T H E S I S

W A Y S A N D M E A N S

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I N C R E A S I N G T H E F A R M E R S' R E T U R N S

F O R

T H E I R P O U L T R Y A N D E G G S

Submitted by

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for the Degree of Master of Science

Colorado Agricultural College

Fort Collins, Colorado

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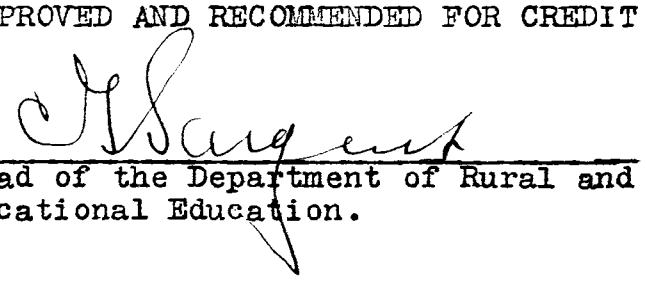
THIS THESIS HAS BEEN APPROVED AND RECOMMENDED FOR CREDIT



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INTRODUCTION.

Because of the large number of farmers engaged in poultry raising, and because of the inefficient methods of production and marketing found on farms during my eight years experience as a teacher of Vocational Agriculture, I have decided to make this study of ways and means of increasing the farmers' returns for their poultry and eggs.

According to the 1920 census, poultry, to the value of $1,047,000,000 was raised on 90.8% of the farms in the United States. In 1919, in Arkansas (46), eggs produced and chickens raised were valued at $16,245,102.

It has been my aim in this study to find where losses exist in the production and marketing of poultry and eggs and to find ways, based on reliable experimental data, of reducing these losses to a minimum.

In order to secure reliable experimental data, I have written to the heads of the poultry departments of all the Agricultural Experiment Stations in the United States. This material has been used in the preparation of this thesis.

PRODUCTION OF EGGS.

Average Egg Production.

The average production of eggs in Arkansas and throughout the United States is low, but the fact that production can be increased is clearly demonstrated by the experimental data which follows:

In Arkansas (46), in 1919, the average production per hen was 49 eggs. Yet in 1925, the 1000 hens entered in the Vineland International Egg Laying contest (1) averaged 182.2 eggs per hen. The 20 high pens averaged over 200 eggs.

Out of 96 pens entered in the First Maryland Egg Laying contest, 19 produced an average of over 200 eggs per hen (2).

Records from 28 flocks from Churchill and Washoe counties, Nevada (7), show five flocks which produced an average of over 200 eggs per hen.

During the year 1925 the average egg production per hen on 461 Ohio Poultry demonstration farms was 140.3 eggs.

In the 11th Arkansas Egg Laying contest (41), the 150 pullets laid an average of 193.64 eggs per bird. Six of the thirty pens of five birds each averaged over 200 eggs. Seventy-two pullets, or almost fifty per cent of the birds entered, laid over 200 eggs.

The foregoing records demonstrate that better pro-

duction, than the average for Arkansas, can and is, being obtained.

This increased average egg production has been brought about by better production practices. I shall now present some of the evidences of better production practices which help to increase egg production.

The Effect of Breeding.

In a breeding-up experiment conducted at Manhattan, Kansas (3), 40 mongrel pullets were divided into four lots of ten each. The pens were housed in colony houses, which were alike, and surrounded by yards of equal size. At the end of one year, each original pen was displaced by a pen of daughters. This process was repeated for three years. All pens were fed the same ration, and, so far as possible, given the same environmental conditions. A White Orpington cockerel was mated with pen 1, a Barred Rock cockerel with pen 2, a single-comb White Leghorn cockerel with pen 3, and a mongrel cockerel with pen 4. Through-out the remaining part of the experiment, ten of the pullet offsprings were mated with cockerels of the same breed as their respective sires. Fair uniformity, with regard to type and color, was secured for three successive generations. The egg production was improved in the pens using cockerels from high laying families of the single-comb White Leghorn and Barred Rock varieties.

The Maine Agricultural College (42) started in trap-

nesting Barred Plymouth Rocks, November 1, 1898. The first year 140 were trapnested, and the average production was 120 eggs per bird. Three pullets laid over 200 eggs each. The trapnesting was continued, and in the breeding work no males were used, except their dam had a record of over 200 eggs in her pullet year, and no hens were used in the breeding pens if their record was under 160 eggs in their pullet year. At the end of the seventh year, October 31, 1905, it was found that of the 400 pullets trapnested during the year 1904-5, 54 of the pullets had made a record of more than 200 eggs, and 217 had made a record of more than 160. The average production per hen had increased from 120 to 147 eggs per hen.

Table I (16) is an official record of pedigreed layers. Hens 237, 250, and 251 are full sisters and each has a record of 200 eggs or over. Their dam laid 190 eggs in her pullet year. The record of the sire's dam is not known, but it must have been high.

Table 1. Record of Pedigreed Layers.

Hen Number	233	251	237	250	306	Totals
December	18	14	13	9	0	54
January	18	23	16	21	4	80
February	16	19	19	20	15	85
March	12	15	23	23	21	100
April	18	16	24	17	20	98
May	21	16	25	19	13	94
June	21	17	25	15	10	84
July	17	23	15	25	20	100
August	17	20	24	13	21	94
September	16	10	14	17	18	71
October	2	18	19	15	0	54
November	0	15	9	6	0	30
Totals	170	206	226	200	142	944

According to Clayton (4) a flock of White Leghorns owned by the Mississippi Agriculture and Mechanical College, averaged 188 eggs in 1922. He began in 1914 with an average of 130 eggs and by trapnesting to select the heavy layers, and by using the heavy layers as breeders, mated to sons of their best layers, the flock average has been increased.

Culling.

According to Payne (6), the average farm flock of 100 hens divides itself up into three groups as follows: First group, 15 to 30 hens, very poor layers; second group, usually more than ½ the flock, medium layers; third group, small number of individuals, relatively high producers.

In a culling and feeding project carried on by co-operators under the supervision of V. E. Scott (7) from November 1, 1925, to October 31, 1926, flock number 9, which consisted of an average of 367.7 hens, culled 30.6%, averaged 228.8 eggs per hen. Flock number 5, average 367.7 hens, culled 16.2%, averaged 226.4 eggs per hen, and flock number 10, average 117 hens, culled 10%, averaged 216.4 eggs per hen.

Mussehl (8) reports a flock of 94 hens in Fillmore County, Nebraska, before culling, in three successive days, July 25, 26, and 27, laid a total of 29 eggs. This same flock after being culled down to 50 hens, in three successive days, July 31, August 1, and 2nd, laid a total of 61 eggs.

This improved egg production is attributed to the improved opportunity for the good hens to secure feed and care.

Four hundred fifty hens in an Indiana flock (49) laid the week before culling 643 eggs. Two hundred seven were culled out, leaving as layers 243. The week following the culling those selected as layers laid 624 eggs, while the 207 culled out laid 13 eggs.

Jones and Wilbur (9) found that flocks culled made a higher average egg production and greater labor return than flocks not culled (See table II).

Table II. Flocks Culled and not Culled.

Group	Number eggs per hen	Labor per hen	Income per hr.	Number flocks	Number Hens.
Culled	129	$2.62	$0.61	207	18,265
Not culled	119	2.17	.47	45	3,812

A study made by R. M. Sherwood of the Texas Agricultural Experiment Station (5) shows that hens laying the smallest number of eggs show the greatest amount of yellow in their shanks and beaks, and molt earlier. The heaviest producers had the most pliable pubic bones and the most pliable skin.

From the foregoing, it is evident that the non-producers can be eliminated by culling and the average egg production increased. When you take into consideration the value of feed consumed by non-producers it is quite evident, from the data presented, that culling is one of the very

important factors in the economic production of eggs.

Time of Hatch.

An experiment conducted at Iowa State College (12) and extending over a period of several years with White Rocks hatched March 1, April 1, May 1, and June 1, gave the following results: The March hatched pullets averaged 217.5; April hatched, 171.67; May hatched, 117.43 and June hatched, 53.76, eggs per bird annually. The early hatched birds also laid more heavily during the months of November, December, January and February, the time of the year when fresh eggs are scarce and consequently high in price. During this period the March hatched pullets laid an average of 51.42, April hatched 36.85, May hatched 13.39, and June hatched 3.28, eggs per bird.

Vickers and Cray (13) show the effect of early and late hatching on the egg production of pullets (See table III).

Table III. Effect of Time of Hatching on Egg Production. of Pullets.

Month	Lights		No Lights		All Pullets	
	24 Flocks hatched before May 1	22 Flocks hatched after May 1	83 Flocks hatched before May 1	21 Flocks hatched after May 1	107 Flocks hatched before May 1	43 Flocks hatched after May 1
November	8.5	3.8	5.2	2.5	5.9	3.2
December	10.4	9.3	7.2	5.4	7.9	7.4
January	12.0	12.3	8.2	8.5	9.1	10.4
February	14.2	13.6	12.0	11.5	12.5	12.5
March	18.7	16.8	18.3	17.3	18.4	17.1
April	19.3	16.9	20.2	19.2	20.0	18.0

Table III. Cont'd.

Month	Lights		No Lights		All Pullets	
	24 Flocks hatched before May 1	22 Flocks hatched after May 1	83 Flocks hatched before May 1	21 Flocks hatched after May 1	107 Flocks hatched before May 1	43 Flocks hatched after May 1
April	19.3	16.9	20.2	19.2	20.0	18.0
May	18.7	17.5	19.0	17.2	18.9	17.4
June	16.4	15.1	15.6	15.1	15.8	15.1
July	14.9	13.9	14.8	13.9	14.8	13.9
August	13.8	12.2	12.9	13.7	13.1	12.9
September	9.7	9.6	10.7	10.0	10.4	9.8
Oct.	5.4	6.3	5.3	5.1	6.1	5.7
Totals	162.0	147.3	150.4	139.4	152.4	143.4

Jones and Wilbur (9) found that pullets hatched before May 1, laid more eggs and paid a higher labor return per bird than pullets hatched after May 1 (See table IV).

Table IV. Effect of Time of Hatching on Egg Production of Pullets.

Date hatched	Number eggs per hen	Labor per hen	Income per hr.	Number flocks	Number hens.
March 1 to Apr.1	143	$3.33	$1.04	12	2,121
April 1 to May 1	133	2.70	.66	71	13,348
After May 1	122	2.49	.63	64	6,855

In an experiment conducted at the New Mexico College of Agriculture (11), 50 single-comb White Leghorn hens, true to type with an average egg production of approximately 190, were mated to outstanding males of good type. The production records of the ancestry of the male birds used was 200 eggs or over. The same birds were used for the duration of the hatch period, January 1, 1924 to October 31, 1924. Chicks hatched in February laid an average for twelve months of 124.3

eggs per bird; hatched in March 133.4; hatched in April 155.7 hatched in May 133.3; hatched in June 110.7; hatched in July 97.7; hatched in August 120; hatched in September 128.3; hatched in October 140.1; and hatched in November 136.0.

It is apparent that chicks hatched before May 1, will produce more eggs than chicks hatched after that date. In the heavier breeds better results were obtained when chicks were hatched before April 1. The early hatched chicks proved to be better layers during the winter months, when eggs are higher in price.

Early Layers as Producers.

The Maine Station (10) selected 29 pullets from those laying, or about to lay, during August and September. Of this number four died, but the remaining twenty-five averaged 180 eggs per bird. Eight laid over 200 eggs per bird.

Age of Hens.

Jones and Wilbur (9) found that the larger the percent of pullets in the flocks the greater was the average egg production and labor return per bird. Eggs from pullets, owing to the fact that they laid during the months when eggs were high in price, brought a higher average price per dozen for the year than did eggs from old hens (See table V).

Table V. Percent Pullets and Average Egg Production.

Proportion of flock pullets	Number eggs per hen	Labor per hen per hr.	Income Price Eggs Per Doz.	No. flocks	No. Hen

Table V. Cont'd.

Proportion of flock pullets	Number eggs per hen	Labor per hen per hr.	Income Price eggs Per doz.		Number flocks	Number hen
Less 39%	98	$1.57	$0.41	$0.38	47	4,220
40 to 79%	124	2.52	.58	.41	309	42,915
80 to 100%	133	3.01	.71	.45	157	28,116

A three years' record at the Kansas Agricultural Experiment station (6) on a number of White Leghorns, Rhode Island Reds, and Barred Plymouth Rocks, is shown in Table VI.

Table VI. Average Production and Percent Production by Years.

	Rocks and Reds Average Production	Per-cent	Leghorns Average Production	Per-cent
First year	170	100	198	100
Second year	140	82	151	76
Third year	104	61	120	61

Eight pens of seven different varieties, containing 90 hens were trapnested and careful records kept over a period of three years for the light and four years for the heavy breeds, by the University of Arkansas (14). It was found that the hens lay the majority of eggs during the first two laying seasons' and especially during the pullet year if hatched early. Old hens laid during the Spring when the price of eggs was the lowest. Heavy producers, during the pullet year, were usually good producers during the second year. Poor layers, during the pullet year were with few exceptions, poor layers during succeeding years. The mortality increased rapidly with the age of the hens. Birds of the Mediterranean class were more consistent layers during the three years than the American and English classes. The fourth year showed a greater de-

crease in production than did the third year.

In an experiment conducted by the Utah Agricultural College (16), to determine the effect of the age of hens on egg production, the 41 pullets used, laid 916 eggs as pullets before February 1, and as year-old hens they laid only 437 eggs up to the same date. This shows that pullets not only lay more eggs during the year than hens do but that they lay a larger proportion in the Winter when the prices are high. Out of the 41 hens of the different breeds for which records were completed for two years, it was found that they averaged 178 eggs per hen for the first year, and 125 for the second year, or 40% more for the first year than for the second year (See table VII).

Table VII. Effect of Age of Hens on Egg Production.

Hen number	Breed	1st yr.	2nd yr.	3rd yr.	Total
	R. C. Brown Leghorn				
71		202	153		
72		202	129	96	427
129		170	30		200
131		201	241	126	568
152		207	185	136	528
155		186	197	117	500
173		182	172		354
238		156	192		348
26		221	164		385
5		228	170		398
68		183	185		268
25		181	152		
79		187	75		
	Average	193	157	94	

Table VII. Cont'd.

Hen number	Breed	1st yr.	2nd yr.	3rd yr.	Total
	S. C. White Leghorns				
9		169	106		275
10		199	126		325
87		203	113		316
83		161	34		195
	Average	192	129		
	Barred Plymouth Rocks				
115		145	126		271
118		145	40		185
120		144	116		260
124		212	181		393
213		122	86		208
	Average	154	110		
	White Wyandotts				
101		216	130	42	388
195		190	150	118	458
189		190	106	54	350
190		207	92	47	346
191		159	115		274
184		149	121	81	351
185		121	85	67	273
186		147	127	87	361
187		174	76		250
23		177	121		298
30		208	129		337
48		201	161		362
67		160	104		264
90		155	74		229
16		115	87		202
203		150	99		249
	Average	170	111	71	

Lemon and Lee (43) found that the egg production of the general purpose fowls decreased 32% in their second laying year. The decrease was considerably less in the Leghorns. Their second year average egg production exceeded that of the general purpose breeds by nineteen eggs. The decrease in production from the second to the third year was only 4% with

the Leghorns compared with 13% in the general purpose breeds.

Records from flock number 5, pullets, and flock number 5, hens, from Churchill County, Nevada (7) showed an average egg production of 228.8 eggs for the pullets and 139.4 eggs for the old hens. A flock, number 17, old hens, from Washoe County averaged 142.5 eggs.

Data gathered from 28 New Jersey poultry farms (15) showed the average egg production to be 115.5 eggs. The pullets outlaid the hens by 42.9 eggs per bird, the records from the pullets being 169.9 and the hens 127. The best flock of pullets averaged 199.2 eggs, best flock of hens 166.5, poorest flock of pullets 106, and poorest flock of hens 93.1 eggs per bird.

The Maryland Experiment Station (48) kept 60 White Leghorn hens for three years under the same conditions with the result, that during their pullet year they produced 875 dozen eggs, during their second year they produced 745 dozen eggs, and during the third year they produced 576 dozen eggs. The profits were for the first year $124.00; second year $96.00; and third year $54.00

From the foregoing, it is apparent that the greater the percent of pullets the greater the average egg production. The pullets laid more eggs during the winter months when eggs were higher in price. The percentage of eggs decreased each succeeding year after the pullet-year and the mortality increased.

Exercise.

The Utah Agricultural College (16) conducted an experiment to determine the value of exercise and close confinement on the egg laying capacity of poultry. The mixed pen in close confinement consisted of one Brown Leghorn, one White Rock, and one Wyandott, confined on a board floor in a space 2½ by 7 ft. Results of the experiment indicate, (See table VIII), that for the Leghorns, which are naturally active by disposition, greater yields are obtained when the grain is fed in a box; that best yields are obtained from the Rocks, which are of a more sluggish and lazy disposition, when they are forced to exercise, and that poor results are obtained from all breeds when kept in close confinement.

Table VIII. Value of Exercise and Close Confinement on Egg Laying Capacity of Poultry.

How Fed	Pen number	Breed	Ave. eggs laid per fowl
Grain in straw, mash at night	2	R.C. Brown Leghorns	185¼
Night, feed grain in box	3	R.C. Brown Leghorns	191-1/3
Grain fee in straw	8	Barred Plymouth Rocks	129½
Grain feed in box	12	Barred Plymouth Rocks	117-1/3
Grain feed in box	13	White Plymouth Rocks	119
Grain feed in straw	14	White Plymouth Rocks	153
Board floor, no exercise	23	Mixed	38-2/3

Lights.

Lunn and Fox (47) found that the use of lights during the months of October, November, December, January and February

increased the returns on early maturing White Leghorn pullets, slow maturing White Leghorn pullets, and White Leghorn hens in their second laying year. There was a profit over feed and lights in pens of both early and late maturing pullets; but hens both lighted and unlighted were kept at a loss, though the loss was less in the lighted than in the unlighted pens.

In an experiment conducted jointly by the Agricultural Engineering Department and the Poultry Department at the University of Nebraska (17), ninety single comb White Leghorn pullets were placed in each of a number of standard poultry house units, feed and conditions, other than heat and light, were the same. The four flocks which were heated so that the minimum temperature rarely went below 40 degrees Fahrenheit, averaged 4,032 eggs during the winter months. The flock which was lighted from 5 O'clock in the morning until daylight laid 4,995 eggs. A check flock neither heated nor lighted, and housed next to the lighted unit laid 3,935 eggs, or a difference of 1,060 eggs in favor of the lighted birds.

The Extension Service of the College at New Brunswick, N. J. (18), collected data on 286 flocks with a population of 804,139 birds over a three year period, and found that 134 flocks, where lights were used during the months of November, December, January, February, March and April, 59,224 pullets averaged 75.8 eggs, while during the same period 90 flocks with a population of 20,244 where no lights were used, averaged

67.1 eggs per bird.

Forty flocks with a population of 15,305 pullets fed under lights for one hour in the evening, averaged 71.9 eggs. Seventy-nine flocks with a population of 37,481 on which the the lights were turned early enough in the morning to make a twelve hour day, averaged 77.2 eggs, and eleven flocks with a population of 5,593 pullets where the lights were used both night and morning, so as to make the day begin and end at 6 o'clock, averaged 75.9 eggs.

Walker (30) found that the use of lights tended to increase egg production during periods of high egg prices, although systems of feeding where they were not used gave more economical returns over long periods of time.

In an experiment conducted by the United States Department of Agriculture, (46) in which one 75 watt light was used in each of two pens of White Leghorn pullets, it was found that 50.2 and 60.2 dozen eggs more were produced respectively than in two check pens of the same number of White Leghorn pullets where lights were not used.

From the foregoing, it is apparent that lights increase egg production during the winter months, when eggs are scarce and prices high.

Calcium.

Buckner, Martin, and Peter (33) found that deficiency of limestone decreased the number of eggs laid, the product-

ion of egg shell, the percentage of Ca O and P2 O5, caused a general depletion of the body material, and general vigor of the hens.

Importance of Vitamins.

Sherwood (25) found that with hens given feeds containing only limited quantities of fat soluable "A" for a period of seven months and three weeks, the mortality was very high and the egg production low. The greatest mortality and the lowest egg production occurred during the last seven weeks of the experiment.

Parkhurst (27) found that cod liver oil given with a well balanced ration proved to be most productive and profitable. Cod liver oil proved to be slightly more valuable as a food of high vitamin content than lawn clippings. Pens fed mash containing no cod liver oil and no green feed produced eggs which had lower hatchability and greater mortality.

Davis and Beach (32) found that Yellow Giant carrots and Danvers Half Long carrots (red) were equally as good sources of vitamin "A" for poultry as commonly used green feeds. Salmon oil also compared favorably with cod liver oil.

The foregoing shows that vitamins are necessary for health and egg production. Cod liver oil, Salmon oil, green feed, Yellow Giant carrots, and Danver's Half Long carrots are valuable sources of vitamins.

Putting Pullets into Lay.

Kaupp (23) found that skim milk as a source of animal protein gave better results, but at greater cost, in putting single comb Rhode Island Red pullets into lay than did meat-meal. The pullets fed milk began laying at a slightly younger age; 4 months and 22 days, and 4 months and 23 days as compared with 5 months and 4 days, and 5 months, for the meat fed chicks. Chicks fed milk were stronger and more vigorous. The cost of raising to 8 weeks of age, was, for the milk fed 14.39 cents, and 15.21 cents as compared with 9.36 and 9.22 cents for the meat fed chicks.

At Cornell University (24) 80 single comb White Leghorn pullets were divided into four pens of 20 each, and in such a way that the pens were equal, as near as possible in weight, vigor, maturity, and surroundings. The pullets were five months old at the time the experiment was started. They were examined carefully every 28 days and records were kept. All four pens had grit, oyster shell, and water, always before them. Pen number 1 was fed wet mash and grain, nutritive ratio 1:4.6 Pen number 2 was fed dry mash and grain, nutritive ratio 1:4.4 Pen number 3 was fed grain, nutritive ratio 1:5.5. Pen number 4 was hopper fed grain, nutritive ratio 1:5.8. The grain mixture was the same for all four pens. It was made up of four mixtures as follows:
Mixture number 1: equal parts of cracked corn, wheat, and oats.

Mixture number 2: 3 parts cracked corn, 4 parts wheat, and 1 part oats. Mixture number 3: 4 parts cracked corn, 3 parts wheat, and 1 part oats, and 1 part buckwheat. Mixture number 1 was fed from July 28 to September 8. Mixture number 2 was fed from September 9 to December 8. Mixture number 3 was fed from December 9 to January 18. Mixture number 4 was fed from January 19 to February 16. Mixture number 3 was fed from February 17 to April 12. Mixture number 2 was fed from April 13 to the end of the contest, July 27. The mash fed to both pens, number 1 and number 2 was the same, and consisted of 2 parts corn meal, 2 parts wheat middlings, 2 parts beef scraps, 1 part wheat bran, and 1 part alfalfa meal. The findings as a result of this experiment were as follows:

The forced pullets made a better profit than the retarded pullets, ate less food per hen at less cost per hen, produced more eggs of a larger size at less cost per dozen, gave better hatching of eggs, made a greater percentage of gain in weight, showed less broodiness, better vigor, and first mature molt. The hopper-fed, dry-mash pullets gave better results in gain of weight, production of eggs, gain in weight of eggs, hatching power of eggs, days lost in molting, mortality, health, and profit per hen than the wet-mash fed pullets. The wet mash and grain-fed pullets consumed slightly less food, at less cost, and produced eggs at slightly less cost per dozen,

produced slightly larger eggs of slightly better fertility, and showed less broodiness. The dry-mash and grain-fed pullets laid eggs of good size at an earlier period than wet-mash and grain-fed pullets. Hopper-fed pullets ate more than hand-fed pullets. Pullets having whole grain ate more grit and shell than those having a proportion of ground grain. Pullets fed on grain were more inclined to develop bad habits than those having mash.

The foregoing shows that pullets fed skim milk, laid eggs at a younger age, were stronger and more vigorous, but that the cost was slightly greater than for pullets fed meat meal. Pullets fed mash and grain laid more eggs, at less cost, and were more vigorous than pullets fed grain alone.

Comparison of Methods of Feeding Laying Hens.

In an experiment conducted by Pennsylvania State College (29) from December 24, 1922, to October 27, 1923 to determine the effect of various sources of protein on egg production, 350 single comb White Leghorns were divided into seven pens of 50 pullets each. All pens received the same scratch-grain mixture, consisting of 1½ parts cracked corn, 1 part wheat, and ½ part oats. The basal mash consisted of 20 pounds corn meal, 50 pounds ground oats, 75 pounds ground wheat and 25 pounds wheat bran. Pen number 3 received 40 pounds basal mash, 10 pounds meat scraps, and averaged for

the 44 week period 133.6 eggs per bird. Pen number 4 fed 50 pounds basal mash and 6 pounds condensed butter-milk, per 50 birds daily, averaged 147.9 eggs. Pen number 5 fed 38.2 pounds basal mash, 5 pounds meat scraps, and 3 pounds of condensed butter-milk, per 50 birds daily, averaged 163.9 eggs per bird. Pen number 6 fed 39.08 pounds basal mash, 7.5 pounds meat scraps, and 1.5 pounds condensed butter-milk, per 50 birds, averaged 171.9 eggs per bird. Pen number 7 fed 33.44 pounds basal mash and 16.65 pounds dried butter-milk, averaged 171.1 eggs. Pen number 8 fed basal mash 19.25 pounds meat scraps, 3.375 pounds, and dried butter-milk 2.375 pounds, averaged 110.4 eggs. Pen number 39 fed basal mash 21.25 pounds, meat scraps, 2.5 pounds, dried butter-milk, 1.25 pounds, and condensed butter-milk 1.25 pounds, averaged 144.8 eggs. Pen number 10 fed basal mash 14 pounds, meat scraps 1.25 pounds, cocoanut oil-meal 8.5 pounds, and mineral 1.25 pounds, averaged 91.7 eggs. The mineral mixture consisted of 3 pounds bone meal, 1 pound ground limestone, and 1 pound salt. Pen number 11 was fed from first to sixteenth week basal mash 11.75 pounds, cocoanut oil-meal 8.5 pounds, mineral mixture 1.25 pounds, dried butter-milk 2 pounds, and averaged 112.2 eggs.

In an experiment conducted by the Agricultural Experiment Station of Purdue University (31), eight pens of 30 pullets were used. The experiment lasted for four years.

The basal ration in all pens consisted of a grain mixture of 10 pounds corn, 10 pounds wheat, 5 pounds oats, and a mash mixture of 5 pounds bran, and 5 pounds middlings. Grit and Oyster shells in abundance were kept before the pullets at all times. They were on free range all the time, except during the severe winter months. Feed in addition to the basal ration and egg records are shown in tables IX, X, Xl, and Xll.

Table IX. First Experiment. October 1, 1920 to September 30, 1921.

Pen number	Breed	Tankage pounds	Soy bean Oil-meal pounds	Bone Meal Pounds	Average Production per pullet.
1	Leghorns	3.00	0.00	0.00	117.4
2 2	Leghorns	0.00	4.75	.75	57.1
3	Plymouth R.	3.00	0.00	0.00	143.5
4	Plymouth R.	2.25	1.187	.19	188.6
5	Plymouth R.	1.50	2.375	.375	135.2
6	Plymouth R.	.75	3.560	.570	91.9
7	Plymouth R.	0.00	4.75	0.000	40.3
8	Plymouth R.	0.00	4.75	0.000	38.6

In the second experiment, table X, a mineral mixture made up of 15 pounds salt, 24 pounds limestone, and 21 pounds soluble bone was used, instead of the bone meal used in the first experiment.

Table X. Second Experiment. October 1, 1921 to September 30, 1922.

pen number	Breed	Tankage pounds	Soy Bean oil-meal	Mineral mixture	Average Production pe pullet.
1	Leghorns	3.00	0.00	0.00	139.8
2	Leghorns	0.00	4.42	1.20	150.8
3	Plymouth Rocks	3.00	0.00	0.00	138.5
4	Plymouth Rocks	2.125	1.10	.30	134.2
5	Plymouth Rocks	1.500	2.21	.60	123.1

Table X. Cont'd.

pen number	Breed	Tankage pounds	Soy Bean Oil-meal	Mineral mixture	Average production per pullet.
6	Plymouth Rocks	.750	3.31	.90	105.9
7	Plymouth Rocks	0.000	4.42	1.20	124.9
8	Plymouth Rocks	0.000	4.42	0.00	38.7

Table Xl. Third Experiment. October 1, 1922 to September 30, 1923.

pen number	Breed	Tankage pounds	Soy Bean oil-meal	Mineral mixture	Average production per pullet.
1	Leghorns.	3.00	0.00	0.00	132.6
2	Leghorns	0.00	4.00	1.60	144.2
3	P. Rocks	3.00	0.00	0.00	131.9
4	P. Rocks	2.125	1.00	.40	149.2
5	P. Rocks	1.500	2.00	.80	144.8
6	P. Rocks	.750	3.00	1.20	123.5
7	P. Rocks	0.000	4.00	1.60	137.5
8	P. Rocks	0.000	4.00	0.00	27.2

Table Xll. Fourth Experiment. October 1, 1923 to September 30, 1924.

pen number	Breed	Tankage pounds	amount and kind of vegetable protein	Mineral matter pounds	Phos. carrier pounds	Ave. production per pullet
1	Leghorns	3.0	None	0.00	none	186.3
2	Leghorns	0.0	4.5 Soy bean oil-meal	1.46	steam bone	172.7
3	P. Rocks	3.0	None	0.00	None	153.2
4	P. Rocks	1.5	2.5 Soy bean oil-meal	.65	Steam bone	141.8
5	P. Rocks	0.0	5. Soy-bean oil-meal	1.30	Steam bone	135.2
6	P. Rocks	0.0	4.75 ground Soy-bean	1.64	Acid Phos.	134.1
7	P. Rocks	0.0	4.5 C. S. meal	.81	Acid Phos.	142.0
8	P. Rocks	0.0	7.5 Gluten M	1.40	Acid Phos.	144.1

Clayton (4), in a poultry feeding experiment covering a period of three years with four pens of White Leghorn pullets fed mixed grain twice per day and kept dry mash before the pullets at all times. He supplied additional protein in the form of cotton seed meal, beef scraps, and milk, respectively, to three of the pens, leaving the fourth pen as a check pen. At the end of the three-year period, he found that the milk-fed pullets were in the lead in egg production, followed in the order named by the pens fed beef scraps, cotton seed meal, and no additional protein.

Kaupp (23), over a two-year period in comparing milk and meat scraps as a source of animal protein, found that the meat-meal flock averaged 148 eggs per hen the first year, and 135 eggs per hen the second year. The milk-fed flock averaged 165 eggs per hen the first year, and 138 eggs per hen the second year.

Sherwood (25) found freshly ground cotton seed meal to be a good substitute for meat scraps and tankage for laying hens. The ration fed in which cotton-seed meal gave best results was: wheat bran 125 pounds, grey wheat shorts 75 pounds, corn meal 75 pounds, and cotton seed meal 120 pounds.

Martin (26) found meat scraps in the laying mash in any proportion from 5 to 20%, to be profitable. The production increased as the percentage of meat scraps in the mash increased up to 20%. One gallon of skim milk had the same

value as one pound of meat scraps. No advantage was found in a dry mash containing ground grain and wheat by-products, when all the animal protein was supplied by skim milk. Both dried butter-milk and condensed butter-milk proved to be efficient sources of animal protein. Shelled yellow corn and skimmed milk produced satisfactory egg yields. Greatest returns and the largest egg yield was obtained by feeding a mash, containing 10% meat scraps, and butter-milk in addition to the grain ration.

Parkhurst (28), over a period of three years in which skim milk, milk whey, tankage, meat-meal, fish-meal, pea-meal, dried butter-milk, and combinations of these feeds were studied, obtained best results with a mash, 20% of which was pea-meal and all the sour skim milk the pullets would drink. The basal ration fed in addition to the above was wheat, and a mash made up of equal parts of wheat bran, shorts, corn-meal, and ground oats. Two pounds of charcoal, and five ounces of salt, per 100 pounds, were added to the mash. The annual egg production of the 25 single comb White Leghorn pullets over the three-year period was 153.6 eggs per bird.

Walker (30) found milk to be an economical source of protein, when fed alone with scratch, but tankage was more economical than milk, when the by-products of grains and grains themselves were used for a portion, or, for the entire mash mixture.

The Ontario Experiment Station at Guelph, Canada (49), divided 75 hens into three pens of 25 each. Hens in Pen number 1 were fed butter-milk, pen number 3, beef scraps, and pen number 2, had no milk or meat scraps. The experiment was carried on from September 1 to May 1. Pen number 1, during that time produced 1,762 eggs, pen number 3, produced 1,625, and pen number 2, produced 730 eggs. The profit on pen number 1 was $11.00. Pen number 3, was $10.00, and pen number 2, netted a loss of $3.00.

From the foregoing, it is apparent that good results are obtained with either buttermilk or meat scraps as a source of protein. Buttermilk gives better results than meat scraps, though it does not give better results than a combination of these two. Vegetable protein, when supplimented by the proper mineral mixture, gives equally as good results as animal protein. The foregoing statement has been verified by Mr. J. G. Hendricks, Commercial Poultryman, Van Buren, Arkansas. Skim milk and scratch feed have given good results as have skim milk and yellow corn.

PRODUCTION OF BIRDS.

Effect of Age of Eggs on their Hatching Quality.

Waite (34) found that the deteriation in hatching eggs was very slight up to the sixth or seventh day. Turning eggs before the period of incubation proved to be unnecessary.

Hatching Results for Different Temperatures;

Brooks (36) found, as a result of eight years experimentation, that a temperature of 101 or 102 degrees Fahrenheit throughout the incubation period gave the best results. See tables XIII and XIV.

Table XIII. Hatching Results for Different Temperatures. Standing Thermometer Used. Temperature Increased One Degree Each Week.

First Week	98F	99F	100F	101F	102F	103F
Second Week	99	100	101	102	103	104
Third Week	100	101	102	103	104	105
Chicks hatched from 100 eggs	48	62	64.4	62.3	59.6	33.1

Table XIV. Hatching Results for Different Temperatures. Standing Thermometer Used. Temperature the same Throughout the Incubation Period.

First Week	100F	101F	102F	103F
Second Week	100	101	102	103
Third Week	100	101	102	103
Chicks hatched from 100 eggs	61.5	70	66.8	56.2

Walker and Voss (35) found that a temperature of 101F for the first week, 102F for the second week, and 103F for the third week gave the best results.

From the foregoing it is evident that a constant temperature of 102 degrees Fahrenheit and a varying temperature of 100 degrees for the first week, 101 degrees for the second week, and 102 degrees for the third week gave the best results.

Age of Most Economical Gain.

Table number XV (49) shows the most economical gain in the growth of young chickens, occurs within the

first ten weeks.

Table XV. Gain at Different Ages and Number of Pounds of Feed Required.

Gain	Time to Make	Feed Required
First pound	6½ weeks	3 pounds
Second pound	3½ weeks	3.2 pounds
Third pound	5½ weeks	6.5 pounds
Fourth pound	5½ weeks	10.0 pounds
Fifth pound	10 weeks	18.0 pounds

The first two pounds of gain are the most economical,, from the stand point of feed consumed. It took more than twice as much feed to produce the third pound; more than three times as much to produce the fourth pound; and six times as much to produce the fifth pound as it did to produce the first pound of gain.

Length of Fattening Period.

Kaupp (23), in pen fattening single comb Rhode Island Red broilers, found ten days to be the most satisfactory fattening period. Most of the chicks fed fourteen days had the feathers eaten from their backs. This feather eating started about the tenth day. Both meat-meal and milk gave good results as sources of animal protein. Fattening started when the broilers were eight weeks old.

From the foregoing it is evident that broilers should not be fattened for a longer period than ten days.

Influence of Milk on Growth.

In an experiment conducted by the New Jersey Station at Vineland (20), at the end of a twelve week feeding period, American class chickens

fed milk weighed, at the beginning of the feeding period 8 pounds per 100, and at the close 204 pounds. White Leghorn chicks, fed no milk weighed 8 pounds per 100 at the beginning, and 140 pounds at the end of the 12 weeks feeding period, a difference of 64 pounds per 100 chicks in favor of the milk fed. Leghorns fed milk weighed 8 pounds, per 100 chicks at the beginning and 177 pounds at the close. The American class pullets fed milk at the end of 24 weeks weighed 410 pounds per 100, while those fed no milk weighed 385 pounds. Leghorn pullets fed milk weighed 335 pounds, and those fed no milk weighed 301 pounds.

Clayton and Clayton (19), in an experiment with two lots of 25 baby chicks, fed the first lot a regular chick ration and all the milk they would drink. The second lot was fed the same ration as the first lot minus the milk. No difference in growth was apparent during the first month, but at the end of five months the milk fed chicks averaged 4.55 lbs., while the chicks fed no milk averaged only 2.5 lbs. At the expiration of the five months one-half the lot, which had been fed water and mash were given milk and mash, and in one month's time gained one pound each. One-half the lot fed milk and mash were given water and mash, and at the end of one month they gained less than ¼ lb. per bird (See tables XVI and XVII).

Table XVl. Results of Feeding Milk to Young Chicks and Growing Stock. This lot Received Milk.

Age	Number of Chicks	Weight per Chick pounds	Gain per chick pound	Grain per Chick pound	Mash per Chick pound	Milk per Chick pound	Feed cost per chick	Profit per Chick
1 Day	25	.01	.00	.00	.00	.00	.00	$0.00
1 month	25	.75	.65	.40	.40	1.50	.02	.14
2 months	25	1.50	.75	1.00	1.00	4.00	.06	.12
3 months	25	2.30	.80	1.40	1.40	6.50	.09	.11
4 months	16	3.60	1.30	2.00	2.00	8.00	.12	.15
5 months	16	4.55	.95	2.00	2.00	8.00	.12	.13
Totals	16	4.55	4.55	6.80	6.80	28.00	.41	.65

Table XVll. Results of Feeding Milk to Young Chicks and Growing Stock. This Lot Received Water.

Age	Number of chicks	Weight per chicks pounds	Gain per chick pound	Grain per chick pounds	Mash per chick pounds	Feed cost per chick	Profit per chick
1 day	25	.01	.00	.00	.00	$0.00	$0.00
1 month	25	.75	.55	.40	.40	.02	.14
2 months	25	1.00	.25	1.00	1.00	.05	.01
3 months	25	1.50	.50	1.40	1.40	.07	.06
4 months	16	2.10	.60	2.00	2.00	.10	.05
5 months	16	2.50	.40	2.00	2.00	.10	.00
Totals	16	2.50	2.40	6.80	6.80	.34	.26

From the foregoing, it is apparent that chicks fed milk, in addition to the regular mash, made much better gains than those fed mash alone.

Control of Coccidiosis with Skim Milk.

In an experiment conducted by the Agricultural Experiment Station of Texas (21), 830 single comb White Leghorn chicks were divided into nine lots. All were fed the same basal ration and were artificially infected by feeding infectious material mixed with mash. The mortality of the lots getting

butter-milk was 64.7, those getting condensed butter-milk, diluted 1 to 6,44.8, and the ones which received condensed butter-milk, diluted 1 to 3,26 percent.

Beach and Davis (22), found that Coccidiosis can be controlled by feeding a ration 40 percent of which is dry skim milk or buttermilk.

From the foregoing, it is evident that skim milk or buttermilk is effective in the control of Coccidiosis.

MARKETING EGGS.

Losses in Marketing.

According to Quisenberry (38), fifty million dollars worth of eggs a year are placed before the candle and are found to be unfit for human food.

The United States Department of Agriculture estimates the annual loss on poultry and eggs in the United States at 17% of the value of the product (45). Specialists in Animal Production estimate that $15,000,000 annually are lost from infertile eggs alone. Incubation in hen eggs starts at a temperature of 70 degrees Fahrenheit, but will not take place below 70F or above 109F.

The United States Department of Agriculture, in co-operation with Kansas egg dealers and farmers, (45), selected 10,000 fresh eggs, one-half of which were fertile and the other one-half infertile. An equal number of fertile and infertile eggs were subjected to identically the same conditions with the result that on the farm 29% of the fertile

eggs spoiled as compared to 16% of the infertile eggs. On the way to market 14% of the fertile eggs spoiled as compared with 9% of the infertile. This made a total of 43% fertile eggs spoiling as compared to 25% infertile.

It is estimated by United States Department of Agriculture, specialist in Animal Production (38), that $45,000,000 annually is lost from bad eggs. This loss amounts to 17% of all eggs sold, and is distributed as follows: Shrinkage 5%, blood rings 5%, rotten eggs 2½%, breakage 2%, dirty eggs 2% and mold ½%.

Professor F. S. Jacoby of the Bureau of Chemistry, United States Department of Agriculture (38), found at one town in Missouri that out of a 30 dozen case of eggs bought by a dealer from a farmer, 21 dozen and 10 eggs were rotten, and 8 eggs were broken. A dealer in another town shipped 25 cases of eggs to Springfield and lost 170 dozen (five and two-thirds cases) in spots and rots. In still another instance a woman brought ½ case, (15 dozen) eggs to a dealer who offered to buy them case count at seven cents per dozen or thirteen cents per dozen candled. The dealer counted out four and one-half dozen rotten eggs. The woman refused to sell the remaining eight and one-half dozen at thirteen cents, but sold the entire fifteen dozen to a grocer at thirteen cents. The grocer in turn sold the candled eggs to the same dealer for fourteen cents per dozen.

The writer recalls a visit to Muskogee, Oklahoma, in August 1922, where he obtained two dozen eggs from a groceryman in a tourist park, and of this number twenty were spoiled.

According to the foregoing, the losses in marketing eggs are tremendious. It is also evident that considerable savings could be made if the farmers would gather their eggs more frequently, and produce infertile eggs during the summer months. Since the losses are caused by shrinkage, blood rings, rotten eggs, breakage, dirty eggs, and mold, the eggs in addition to being gathered frequently, should be candled and graded in order to eliminate this waste.

Loss in price to the farmer occurs because of poor quality, because of loss in transportation charges on worthless eggs, and because of the necessity for a large number of graders and candlers to sort the good eggs from the bad ones.

Graded Eggs Bring Better Prices.

Mussehl (40) says that 85% of the eggs from an average well-cared for flock will meet the requirements for United States Extras and Standards, if the hens are properly fed, have plenty of clean nests, and the eggs are gathered often, and marketed promptly in good strong shipping cases.

Table XVlll (40), gives a typical New York market egg report, showing relative price distinctions.

Table XVIII. Typical New York Market Egg Report.

Fresh Gathered, extras per dozen	38	@39
Fresh gathered, extra firsts	35	@37
Fresh gathered, firsts	31	@34
Fresh gathered, seconds	27½	@30
Fresh gathered, inferior	20	@26
Fresh gathered, trade eggs	25	@28
Fresh gathered, dirties, regular packed, No.1	26	@27
Fresh gathered, dirties, No.2, and poorer	20	@25
Fresh gathered, checks, fair to choice, dry	22	@24
Checks, undergrades	16	@21
Refrigerator, special marks, fancy, charges paid to expiring dates	35½	@36
Refrigerators, firsts, charges paid to expiring dates	33	@35
Refrigerators, second, charges paid to expiring dates	29	@ 32
Refrigerator, undergrades	25	@28
Nearby and White Eggs.		
State, Penn., and nearby western hennery whites, extras	50	@52
State, Penn., and nearby western hennery whites, extra firsts	46	@49
State, Penn., and nearby hennery whites, firsts	41	@45
State, Penn., and nearby, gathered whites firsts to extra firsts	41	@49
State, Penn., and nearby, undergrades	35	@40
Pacific Coast, white, extras	50	@ 52
Pacific Coast, whites, extra firsts	46	@49
Pacific Coast, whites, firsts	42	@45
Pacific Coasts, whites, undergrades	38	@40
Pacific Coast Pullets	-	
Other western and southern gathered whites	34	@44
State, Penn., and nearby western, hennery browns, extra	41	@43
State, Penn., and nearby, brown and mixed colors, gathered, graded, extras	38	@39
State Pen., and nearby, brown and mixed colors, firsts to extra firsts	32	@37
State, Penn., and nearby, seconds	28	@31

It will be noted from the foregoing, that the poultry markets buy eggs according to grade. The price ranges from 20 cents per dozen for the lowest grade, to 50 cents per dozen

for the highest grade. A good grade of eggs can be produced.

Marketing Eggs by Parcel Post.

The Office of Markets and Rural Organizations of the United States Department of Agriculture (44), beginning in October 1913 and ending in February 1914, made 460 shipments of eggs by Parcel Post. Nine thousand one hundred thirty-one eggs were shipped in lots varying from one to ten dozen, 327, or slightly less than 3.6% were broken, and 209, or slightly less than 2.3%, were broken too badly to use.

It is apparent from the foregoing, that Parcel Post can be used to good advantage in marketing eggs; by means of Parcel Post eggs can be shipped direct from the producer to the consumer and the middleman eliminated.

Winter Egg Production Most Profitable.

According to Pennington and Pierce (38), 49.8% of the eggs are produced during March, April, May, and June, and 86.1% of all cold storage eggs are stored during this time. Eighteen and seven tenths percent of the eggs are produced in October, November, December, and January, and 77.8% of the eggs in cold storage are consumed during these months.

As a result of grouping together the records obtained on 164 poultry farms over a period of seven years, the Poultry Department of Cornell University (39) found that farms

getting good winter egg production, November to February inclusive, had the largest annual egg production and the largest labor income. Spring production, March to June inclusive, was relatively high on all farms. Production during the late summer and fall had a greater effect on the production per bird and the labor income per farm than did either the winter or spring production.

Price curves over a period of years (46), show that eggs are higher in price during the winter months.

The foregoing information, shows that during the winter months the number of eggs produced are not sufficient to supply the demand and that the farmers getting good winter production make the most money from their eggs.

Preserving Eggs.

An experiment was conducted, jointly by the Poultry and Home Economics Departments of the University of Arkansas (37), to determine the practicability of preserving eggs during the spring and summer months for winter use. Both fertile and infertile, brown and white shelled, washed and unwashed, eggs were preserved in water glass, lime water, Flemings Egg Preservative, E. Z. Egg Preservative, dry salt, and Vaseline. It was found that the eggs preserved in water glass and lime water were as good as fresh eggs for all purposes except poaching. Eggs preserved in salt were salty and when used in custards had an alkaline flavor. The E. Z. Preservative was superior to any of the other patent preservatives

or Vaseline. Neither the color of the shell or washing of the eggs had any effect on the quality of the eggs. Infertile eggs were slightly superior to fertile eggs, expecially with the patent preservatives.

From the foregoing, it is apparent that eggs for home use can be preserved during the Spring months when eggs are plentifull and consequently low in price. By using these preserved eggs at home during the winter months when eggs are high in price the winter eggs can be put on the market.

MARKETING BIRDS.

Early Hatched Broilers Bring Better Prices.

No information of an experimental nature was found on the marketing of fowls except in regard to the marketing of broilers.

The results of four years sales by the Iowa State College of Agriculture and Mechanic Arts (12) showed that broilers hatched March 1 averaged 45 to 54 cents per pound April 1, 35 to 45 cents per pound May 1, 25 to 35 cents per pound, and June 1, 20 to 25 cents per pound.

Price curves over a period of years (46), show that broilers are higher in price during early spring.

It will be noted that the price varied from 54 cents per pound for broilers hatched March 1, to 25 cents per pound for broilers hatched June 1.

CONCLUSION

From the data presented, the following conclusions are evident:

1. The flock average can be materially increased by using as breeders, hens with high records, and cock birds whose dams are high producers. The farmer who does not have time to trapnest his flock can secure pedigreed males from reliable breeders , and can secure the benefits of trapnesting by entering pullets in one of the many egg laying contests, where trapnesting is done, and accurate records are kept.

2. Systematic culling throughout the year will materially increase egg production.

3. The age of hens materially effects their egg production. The greatest production occurs during the pullet year.

4. Exercise is necessary for the heavy breeds, but not for the light breeds. Poor results are obtained from all breeds when kept in close confinement.

5. The use of lights speed up egg production during the winter months, when eggs are scarce and consequently high in price.

6. Vitamins are essential and can be obtained by feeding green feed, yellow carrots, red carrots, salmon oil, and cod liver oil.

7. Feeding plenty of milk is one of the best ways to secure good egg production, growth, and at the same time safeguard the health of the flock.

8. Egg production can be increased by feeding at all times, a well balanced ration, containing an ample supply of mineral matter.

9. The deteriation in hatching eggs is very slight up to the sixth day. Turning, before incubation begins, is unnecessary.

10. Best hatching results are obtained where the temperature does not go lower than 101 degrees nor higher than 103 degrees Fahrenheit.

11. In broiler raising, the first two pounds are the most economically produced from the standpoint of feed consumed. Early hatched broilers bring better prices than late hatched.

12. Best results in broiler fattening have been obtained when the duration of the fattening period was ten days.

13. A better grade of eggs can be produced during the summer months, if the male birds are separated from the hens, or disposed of at the end of the breeding season.

14. Farmers can realize more profit from their eggs by preserving eggs in the spring and summer for winter use at home, and selling all eggs produced during the winter months.

15. Graded eggs shipped in clean strong new cases bring best prices.

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