4-1957

Production and Marketing of Hatching Eggs in Tennessee

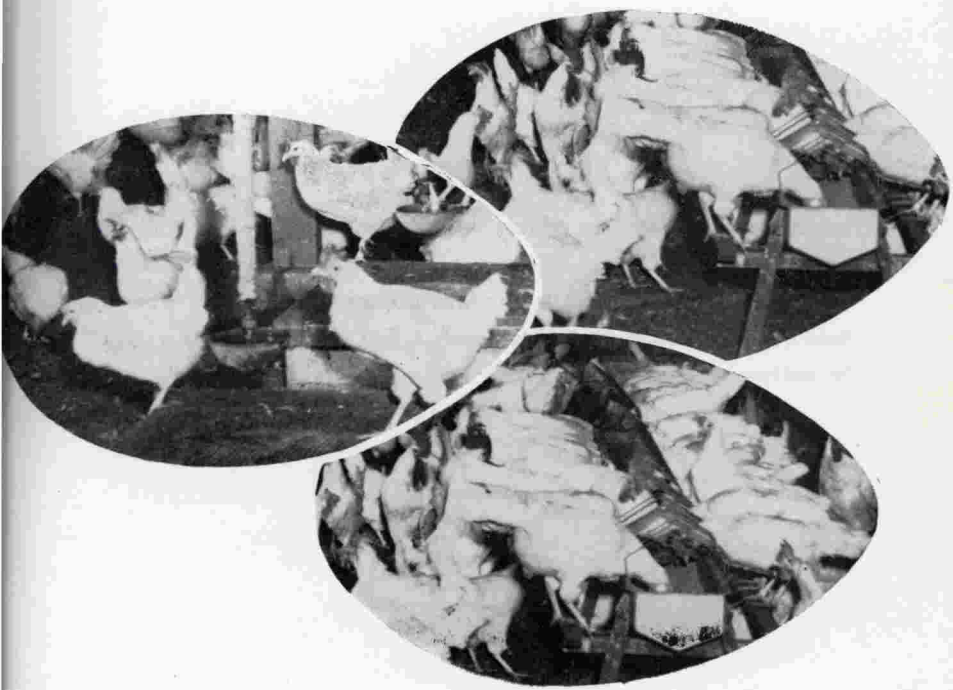
University of Tennessee Agricultural Experiment Station

B. D. Raskopf

Bulletin No. 259 April, 1957

Production and Marketing of Hatching Eggs in Tennessee

B. D. Raskopf



THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION
KNOXVILLE

Production and Marketing of Hatching Eggs in Tennessee

B. D. Raskopf

Associate Agricultural Economist

The author acknowledges the assistance and cooperation given in this study by 517 market egg producers, 116 hatcherymen, personnel of the Department of Agricultural Economics, and the Poultry Department of the Agricultural Experiment Station and Extension Service, and members of the Technical Committee of the Regional Poultry and Egg Marketing Project, SM-15.

THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION
KNOXVILLE

TABLE OF CONTENTS

INTRODUCTION

Importance and Purpose of Study

The poultry enterprise is an important source of income on Tennessee farms. From 6 to 10 percent of the cash farm income each year is from chickens and eggs. From 1950 to 1955 the value of eggs sold in the state averaged over 23 million dollars annually (Appendix I).

Hatching egg production has become a specialized enterprise on many farms in the state. In 1952 about 2,000 farmers produced eggs for 116 hatcheries. These farmers produced 3,187,000 dozen eggs of which 1,540,000 dozen, valued at $1,169,000, were sold to hatcheries.

Previous studies have reported on the practices of market egg producers, primary and secondary buyers and commercial hatchery operators.[1] These studies revealed various difficulties in the production and marketing of hatching eggs which merited further research.

The objectives of this study were to evaluate the important factors associated with labor returns in the hatching egg enterprise and to estimate the extra costs of producing hatching eggs.[2]

Methods and Scope of Study

This study is based on records secured from 517 hatching egg producers and 116 commercial hatcheries.[3] The location of 479 producers in Tennessee is shown in Figure 1. Included in the study were 38 farmers located in four adjoining states who produced

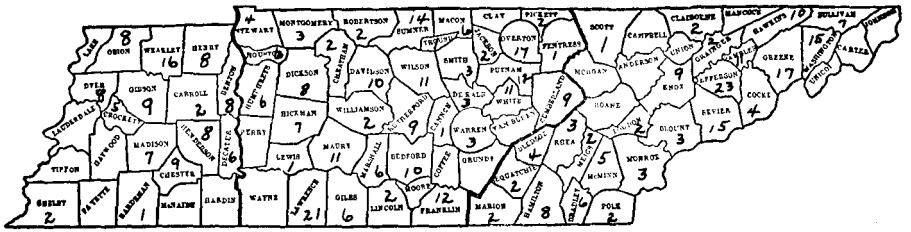


Figure 1.—Location of 479 farmers included in the survey who produced eggs for hatcheries and market in Tennessee, 1952.

---

[1] Keaton, Clyde R. and Raskopf, B. D., **Practices of Market Egg Producers in Tennessee**, Tennessee Agricultural Experiment Station, Monograph No. 249, Oct. 1949.
Keaton, Clyde R. and Raskopf, B. D., **Distributive Functions of Primary Egg Buyers**, Tennessee Agricultural Experiment Station, Monograph No. 254, May 1950.
Marketing Eggs at the Producer Level in Nine Southern States, Southern Cooperative Series Bulletin No. 17, December 1951.
Marketing Eggs at the First Buyer Level in Nine Southern States, Southern Cooperative Series Bulletin No. 18, December 1951.
Commercial Hatchery Operations in Six Southern States, Southern Cooperative Series Bulletin No. 34, July 1953.
Raskopf, B. D., **Egg Marketing Wholesale and Retail in Tennessee**, Tennessee Agricultural Experiment Station Monograph No. 267, July 1953.

[2] This report deals with the Tennessee phase of the Southern Regional Research Project on Marketing Hatching Eggs. Cooperating agencies in this project include the states of Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas, Virginia and the Agricultural Marketing Service, U.S.D.A. The study was partly supported by funds of the Research and Marketing Act.

[3] Producers kept records on receipts and expenses as defined in Appendix II. Supplementary data on practices of hatching egg producers and hatchability of eggs were secured from hatcheries.

eggs for Tennessee hatcheries. Data were collected for the calendar year 1952.

A stratified sample was used. Sampling factors taken into consideration included geographic location, size of flock, breed of layer, type and size of hatchery, market outlet, and type of farming.

The population from which the sample was taken included 2,000 farmers who produced eggs for Tennessee hatcheries in 1952. Of these farmers 114 were located in four adjoining states. Of the 95 counties in Tennessee, 41 had no active hatcheries and 23 no hatching egg producers in 1952.

CONSIDERATIONS IN SELECTING A MARKET

Geographic Location

There are opportunities for profitable hatching egg production in each of the major areas of the state; that is, East, Middle and West Tennessee. Among the three major areas from 17 to 38 percent of the producers operated at a profit and from 31 to 63 percent received labor returns (Table 1).

The most important factor associated with the variations in labor returns per hour among areas were egg production per layer, feed and labor efficiency and receipts per dozen eggs. The effects of each of these factors on labor returns are discussed later in the report.

Table 1.—Relation of Geographic Location to Labor Returns and Other Factors, 517 Farmers Producing Eggs for Hatcheries in Tennessee, 1952.

Item	Unit	Location of Flocks			
		East Tenn.	Middle Tenn.	West Tenn.	Other States**
Flocks*	No.	158	224	97	38
Layers per flock	No.	538	396	329	569
Eggs per layer	No.	172	156	184	178
Feed cost per cwt.	$	5.10	4.92	5.03	5.56
Feed used per layer	Lbs.	95	97	103	121
Minutes used per layer	No.	105	115	135	100
Feed cost per dozen eggs	¢	33.8	36.5	36.2	45.3
Receipts per dozen eggs***	¢	63.3	66.0	59.6	71.1
Receipts per dozen over feed cost	¢	29.5	29.5	23.4	25.8
Total cost per dozen eggs	¢	57.7	61.3	58.9	74.0
Profit or loss per dozen eggs	¢	5.6	4.7	0.7	—2.9
Labor returns per layer	¢	209.1	135.2	133.0	120.2
Labor returns per hour	¢	119.9	75.0	58.9	56.2
Flocks with plus labor returns****	%	63	41	31	55
Flocks showing a profit****	%	38	28	17	37

* Total flocks. All other items refer to averages.
** Includes flocks located in Alabama, Georgia, Kentucky and Virginia which produced eggs for Tennessee hatcheries in 1952.
*** In this and subsequent tables the receipts per dozen eggs include the value of poultry manure and feed sacks. See Appendix II.
**** See Appendix II for definitions of profit and labor returns per hour.

Size of Enterprise

About 27 percent of the hatchery egg producers included in the survey had flocks ranging from 400 to 12,000 layers. There were definite advantages to the larger flock operators in lower price paid for feed through volume purchases, more efficient use of labor, and higher returns per dozen eggs (Table 2). Egg production per layer was higher, and percent flock mortality lower, in the larger flocks. This was attributed to the fact that, as an average, better care and management practices used by the larger producers helped increase egg production and reduce mortality. On the other hand, several of the small flock owners with high labor returns maintained high efficiency in such factors as eggs per layer and low flock mortality.

The effects of such factors as feed and labor efficiency, receipts per dozen eggs, rate of lay, and percent flock mortality on labor returns per hour are discussed later in the report.

Table 2—Relation of Size of Flock to Labor Returns and Other Factors, 517 Farmers Producing Eggs for Hatcheries in Tennessee, 1952.

Item	Unit	Number of Layers in the Flock				
		13 to 99	100 to 199	200 to 399	400 to 699	700 to 12,000
Layers per flock	No.	69	132	266	506	1915
Flocks*	No.	144	150	84	65	74
Feed cost per cwt.	$	5.65	5.56	5.18	5.09	4.96
Eggs per layer	No.	127	126	142	171	182
Minutes used per layer	No.	178	166	160	128	89
Flock mortality	%	18.8	16.7	14.2	12.6	11.7
Feed cost per dozen eggs	¢	48.6	47.6	40.8	36.9	33.7
Receipts per dozen eggs	¢	55.4	56.6	59.6	63.9	66.7
Receipts per dozen over feed cost	¢	6.8	9.0	18.8	27.0	33.0
Total cost per dozen eggs	¢	82.9	78.0	67.2	60.8	58.4
Profit or loss per dozen eggs	¢	−27.5	−21.4	−7.6	3.1	8.3
Labor returns per layer	¢	−192.0	−138.3	8.6	140.6	252.1
Labor returns per hour	¢	−72.1	−46.7	3.1	65.9	173.2
Flocks with plus labor returns	%	15	30	58	86	96
Flocks showing a profit	%	4	12	31	71	78

* Total flocks. All other items refer to averages.

Breed of Layer

Of the 517 producers included in the survey, 15 percent had White Leghorns, 52 percent had New Hampshires and 33 percent had other heavy breeds (Table 3). With respect to breed differences, the White Leghorn flocks had the advantage of higher egg production, less feed used per layer, and lower housing cost due to less floor space required per bird. The extra cost of producing hatching eggs rather than table eggs was also lower for Leghorns (Table 14). Heavy breed flocks had the advantage of lower depreci-

ation cost per layer, and higher receipts per dozen eggs. Receipts per dozen eggs were influenced by differences in premiums paid for hatching eggs, percent of eggs sold to hatcheries, length of the hatching season, and number of layers per flock. The above factors are discussed elsewhere in this report.

Labor returns per hour for heavy breeds, other than New Hampshires, were significantly lower than for White Leghorns. This was attributed mainly to the effects of size of flock and egg production rather than to breed differences—see Tables 2 and 5. Labor returns per hour from the best-managed of other heavy breed large flocks were as high as those from the well-managed flocks of White Leghorns or New Hampshires.

Table 3.—Relation of Breed of Layer to Labor Returns and Other Factors, 517 Farmers Producing Eggs for Hatcheries in Tennessee, 1952.

Item	Unit	Breed of Layer		
		White Leghorns	New Hampshires	Other Heavy Breeds
Flocks*	No.	77	270	170
Layers per flock	No.	636	543	184
Eggs per layer	No.	196	163	152
Extra feed used per layer**	Lbs.	—	15.3	19.7
Sq. ft. floor space used per layer	No.	2.8	3.5	3.6
Housing cost per layer	¢	21.9	26.9	26.9
Flock depreciation per layer	¢	162.0	127.0	102.0
Eggs sold to hatcheries	%	15	62	46
Feed cost per dozen eggs	¢	29.3	37.7	43.0
Receipts per dozen eggs	¢	57.2	68.2	62.1
Receipts per dozen over feed cost	¢	27.9	30.5	19.1
Total cost per dozen eggs	¢	49.4	63.3	71.5
Profit or loss per dozen eggs	¢	7.8	4.9	—9.4
Labor returns per layer	¢	231.5	175.4	—20.8
Labor returns per hour	¢	135.1	98.0	—8.1
Flocks with plus labor returns	%	71	55	24
Flocks showing a profit	%	47	36	12

* Total flocks. All other items refer to averages.
** Difference in feed requirements when rate of lay was held constant.

About 64 percent of all flocks producing eggs for hatcheries in 1952 were in the National Poultry Improvement Plan. Based on the participation in this plan in Tennessee, important changes

occurred in the popularity of some breeds from 1952 to 1956. Little change has taken place in the popularity of White Leghorns and other breeds including Barred Rocks and Rhode Island Reds. New Hampshire flocks have declined in popularity. On the other hand, a significant increase has taken place in both number and size of flocks of White Rocks and cross breeds (Table 4).

Table 4.—Breed Popularity in Tennessee, Based on Participation in National Poultry Improvement Plan, Tennessee, 1952-53 to 1955-56.

Item			1952-53	1953-54	1954-55	1955-56
White Leghorns:	Flocks	(No.)	120	105	104	93
		(%)	9.4	9.0	8.4	9.3
	Birds	(No.)	26,688	34,042	39,507	41,378
		(%)	8.2	10.4	8.6	11.5
New Hampshires:	Flocks	(No.)	659	529	393	164
		(%)	51.6	45.2	31.7	16.4
	Birds	(No.)	209,343	132,526	107,817	23,143
		(%)	64.5	40.3	23.6	6.5
White Rocks:	Flocks	(No.)	190	251	403	309
		(%)	14.9	21.5	32.5	30.9
	Birds	(No.)	35,193	84,998	177,743	115,130
		(%)	10.8	25.9	38.9	32.2
Cross-bred and In-cross-bred:	Flocks	(No.)	64	64	143	260
		(%)	5.0	5.5	11.6	26.0
	Birds	(No.)	24,594	50,337	102,817	152,204
		(%)	7.6	15.3	22.5	42.5
Other breeds*:	Flocks	(No.)	243	220	196	175
		(%)	19.1	18.8	15.8	17.4
	Birds	(No.)	29,044	26,769	29,500	26,189
		(%)	8.9	8.1	6.4	7.3
Total	Flocks	(No.)	1,276	1,169	1,239	1,001
	Birds	(No.)	324,862	328,672	457,384	358,044

* Mainly Barred Rocks and Rhode Island Reds.
Source: Annual Reports, Tennessee Poultry Improvement Board, Inc., Nashville, Tennessee.

PRODUCTION FACTORS AFFECTING LABOR RETURNS

Eggs Per Layer

Egg production per layer was one of the important factors related to labor returns per hour. Rate of lay was associated with about 34 percent of the variability in labor returns per hour.[1] Among groups of flocks averaging from 91 to 181 eggs per layer, a significant difference existed in labor returns per hour in favor of the flocks with the highest rate of lay (Table 5). Among these groups the labor returns tended to increase about 17 cents per hour for each additional increase in production of ten eggs per layer.

Producers with the higher rate of lay made greater use of electric lights in the laying house, tended toward keeping layers in

[1] See Appendix III for net correlation.

Table 5.—Relation of Eggs Per Layer to Labor Returns and Other Factors, 517 Farmers Producing Eggs for Hatcheries in Tennessee, 1952.

Item	Unit	Eggs Per Layer			
		64 to 108	109 to 142	143 to 177	178 to 254
Eggs per layer	No.	91	128	164	181
Flocks*	No.	62	135	155	165
Laying house with electric lights	%	40	56	60	61
Months in production	No.	9	9.9	11	12
Flock mortality	%	18.5	15.7	15.1	11.4
Pullets in all flocks	%	38	61	75	84
Flocks culled monthly or oftener	%	6	19	60	87
Feed cost per dozen eggs	¢	60.1	46.8	41.5	32.8
Receipts per dozen eggs	¢	58.7	58.9	66.0	65.1
Receipts per dozen over feed cost	¢	—1.4	12.1	24.5	32.3
Total cost per dozen eggs	¢	99.4	75.5	68.9	55.8
Profit or loss per dozen eggs	¢	—40.7	—16.6	—2.9	9.3
Labor returns per layer	¢	—286.2	—98.9	79.7	252.5
Labor returns per hour	¢	—89.9	—30.1	33.3	178.2
Flocks with plus labor returns	%	2	12	53	87
Flocks showing a profit	%	—	5	20	70

* Total flocks. All other items refer to averages.

production the entire laying year, had low flock mortality, kept a high percentage of pullets in the flock, and culled flocks more frequently. A combination of these factors accounted for about 66 percent of the variation in rate of lay among groups of flocks or 60 eggs per layer.[1]

Between groups of 62 and 165 flocks averaging from 91 to 181 eggs per layer, the use of electric lights in the laying houses was associated with about 29 percent of the variation in rate of lay, or 25 eggs per layer. Previous studies have indicated that the use of lights with laying hens exercises a pronounced influence on egg production, mainly through sexual activity and feed consumption. In two different experiments, the flocks on which artificial lights were used produced from 19 to 26 more eggs per hen than the flocks on which lights were not used.[2]

An additional 20 percent of the variation in egg production, or 18 eggs per layer, was associated with the length of time layers were held in production. Egg production tended to increase per layer for each month layers were held in production over nine months, but not above 12 months. Nearly half of the producers did

[1] See Appendix III for net correlation.

[2] Brumley, Frank W., **An Economic Study of Commercial Poultry Farming in Florida**, Agricultural Experiment Station Bull. 105, May 1940, Gainesville, Fla., p. 58. Jull, Morley A., **Poultry Breeding**, John Wiley and Sons, Inc., New York, New York, 1952, p. 41.

not keep layers during the entire year. This procedure was most prevalent where producers sold eggs to hatcheries only a few months during the year, or where layers were sold in the spring or summer following the break in egg prices.

The rate of flock mortality was associated with nine percent of the variation in egg production, or eight eggs per layer. Egg production tended to increase as the percent of flock mortality decreased. The proportion of pullets kept in the flock accounted for four percent of the variation in egg production, or four eggs per layer. Between groups of flocks averaging from 38 to 84 percent pullets, production tended to increase an average of 1.7 eggs for each 10 percent increase of pullets in the flock. The 165 flocks having the highest rate of lay averaged 84 percent pullets. In flocks averaging over 84 percent pullets the rate of lay tended to decline. Apparently there was some advantage in carrying over from the previous year a small proportion of high-producing hens. The percent of flocks culled monthly was associated with four percent of the variation in rate of lay, or four eggs per layer. Rate of lay tended to increase with the frequency of culling.

About one-third of the variation in rate of lay was not associated with factors included in this analysis. No data were available to measure the effects on egg production of such factors as inherited capabilities of hens to lay eggs, quality of ration fed, and general care and management. Of these factors the inherited capability of hens to lay eggs was probably the most important. Previous studies have shown that breeding may affect egg production by 25 percent or more.[1]

Receipts Per Dozen Eggs

Receipts per dozen eggs was associated with 18 percent of the variability in labor returns per hour.[2] Among groups of flocks whose receipts per dozen eggs averaged from about 52 to 70 cents, existed a significant difference in labor returns per hour (Table 6). Among these groups the labor returns tended to increase 45 cents per hour for each additional increase of 10 cents in receipts per dozen eggs.

Four combined factors accounted for about 9 cents or 51 percent of the variability in receipts per dozen eggs. In the order of their importance, these factors included: (1) differences in premiums paid for hatching eggs, (2) percent of eggs sold to hatcheries, (3) length of the hatching season, and (4) number of layers per flock.

Of the above factors, the difference in premiums paid for hatching eggs was associated with four cents or 22 percent of the variation in receipts per dozen eggs.

The proportion of eggs sold to hatcheries was associated with

[1] Jull, Morley A., **Poultry Breeding**, John Wiley and Sons, Inc., New York, New York, 1952, pp. 289-350.

[2] See Appendix III for net correlation.

Table 6.—Relation of Receipts Per Dozen Eggs to Labor Returns Per Hour and Other Factors, 517 Farmers Producing Eggs for Hatcheries in Tennessee, 1952.

Item	Unit	Receipts Per Dozen Eggs (¢)			
		42-54	55-61	62-68	69-83
Receipts per dozen eggs	¢	51.8	57.1	63.6	70.1
Flocks*	No.	103	228	64	122
Premium per dozen for hatching eggs	¢	3.1	7.7	16.7	30.5
Eggs sold to hatcheries	%	26.8	33.5	38.8	57.0
Months eggs sold to hatcheries	No.	5.0	6.2	5.6	9.9
Layers per flock	No.	185	234	375	1069
Feed cost per dozen eggs	¢	39.3	38.8	36.2	35.0
Receipts per dozen eggs	¢	51.8	57.1	63.6	70.1
Receipts per dozen over feed cost	¢	12.5	18.3	27.4	35.1
Total cost per dozen eggs	¢	65.4	63.7	61.7	59.7
Profit or loss per dozen eggs	¢	−13.6	−6.6	1.9	10.4
Labor returns per layer	¢	−8.4	9.5	139.2	252.2
Labor returns per hour	¢	−3.4	4.1	71.6	159.0
Flocks with plus labor returns	%	15	33	56	95
Flocks showing a profit	%	5	16	34	74

* Total flocks. All other items refer to averages.

three cents or 19 percent of the variation in receipts per dozen eggs. Receipts per dozen eggs tended to increase about 1.4 cents per dozen for each additional increase of 10 percent in eggs sold to hatcheries.

Length of the hatching season was associated with one cent or six percent of the variation in receipts per dozen eggs. Receipts per dozen eggs tended to increase about 0.3 cent for each increase of one month in the contractual sale of eggs to the hatchery.

Size of flock was associated with less that one cent or about four percent of the variation in receipts per dozen eggs. Among groups of flocks averaging from 185 to 1,069 layers the receipts per dozen eggs tended to increase only 1.3 cents for each 1,000 layer increase in size of flock. Because certain market outlets required eggs in volume the year-round, however, some of the larger producers obtained higher receipts per dozen eggs.

About half of the variation in receipts per dozen eggs was not associated with factors analyzed in this report. Data were not secured on type of market outlet, other than hatchery, and the proportion of eggs sold during the season of highest prices. The latter factor is of considerable importance. Another study indicated that an increase of 10 percent in the percentage of all eggs produced during the fall months resulted in an increase of one-half cent in the average receipts per dozen eggs.[1]

[1] Oberholtzer, J. W., An Economic Study of Semi-Commercial Egg Farms in North Central Indiana, Purdue University Bulletin 486, August, 1943. p. 22.

Feed Cost Per Hundredweight

For most flocks the feed cost comprised from 55 to 60 percent of the total cost. Among groups of flocks wherein feed cost averaged from $4.70 to $5.49 per hundredweight, a significant difference existed in labor returns per hour (Table 7). However, when other factors were held constant feed cost per hundredweight was associated with only five percent of the total variation in labor returns per hour.[1] Among the groups of flocks in which feed cost per hundredweight ranged from $4.70 to $5.49 the labor returns per hour tended to increase about four cents per hour for each successive decrease of 10 cents in feed cost per hundredweight.

About 14 percent of the variation in feed cost per hundredweight was associated with the number of layers per flock. The feed cost per hundredweight tended to decrease about 1.3 cents with each additional increase of 100 layers up to 2,000 layer flocks. Some of the larger producers, through volume purchases, were in position to buy feed at lower prices.

About 86 percent of the variation in feed cost per hundredweight was unaccounted for. This merits further investigation. Estimates obtained from producers on the proportion of home-grown feeds used in the ration indicate that this is an important factor affecting feed cost per hundredweight.

Table 7.—Relation of Price Paid for Feed to Labor Returns and Other Factors, 517 Farmers Producing Eggs for Hatcheries in Tennessee, 1952.

Item	Unit	Price Paid Per Cwt. for Feed			
		Under $4.75	$4.76 to $4.99	$5.00 to $5.24	$5.25 and over
Feed cost per cwt.	$	4.70	4.93	5.15	5.49
Flocks*	No.	27	90	126	274
Layers per flock	No.	1979	727	434	195
Home grown feed used (estimate)**	%	45.1	35.2	25.8	11.2
Feed cost per dozen eggs	¢	30.4	33.5	37.6	45.0
Receipts per dozen eggs	¢	65.0	64.3	66.0	63.2
Receipts per dozen over feed cost	¢	34.6	30.8	28.4	18.2
Total cost per dozen eggs	¢	51.1	57.3	68.7	78.3
Profit or loss per dozen eggs	¢	13.9	7.0	—2.7	—15.1
Labor returns per layer	¢	271.1	220.6	111.8	25.7
Labor returns per hour	¢	201.6	125.2	58.8	10.1
Flocks with plus labor returns	%	96	74	59	27
Flocks showing a profit	%	89	54	36	13

* Total flocks. All other items refer to averages.

** Home-grown feed included that grown by the producer or purchased locally. Home-grown feed was valued at market price.

There was little relation between labor returns per hour and feed cost per layer.[2] The amount of feed used per layer annually

[1] See Appendix III for net correlation.

[2] The simple gross correlation coefficient: r = .0967.

between flocks varied 59.4 pounds. As an aid in estimating feed requirements the number of pounds of feed used daily per 100 layers was calculated from 806 records of 485 producers. Factors taken into consideration were breed, age of layer, and rate of lay.

The approximate amounts of feed used daily per 100 layers for pullets and hens of the three important breeds at specified rates of lay are shown on Table 8. These figures are based on records of flock averages and should be used only as a guide in estimating feed requirements. The amount of feed used per layer annually at any given rate of lay may be calculated by multiplying any of the figures on pounds of feed used daily by 365 and dividing by 100. For example, a White Leghorn flock of 100 pullets uses about 26 pounds of feed daily at 70 percent egg production. For one year the feed required would be about 9,500 pounds or 95 pounds per layer.

Feed requirements per 100 birds daily, presented in Table 8, closely approximate those found in another study.[1] However, even under controlled conditions, it is impossible to state exactly how much feed should be given a particular flock every day. Daily requirements may be expected to vary as much as five percent from the average. This is true because the data were compiled without taking into consideration such factors as changes in body weights of layers, kind of diet, and differences in flock care and management.

Table 8.—Estimated Pounds of Feed Used Daily Per 100 Layers by Rate of Lay, Breed and Age of Layer, 806 Records of 485 Farmers Producing Eggs for Tennessee Hatcheries, 1952.

Percent production	Leghorn		New Hampshire		Plymouth Rock	
	Pullets	Hens	Pullets	Hens	Pullets	Hens
	(Pounds of feed used daily per 100 layers without roosters)					
20	18.1	19.4	21.7	24.8	23.1	25.7
30	19.7	20.9	23.2	26.0	24.5	27.2
40	21.3	22.5	24.6	27.1	25.9	28.6
50	22.9	24.0	26.1	28.3	27.3	30.0
60	24.4	25.5	27.5	29.4	28.8	31.5
70	26.0	27.0	29.0	30.6	30.2	32.9

Source: Summary of basic data are shown in Appendix IV.

Labor Used Per Layer

For all flocks the cost of labor comprised about 13 percent of the total costs per layer. The amount of labor used per layer was associated with about 3.4 percent of the variation in labor returns per hour.[2] Among groups of flocks where the minutes used per layer averaged from 59 to 200, there existed a significant difference in labor returns per hour (Table 9). Among these groups the labor returns tended to increase about four cents per hour for each successive decrease of 10 minutes in labor used per layer.

[1] Jull, Morley A., **Successful Poultry Management**, McGraw-Hill Book Company, New York, 1943, p. 273.

[2] See Appendix III for net correlation.

Number of layers per flock was associated with 22 percent of the variation in minutes used per layer.[1] Labor used per layer tended to decrease about three minutes for each 100 layers added to the flock. The number of roosters used per 100 layers was associated with only two percent of the variation in minutes used per layer, largely because of the small differences occurring among groups of flocks in the number of roosters used. Labor used per layer tended to decrease about 3.2 minutes for each decrease of one rooster used per 100 layers. This was an important factor among individual flocks where more roosters were used than were actually required to maintain high percentage hatchability of eggs sold.[2]

Table 9.—Relation of Labor Efficiency to Labor Returns and Other Factors, 517 Farmers Producing Eggs for Hatcheries in Tennessee, 1952.

Item	Unit	Minutes Used Per Layer				
		32 to 79	80 to 129	130 to 164	165 to 184	185 to 330
Minutes used per layer	No.	59	107	154	173	200
Flocks*	No.	20	108	131	115	143
Layers per flock	No.	2990	929	261	156	101
Roosters used per 100 layers	No.	7.1	8.2	8.2	8.7	8.8
Feed cost per dozen eggs	¢	30.6	36.3	38.8	46.2	54.9
Receipts per dozen eggs	¢	65.6	66.8	61.1	59.5	53.4
Receipts per dozen over feed cost	¢	35.0	30.5	22.3	13.3	−1.5
Total cost per dozen eggs	¢	52.5	60.2	63.5	75.6	91.6
Profit or loss per dozen eggs	¢	13.1	6.6	−2.4	−16.1	−38.2
Labor returns per layer	¢	318.7	203.4	64.7	−81.3	−266.3
Labor returns per hour	¢	321.6	113.6	25.3	−28.2	−79.7
Flocks with plus labor returns	%	95	89	70	30	1
Flocks showing a profit	%	95	72	35	10	0

* Total flocks. All other items refer to averages.

Only 24 percent of the variation in minutes per layer was explained by factors included in this analysis. However, among the 517 flocks many different ways were observed in reducing labor. Some of the more important of these included:

1. Installing running water and automatic fountains.
2. Use of mechanical feeders or overhead feed carriers.
3. Increasing feed storage capacity and having feed source near pens.
4. Use of built-up litter and pits.
5. Mechanical washing and grading of eggs.
6. Planning poultry house arrangement to reduce walking time.

[1] See Appendix III for net correlation.
[2] See Table 10.

Flock Mortality

Losses in individual flocks due to disease and other causes was a very serious matter. However, the overall influence of mortality on labor returns per hour did not appear to be of major importance among all flocks. The percent of flock mortality was associated with less than one percent of the variation in labor returns per hour.[1] The minor association of flock mortality to labor returns found in this study is supported by the results of four other recent studies.[2]

Death losses varied widely among individual flocks and the factors related to mortality rates merit consideration. About 45 percent of the variation in percent flock mortality was related to six factors.[3] Frequency of culling was associated with about 18 percent of the variation in percent flock mortality. The percent flock mortality tended to decrease one percent for each five times the flock was culled. Rate of lay was associated with about 11 percent of the variation in percent flock mortality. Mortality tended to decrease one percent for each increase of 55 eggs per layer. The extent of control of the range of layers was associated with eight percent of the variation in percent flock mortality. Flocks without controlled range of layers showed an increase of 1.3 percent flock mortality, over flocks where the range of layers was controlled. The number of layers per flock was associated with about eight percent of the variation in percent flock mortality. Flock mortality tended to decrease one percent with each increase of 1,000 layers added to the flock. Apparently, as the size of flock increased, there was a tendency for the producer to follow better methods of disease prevention.

About 55 percent of the variation in percent flock mortality was not associated with factors included in this analysis. Other factors which probably contributed to low flock mortality were programs followed by producers in the prevention of disease and the selection of breeding stock for livability.

Housing and Miscellaneous Cost Per Layer

For all flocks the cost of housing averaged less than three percent of the total cost per layer. Among individual flocks the housing cost varied about 24 cents per layer. Housing cost per layer was associated with less than one percent of the variation in labor returns per hour.[3] About 55 percent of the variation in housing cost per layer was associated with miscellaneous costs.[1] Some of

[1] See Appendix III for net correlation.

[2] A. Burlington, B. B., and Hertel, Joe; **Poultry Management Study**, 1949, San Bernardino, California.
B. Retson, G. C., **Commercial Poultry Farming in Nova Scotia**, Canada Department of Agriculture, Economics Division, Ottawa, 1952.
C. Smith, Harold and Trower, John, **Relation of Various Egg-Marketing Methods to Producer Returns in Maryland**, Maryland Agricultural Experiment Station, Bulletin A70, 1952.
D. Blackstone, Homer J., and Henderson, H. A., **Cost and Returns to Commercial Egg Producers**, Alabama Agricultural Experiment Station, Bulletin 290, 1954.

[3] See Appendix III for net correlation.

the unexplained variation in housing cost may have been associated with breed. It cost about five cents less per layer to house light breeds than the heavy breeds. Light breeds required about 20 percent less floor space per bird than did the heavy breeds (Table 3).

Miscellaneous costs comprised about 10 percent of the total costs per layer as an average for all flocks. Among individual flocks the miscellaneous costs varied about 86 cents per layer. These costs included such items as depreciation on equipment, land, taxes, insurance, interest on investment, electricity, cartons, crates, gasoline and auto repair or hauling charge, veterinary care and medicine, blood testing, litter, telephone and records. Because of the number of interrelationships of these costs no satisfactory method could be devised for measuring the relative effects of each on labor returns per hour. However, all miscellaneous costs per layer (combined) were associated with less than one percent of the variation in labor returns per hour.[1]

OTHER FACTORS RELATED TO LABOR RETURNS

Number of Roosters Used Per 100 Layers

It was costly to maintain male birds in the flock, the average being $8.00 per cockerel in 1952. The most important costs included feed, depreciation, extra labor and equipment, and selection and blood testing (Table 14).

One study has shown that in New hampshire breeder flocks, from 6 to 7 males per 100 females were required for consistently high fertility.[2] In this study no significant increase in hatchability resulted from the use of more than 6 males per 100 females (Table 10).[2] These data suggest that most of the hatchery egg producers were keeping too many males per 100 females in their flock.[3]

Table 10.—Relation of Number of Roosters Used Per 100 Layers to Hatchability of Eggs Sold, 517 Farmers Producing Eggs for Hatcheries in Tennessee, 1952.

Item	Unit	Roosters Used Per 100 Layers				
		4-6	7	8	9	10-25
Flocks (total)	No.	44	64	215	53	141
White Leghorn flocks	No.	19	16	24	7	11
Heavy breed flocks	No.	25	48	191	46	130
Layers per flock	No.	594	680	464	310	224
Hatchability of eggs sold	%	75.8	76.1	76.1	76.7	76.3

Experience of Hatching-Egg Producers

The 517 farmers included in the survey averaged about eight years' experience as producers of hatching eggs. About 37 percent of the producers had less than five years of experience and less

[1] See Appendix III for net correlation.

[2] Bernier, P. E. and Parker, J. E., Relation of Male to Female Ratio in New Hampshire Breeder Flocks to Fertility of Eggs, Poultry Science, Vol. XXIX, No. 3, May 1950.

[3] Data relating to the hatchability of eggs were secured from 116 hatcheries in Tennessee.

than 16 percent had more than 14 years' experience (Table 11).

Operators with 15 or more years of experience averaged significantly higher labor returns per hour than producers having from one to 14 years' experience. This was largely attributed, however, to the fact that they had larger flocks, obtained higher egg production, paid less for feed, or secured higher labor efficiency. The effects of these factors on labor returns have been analyzed in earlier sections of this report.

Years of experience is not necessarily related to labor returns per hour or to the adoption of improved practices. Lack of experience as a hatching egg producer, therefore, should not be regarded as a deterring factor by potential producers. It may be offset by following improved practices.

Table 11.—Relation of Experience of Producer to Labor Returns and Other Factors, 517 Farmers Producing Eggs for Hatcheries in Tennessee, 1952.

Item	Unit	Years Experience as Hatching Egg Producer					
		1	2-4	5-9	10-14	15-19	20-40
Flocks*	No.	54	138	155	88	42	40
Layers per flock	No.	297	334	348	508	1019	583
Eggs per layer	No.	145	152	169	180	174	184
Minutes used per layer	No.	119	125	127	113	85	101
Feed cost per cwt.	$	5.22	5.13	5.14	5.06	4.91	5.09
Feed cost per dozen eggs	¢	35.3	38.3	37.1	37.3	34.2	33.3
Receipts per dozen eggs	¢	58.1	66.7	66.1	63.6	65.0	63.4
Receipts per dozen over feed cost	¢	22.8	28.4	29.0	26.3	30.8	30.1
Total cost per dozen eggs	¢	59.6	64.3	62.1	62.3	57.7	56.1
Profit or loss per dozen eggs	¢	—1.5	2.4	4.0	1.3	7.3	7.3
Labor returns per layer	¢	74.5	151.1	152.5	132.9	208.4	221.4
Labor returns per hour	¢	37.5	72.7	71.9	70.3	147.0	131.5
Flocks with plus labor returns	%	31	44	50	50	52	55
Flocks showing a profit	%	24	23	29	34	40	43

* Total flocks. All other items refer to averages.

Importance of an Egg Enterprise in Farm Business

Among individual flocks the proportion of farm income from the sale of eggs ranged from one to 100 percent and averaged 22 percent for all flocks. As the egg enterprise increased in importance in relation to the producer's farm income, there was a significant increase in labor returns per hour (Table 12). However, these variations in labor returns per hour between flocks were largely attributed to differences in the following factors which have been analyzed in foregoing sections of this report:

1. Size of flock
2. Eggs per layer

3. Percent pullets in the flock
4. Feed cost per hundredweight
5. Minutes used per layer
6. Roosters used per 100 layers
7. Receipts per dozen eggs

The importance of the egg enterprise in the farm business is not necessarily related to labor returns per hour or the adoption of improved practices. There were profitable and unprofitable flocks regardless of the proportion of the producer's farm income resulting from the sale of eggs.

Table 12.—Relation of Importance of Egg Sales in Farm Business to Labor Returns and Other Factors, 517 Farmers Producing Eggs for Hatcheries in Tennessee, 1952.

Item	Unit	Percent of Producers' Farm Income from Egg Sales					
		Under 10	10-19	20-29	30-39	40-49	50 and over
Flocks*	No.	153	136	87	60	29	52
Layers per flock	No.	100	214	399	496	777	1834
Eggs per layer	No.	126	150	165	150	182	185
Pullets in all flocks	%	65	67	73	76	79	86
Feed cost per cwt.	$	5.51	5.22	5.07	5.19	5.00	4.97
Minutes used per layer	No.	178	142	127	120	108	87
Roosters used per 100 layers	No.	8.5	8.4	8.2	8.1	7.8	7.7
Feed cost per dozen eggs	¢	47.2	38.9	35.7	38.2	33.4	34.8
Receipts per dozen eggs	¢	54.4	60.9	60.3	66.2	64.6	67.8
Receipts per dozen over feed cost	¢	7.2	22.0	24.6	28.0	31.2	33.0
Total cost per dozen eggs	¢	77.9	64.2	59.0	64.3	55.8	59.0
Profit or loss per dozen eggs	¢	—23.5	—3.3	1.3	1.9	8.8	8.8
Labor returns per layer	¢	—146.9	49.1	114.4	141.2	237.6	248.4
Labor returns per hour	¢	—49.5	20.7	54.1	70.3	132.3	171.3
Flocks with plus labor returns	%	18	33	62	75	79	94
Flocks showing a profit	%	4	17	38	58	66	71

* Total flocks. All other items refer to averages.

Capital Efficiency

Receipts from the egg laying enterprise in relation to money invested in the business determine the returns obtained on investment. In this study the measure of capital efficiency used was the number of months it took for gross egg receipts to equal the money invested in the hatchery egg enterprise. Included in investment was the capital represented in land, buildings, equipment, layers, roosters, feed on hand and supplies necessary to conduct the enterprise.

Of all producers showing positive labor returns per hour, 162 required less than 12 months for receipts to equal money invested (Table 13). The most important factors contributing to this rapid turnover included high rate of lay, high proportion of pullets in the flock, less than 8 roosters used per 100 layers, low feed cost and high returns per dozen eggs. The effect of each of these factors on labor returns per hour has been analyzed in earlier sections of this report.

This study does not show how much money should be invested on an individual layer basis. Rather, it indicates that the amount of money invested on an individual hen basis does not necessarily measure productive capacity and efficiency. There was little difference between groups of flocks in the amount of money invested per layer, the range being only 34 cents per bird.

Table 13.—Relation of Capital Efficiency to Labor Returns and Other Factors, 517 Farmers Producing Eggs for Hatcheries in Tennessee, 1952.

Item	Unit	Months for Receipts to Equal Capital Investment			
		Under 12	12-17	18-23	Over 23
Flocks*	No.	162	240	81	34
Layers per flock	No.	1024	208	94	104
Eggs per layer	No.	185	132	109	77
Pullets in all flocks	%	82	73	49	37
Minutes used per layer	Min.	96	148	198	211
Roosters per 100 layers	No.	7.7	8.7	8.8	8.8
Feed cost per cwt.	$	5.00	5.25	5.57	5.48
Capital investment per layer	$	6.93	6.60	6.59	6.85
Feed cost per dozen eggs	¢	34.0	43.0	52.3	77.9
Receipts per dozen eggs	¢	66.9	57.1	47.1	52.1
Receipts per dozen over feed cost	¢	32.9	14.1	—5.2	—25.8
Total cost per dozen eggs	¢	57.4	70.9	86.5	130.4
Profit or loss per dozen eggs	¢	9.5	—13.8	—39.4	—78.3
Labor returns per layer	¢	257.9	—79.3	—264.1	—395.7
Labor returns per hour	¢	160.7	—32.2	—79.8	—112.5
Flocks with plus labor returns	%	100	33	——	——
Flocks showing a profit	%	86	6	——	——

* Total flocks. All other items refer to averages.

Estimated Extra Cost of Producing Hatching Eggs

There are obvious costs in producing hatching eggs not experienced in producing table eggs. These include feed cost and depreciation of roosters, extra feed cost of breeder mash, extra labor, equipment, and maintenance and blood testing. In addition, there are other costs not so easily recognized and determined. These include layers culled because they are not suitable for breeding, reduced number of layers in case of heavy vs. light breeds,

lower egg production from broiler production strains, and market price discount for eggs not suitable for hatching.[1]

Premiums over market eggs (table eggs) should cover all of the above extra cost and under efficient management provide for some additional profit. If premiums do not exceed the extra cost there is no incentive for the farmer to change from table egg to hatching egg production.

Producers should consider the extra cost per dozen of producing hatching eggs under existing conditions. When this extra cost is estimated it may be used as an aid in determining the premium necessary to make a profit and compensate increased risk.

The extra cost of producing hatching eggs was estimated for 329 flocks, separated as to light and heavy breeds and as to production of eggs for flock replacements or broilers. These groups averaged about the same number of layers per flock. The extra cost of producing hatching eggs for flock replacements averaged 6.5 cents per dozen or $1.08 per layer for light breeds, and 8.3 cents per dozen or $1.26 per layer for heavy breeds. Where eggs were produced for broiler production the extra cost was highest, averaging 9.4 cents per dozen eggs or $1.34 per layer.

A list of the most important extra costs of producing hatching eggs for 329 producers is given in Table 14. These costs will be discussed separately.

Breeder mash. Breeder mash contains certain costly ingredients desirable for high hatchability percentage but are unnecessary for table egg production. The extra cost of breeder mash per layer averaged 34.2 cents for light breeds and 34.9 cents for heavy breeds for flock replacements. For broiler flocks the cost was 35.8 cents per layer. The cost of breeder mash per layer varied somewhat from flock to flock because of differences in feed requirements due to such factors as rate of lay, breed, roosters used per 100 layers, and flock care and management.

Feed cost of roosters. The feed cost of roosters when prorated per layer averaged 31.5 cents for light breeds, 37.9 cents for heavy breeds and 38.9 cents for broiler flocks. Roosters consumed about 91 pounds of feed per bird in the light breed flocks and 95 pounds per bird in the heavy breeds. Feed cost of roosters varied among flocks according to breed, roosters used per 100 layers, length of the hatching season, and flock care and management.

Depreciation of roosters. Depreciation averaged $1.62 per rooster for light breeds and $1.27 for heavy breeds. This cost when prorated per layer averaged 11 cents for light breeds and 10.3 for heavy breeds. The most important factor affecting the cost of rooster depreciation among flocks was the extent to which hatcheries share in the cost of male birds.

Layers not suitable for breeders. Layers not suitable for hatching egg production were culled although many of these layers could

[1] Botsford, Harold E., **The Economics of Poultry Management**, John Wiley and Sons Inc., New York City, 1952. pp. 137-145.

have been kept for table egg production. This extra cost amounted to about five percent of the layer depreciation or 6.4 cents per layer.

Extra labor. The production of hatching eggs required about 10 percent more labor than that needed for table eggs. Extra labor included the selection and replacement of layers and roosters used for breeding and the selection and sorting of eggs sold to hatcheries. This extra cost when prorated per layer averaged 8.9 cents for light breeds and 9.2 cents for heavy breeds. The extra labor cost was somewhat higher for heavy breeds because of a higher ratio required of roosters to hens.

Extra equipment and maintenance. The male birds used in the flock required extra investment in buildings, ranges and coops for surplus roosters, and extra supplies and equipment. Other charges over and above those required for table egg production included interest on extra investment, insurance, taxes and electricity. The extra equipment and maintenance costs amounted to about five percent of the housing and miscellaneous costs per bird or 5.5 cents per layer.

Reduced number of layers; heavy vs. light breeds. As shown in Table 3, the heavy breeds occupied about 20 percent more square feet of floor space per bird than light breeds. In flocks where heavy breeds were used in producing hatching eggs, five light breed layers could have been housed in the space occupied by four heavies. For table egg production, therefore, the number of layers could have been increased by 20 percent. Thus a loss in labor returns was estimated at 95 cents for each layer which could have been added.[1] The extra cost resulting from reduced number of layers when prorated amounted to 9.5 cents per layer for the heavy breeds.

Loss of eggs from broiler production strains. The loss in eggs from broiler production strains averaged 11 eggs per layer. This loss when prorated per layer averaged 5.3 cents in the broiler flocks.

Inspection and blood testing. The extra cost of inspection and blood testing when prorated per layer averaged 10.7 cents for light breeds and 10.8 cents for heavy breeds. This cost was slightly higher for the heavy breeds because of the higher ratio of males to females in the flock.

Eggs unsuitable for hatching and sold at discount. Eggs not meeting hatchery requirements generally included those with poor shells, cracks, odd shapes and those of undesirable weights. Such eggs offered on the wholesale market brought lower prices than they would have brought if sold in normal proportions with other eggs. This extra cost when prorated per layer averaged 6.1

[1] The labor returns were 95 cents per layer or 5.8 cents per dozen eggs for 77 light-breed flocks when adjustments were made for the extra cost of producing hatching eggs and price received for eggs.

cents for light breeds, 21.4 cents for heavy breeds for flock replacements and 22.2 cents for broiler flocks.[1]

Male activity. Other studies indicate that some of the extra cost of producing hatching eggs may be due to male activity; that is, the use of roosters in the flock may result in fewer eggs and

Table 14.—Estimated Extra Cost of Producing and Marketing Hatching Eggs Over Table Eggs, 329 Farmers Producing Eggs for Hatcheries in Tennessee, 1952.

Item	Extra Cost of Producing Hatching Eggs[1]					
	Light Breeds		Heavy Breeds			
	For flock replacement		For flock replacement		For broilers	
	Per layer (cents)	Per dozen eggs (cents)	Per layer (cents)	Per dozen eggs (cents)	Per layer (cents)	Per dozen eggs (cents)
Extra feed cost of breeder mash	34.2	2.1	34.9	2.3	35.8	2.5
Feed cost of roosters	31.5	1.9	37.9	2.5	38.9	2.7
Depreciation of roosters	11.0	0.7	10.3	0.7	10.3	0.7
Layers not suitable for breeders[2]	6.4	0.4	6.4	0.4	6.4	0.4
Extra labor	8.9	0.5	9.2	0.6	9.2	0.6
Extra equipment and maintenance	5.5	0.3	5.5	0.4	5.5	0.4
Reduced number of layers[3]	—	—	9.5	0.6	9.5	0.7
Loss of eggs from broiler strains	—	—	—	—	5.3	0.4
Selection and blood testing	10.7	0.7	10.8	0.7	10.8	0.8
Eggs sold at discount[4]	6.1	0.4	21.4	1.4	22.2	1.6
TOTAL	114.3	7.0	145.9	9.6	153.9	10.8
CREDIT:						
Transportation of eggs by hatchery	4.9	0.3	17.1	1.1	17.8	1.2
Value of manure produced by roosters	1.2	0.1	1.7	0.1	1.7	0.1
Feed sacks[5]	0.6	0.1	0.7	0.1	0.8	0.1
TOTAL	6.7	0.5	19.5	1.3	20.3	1.4
NET COST	107.6	6.5	126.4	8.3	133.6	9.4
Number of flocks	77		106		146	
Layers per flock	636		632		626	
Eggs per layer	196		183		172	
Roosters used per 100 layers	6.8		8.1		8.1	

[1] Itemized costs were arrived at by calculating the dollar value of each cost and dividing by the number of layers and eggs produced to determine cost per layer or per dozen eggs.
[2] Layers not suitable for hatching egg production were culled.
[3] Reduced number of layers in the case of heavy vs. light breeds.
[4] Eggs unsuitable hatching and sold at discount.
[5] Value of feed sacks for feed consumed by roosters.

[1] This cost was much higher for the heavy breeds because higher proportions of the eggs produced were sold to hatcheries (Table 3).

extra mortality.[1] In this study male activity was not included in estimating the extra cost of producing hatching eggs. The use of as many as 10 roosters per 100 layers in the flock was associated with a decrease of only two eggs per layer and no increase in percent flock mortality.[2]

SUMMARY AND CONCLUSIONS

The objectives of this study were to evaluate the important factors associated with labor returns in the hatching egg enterprise and to determine the extra costs of producing hatching eggs. The study was based on schedules obtained from 116 hatcheries and 517 farmers producing eggs for these hatcheries in Tennessee in 1952.

There were definite advantages to the larger flocks in higher returns per dozen eggs, lower price paid for feed through volume purchases and more efficient use of labor. Although the larger flocks had certain advantages, there were many small profitable flocks included in the study. Of 467 flocks averaging under 400 layers, 101 showed a profit and 204 showed positive labor returns. The smaller producers with high labor returns maintained high efficiency in such factors as eggs per layer, use of home-grown feeds, and selection of favorable market outlets.

Rate of lay was associated with 34 percent of the variation in labor returns per hour. Among groups of flocks averaging from 91 to 181 eggs per layer annually, labor returns tended to increase 17 cents per hour for each additional increase of 10 eggs per layer. High egg production per layer was associated with the use of electricity in the laying house, hens kept in production the entire laying year, low flock mortality, high percentage of pullets in the flock and frequent culling.

Receipts per dozen eggs were associated with 18 percent of the variation in labor returns per hour. Among flocks whose receipts per dozen eggs averaged from 52 to 70 cents, labor returns tended to increase 45 cents per hour for each additional increase of 10 cents in receipts per dozen eggs. High receipts per dozen eggs were associated with differences in premiums paid for hatching eggs, percent of eggs sold to hatcheries, length of the hatching season, and number of layers per flock.

Feed cost per hundredweight was associated with five percent of the variation in labor returns per hour. Between groups of flocks in which feed cost averaged from $4.70 to $5.49 per hundredweight, the labor returns tended to increase about four cents per hour for each additional decrease of 10 cents in feed cost per hundredweight. The most important ways of reducing feed costs were by

[1] Botsford, Harold E., **The Economics of Poultry Management**, John Wiley and Sons, Inc., New York City, 1952. p. 140.

[2] See Appendix III for net correlation.

purchasing feed in volume, which was influenced by size of flock; and using more home-grown feeds.

The amount of labor used per layer was associated with 3.4 percent of the variation in labor returns per hour. Between groups of flocks wherein time used per layer averaged from 59 to 200 minutes the labor returns tended to increase about four cents per hour for each additional decrease of 10 minutes used per layer. Variation in minutes required per layer was associated with size of flock. The time required per layer tended to decrease about three minutes for each additional 100 layers added to the flock.

Flock mortality was not related to labor returns per hour but was associated with other factors. Factors which were associated with low flock mortality were frequency of culling, rate of lay, control of range of layers, and size of flock.

In this study about 85 percent of the flocks ranged from seven to 25 roosters per 100 layers. No significant increase in hatchability, however, resulted from the use of more than six males per 100 females.

The extra cost of producing hatching eggs for flock replacements averaged 6.5 cents per dozen or $1.08 per layer for light breeds, and 8.3 cents per dozen or $1.26 per layer for heavy breeds. Where eggs were produced for broiler production the extra cost was highest, averaging 9.4 cents per dozen eggs, or $1.34 per layer.

Labor returns per hour were not significantly associated with such factors as geographic location, experience of hatchery egg producers, percent of producer's farm income from egg sales, capital efficiency and housing and miscellaneous costs per layer.

APPENDIX I

Production and Marketing of Eggs in Tennessee, 1924-55

Year	PRODUCTION					MARKETING			
	Farms reporting Chickens (000)	Eggs produced (000000)	Average number layers on farms (000)	Layers per farm (No.)	Eggs produced per layer (No.)	Farms selling eggs (000)	Cases eggs sold per farm (No.)	Dollar value of eggs sold (000)	Egg sales per farm selling eggs ($)
1924	224	845	8366	37	101	179	9.1	11271	63
1925	222	862	8406	38	103	177	9.5	13635	77
1926	221	948	8371	38	113	175	10.7	14928	85
1927	220	1002	9190	42	109	173	11.5	13122	76
1928	219	920	8652	40	106	172	10.7	13915	81
1929	218	816	7384	34	111	170	9.4	13152	77
1930	217	819	7321	34	112	167	9.5	10428	62
1931	221	770	6752	31	114	164	8.7	6712	41
1932	226	754	6785	30	111	161	8.3	4650	29
1933	230	733	6950	30	105	159	8.1	4447	28
1934	235	712	6766	29	105	156	8.1	5738	37
1935	240	742	7026	29	106	153	8.9	8279	54
1936	236	714	6855	29	104	150	8.5	7590	51
1937	231	746	6703	29	111	147	8.8	7527	51
1938	227	753	6416	28	117	144	8.9	6892	48
1939	223	785	6939	31	113	141	9.8	6627	47
1940	219	700	6340	29	110	139	8.5	6098	44
1941	217	810	6619	31	122	136	11.0	9711	72
1942	215	970	7698	36	126	133	14.5	15743	118
1943	213	1171	9226	43	127	130	18.9	25386	195
1944	211	1156	9108	43	127	127	18.9	21981	173
1945	208	1092	8466	41	129	124	17.6	23812	192
1946	207	1069	8160	39	131	121	17.2	22595	187
1947	205	1050	7814	38	134	119	17.3	25927	218
1948	203	1034	7657	38	135	116	17.2	26220	226
1949	202	1071	7503	37	143	113	18.4	26332	233
1950	196	1002	7221	37	139	105	18.6	19305	184
1951	189	1010	6946	37	145	96	21.1	27398	285
1952	183	1023	7014	38	146	88	23.2	23733	270
1953	176	1011	6786	39	149	79	25.4	26932	341
1954	170	966	6529	38	148	71	26.3	20410	287
1955*	163	955	5987	37	160	68	28.8	22452	330

Source: Data on farms reporting chickens and selling eggs were based on the Census of Agriculture and adjusted for years between Census periods. Data on production, layers, and egg sales were secured from annual reports of the Federal-State Crop Reporting Service, Nashville, Tennessee.

* Preliminary estimates.

APPENDIX II

Definition of Terms

1. **Hatching egg producer:** Any farmer producing eggs for one or more of the 116 hatcheries in Tennessee in 1952.
2. **Total cost:** Includes feed, depreciation per layer, labor used in production and marketing, housing and miscellaneous costs such as depreciation on equipment, land, taxes, insurance, interest on investment, electricity, cartons, crates, gasoline and auto repair or hauling charge, veterinary care and medicine, litter, blood testing, telephone and records.
3. **Total receipts:** Include gross receipts from the sale of eggs to hatcheries and other market outlets, value of eggs consumed in the households of producers, value of feed sacks sold or used and poultry manure valued at $6.00 per ton.
4. **Profit:** Amount remaining after subtracting total costs from receipts.
5. **Labor returns per hour:** Arrived at by subtracting all costs, except operator and family labor, from total receipts and dividing remainder by number of hours of operator and family labor. Charge for labor per hour averaged 58 cents for the 517 flocks.
6. **Mortality percent:** The number of layers that died during the year divided by the average number of layers in the flock.
7. **Eggs per layer:** The total number of eggs produced during 12 months, divided by the average number of layers on hand during the year.
8. **Labor efficiency:** Minutes of labor used per layer.
9. **Capital efficiency:** Number of months required for gross egg receipts to equal the money invested in the hatching egg enterprise.

APPENDIX III

Values and Equations Used in Net Correlation

$$\text{Net correlation} = \frac{\Sigma\, b_{1n}\, x_1 x_n}{\Sigma\, x_1^2}$$

1. Relation of Various Factors to Labor Returns Per Hour X_1

Variable	b_{1n}	$\Sigma\, x_1 x_n$	Net correlation	Level of significance* (probability)
X_2 — Eggs per layer	.017	15,242.78	.336	99+%
X_3 — Receipts per dozen	4.498	30.20	.180	99+%
X_4 — Feed cost per cwt.	— .401	91.92	.049	68%
X_5 — Mortality percent	.003	1,327.25	.005	Under 50%
X_6 — Labor per layer	— .004	5,774.71	.034	54%
X_7 — Housing cost per layer	—6.947	.11	.001	Under 50%
X_8 — Misc. cost per layer	— .018	2.32	.000	Under 50%
$\Sigma\, x_1^2 = 755.24$		Total	.592	99+%
2. Relation of Various Factors to Eggs Per Layer X_1				
X_2 — Layers per flock	.001	6,623,177.0	.009	Under 50%
X_3 — Mortality percent	—1.905	—40,490.0	.088	96%
X_4 — Pullets in flock %	.168	209,408.0	.040	59%
X_5 — Months in production	10.657	16,408.0	.199	99+%
X_6 — Times culled monthly	.691	50,372.5	.039	58%
X_7 — % laying houses with electric lights	.545	469,158.0	.291	99+%
X_8 — Males per 100 layers	— .194	— 3,134.4	.001	Under 50%
$\Sigma\, x_1^2 = 878{,}624$		Total	.666	99+%
3. Relation of Various Factors to Receipts Per Dozen Eggs X_1				
X_2 — Layers per flock	.001	411,711,605.00	.036	56%
X_3 — Premium per dozen eggs	.283	81,370.03	.220	99+%
X_4 — Months eggs sold to hatchery	.321	5,452.35	.061	80%
X_5 — % eggs sold to hatchery	.142	253,652.50	.187	99+%
$\Sigma\, x_1^2 = 46{,}969.3$		Total	.504	99+%
4. Relation of Various Factors to Feed Cost Per Hundredweight X_1				
X_2 — Layers per flock	— .00013	—55,777.85	.140	99+%
X_3 — Years experience of producer	— .003	— 116.39	.006	Under 50%
$\Sigma\, x_1^2 = 51.5923$		Total	.146	99+%

APPENDIX III (continued)

Values and Equations Used in Net Correlation

$$\text{Net correlation} = \frac{\Sigma\, b_{1n}\, x_1 x_n}{\Sigma\, x_1^2}$$

5. Relation of Various Factors to Labor Used Per Layer X_1

Variable	b_{1n}	$\Sigma\, x_1 x_n$	Net correlation	Level of significance* (probability)
X_2 — Layers per flock	— .029	—12,656,706.0	.219	99+%
X_3 — Roosters per 100 layers	3.280	8,197.3	.017	Under 50%
$\Sigma\, x_1^2 = 1{,}693{,}836$		Total	.236	99+%

6. Relation of Various Factors to Percent Flock Mortality X_1

X_2 — Layers per flock	— .001	—644,027.00	.074	91%
X_3 — Eggs per layer	— .019	— 40,307.10	.115	99+%
X_4 — % producers controlling range of layers	— .013	— 40,400.90	.079	70%
X_5 — Frequency of culling	— .235	— 4,946.16	.179	99+%
X_6 — % pullets in flock	— .003	— 13,208.30	.006	Under 50%
X_7 — Roosters per 100 layers	— .034	255.61	.001	Under 50%
$\Sigma\, x_1^2 = 6{,}494.99$		Total	.452	99+%

7. Relation of Various Factors to Housing Cost Per Layer X_1

X_2 — Layers per flock	— .0001	144,087.00	.001	Under 50%
X_3 — Misc. cost per layer	.234	39,705.10	.554	99+%
X_4 — Sq. ft. floor space per layer	.154	716.77	.005	Under 50 %
$\Sigma\, x_1^2 = 16{,}797.8$		Total	.558	99+%

* The higher the percent probability the greater the possibility that the net correlation is not due to chance alone.

Correlation analysis was used in determining the relative importance of various factors related to labor returns per hour and other variables. Most of the correlation was performed on IBM equipment at the Louisiana Agricultural Experiment Station under the supervision of Dr. E. P. Roy, Cooperative Agent, Southern Regional Research Project, Poultry and Egg Marketing. Copies of the detailed multiple correlation procedure will be mailed upon request.

The net correlation coefficient is defined as a measure of the degree of correlation between the dependent variable and a particular independent variable when the values of specified combinations of the remaining independent variables are held constant. For further explanation of net correlation see Ferber, Robert, Statistical Techniques in Market Research, McGraw-Hill Book Co., Inc., New York, 1949, p. 357.

APPENDIX IV

*Estimated Pounds of Feed Required Daily Per 100 Layers, by Breed, Age and Rate of Lay, 806 Records, 185 Farmers Producing Eggs for Hatcheries in Tennessee, 1952**

77 Leghorn Flocks

Percent production	Pullets		Hens	
	Number records	Lbs. of feed used daily per 100 layers	Number records	Lbs. of feed used daily per 100 layers
18 to 24	5	18.0 to 19.0	6	19.2 to 20.2
25 to 34	7	19.2 to 20.4	8	20.2 to 21.6
35 to 44	24	20.6 to 21.7	13	21.8 to 22.8
45 to 54	16	21.7 to 22.9	12	23.1 to 24.3
55 to 64	16	23.2 to 24.3	6	24.5 to 25.4
65 to 70	5	24.7 to 27.4	3	26.1 to 28.6

277 New Hampshire Flocks

Percent production	Pullets		Hens	
	Number records	Lbs. of feed used daily per 100 layers	Number records	Lbs. of feed used daily per 100 layers
20 to 24	12	21.7 to 22.6	12	24.0 to 24.9
25 to 34	31	22.6 to 24.2	32	24.7 to 26.4
35 to 44	84	23.8 to 25.6	63	26.1 to 28.5
45 to 54	107	25.2 to 26.9	61	27.4 to 29.1
55 to 64	35	26.5 to 28.0	18	29.0 to 30.2
65 to 67	5	28.2 to 28.6	3	30.4 to 30.8

131 Barred and White Rock Flocks

Percent production	Pullets		Hens	
	Number records	Lbs. of feed used daily per 100 layers	Number records	Lbs. of feed used daily per 100 layers
19 to 24	11	22.7 to 23.8	12	25.8 to 26.9
25 to 34	24	24.1 to 25.3	27	26.7 to 28.3
35 to 44	44	25.1 to 26.5	31	28.2 to 29.6
45 to 54	36	26.3 to 28.0	25	29.4 to 31.3
55 to 61	8	27.9 to 28.9	4	31.1 to 31.8

* Data on feed requirements do not include the feed used for roosters.