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Egg Weight in the Domestic Fowl

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With the growing tendency toward the buying of eggs on a graded basis, the demand for information on egg grades has increased. Since agencies establishing grades emphasize weight; small eggs never being placed in the top grades, it is becoming more important that the producer market eggs of larger size. Before the weight of eggs can be improved, the factors which affect, or those associated with egg weight must be understood. This bulletin presents the results obtained in a study of these factors at the Missouri Agricultural Experiment Station from 1930 to 1933.

Beginning in 1930, the eggs laid on four successive days of each month were weighed in grams. During the year from October 1, 1932 to June 30, 1933 all the eggs laid by 240 White Plymouth Rock pullets were weighed. The eggs were weighed the day they were laid.

Relation of Date of Sexual Maturity and the Weight of Eggs Produced

The weight of the eggs laid by pullets during their first few months of production is very definitely related to the month in which sexual maturity occurs. This is shown in Table 1 and Fig-

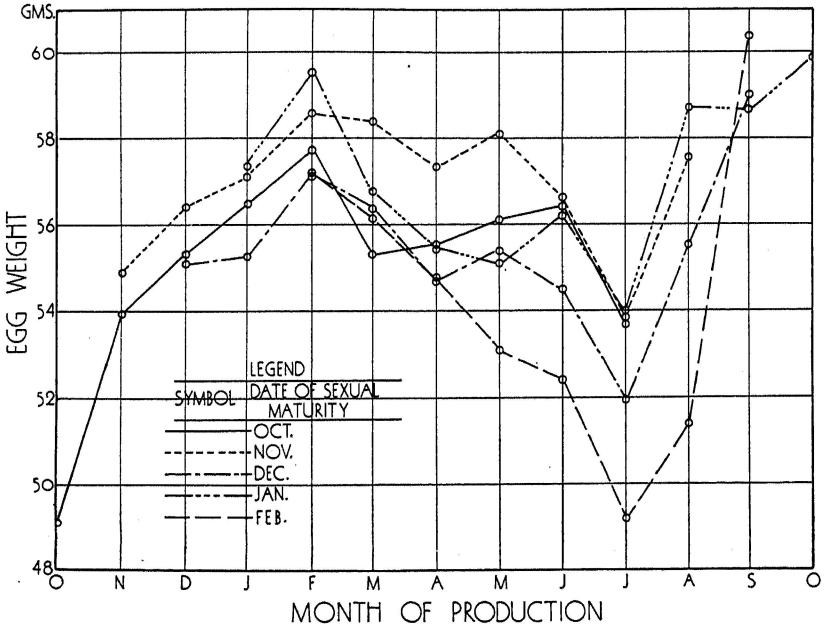

Fig. 1.—Relation of Sexual Maturity to Weight of Eggs Laid. Rhode Island Red Pullets. 1932-33.

TABLE 1.—RELATION OF DATE OF SEXUAL MATURITY AND THE WEIGHT OF EGGS PRODUCED BY RHODE ISLAND RED PULLETS 1931-32 and 1932-33

Date of Sexual Maturity	No. Birds		Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Mean of the Period
Sept.	14	Egg Weight (Grams)	48.4	51.3	55.4	58.0	57.4	61.2	61.0	60.4	58.4	59.2	54.7	----	----	----	56.9
		Percent of the Mean	85.1	90.2	97.4	101.9	100.9	107.6	107.2	106.2	102.6	104.0	96.1	----	----	----	----
Oct.	19	Egg Weight (Grams)	----	50.9	54.5	56.6	57.3	59.6	58.4	57.7	56.7	56.9	56.3	----	----	----	56.5
		Percent of the Mean		90.1	96.5	100.2	101.4	105.5	103.4	102.1	100.4	100.7	99.6	----	----	----	----
Nov.	50	Egg Weight (Grams)	----	----	54.6	56.4	57.0	58.4	58.2	57.1	57.8	56.5	53.5	57.5	----	----	56.7
		Percent of the Mean-----	----	----	96.3	99.5	100.5	103.0	102.6	100.7	101.9	99.6	94.4	101.4	----	----	----
Dec.	39	Egg Weight (Grams)	----	----	----	56.3	56.0	58.2	57.2	55.3	55.1	55.0	53.0	55.6	57.8	----	56.0
		Percent of the Mean	----	----	----	100.5	100.0	103.9	102.1	98.7	99.5	98.2	94.6	99.3	103.2	----	----
Jan.	32	Egg Weight (Grams)	----	----	----	----	57.8	59.2	57.8	56.3	55.4	55.6	52.8	57.0	57.0	58.3	56.7
		Percent of the Mean	----	----	----	----	101.9	104.4	101.9	99.3	97.7	98.1	93.1	100.5	100.5	102.8	----

ure 1. Maximum egg weight was reached during February by pullets which began laying in September, October, November, December, January or February. There is possibly some biological reason for this apparent endeavor of nature to store additional nutrients in the eggs which were produced during the natural breeding season. This table and figure also show that eggs produced during July were smaller than those laid in any month after February. The average weight of the eggs produced during the entire period reported in the table was practically the same for birds which began laying in any month from September to February.

Relation of Age at Sexual Maturity and Egg Weight

It is evident from Table 2 that the age at which the pullet began to lay influenced the weight of the eggs laid. This was particularly true of eggs laid from November to February or until maximum egg weight was reached. Birds which began laying at an early age laid smaller eggs than did pullets which were older when they produced their first egg. This relationship is overemphasized by the table because birds which began laying early were also smaller birds than birds which came into production at a later age. Therefore this table indicates both the influence of sexual maturity and body size upon egg weight. Calculation made eliminating the influence of body weight showed that age at sexual maturity does however significantly influence egg weight. Likewise partial correlation studies which eliminated the influence of age at sexual maturity showed that body weight at first egg was related to egg weight.

TABLE 2.—RELATION OF AGE AT FIRST EGG TO WEIGHT OF EGGS LAID.
R. I. Red Pullets Which Started to Lay Between Oct. 15 and Dec. 1

Age in Days at First Egg	No. Birds	Egg Weights (Grams) By Months									
		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Nov.-July
201-230	20	52.7	54.7	56.2	57.1	56.2	56.3	56.2	55.6	52.8	55.4
231-240	23	56.4	55.5	56.2	58.6	57.3	56.5	57.2	55.9	52.1	56.4
241-260	24	56.8	56.7	56.8	59.7	58.7	56.4	57.3	55.8	53.6	57.0

Table 3 shows that the age of pullets at sexual maturity very definitely influenced the size of the first 10 eggs laid. However, the age at which the pullet began to lay was not closely related to maximum and average egg weight.

TABLE 3.—RELATION OF AGE AT FIRST EGG AND EGG WEIGHTS.
White Rock Pullets 1932-33.

Age in Days at First Egg	No. Birds	Average Weight First 10 Eggs Grams	Average Annual Egg Weight Grams	Maximum Monthly Egg Weight Grams
151-200	23	49.1	54.9	57.5
201-225	32	50.8	54.9	57.4
226-250	41	55.0	56.8	58.7
251-325	26	55.9	56.8	58.4

Relation of Body Weight and Egg Weight

Body weight at first egg was definitely related to the weight of the first 10 eggs, the maximum egg weight and the average weight of the eggs produced from October to June by White Plymouth Rock pullets (Table 4). It is also evident from Table 5 that the average body weight for the entire period (October-June) was related to the weight of eggs produced. This table also shows that an increase in body weight from 16.7 per cent to 25.0 per cent was accompanied by an increase in egg weight of from 1.7 per cent to 6.2 per cent.

TABLE 4.—RELATION OF BODY WEIGHT AT FIRST EGG AND EGG WEIGHT
White Plymouth Rock Pullets—1932-33.

Body Weight at First Egg (pounds)	Number Birds	Average Weight of First 10 Eggs (Grams)	Average Egg Weight Oct.-June (Grams)	Maximum Monthly Egg Wt. (Grams)
3.6-4.5	21	47.8	54.9	56.8
4.6-5.5	44	52.4	55.2	57.5
5.6-6.5	49	54.8	56.6	58.4
6.6-7.5	8	58.3	59.7	61.2

TABLE 5.—RELATION OF AVERAGE BODY WEIGHT AND EGG WEIGHT
White Plymouth Rock Pullets 1932-33.

Average body weight		No. Birds	Average weight of first 10 eggs		Average egg wt. October-June		Maximum monthly egg wt.	
Pounds	Percent Increase		Grams	Percent Increase	Grams	Percent Increase	Grams	Percent Increase
3.6-4.5	----	10	49.3	---	52.7	---	54.5	---
4.6-5.5	25.0	65	52.2	5.9	55.4	5.1	57.9	6.2
5.6-6.5	20.0	40	54.5	4.4	56.8	2.5	58.9	1.7
6.6-7.5	16.7	7	56.7	4.0	58.7	3.3	60.7	3.0

Effect of a Pause in Production on Egg Weight

Do rest periods increase or decrease the weight of eggs laid? An attempt was made to answer this question by analyzing the

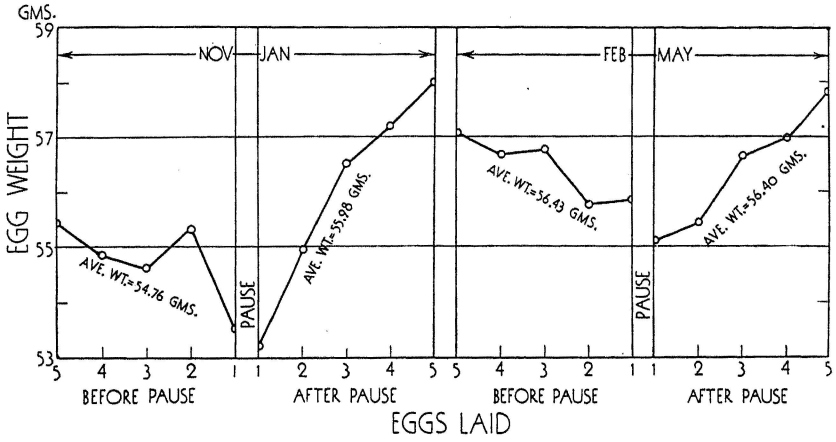

Fig. 2.—Relation of a Pause to the Weight of Eggs Laid. White Rock Pullets. 1932-33.

records of 25 White Plymouth Rock pullets which had a pause of 7 days or more during the period from November to January and also a similar pause from February to May. The change in egg weight was measured by calculating the average weights of the five eggs laid before and after the pause in production. Figure 2 shows the results obtained. The first egg laid after a pause was slightly smaller than the last egg laid before the pause. The weight of the eggs decreased before the pause but there was a marked increase in the weight of eggs laid immediately after the pause. There was no significant difference in the total weight of the five eggs laid before and after the pause in production, particularly during the period from February to May when the variations in egg weights were at a minimum.

Relation of the Weight of the First Egg Laid to the Weight of Succeeding Eggs

Table 6 shows that egg weight increased quite perceptibly from the first egg to the next few eggs laid, the increase gradually diminishing until the mean egg weight was reached by the time the 30th egg was laid. The total increase in egg weight from the first to the fifth egg was approximately 5 per cent and the increase in weight from the first five eggs to the sixth five eggs laid was between 5 and 6 per cent. The above conclusions refer to the weight of eggs laid by White Plymouth Rock pullets which started to lay in October and November, 1932. It was evident from the

TABLE 6.—INCREASE IN WEIGHT OF THE FIRST 30 EGGS LAID BY WHITE PLYMOUTH ROCK PULLETS WHICH STARTED TO LAY IN OCTOBER AND NOVEMBER, 1932

Successive Eggs	Average Weight Grams	Increase (per cent)
First egg	50.7	----
Second egg	51.6	1.78
Third egg	52.2	1.16
Fourth egg	52.4	.38
Fifth egg	53.0	1.15
Successive Groups	**Average Weight**	**Increase (per cent)**
First 5 eggs	52.0	----
Second 5 eggs	53.1	2.12
Third 5 eggs	53.7	1.13
Fourth 5 eggs	53.9	.37
Fifth 5 eggs	54.6	1.30
Sixth 5 eggs	55.1	.92

results obtained with Rhode Island Reds that the time required to reach maximum egg weight depended upon the month the birds began to lay. Birds which began laying in September did not produce eggs of maximum egg weight until February while those which began in February also produced their largest eggs in February.

Relation of Time (Hour) of Laying to Weight of Egg Laid

An analysis of the weights of 2201 Single Comb White Leghorn eggs, (Table 7) 1054 White Rock eggs, and 888 Rhode Island Red eggs showed that there was a very definite relation between the time (hour) of laying and the weight of the egg laid. Eggs

TABLE 7.—RELATION OF TIME (HOUR) OF LAYING TO WEIGHT OF EGGS LAID BY SINGLE COMB WHITE LEGHORN PULLETS

Month	Time of Laying							
	Before 9 a. m.		9-12 a. m.		12-2 p. m.		After 2 p. m.	
	No. eggs	Average weight in grams	No. eggs	Average weight in grams	No. eggs	Average weight in grams	No. eggs	Average weight in grams
January	182	55.05	86	54.17	113	52.31	26	53.70
February	204	56.82	64	55.64	117	54.27	63	53.65
March	84	56.83	41	55.44	63	54.62	14	54.29
April	142	55.49	91	54.19	95	53.51	56	52.93
May	117	56.09	93	55.32	98	53.73	23	53.36
June	123	54.72	63	53.30	113	52.58	80	51.30
January to June	852	55.82	438	54.62	599	53.41	312	52.88

produced in the morning were definitely larger than those laid during the affernoon. This relationship was attributed to the fact that the first eggs laid in a given clutch were larger and were produced during the morning.

Effect of Season on Egg Weight

In Missouri, eggs of maximum weight are produced during the early spring months of February and March while smaller eggs are laid during the summer months of June, July and August. Dr. D. C. Warren of the Kansas State Agricultural College has shown that high temperatures cause the birds to produce smaller eggs. Apparently there is a tendency for the domestic fowl to lay large eggs during the natural breeding season. (See Fig. 3)

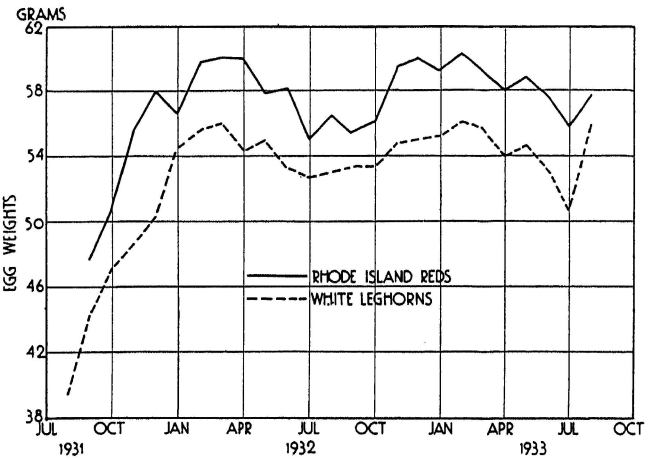

Fig. 3.—Seasonal variation in the Weight of Eggs Laid by Rhode Island Reds and White Leghorns During the First Two Years Production.

Position of the Egg in the Clutch

The position of the egg in the clutch (group of eggs laid on consecutive days) influenced the weight of the egg. The first egg laid in a clutch was usually the largest egg laid in that clutch. This was not true in every case but when the average weights of a representative number of eggs were compared, the first egg laid was slightly larger than the eggs laid on succeeding days. If the first egg laid in a clutch followed a rest period of 7 days or longer, it was usually smaller than the other eggs in that clutch. These long rest periods were, of course, relatively rare in the records of high

producing hens. A random observation on 100 two-egg clutches, which followed rest periods of not over three days, showed 83 cases where the first egg was larger than the second egg, 8 cases where the two eggs were the same weight, and 9 cases where the second egg was larger than the first egg in the clutch.

An examination of a number of clutches as reported in Tables 8, 9, 10, 11, and 12 showed that the first egg laid in 2, 3, 4, 5, 6, 7, 8, 9, and 10 egg clutches was larger than the other eggs laid in those clutches. It was also observed that the decrease in weight per egg was greatest in the shorter clutches and that the total decrease from first to last egg was not materially greater in the longer clutches. The results reported on the 6, 7, 8, 9, and 10 egg clutches were based upon a small number of cases and, therefore, were not considered

TABLE 8.—RELATION OF POSITION IN THE CLUTCH TO EGG WEIGHT
White Plymouth Rock Pullets. 1932-33.

	Mean Egg Weight in Grams										Decreease. in Wt.	
	1	2	3	4	5	6	7	8	9	10	1st to last egg	Per egg
2-Egg Clutch (856 Samples)	57.3	54.7										
Difference		−2.6									2.6	2.60
3-Egg Clutch (178 Samples)	57.5	55.8	54.6									
Difference		−1.7	−1.2								2.9	1.45
4-Egg Clutch (232 Samples)	56.2	54.6	53.9	53.7								
Difference		−1.6	− .7	− .2							2.5	.83
5-Egg Clutch (104 Samples)	54.7	53.6	53.0	52.7	52.7							
Difference		−1.1	− .6	− .3	0						2.0	.50
6-Egg Clutch (37 Samples)	56.2	55.1	54.8	54.2	54.4	53.8						
Difference		−1.1	− .3	− .6	+ .2	− .6					2.4	.48
7-Egg Clutch (16 Samples)	55.9	54.8	53.2	53.4	53.3	52.7	53.3					
Difference		−1.1	−1.6	+ .2	− .1	− .6	+ .6				2.6	.43
8-Egg Clutch (8 Samples)	55.7	54.4	55.1	55.7	55.3	55.1	55.0	54.4				
Difference		−1.3	+ .7	+ .6	− .4	− .2	− .1	− .6			1.3	.19
9-Egg Clutch (7 Samples)	55.9	55.4	55.0	55.0	55.1	54.3	54.0	52.4	53.0			
Difference		− .5	− .4	0	+ .1	− .8	− .3	−1.6	+ .6		2.9	.36
10-Egg Clutch (5 Samples)	54.8	54.8	54.4	54.6	53.6	53.4	53.6	51.0	51.0	51.4		
Difference		0	− .4	+ .2	+1.0	− .2	+ .2	−2.6	0	+.4	3.4	.38

conclusive. However, they showed the same general relationship that characterized the shorter clutches and, therefore, strengthen the evidence reported for the shorter clutches.

Relation of the Weight of the First Egg Laid in a Clutch to the Decrease in Weight of the Eggs Laid on Succeeding Days

If the first egg laid in a clutch was a large egg, the decrease in weight of succeeding eggs was much greater than if the first egg laid was a small egg. The decrease in weight in 2-egg clutches laid by White Plymouth Rock pullets, where the first egg weighed 50 grams or less, was 1.43 grams, but when the first egg weighed 66 grams or more the decrease was 6.28 grams. A similar relationship existed in 3, 4, and 5 egg clutches. The data (Table 9) were analyzed by three month periods to prevent seasonal influences from biasing the results. Apparently, the weight of the first egg laid in any clutch materially influences the amount of decrease in weight of eggs laid on succeeding days.

TABLE 9.—EFFECT OF WEIGHT OF EGG UPON THE DECREASE IN WEIGHT OF EGGS IN TWO EGG CLUTCHES.

White Rock Pullets Which Started to Lay in October, 1932.

Wt. of first egg in the clutch		50 grams or less	51-55 grams	56-57 grams	58-60 grams	61-65 grams	66 or more grams
Oct.-Dec.	Number Clutches	48	105	45	51	35	5
	Average Decrease	.91	1.00	2.16	2.73	3.66	5.80
Jan.-Mar.	Number Clutches	31	73	36	75	86	17
	Average Decrease	1.74	.79	2.06	2.68	3.76	5.94
Apr.-June	Number Clutches	17	68	30	65	67	7
	Average Decrease	2.29	1.59	2.47	3.29	4.73	7.43
Oct.-June	Number Clutches	96	246	111	191	188	29
	Average Decrease	1.43	1.10	2.21	2.90	4.09	6.28

TABLE 10.—EFFECT OF WEIGHT OF EGG UPON DECREASE IN WEIGHT FROM THE FIRST TO THE LAST EGG LAID IN FOUR AND FIVE EGG CLUTCHES

White Rock Pullets Which Started to Lay in October, 1932.

Weight of First Egg		50 grams or less	51-54 grams	55-57 grams	58-60 grams	61-65 grams	66 or more grams
Four Egg Clutches							
Oct.-June	Number Clutches	24	58	63	41	36	9
	Average Decrease	1.21	1.81	2.54	3.39	3.53	4.78
Five Egg Clutches							
Oct.-June	Number Clutches	13	47	18	14	8	4
	Average Decrease	.77	1.60	2.17	3.00	4.50	5.75

Seasonal Differences in Decrease of Egg Weight Within a Clutch

The decrease of egg weight within a clutch was greatest during the spring months and least during the fall and winter months (Tables 11 and 12). The production of small eggs by pullets during the fall and larger eggs during the spring would explain part of the difference since it was shown in Tables 9 and 10 that the weight of the first egg in a clutch influences the decrease in weight of succeeding eggs. However, eggs of the same weight showed greater decreases in weight within a clutch during the spring than eggs of the same weight showed in the fall and winter. These seasonal differences in decrease in weight can be explained possibly by the fact that egg weight is increasing during the fall and this force tends to minimize the decrease in weight during a clutch at this season of the year while in the late spring and early sum-

TABLE 11.—EFFECT OF SEASON UPON THE DECREASE IN WEIGHT OF EGGS IN THREE EGG CLUTCHES

White Rock Pullets Which Started to Lay in October, 1932.

	Oct.-Dec.	Jan.-Mar.	April-June
Avg. weight of first egg	Grams 55.00	Grams 58.27	Grams 59.18
Second egg	54.20	56.27	57.07
Third egg	53.18	55.23	55.54
Decrease from 1st to 2nd egg	.80	2.00	2.11
Second to third egg	1.02	1.04	1.53
First to third egg	1.82	3.04	3.64
No. clutches	60	62	56

mer egg weight decreases quite markedly and therefore the decrease in weight during a clutch is accelerated at this season of the year.

TABLE 12.—CHANGE IN WEIGHT OF EGGS IN TWO EGG CLUTCHES BY MONTHS OF PRODUCTION

White Rock Pullets Which Started to Lay in October, 1932.

Month	Number Clutches	Weight of first egg	Weight of second egg	Difference	Deviation from the mean difference
October	75	51.38	49.61	−1.77	− .81
November	106	55.54	53.26	−2.28	− .30
December	106	57.83	56.25	−1.58	−1.00
January	106	57.48	55.12	−2.36	− .22
February	103	58.95	56.11	−2.84	+ .26
March	106	59.13	56.18	−2.95	+ .37
April	99	59.60	56.26	−3.34	+ .76
May	81	57.38	54.32	−3.06	+ .48
June	74	56.48	53.39	−3.09	+ .51
Oct.-June	856	57.28	54.70	−2.58	

Breed or Strain Differences in Egg Weight

That certain breeds or strains usually produce larger eggs than other breeds or strains is common knowledge. The largest eggs produced in our station flock are those laid by Rhode Island Reds. However, within any given breed there is a wide variation in the weight of eggs produced. These differences may be established by breeding and become what are called strain differences. Large egg size is not confined to any one breed, but can be bred into any of the common breeds of chickens. The results reported in Table 13 show the differences in egg weights which exist here at the Missouri Station. These differences should be considered strain differences instead of breed differences.

TABLE 13.—BREED OR STRAIN DIFFERENCES IN EGG WEIGHT. 1931-33

Breed	Age	Eggs Weighed	Average Egg Weight
			(Grams)
R. I. Reds	Pullets	820	57.35
Barred Rock	Pullets	234	55.85
White Rock	Pullets	527	55.46
Ancona	Pullets	107	55.08
Wyandotte	Pullets	155	53.43
White Leghorn	Pullets	1199	51.80

Inheritance of Egg Weight

Egg weight is an inheritable factor. A correlation of the weight of eggs produced by dams and their daughters during the first ten months' production gave $r = .288 \pm .06$. Monthly samples of from one to four eggs were used for determining an average egg weight for the first ten months' production. The records of 92 White Plymouth Rock pullets which were the daughters of 41 hens were used for this study. The results showed that dams which lay large eggs tend to produce daughters which also produce large eggs and vice-versa. The correlation coefficient was significant, but it was relatively small indicating that other factors influenced egg weight more than inheritance from the dam. Egg weight is no doubt inherited from the male also.

Effect of Ration on Egg Weight

That egg weight may be influenced by deficiencies in the ration has been demonstrated by several investigators. Missouri Bulletin 288, The Influence of Various Protein Concentrates on Egg Production, shows that birds receiving milk laid larger eggs than did those receiving meat scrap, tankage, soybean meal, cottonseed meal, or ground soybeans.

The use of mineral supplements such as oyster shell or ground limestone increases egg weight. Since body weight is related to egg weight, the maintenance of body weight by proper feeding methods would no doubt be helpful in maintaining egg weight. It was found here at the Missouri Station that the maintenance of body weight is essential for high egg production.

Stimulation of egg production by the use of artificial lights has not affected egg weight.

In general one may conclude that the use of a complete ration will insure maximum egg weight.

A PROGRAM FOR INCREASING EGG WEIGHT

1. **Breeding.**
   a. Select breeding stock which produces eggs weighing from 24 to 28 ounces per dozen.
   b. When possible breed from males and females whose daughters laid large eggs.
   c. Select medium to large sized breeders within a given breed. Large birds tend to produce larger eggs than do small birds.
   d. Set eggs that are of the desired shape and color and which weigh from 24 to 28 ounces per dozen or purchase chicks hatched from eggs of this character.

In some cases it will be advisable to discard the present stock and replace them with chicks or hatching eggs from some breeder who has bred the factor for large egg size into his stock.

2. **Feeding.**
   a. Feed a complete or well balanced ration throughout the year.
   b. Use some form of milk in the ration. Milk is beneficial in improving egg weight.
   c. Keep clean, fresh water before the birds.
   d. Maintain the body weight of the birds. If necessary use a moist fattening mash and hopper feed the grain.

3. **Temperature.**
   a. During the summer months house the birds in cool quarters and provide shade. Egg weight is much reduced during the summer months when the temperature is high.

BETTER RETURNS FROM EGGS

In order to realize financially on such a program as outlined above it is necessary to have a market which pays a premium for high quality eggs. Your dealer however is unable to obtain an outlet for high quality eggs unless his territory produces such a product throughout the year. The breeder may profit by the sale of hatching eggs, baby chicks or breeding stock. To obtain maximum results, market eggs must be properly cared for on the farm. They should be held below 68°F. and marketed at least twice each week. For detailed information on the production of high quality eggs read Agricultural Extension Circular 298 "Improve Missouri Eggs."