, auto. 32' stand type	9, auto. 8'; 6, auto. 32' stand type	19, auto. 8'; 13, auto. 32' stand type	27, auto. 8'; 12, auto. 52' stand type	54, auto. 8'; 12, auto. 102' stand type
Brooders	3, gas, 6', 500 chick cap.	4, gas, 6', 500 chick cap.	6, gas, 6', 500 chick cap.	10, gas, 6', 500 chick cap.	24, gas, 6', 500 chick cap.
Nests	43, metal, 5' sec. 14 holes	72, metal, 5' sec. 14 holes	143, metal, 5' sec. 14 holes	216, metal, 5' sec. 14 holes	429, metal, 5' sec. 14 holes
Feed and/or egg carts	2, metal push, 3 wheel	1, metal push, 3 wheel	2, metal push, 3 wheel	2, metal push, 3 wheel	3, metal push, 3 wheel
Egg room cooler	1, 1/2 H.P., refr. unit	1, 1/2 H. P., refr. unit	1, 1 H. P., refr. unit	1, 1-1/2 H. P., refr. unit	1, 2 H. P., refr. unit
Small tools	general, misc. small tools	general, misc. small tools	general, misc. small tools	general, misc. small tools	general, misc. small tools
Other	20, round egg baskets	30, round egg baskets	50, round egg baskets	100, round egg baskets	150, round egg baskets

[a]Flock size most frequently encountered in the investment group. Flock size is varied for each investment group in the development of the short-run average cost curves.

TABLE 11.--Average Investment Value[a] of Fixed Resources by Investment Group, South Central Arizona Floor Flocks, 1963.

Type of Investment	Investment Group				
	I (3,000)[b]	II (5,000)[b]	III (10,000)[b]	IV (15,000)[b]	V (30,000)[b]
Buildings					
Labor housing				2,250	4,500
Laying houses	3,150	5,198	10,395	14,742	31,358
Replacement houses	938	882	2,048	3,024	5,650
Brooder houses		630	1,440	2,160	3,900
Egg houses	504	809	1,575	1,575	1,969
Egg cooler room	249	286	456	552	708
Total buildings	4,841	7,805	15,914	24,303	48,085
Machinery					
Pickups and/or auto	1,124	1,091	1,091	1,091	2,265
Feed tanks	180	636	894	952	1,132
Feeders	648	1,187	2,205	3,057	7,530
Waterers	176	269	566	722	1,252
Brooders	87	115	173	288	690

TABLE 11--Continued

Type of Investment	Investment Group				
	I (3,000)[b]	II (5,000)[b]	III (10,000)[b]	IV (15,000)[b]	V (30,000)[b]
Nests	366	612	1,216	1,836	3,647
Feed and/or egg carts	80	40	80	80	120
Egg room cooler	312	312	394	500	603
Small tools	125	125	250	250	500
Other	18	26	44	88	132
Total machinery	3,116	4,413	6,913	8,864	17,871
Total fixed investment	7,957	12,218	22,827	33,167	65,956

[a]Average investment over the life of the investment assuming 1963 prices and a zero salvage value.

[b]Flock size most frequently encountered in the investment group. Flock size is varied for each investment in the development of the short-run average cost curves.

TABLE 12.--Total Variable Costs,[a] Excluding Labor, per One Hundred Layers, by Type of Cost, for Five Floor-Flock Sizes, South Central Arizona, 1963.

Item	Size of Laying Flock				
	3,000	5,000	10,000	15,000	30,000
	dollars/100 layers				
Feed purchased	357.57	362.08	366.26	365.86	365.15
Utilities and power	7.75	7.75	7.75	7.75	7.75
General production expense	5.50	5.50	5.50	5.50	5.50
Replacement cost[b]	26.67	30.00	30.00	29.25	28.50
Interest on poultry (6%)	8.33	9.56	9.77	9.73	9.74
Flock depreciation[c]	13.92	15.66	15.66	15.08	14.16
TOTAL	419.74	430.55	434.94	433.17	430.80

[a]Includes costs of rearing replacements.

[b]Cost of day-old sexed pullets.

[c]Difference between initial laying flock value plus purchases and additions, and the closing value plus sales.

TABLE 13.--Typical Production Period, Optimum Egg Production, Feed Requirement per Layer, and per Dozen Eggs Produced for Five Floor-Flock Sizes, South Central Arizona, 1963.

Size of Laying Flock	Typical Production Period[a]	Optimum Rate of Lay	Feed Requirement per Layer per Year[b]	Feed Requirement per Dozen Eggs
	Months	Eggs	Pounds	
3,000	18	224	82.50	4.42
5,000	16	232	83.64	4.33
10,000	16	232	83.64	4.33
15,000	16	232	83.64	4.33
30,000	16	232	83.64	4.33

[a]Modal value used in determining the typical production period.

[b]See Appendix I for estimating technique involved in calculating per layer feed requirement.

it can be seen that for all comparable flock sizes except the smallest, layers in floor flocks are kept for a longer production period than are those in cage flocks.

The maximum number of layers that may be handled with each of the fixed resource combinations studied was determined on the basis of square feet of laying area and the current observed management practice with respect to layer house density. For example with size group I it was found that the better operators were allowing approximately 2 square feet per bird. Thus, the capacity for a laying house with 6,000 square feet of laying area was assumed to be 3,000 layers.

Cost Structure for Floor Flocks

Short-run average total cost functions for five model floor flocks and the resulting "envelope" LRAC curve are shown in Figure 7. Throughout their range these curves assume optimum production levels and high efficiency in resource use. Production levels assumed represent current levels being attained by the better commercial egg producers in the area.

The cost curves presented in Figure 7, as do those of Figure 6, include all costs incurred in the production of shell eggs, excepting a charge for management. The price received for eggs is assumed to the same regardless of the type of flock producing the eggs.[1] Thus,

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[1]This is true in so far as both types of flocks are producing eggs from basically the same breed of birds as is the case for the ranches included in this study.

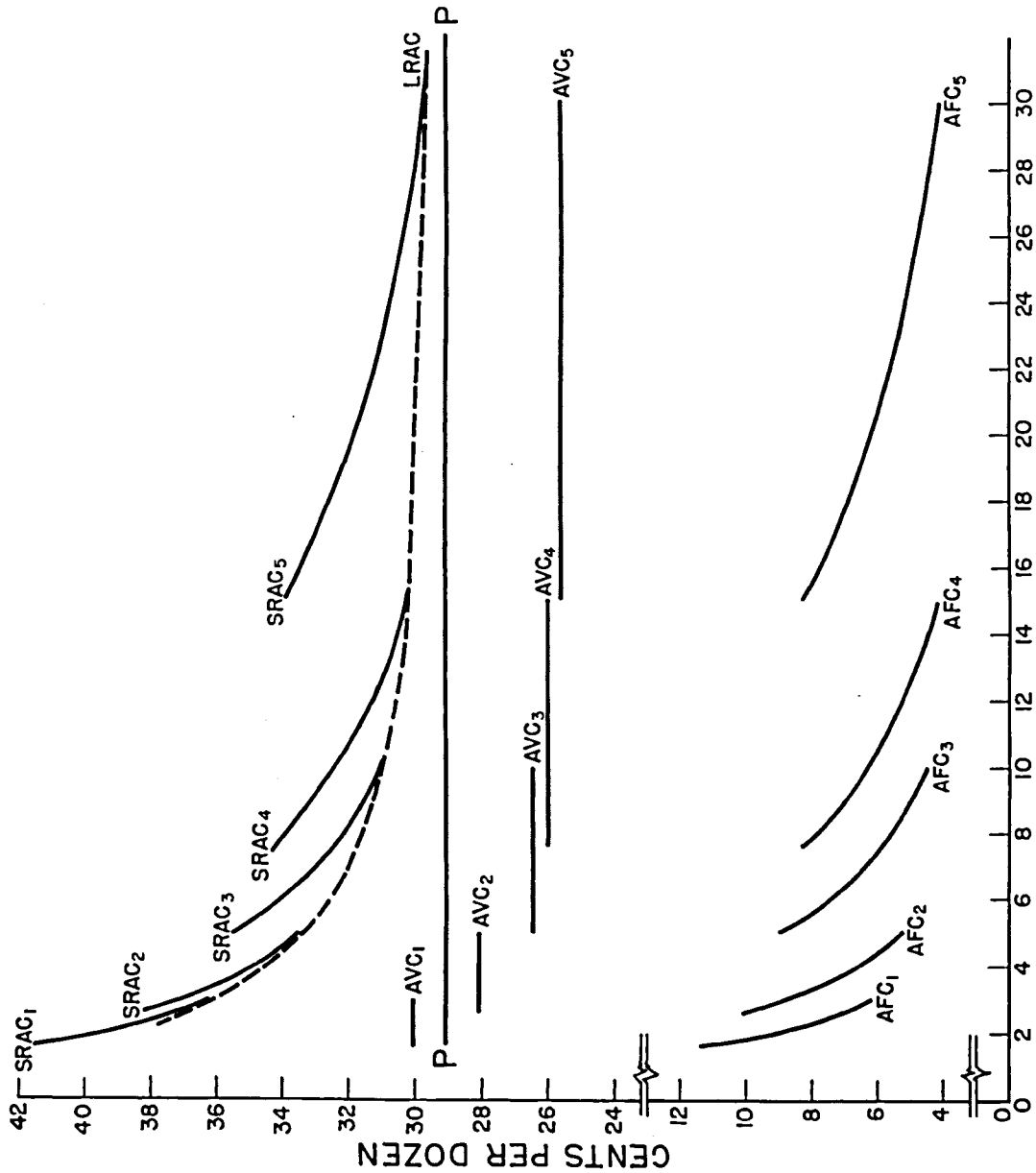

Figure 7.—Costs of Production per Dozen Eggs Produced, Floor Flocks, South Central Arizona, 1963.

price line P shown in Figure 7 is the same as that shown in Figure 6.

Average variable costs per dozen eggs produced are constant within each size group but are successively lower for each larger size group. This reflects reductions in labor and feed costs on a per dozen basis as size of flock is increased. The discontinuities between size groups indicate production costs are reduced by operating a smaller fixed plant to capacity versus under-utilizing a larger plant. However, when used to capacity, each larger fixed resource combination (plant) has a cost of production advantage over the next smaller plant.

A long-run average cost curve is drawn as an "envelope" to the short-run curves (Figure 7). This "envelope" shows the minimum production costs per dozen eggs produced associated with the entire range of flock sizes from 3,000 to 30,000 layers. Production costs per dozen eggs produced decline sharply as flock size increases from 3,000 to a 10,000 bird operation. Costs decrease from 36.3 cents per dozen for the 3,000 bird operation, down to 31.0 cents for the 10,000 bird flock. The saving in cost per dozen associated with flock expansion to 10,000 birds amounts to approximately 5.2 cents per dozen. Savings in per unit costs amount to .8 cent and 1.2 cents, respectively, by expansion to the 15,000 and 30,000 layer operations from the 10,000 bird flock. In no case for the flock sizes considered were producers

covering all costs of production from the sale of eggs. Negative returns to management are at a minimum for the 30,000 layer flock amounting to .67 cent per dozen.

Unit Cost Comparisons Between Cage and Floor Flocks

A number of comparisons of laying hens in cages and floor pens have been made.[1] The objectives of most of these studies have been to compare such things as egg production, various egg quality factors, mortality, feed conversion, etc., between bird housed on the floor and in cages. From such studies a producer might infer that one type of flock is more desirable from a cost point of view than the other simply because egg production or feed conversion was determined to be better under one housing system than another. This section attempts to compare total costs of egg production for the two housing systems offering a complete cost picture which individuals can use as a guide in decision-making.

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[1]For example, see Francis, D. W., R. H. Roberson, and L. N. Berry, Egg Production Characteristics of Pullets Managed Under Three Systems, New Mexico State University, Agr. Expt. Station, Research Report 52, March, 1961; Bailey, B. B., J. H. Quisenberry, and J. Taylor, A Comparison of Performance of Layers in Cage and Floor Housing, Poultry Science 38:565-568, 1959; Kurnick, A. A., H. J. Pforsich, M. W. Pasvogel, H. B. Hinds, and L. W. Benhurst, Reproductive Performance and Egg Quality as Influenced by Cage and Floor Management Systems in the Presence of Dietary Furazolidone and Arsanilic Acid, Paper presented at the XI Congresso Nundial de Avicultura del 21 al 28 de Septiembre, Mexico, D. F., 1958.

A summary of investment by size of laying flock for cage and floor flocks is shown in Tables 14 and 15. The investment costs shown include the investment associated with the raising of replacements. All replacement birds were raised on the floor for both types of flocks except for the 30,000 layer cage flock. Managers of the 30,000 layer cage flocks put pullets in cages at ten weeks of age.

Feed is the largest single cost item for all flocks included in the study, irrespective of type or size of flock. It accounts for between 54 and 67 percent of total egg production costs for the cage flocks while for floor flocks between 53 and 63.5 percent of total cost is attributed to cost of purchased feed (Table 16).

Labor expense is the second largest item of cost in the production of eggs. Labor cost accounts for approximately 19 percent of the total costs of egg production for a 3,000 layer cage flock declining for each larger size group up to and including a 30,000 layer cage flock for which the labor costs account for approximately 8 percent of total costs. For the largest size group observed, 65,000 layer cage flock, labor costs amount to approximately 9 percent of the total egg production costs. This increased percent of total cost indicates slight diseconomies in the utilization of labor for this large of flock (Table 16).

Labor costs for floor flocks as a percent of total production costs range from 21 percent for a 3,000 hen operation to 11 percent

TABLE 14.--Summary of Investment[a] by Size of Laying Flock, for Six Cage-Flock Sizes, South Central Arizona, 1963.

Item	Size of Laying Flock											
	3,000 Average Investment[b]		5,000 Average Investment[b]		10,000 Average Investment[b]		15,000 Average Investment[b]		30,000 Average Investment[b]		65,000 Average Investment[b]	
	$	%	$	%	$	%	$	%	$	%	$	%
Buildings and improvements	5,796	43.5	9,035	40.1	14,690	36.6	21,434	37.5	38,753	33.3	89,768	34.9
Machinery and equipment	3,364	25.2	4,777	21.2	6,732	16.8	8,772	15.3	16,380	14.0	34,303	13.4
Poultry	4,163	31.3	8,725	38.7	18,709	46.6	26,985	47.2	61,350	52.7	132,925	51.7
TOTAL INVESTMENT	13,323	100.0	22,537	100.0	40,131	100.0	57,191	100.0	116,483	100.0	256,996	100.0

[a] Includes investment associated with rearing of replacements.

[b] Average refers to average value of items during their useful life.

TABLE 15. --Summary of Investment[a] by Size of Laying Flock for Five Floor-Flock Sizes, South Central Arizona, 1963.

Item	Size of Laying Flock									
	3,000 Average Investment[b]		5,000 Average Investment[b]		10,000 Average Investment[b]		15,000 Average Investment[b]		30,000 Average Investment[b]	
	$	%	$	%	$	%	$	%	$	%
Buildings and improvements	5,888	44.7	8,852	41.5	16,961	42.2	25,350	43.3	50,313	43.0
Machinery and equipment	3,116	23.7	4,534	21.2	6,913	17.2	8,864	15.2	17,871	15.3
Poultry	4,163	31.6	7,966	37.3	16,278	40.6	24,330	41.5	48,703	41.7
TOTAL INVESTMENT	13,167	100.0	21,352	100.0	40,152	100.0	58,594	100.0	116,887	100.0

[a]Includes investment associated with rearing of replacements.

[b]Average refers to average value of items during their useful life.

TABLE 16.--Comparison of Two Major Cost Items in the Production of Table Eggs Shown as Percent of Total Cost for Type and Sizes of Flocks Considered.

Size Group	Number of Laying Hens	Percent of Total Cost		
		Feed	Labor	Total
Cage Flocks				
I	3,000	54.0	19.0	73.0
II	5,000	58.4	14.0	72.4
III	10,000	64.7	9.1	73.8
IV	15,000	66.0	8.4	74.4
V	30,000	67.1	7.8	74.9
VI	65,000	65.4	8.8	74.2
Floor Flocks				
I	3,000	52.8	21.1	73.9
II	5,000	56.8	16.9	73.7
III	10,000	61.1	12.9	74.0
IV	15,000	62.5	12.0	74.5
V	30,000	63.5	11.2	74.7

for a 30,000 hen operation. Labor expense for floor flocks when compared to cage flocks makes up a greater percentage of total costs for all comparable size flocks. Labor represents approximately 3 percent more of the total costs of producing eggs for floor flocks than it represents for the comparable size cage flocks.

Hired and family labor and the amount of labor used in the production of eggs as reported by the most efficient operators are shown in Tables 17 and 18. On the average, flocks housed on the floor utilized approximately 37 percent more hours of labor than did the comparable size cage flocks.

The combination of feed and labor costs amount to between 72.4 and 74.9 percent of the total costs of producing eggs for all operations synthesized. Since approximately 74 percent of the total costs of producing eggs is attributed to feed and labor costs it appears if either one of these cost items could be reduced it would have a favorable effect upon lowering per unit production costs.

Total fixed, labor, and variable costs for the six investment groups of cage laying flocks are presented in Table 19. Costs and returns per dozen eggs produced for the various size cage flocks is then presented in Table 20. The same type cost information for five size floor-flocks is shown in Tables 21 and 22. Income items are eggs and cull hens. Manure is not considered an income item since most ranchers

TABLE 17.--Labor Use for Most Efficient Cage Flock Operations, by Type of Labor and Cost per Ranch, South Central Arizona, 1963.

Size of Laying Flock	Labor Use		Labor Cost		
	Family	Hired	Family	Hired[a]	Total
	hours/week		dollars		
3,000	48		3,744		3,744
5,000	59		4,472		4,472
10,000	72		5,304		5,304
15,000	52	48	4,056	3,331	7,387
30,000	48	144	3,744	9,993	13,737
65,000		438		33,248	33,248

[a]Includes Social Security and Workmen's Compensation Insurance.

TABLE 18.--Labor Use for Most Efficient Floor Flock Operations, by Type of Labor and Cost per Ranch, South Central Arizona, 1963.

Size of Laying Flock	Labor Use		Labor Cost		
	Family	Hired	Family	Hired[a]	Total
	— hours/week —		——— dollars ———		
3,000	55		4,290		4,290
5,000	75		5,460		5,460
10,000	55	50	4,290	3,469	7,759
15,000	60	90	4,680	5,828	10,508
30,000	80	200	5,720	13,600	19,320

[a]Includes Social Security and Workmen's Compensation Insurance.

TABLE 19. --Total Fixed, Labor, and Variable Costs[a] by Investment Group and Flock Size for Six Cage Flock Operations, South Central Arizona, 1963.[b]

	Investment Group					
	I	II	III	IV	V	VI
	Number of Laying Hens in Flock					
	3,000	5,000	10,000	15,000	30,000	65,000
	dollars					
Fixed investment costs						
Insurance	214	321	489	678	1,007	2,695
Taxes	213	355	710	1,065	2,130	4,615
Repairs	1,022	1,497	2,196	3,022	5,430	12,315
Depreciation	1,543	2,269	3,348	4,620	8,283	18,894
Interest on investment	538	808	1,235	1,737	3,066	7,230
Total	3,530	5,250	7,978	11,122	19,916	45,749
Labor Costs	3,744	4,472	5,304	7,387	13,737	33,248
Variable Costs						
Feed purchased	10,727	18,619	37,763	56,658	118,143	245,900
Utilities and power	233	388	775	1,163	2,325	5,038

TABLE 19--Continued

	Investment Group					
	I	II	III	IV	V	VI
	Number of Laying Hens in Flock					
	3,000	5,000	10,000	15,000	30,000	65,000
	dollars					
General production expense	120	200	400	600	1,200	2,600
Replacement cost[c]	800	1,600	3,354	5,031	11,400	24,050
Interest on poultry	250	524	1,123	1,619	3,681	7,976
Flock depreciation[d]	418	835	1,709	2,564	5,663	11,619
Total	12,548	22,166	45,124	67,635	142,412	297,183
TOTAL COSTS	19,821	31,888	58,406	86,144	176,060	376,180

[a]Includes costs of raising replacements.

[b]For assumptions, definitions, data sources, and estimating techniques involved, see Appendix I.

[c]Cost of day-old sexed pullets.

[d]Difference between initial laying flock value plus purchases and additions, and the closing value plus sales.

TABLE 20.--Total Costs and Returns per Dozen Eggs Produced for Six Cage-Flock Operations, South Central Arizona, 1963.

Item	Investment Group					
	I	II	III	IV	V	VI
	Number of Layers in Flock					
	3,000	5,000	10,000	15,000	30,000	65,000
	cents/dozen					
Income						
Eggs sold	29.10	29.10	29.10	29.10	29.10	29.10
Cull hens	.650	.763	.814	.814	.933	.933
Total income	29.750	29.863	29.914	29.914	30.033	30.033
Inputs						
Fixed costs						
Insurance	.386	.329	.247	.228	.164	.202
Taxes	.384	.364	.358	.358	.346	.346
Repairs	1.841	1.535	1.107	1.016	.883	.924
Depreciation	2.780	2.327	1.688	1.553	1.346	1.418
Interest on investment	.969	.829	.623	.584	.499	.543
Total fixed costs	6.360	5.384	4.023	3.739	3.238	3.433

TABLE 20--Continued

Item	Investment Group					
	I	II	III	IV	V	VI
	Number of Layers in Flock					
	3,000	5,000	10,000	15,000	30,000	65,000
	cents/dozen					
Labor costs[a]	6.80	4.587	2.675	2.483	2.234	2.495
Variable costs						
Feed purchased	19.328	19.096	19.043	19.048	19.210	18.454
Utilities and power	.420	.398	.391	.391	.378	.378
General production expense	.216	.205	.202	.202	.195	.195
Replacement cost	1.441	1.641	1.691	1.691	1.854	1.805
Interest on poultry	.450	.537	.566	.544	.599	.599
Flock depreciation	.753	.856	.862	.862	.921	.872
Total variable costs	22.608	22.733	22.755	22.738	23.157	22.303
Total costs[b]	35.768	32.704	29.453	28.960	28.629	28.231
RETURNS TO MANAGEMENT	-6.018	-2.841	+.461	+.954	+1.404	+1.802

[a]Includes imputed cost for family labor.

[b]A rough estimate of total cash costs may be obtained by adding taxes, repairs, insurance, labor cost (if hired), and variable costs for a particular laying flock size. However, variable costs include interest on investment in poultry and flock depreciation.

TABLE 21.--Total Fixed, Labor, and Variable Costs[a] by Investment Group and Flock Size for Five Floor-Flock Operations, South Central Arizona,[b] 1963.

Item	Investment Group				
	I	II	III	IV	V
	Number of Laying Hens in Flock				
	3,000	5,00	10,000	15,000	30,000
	dollars				
Fixed investment costs					
Insurance	235	359	572	825	1,532
Taxes	213	355	710	1,065	2,130
Repairs	976	1,414	2,401	3,294	6,522
Depreciation	1,480	2,146	3,672	5,068	10,021
Interest on investment	526	818	1,382	1,970	3,864
Total	3,430	5,092	8,737	12,222	24,069
Labor costs	4,290	5,460	7,759	10,508	19,320
Variable costs					
Feed purchased	10,727	18,356	36,626	54,808	109,544
Utilities and power	233	388	775	1,163	2,325

TABLE 21--Continued

Item	Investment Group				
	I	II	III	IV	V
	Number of Laying Hens in Flock				
	3,000	5,000	10,000	15,000	30,000
	dollars				
General production expense	165	275	550	825	1,650
Replacement cost[c]	800	1,500	3,000	4,388	8,550
Interest on poultry	250	478	977	1,460	2,922
Flock depreciation[d]	418	783	1,566	2,263	4,247
Total	12,593	21,780	43,494	64,907	129,238
TOTAL COSTS	20,313	32,332	59,990	87,637	172,627

[a]Includes costs of raising replacements.

[b]For assumptions, definitions, data sources, and estimating techniques involved, see Appendix I.

[c]Cost of day-old sexed pullets.

[d]Difference between initial laying flock value plus purchases and additions, and the closing value plus sales.

TABLE 22.--Total Costs and Returns per Dozen Eggs Produced for Five Floor-Flock Operations, South Central Arizona, 1963.

Item	Investment Group				
	I	II	III	IV	V
	Number of Laying Hens in Flock				
	3,000	5,000	10,000	15,000	30,000
	cents/dozen				
Income					
Eggs sold	29.10	29.10	29.10	29.10	29.10
Cull hens	.645	.715	.715	.715	.715
Total income	29.745	29.815	29.815	29.815	29.815
Inputs					
Fixed costs					
Insurance	.420	.371	.296	.285	.264
Taxes	.380	.367	.367	.367	.367
Repairs	1.743	1.463	1.242	1.136	1.125
Depreciation	2.642	2.220	1.900	1.749	1.728
Interest on investment	.939	.846	.715	.679	.666
Total fixed costs	6.124	5.267	4.520	4.215	4.150

TABLE 22--Continued

Item	Investment Group				
	I	II	III	IV	V
	Number of Laying Hens in Flock				
	3,000	5,000	10,000	15,000	30,000
	cents/dozen				
Labor costs	7.659	5.649	4.014	3.624	3.332
Variable costs					
Feed purchased	19.152	18.992	18.943	18.903	18.890
Utilities and power	.416	.401	.401	.401	.401
General production expense	.295	.285	.285	.285	.285
Replacement cost	1.428	1.552	1.552	1.513	1.474
Interest on poultry	.446	.495	.505	.504	.504
Flock depreciation	.746	.810	.810	.780	.732
Total variable costs	22.483	22.535	22.501	22.386	22.286
Total costs[b]	36.266	33.451	31.035	30.225	29.768
RETURN TO MANAGEMENT	-6.521	-3.636	-1.220	-.410	+.047

[a]Includes imputed cost for family labor.

[b]A rough estimate of total cash costs may be obtained by adding taxes, repairs, insurance, labor cost (if hired), and variable costs for a particular laying flock size. However, variable costs include interest on investment in poultry and flock depreciation.

included in the study area were giving it to a local processing firm for disposal.

The costs associated with production of shell eggs for table egg consumption for the five sizes of flocks compared, without exception, were lowest for the flocks housed in cages. It appears that greater labor requirements for flocks housed on the floor explain most of the per-unit cost difference.

Arizona and California Unit Cost Comparisons

A comparison of Arizona's and California's egg production costs can be of value when properly compared. Caution needs to be exercised in comparing production cost studies carried out in different localities because different cost items and analytical methods may have been used in the different localities. However, some insight can be gained as to the relative competitive position of the Arizona egg producer by attempting to determine unit costs of producing eggs in California added to transportation cost estimates (available from local egg dealers who ship eggs from California). If California's production costs plus transportation charges is less than the Arizona producers' costs, it might be expected that California would continue to supply eggs to Arizona. If the Arizona producers' costs are lower than the combined cost of getting

California eggs into Arizona it might be expected that Arizona producers would expand production.

The author has not found any detailed cost study for egg production applicable to California. However, each year management studies on egg production are conducted by the California Agricultural Extension Service. Detailed records are kept by cooperating poultrymen. A summary of all record averages for 1963 provides the basis for this cost comparison. It is necessary to emphasize that the California cost estimates presented herein are not necessarily representative of the state and reflect only the conditions of the cooperating poultrymen included in these management studies.[1]

The total cost of producing a dozen eggs for the cooperators in the California study for 1963 was 25.1 cents. This cost represents an average number of hens per flock of 15,175 (Table 23). Arizona's production costs for a 15,000 layer cage flock as developed in this study is compared with the production costs in the California study. A cage flock of this size in Arizona has a cost of production of 28.9 cents per dozen. The difference in production costs between the two areas is 3.8 cents. If floor flocks are considered the differential would be approximately 1.3 cents more.

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[1] In 1963, 1,168,459 hens were covered by these records representing about 3 percent of the total number of hens in California. Forker, Olan D., Poultry Management Studies in California, 1957-1963, Berkely, California, June, 1964.

TABLE 23.--Comparison of Production Costs for California Cooperating Poultrymen and South Central Arizona Shell Egg Producers, 1963.

Item	California[a]	Arizona[b]
Average number of hens per flock	15,175	15,000
Eggs laid per hen housed	238	238
Dozen eggs sold per hen	19.83	19.83
Percent mortality, hens	15	10
Percent culled or removed	62.4	76.0
Percent added as new layers	90.3	86.0
Percent mortality of chicks to layers	7.9	4.0
Average price of feed per cwt.	3.18	3.98
Pounds of feed per hen (includes replacements)	111	103
Hours of labor per hen	.4	.67
	—cents per dozen—	
Average price per dozen eggs	28.8	29.1
Net cost per dozen	25.1	28.9
Management income per dozen	3.7	.2
	—dollars per dozen—	
Income per hen from eggs	5.70	5.77
Poultry sales	.15	.16
Miscellaneous income, manure	.01	--
Increase in poultry stock inventory	.12	--
Total income per hen	5.98	5.93
	—dollars per hen—	
Feed cost per hen	3.54	3.78
Poultry stock bought	.41	.34

TABLE 23--Continued

Item	California[a]	Arizona[b]
	— dollars per hen —	
Miscellaneous	.36	.43
Hired labor	.31	.22
Value of operator's labor	.18	.27
Depreciation	.24	.48
Interest on investment	.21	.22
Total expense per hen	5.25	5.74
Management income per hen	.73	.19
Farm income per hen[c]	1.12	.68

[a]Based on a summary average for all cooperating poultrymen in California's 1963 Poultry Management Studies. They are not necessarily representative of the state. These studies include 1,168,459 hens which represent about 3 percent of the total number of hens in California during 1963.

[b]Costs based on a 15,000 hen cage flock as developed in this thesis for South Central Arizona, 1963.

[c]Farm income per hen is management income plus the value of operator's labor and interest on the investment. It is the return the operator receives from his management, labor, and all invested capital.

The average transportation cost per dozen eggs shipped into Arizona was determined to be 1.5 cents, although estimates ranged from 1 to 2 cents per dozen. This information is based on personal interviews with eight of the largest licensed egg dealers in Arizona. Adding California's average net production cost per dozen to the estimated 1.5 cents per dozen transportation charge gives 26.6 cents per dozen compared to Arizona producers' cost of 28.9 cents. Thus, the Arizona egg producer with a 15,000 layer cage flock operating with optimum production techniques is at a 2.3 cents per dozen cost disadvantage when compared to the average California cooperator. This is based on a comparison of a 15,175 hen average flock in California and a 15,000 hen cage flock in Arizona.

The feed costs per hen for a 15,000 hen cage flock in Arizona was found to be $3.78. This is 24 cents more per hen than the feed costs reported in California by Forker. This difference in feed costs when based on an average rate of lay of 238 eggs per hen housed represents approximately 50 percent of the 2.3 cents per dozen cost disadvantage of the Arizona producer. The remainder of the cost disadvantage is in higher depreciation costs which may be accounted for simply by different depreciation rates or methods used in determining depreciation. Flock depreciation was considered a cost item in computing Arizona's production costs. The author has not determined

whether flock depreciation was included in the Poultry Management Studies in California. If depreciation costs were determined on the same basis it is quite possible that depreciation costs between this study and California's management studies would be more nearly the same. This would lower Arizona's 2.3 cents per dozen cost disadvantage. If this is true considerably more than 50 percent of Arizona's production cost disadvantage may be explained by higher feed costs.

The cost estimates used for California are not necessarily representative of the state. They represent the cost conditions of the cooperating poultrymen. This limits the extent to which conclusions can be drawn about the competitive position of the Arizona shell egg producers. Another limitation of this analysis is that the California estimates reflect averages while the Arizona estimates are presented as reflecting the costs of the better producers. In addition a California flock of 15,175 hens and a 15,000 hen cage flock in Arizona was the only comparison made. The competitive position of the Arizona egg producer might be different for other size flocks.

CHAPTER IV

SUMMARY AND CONCLUSIONS

South Central Arizona egg producers, like other agricultural producers, are facing a cost-price squeeze. Prices paid for the factors of production are rising while product prices decline or at best remain constant. Egg producers must reduce per unit costs if a satisfactory income level is to be attained.

This study has examined costs of table egg production for a three-county area in South Central Arizona in an effort to assess whether or not economies to size exist in the production of table eggs. That is to determine if cost economies can be obtained by expansion of the laying flock. Knowledge of the extent to which economies to size exist, if they do exist, would provide a basis for decision-making relative to flock expansion. Further, an attempt was made to determine the competitive position of the Arizona table egg producers with respect to California producers, who are in a surplus egg producing situation.

Production costs were developed for two types of laying flocks in Arizona: cage and floor flocks. The economic-engineering synthesis procedure was used, employing input structures representative of the

most efficient producers included in the study. These input structures were developed from data gathered in the study area. Short-run average cost curves are presented for six sizes of cage flocks (3,000-65,000 layers) using optimum fixed resource combinations developed from survey data. Five such cost curves are developed for five sizes of floor flocks ranging from 3,000 to 30,000 layers. Their respective "envelope" curves were then approximated.

The analysis of 54 laying flocks by type and size of flock has shown that there are large economies to size in expanding at low levels of output and that economies to size, however small, are likely to exist at high levels of output. No evidence of diseconomies was found in this study.

The results and conclusions of the analysis may be summarized as follows:

1. Given present technologies,above-average management, and high production levels average costs per dozen eggs produced decline throughout the range of the data for both cage and floor flocks. Decreasing costs per unit of output occur as fixed costs are spread over increasing units of output and as average egg production per layer increases. (Larger flocks typically have higher average production than do smaller flocks, because of the management practice of keeping their layers for shorter production periods.) Decreased

labor requirements per dozen eggs produced is also a factor in decreasing costs as output expands.

Although no evidence of diseconomies was found in this study certain indicators of diseconomies do appear for the 65,000 layer cage flock, which would lead one to conclude that much beyond the range of the observed data per unit costs become constant or rise slightly. This conclusion is based upon the fact that both fixed costs and labor costs increase on a cost per unit basis for the largest size flocks observed. However these increased costs are concealed by economies resulting when feed is purchased in truck load quantities and replacement pullets are purchased in large lots making available quantity discounts not available to smaller flocks. Economies predominate over the diseconomies for this size flock allowing a .4 cent per dozen decrease in per unit production costs over the 30,000 layer cage flock. It appears obvious, however, that if the diseconomies in labor and fixed costs continue past the 65,000 layer flock that at some point beyond this size flock the diseconomies will balance or be greater than the economies thus causing unit costs to remain constant or rise.

2. Results of the analysis indicate substantial cost economies can be realized by flock expansion from 3,000 to 10,000 layers. Reduction in per unit cost for cage flocks amounts to 6.3 cents per dozen compared to 5.2 cents per dozen eggs produced from floor type operations.

Beyond a 10,000 layer flock further economies are possible although becoming less, amounting to only .8 cent per dozen for cage flock expansion from 10,000 to 30,000 layers. Further expansion to 65,000 layers results in a further decrease in costs per dozen eggs produced of .4 cent. Expansion of floor flocks from 10,000 to 30,000 layers reduce per unit costs by 1.3 cents per dozen.

3. The analysis presented showed negative returns to management for all cage flocks of less than 11,500 layers and for all floor flocks observed when only returns from eggs are considered as income. When income from cull hens is included positive returns to management begin to accrue for cage operations of 10,000 layers and for 30,000 layer floor flocks. Including both eggs and cull hens as income items per unit returns to management (which is the residual after all production costs have been paid their market value) for cage flocks range from -6.02 cents per dozen for the 3,000 layer flock to +1.40 cents per dozen for the 30,000 layer flock. For the comparable size floor flocks the range is from -6.52 to +.05 cents per dozen. The 65,000 layer cage flock has a positive return to management of 1.80 cents per dozen eggs produced.

4. For all five of the comparable size laying flocks examined, the cage flocks in each instance had lower total production costs per dozen eggs produced. This difference in total production costs was

greatest for the 10,000 layer flocks amounting to 1.59 cents per dozen. Most of the cost differential between the two types of flocks can be explained by the fact that flocks housed on the floor utilize approximately 37 percent more labor in the production of eggs than do the comparable size cage flocks.

5. A brief comparison between Arizona and California egg production costs based on an average flock of 15,175 layers, as reported in a summary of all record averages for the 1963 California Poultry Management Studies, and a 15,000 layer cage flock as synthesized in this study revealed that production costs are 3.8 cents per dozen lower in California than in South Central Arizona. Adding an average transportation charge of 1.5 cents per dozen brings the cost disadvantage to the local producer of 2.3 cents per dozen. Higher feed costs to the Arizona producer explains 50 percent of this cost disadvantage. The remaining 50 percent is explained by a higher depreciation cost per dozen. However, this higher cost item may reflect differences in the depreciation rate used between the two studies and consequently may not be an actual cost disadvantage of local producers. A charge for flock depreciation is made in this study and unless the California management studies include this cost item it is possible that the higher depreciation cost in this study does not accurately reflect a real cost disadvantage. It is

obvious that if the difference in depreciation cost as reflected in the two studies does not represent an actual cost disadvantage, then the present (1963) cost disadvantage of 2.3 cents per dozen for the Arizona producer may be considerably less. If this is the case then higher feed costs of local producers may explain more than 50 percent of the cost disadvantage found. However, it is not possible to assert how much more without knowing the basis for the depreciation cost figure presented in the management studies in California.

6. In general, the trend toward larger and fewer poultry ranches will likely continue in Arizona. When per unit costs decrease as size increases an incentive exists (particularly for above-average managers) to increase the size of business. The upward pressure on poultry ranch size is likely to continue as many poultrymen seek to improve their income positions through the lower unit costs and larger gross income associated with increasing size. At the same time expansion and entry of new flocks will be toward cage type operations rather than the floor type because of lower per unit costs of production associated with cage operations.

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APPENDICES

APPENDIX I

METHODS USED IN DETERMINING COSTS AND RETURNS

The costs of all resources used in the production of eggs with the exception of management were used in this study. Information concerning quantities of physical inputs necessary for egg production were collected by personal interviews with South Central Arizona poultry ranchers. Prices were assigned to each of these inputs using data collected from ranchers, building constructors, feed dealers, machinery dealers, and poultry equipment supply catalogues. In cases where the physical amount of an input was obtained in the survey, for example family labor, the opportunity cost was used to determine the value of the input. Total costs were then obtained for two basic types of laying flocks by building models of various size poultry operations.

Optimum production levels, techniques, and efficiencies were assumed throughout. The input quantities used were selected as optimum types and amounts given present production techniques and level of technology. In all cases the production coefficients presented are indicative of the better operations. Specific estimates are discussed in detail in the following pages.

Capital Investments

Investment in Land, Buildings, and Equipment

Land is not a major cost of egg production and was not considered as an investment in this study. The cost of buildings depends primarily upon the material used in construction and upon construction labor. Cost rates used in this study were representative of 1963 rates in South Central Arizona and excludes the possibility of unusual difficulties with respect to terrain, labor, or materials. Housing for the owner-operator and his family is not considered a cost of production. Poultry equipment and machinery prices are based on current price (1963) listings by several of the leading firms supplying poultry and livestock equipment.

Livestock

The average value of layers maintained for different periods of lay was determined from a pullet and hen inventory value table obtained from a large feed company. This value table is used by this firm and by several other large producers in the area in determining value of their flocks. The average values used in the analysis for different age birds is as follows: layers kept for 18 months of lay, $1.10; layers kept for 16 months of lay, $1.30; layers kept for 15 months of lay, $1.40; layers kept for 14 months of lay, $1.50; layers

kept for 12 months of lay, $1.70; replacement pullets, $1.20; and baby chicks, $.525. The predominate breed is White Leghorn hens. It is assumed that all replacements are raised. Yearly replacement cost is the number of baby chicks necessary to maintain a stable flock. In all cases it was assumed that day-old sexed pullets are purchased. Supply price of these pullets were assumed to be as follows: $40 per hundred up to 2,000 purchased; $39 per hundred up to 4,000 purchased; $38 per hundred up to 10,000 purchased; and $37 per hundred for over 10,000 purchased. These prices are based on the 1963 pricing policy of several large hatcheries in the state. It was assumed that all replacements purchased were reared to laying age (23 weeks of age). This is a realistic assumption since it was assumed that replacement mortality and cockerels would not amount to over 4 percent, and it is common practice among the large hatcheries of the state to furnish four additional chicks for each 100 purchased.

Average Fixed Costs per Year

Depreciation and Repairs

Depreciation is determined by the amount of physical use and length of life of the buildings and equipment. Buildings and improvements were depreciated over a 20-year period while a 7-year usable life was assumed for machinery and equipment. In all cases depreciation was

computed by the "straight line" method. No salvage value was credited to these facilities (i.e., it was assumed that they would be worthless at the end of their usable life).

Repair charges were assessed on an annual basis. These charges were computed as a percentage of the replacement cost of buildings, improvements, machinery, and equipment. A rate of 3 percent per annum was charged for repair costs on buildings and improvements, while machinery and equipment repairs were assessed at a rate of 10 percent on the replacement cost.

Interest on Investment

The amount charged for investment for buildings, improvements, machinery, and equipment was based on the current value of the item. Interest was charged on each investment item at the following rates: 5.5 percent on buildings and improvements; and 6.5 percent for machinery and poultry equipment. These rates represent typical rates as reported by poultry ranchers included in the study who reported purchasing these items on credit. The rates were verified in private interviews with a number of agricultural loan agents associated with local lending institutions. These estimates are thought to approximate the average rate a poultry rancher would have to pay if he borrowed money to purchase the item. Conversely, if the operation is internally financed this rate is the opportunity cost to him for using his capital.

Taxes and Insurance

Commercial egg producers are faced by several taxes. Taxes directly imposed on the production process are the only ones considered here. Income taxes are not assumed to be a cost of egg production. Real estate taxes assessed on poultry buildings and equipment are considered to be a fixed cost of production. Personal property tax on the poultry is a variable expense since layer numbers are a variable resource. All poultry operators interviewed for the study reported paying all taxes for the poultry operation, including license fees, in one payment. Therefore no attempt was made to segregate out the two cost components. An average tax expense as reported by all producers per one hundred layers was determined. The average tax was found to be $7.10 per one hundred layers on this basis.

Insurance includes coverage for fire, windstorms, robbery, and other perils for the average depreciated value of buildings, machinery, and equipment plus $10,000 personal liability. Cost for buildings and contents were as follows:[1] masonry structure, fire coverage--$1.62 per $100 estimated value, and extended coverage--$.14 per $100 estimated value; frame structure, $2.18 and $.144, respectively, for fire and extended coverage per $100 estimated value; dwelling

[1]Rates apply to property outside city limits and to protection class 10.

rates, $2.18 and $.76, respectively, for fire and extended coverage per $100 estimated value.

Cost of the base premium per $10,000 personal liability, which includes bodily injury and/or property damage is $25. Liability insurance carried on the operator's vehicles amounts to $33 annually. Estimates of insurance premiums were based on information furnished by the Insurance Department of the Arizona Trust Company, Tucson.

Labor Costs

Labor costs were divided into two groups--hired and family. Hired labor was valued at the following rates: full-time labor, $1.25 per hour; part-time labor, $1.00 per hour; and full-time manager, $550 per month.[1] These rates are based on labor expenses as reported by the majority of producers included in the study. Owner-operator labor was valued at $1.50 per hour. This rate represents what these ranchers could expect to receive in alternative employment. All other family labor was computed at the rate paid part-time labor. The time reported for family labor excludes the time spent in managing the farm business.

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[1] In most cases the 65,000 layer cage flocks were operated under some type of corporate ownership; thus a full-time manager was budgeted for this size flock.

Variable Costs per Layer

Feed

Feed supply prices were assumed to be as follows: lay mash (16% protein) $72 per ton delivered to the farm in bulk, and $69 per ton for truck load quantity discounts; grow mash (18% protein) $82 per ton delivered in 100-pound bags, $78 per ton delivered in bulk, and $76 per ton for truck load quantities; starter mash (20% protein) $5.05 per cwt. purchased in bags, $4.65 per cwt. if purchase one ton or more per month in bag, $89 per ton delivered in bulk, $86 per ton for truck load quantities. The difference in cost is due primarily to the cost of the bags and handling and to quantity purchases. These figures are based on 1963 feed prices quoted by several large commercial feed companies in the state.

The annual feed requirement per layer was estimated by the following formula developed by L. E. Card, Department of Animal Science, University of Illinois, Urbana, Illinois.[1]

$$F = 25 + 6W + \frac{E}{7}$$

where F = feed consumption per bird per year;

W = body weight, assumed to be 4.25 pounds; and

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[1] Stemberger, A. P. and W. J. Jasper, Effects of Flock Size and Housing Density on Egg Production Costs, A. E. Information Series No. 110, Department of Agricultural Economics, University of North Carolina, Raleigh, January, 1964, p. 14.

E = number of eggs per birds per year, assumed to vary between size groups because of the management practice of different production periods.

Feed requirements of growing chickens was assumed to be 460 pounds per 100 pullets from one day of age to 10 weeks. From 10 weeks to 19 weeks of age 100 pullets will consume approximately 1,085 pounds of grower mash.[1] Lay mash is fed to all chickens from 19 weeks of age on.

Flock Depreciation

This cost item is the difference between the beginning value of the flock plus purchases and additions, and the ending value of the flock plus sales. Flock depreciation results from having to pay a higher price for a day-old baby chick than the salvage value of the bird when sold at the end of the production period. It also results from mortality or death losses which lowers the average return per cull hen. The following assumptions were used to estimate flock depreciation:

a. Flock mortality per year = 10 percent

b. Carcass market value = 5 cents per pound

c. Body weight = 4.25 pounds

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[1] Salsbury, J. E., Dr. Salsbury's Guide Book, Charles City, Iowa, 1962, p. 10.

Interest on Poultry

Interest on investment is normally thought of as a fixed cost item. Interest on investment per layer was treated as a variable expense because layer numbers are a variable resource. Interest was charged at the rate of 6 percent on the average investment in poultry. Average investment was determined by assuming the lay bird has one half of its lay period remaining and then determining the market value of that age bird. Interest cost on the poultry varies directly as the laying period varies.

Other Variable Expenses

Utilities and power include electricity, machine operation expense (gasoline and oil), and telephone. General production expenses include veterinary and medicine, disinfectants, sprays, bookkeeping, and in the case of floor flocks litter expense. In all cases the cost estimates used are from the lower level of the cost figures obtained in the interviews.

Income

Egg Production

Average egg production per layer varies directly with the length of the production period. A rate of lay of 246 eggs per hen housed was based on survey data for a 12-month production period

for cage flocks. This rate represented the upper limit of production for 1963. Research has shown that the rate of lay decreases approximately 20 percent from the pullet to the hen year of production.[1] Assuming a pullet lays 246 eggs her first year of production we can expect approximately 20 percent fewer eggs or 197 eggs in her next 12-month production period. This is approximately a decrease of 4 eggs per month. A decrease of 4 eggs per month was then the criterion used in determining the rate of egg production for cage flocks as the production period varies. For example, if a layer is kept for a 14-month laying period a rate of lay of 238 eggs was assumed. This corresponds quite closely with the empirical observations.

The upper limit of egg production for floor flocks was determined to be 232 eggs per hen housed for a 16-month lay period. The criterion used in determining rate of lay was the same for floor flocks as for cage flocks. For example, if a layer is kept for an 18-month laying period a rate of lay of 224 eggs was assumed.

Egg Prices

Basic to the determination of an average shell egg price are the shell egg price quotations as reported by the Federal-State Market News Service. These reports were obtained for the Los Angeles Market.

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[1]Winter, A. R. and E. M. Funk, Poultry Science and Practice, J. B. Lippincott Company, Chicago, Fifth ed., 1960, p. 104.

Several large licensed Arizona egg dealers were then asked to relate their egg pricing policy relative to these quotations. In all cases the dealers reported that grade AA eggs were priced by taking the low side of the quotation and reducing it by 2, 2.5, and 3 cents per dozen, respectively, for sizes large, medium, and small. Applying this price adjustment to the yearly average price for the different egg sizes the following prices were determined: large, 32.5 cents per dozen; medium, 27.5 cents per dozen; and small, 19.5 cents per dozen. These prices were then weighted by the percentages of the different size and grade eggs which a layer can be expected to produce. The size percentages used were 71 percent large, 25 percent medium, and 4 percent small weight eggs.[1] These size percentages represent the average proportion of different size eggs laid by hens in three different controlled experiments at the University of Arizona Poultry Research Farm in 1963. Percentages used for the grades of eggs were: 83 percent AA, 7 percent A, and 10 percent undergrades.[2] These grade

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[1]For a summary of standards of size for Arizona shell eggs see: Kaffenberger, James D., Arizona Egg Grades, Rules, Regulations, and Laws, Phoenix, Arizona, March, 1960, p. 21.

[2]For a summary of quality standards for Arizona shell eggs see: Arizona Egg Grades, Rules, Regulations, and Laws., p. 3. Undergrades are assumed to be eggs grading B and C.

percentages are thought to represent the approximate disposition of grades of eggs which a flock will lay.[1]

Weighting the annual average egg prices by the percent of different size and grade eggs which a hen can be expected to lay the average 1963 price received by Arizona egg producers for all eggs was determined to be 29.1 cents per dozen.

Cull Hens

Income received from the sale of old birds or cull hens is derived by assuming a bird weight of 4.25 pounds and a carcass market value of 5 cents per pound. Each cull hen is then assumed to represent an income of 21.25 cents.

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[1]Based upon interview with Dr. B. L. Reid, Head of Poultry Science Department, University of Arizona.

It is recognized that this grade disposition will vary with the length of the production period. Thus, the figures used here are only approximations and do not reflect results from any given experiment but represent a reasonable estimate based upon general knowledge.

APPENDIX II

INTERVIEW SCHEDULE USED TO OBTAIN THE

INFORMATION NEEDED FOR THE

RESEARCH STUDY

Poultry Farm No. _____

Date _____

Confidential

Department of Poultry Science
University of Arizona
Tucson, Arizona

Confidential

Interview Guide for Resource Requirements
and Supply Response on Arizona Poultry Farms in Relation
to the Future Demand for Eggs in Arizona

General Information

1. Land

Land Managed and Value	Number	Estimated Value/Acre
Acres Owned	_____	_____
Acres Rented	_____	_____
Acres in Poultry Feed Production	_____	_____
Acres in Poultry Farmstead (corrals, pens, buildings, etc.)	_____	_____

Land Use

Crop	Acres	1963 Yield/Acre	Price/Unit	Total Value	Remarks
Hay (Kind)					
1.					
2.					
Silage (Type)					
1.					
2.					
Greenchop (Type)					
1.					
2.					
Grain (Kind)					
1.					
2.					
3.					
Cotton					
Other Crops (Kind)					
1.					
2.					
3.					

1. Could you handle more birds with the present land you now have?

_____ How many more? _____ (Number)
(yes or no)

II. Improvements

Item	Construction make, model, type and size	Cost or Replacement Value	Age	Estimated Life	Repairs in 1963	Major improvements in 1963	% Used for Replacement Stock
BUILDINGS							
Brooder houses							
Replacement houses							
Laying houses							
Feed facilities							
Shops							
Egg house							
Cooler room							
Miscellaneous							
POULTRY EQUIPMENT							
Cages and/or nests							
Feed Conveyors and tanks							
Egg coolers							
Small tools							
Egg baskets							
Brooders							
Waterers							
Feed or egg carts							
Other equipment (List)							

II. Improvements--continued

Item	Construction make, model, type and size	Cost or Replacement Value	Age	Estimated Life	Repairs in 1963	Major improvements in 1963	% Used for Replacement Stock
MISC. EQUIPMENT							
Pickup truck							
Larger trucks							
Tractor							
Trailer (feed wagon)							
Manure spreader							
Manure loader							
Water systems, pumps							
Electric motors							
Septic tank							
Other equipment (List)							

Could you carry more birds with the present housing facilities on your farm?

_____ How many more? _____

(yes or no) (number of birds)

III. Livestock

Poultry Numbers and Disposition 1963

	1-1-63		Bought		Sold		Died		12-31-63	
	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Laying hens										
Replacement pullets										
Baby chicks										

1. On the average, how many months or to what age do you keep a laying hen in your flock? _____ (Months) _____ (Age)

2. What percent of your replacements do your raise? _____ (Percent)

3. What is the average number of laying days per hen per year in your flock? _____ (Days)

4. On the average, how many hens did you have in your flock in 1962 that were laying? _____ (Number)

5. What was your average production of eggs per hen in 1963? _____ (Eggs)

IV. Labor (For Poultry Enterprise)

Employee or Family Worker	Hours/ week	Weeks/ year	Cost or Value Unit	Cost or Value Value	Value of prereq-uisites	No. of hrs./week for replace-ment stock
Family Labor						
Owner						
Wife						
Son						
Hired Labor						
1.						
2.						
3.						
4.						
5.						
6.						
Manager, Book-keeper, Etc.						

Could you handle more birds with your present amount of labor? _____
(Yes or No)

How many more? _____
(Number)

V. Production Inputs Feed Fed (per day and per year for entire flock)

Kind of Feed	Pounds Fed Laying Flock per Year	Pounds of Replacement Feed per Year	Pounds Fed Baby Chicks per Year	Value per Unit	Total Value
Laying ration					
Growing ration					
Starter ration					

1. Do you change the ration from summer to winter? _____ (Yes or No)

2. Would you be willing to buy more feed at current prices to increase your egg production at present egg prices? _____ (Yes or No)

   At $0.02 per dozen increase in egg price? _____ (Yes or No)

   At $.075 per dozen increase in egg price? _____ (Yes or No)

Item	Total Cost 1963
Utility and Power	
Electricity	
Gasoline and Oil	
Natural Gas	
Water	
Telephone (Flock share)	

V. Production Inputs (continued)

Item	Total Cost 1963
General Production Inputs	
Veterinary and Medicine	
Disinfectants, Cleaning Solvents, Spray, Etc.	
Litter	
Subscriptions (Poultry farm paper)	
Memberships and Assessments	
Poultry Association, Farm Bureau, Etc.	
General Marketing Inputs	
Grading (Labor required)	
Candling (Labor required)	
Cartoning expense	
Egg Inspection Fees	
Other Taxes	

VI. Taxes and Insurance

Item	Total Cost 1963
Taxes	
Real Estate Tax on Poultry	
School or Special Assessments	
Flock and Equipment	

VI. Taxes and Insurance (Continued)

Item	Total Cost 1963
Insurance	
Fires and Extended Coverage	
Personal Liability	
Livestock Coverage	
Other (Specify)	
Employee Insurance	
Workmen's Compensation and OASI	
Industrial Accident Insurance	
Employer's Contribution to Health and Hospitalization Insurance	

VII. Farm Loans

Kind of Loan	Lender	Original Amount	Length of Loan	Interest Rate	Annual Payment
Real Estate Loans					
Machinery and Equipment					
Livestock Loans					
Operating Loans					
Other Loans					