

## EXPERIMENTS WITH LAYING HENS

# OHIO Agricultural Experiment Station

WOOSTER, OHIO, U. S. A., FEBRUARY, 1916

### *BULLETIN 291*



Lot on range in Experiment 1b

Average egg production per hen { First year, 181.2  
Second year, 133.3

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EXPERIMENT STATION, Wooster, Ohio

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# BULLETIN

OF THE

## Ohio Agricultural Experiment Station

NUMBER 291

FEBRUARY, 1916

### EXPERIMENTS WITH LAYING HENS<sup>1</sup>

W. J. BUSS

#### I. RANGE VS. CONFINEMENT

#### II. VARIETY VS. SIMPLE RATIONS

#### III. VARIOUS AMOUNTS OF PROTEIN IN RATIONS

The average yearly egg production per hen in Ohio farm flocks has been variously estimated at 60 to 70 eggs. The most important causes for this low egg yield are poor stock, improper housing conditions, indifferent care and inadequate rations. By keeping carefully selected fowls in properly ventilated houses; feeding a ration similar to one of the better rations reported in this bulletin, and caring for the flock at regular intervals each day, this average yield can be greatly increased: with one lot, the results of which are reported herein, it was almost trebled. The fowls used in the experiments reported in this bulletin were purebred and of good quality, but no better than could be placed on every farm in the State at a very small expenditure on the part of each farmer for a few settings of eggs. The fowls received only such care as was necessary to feed and water them regularly. They were not pampered in any way.

**Prices used in calculations.**—The following prices per hundred-weight for feeds were used in financial calculations in this bulletin:

Shelled corn .....	\$1.00	Middlings .....	\$1.40
Cracked corn .....	1.09	Meat scrap .....	2.75
Ground corn .....	1.09	Linseed oilmeal .....	1.80
Wheat .....	1.50	Oyster shells .....	.75
Oats .....	1.25	Grit .....	.75
Bran .....	1.40	Charcoal .....	2.25

No charge has been made for the range occupied by the various lots.

All feeds used in these experiments, except as noted in Experiment Ia, were of good quality. The meat scrap was guaranteed by

<sup>1</sup>To Ross M. Sherwood, in charge of poultry work at this Station from December 1, 1910 to September 30, 1912, the author is glad to give credit for having planned Experiments Ia and IIa, and for having supervised Experiment Ia until the time of his resignation.

the manufacturers to contain 50 percent crude protein. Five samples analyzed by the Department of Chemistry of this Station at various times during the last 2 years have averaged 55.04 percent crude protein. The linseed oilmeal was old process, finely ground.

Prices of eggs per dozen as used in calculations, for 4-week periods beginning approximately on dates given, were as follows:

	Cents		Cents
January 1 .....	31	July 16 .....	21
January 29 .....	28½	August 13 .....	23½
February 26 .....	23	September 10 .....	25
March 26 .....	19	October 8 .....	27
April 23 .....	19	November 5 .....	32½
May 21 .....	19½	December 3 .....	34
June 18 .....	20		

The reader should bear in mind that it is impossible to use a scale of prices for commodities that will apply through a period of years. In fact, prices that prevail for feeds in different sections of the State at the same time are likely to vary considerably. The prices for feeds as given above are believed not to vary greatly from the average Ohio farm price for them through a period of years. The prices for eggs are possibly a little higher than are realized by most poultrymen, although many who devote some attention to intelligent marketing dispose of their eggs at higher prices than those given above. These arbitrary prices serve only as a means of comparing different lots on a basis of prices given. The reader, in trying to determine which rations will yield best results under his local conditions, should apply local prices to the amounts of feed consumed and number of eggs produced rather than assume that the financial statements will apply in all sections of the State.

**Method of feeding.**—In all experiments reported in this publication, the proportions of feeds are by weight rather than by measure. The grain mixture was fed twice daily in equal parts. The mash mixture was fed dry in self-feeding hoppers. In most cases the hoppers were left open at all times. Occasionally, however, when a lot showed a tendency to consume too much mash and consequently too small an amount of grain, it became necessary to close the hopper for a part of the day. The rations were planned with a view to having the hens consume half as much mash as grain. This was not always accomplished, as will be noted in the tables showing amounts of grain and mash consumed per hen. All lots had constant access to hoppers containing grit and shells. The hens in all except the range and confinement experiments also had access to charcoal. The amount of charcoal consumed was in most cases very small, and the use of charcoal will be discontinued in future experimental work with hens.

**Weighing fowls.**—In the experiments reported in this bulletin, the hens were weighed individually every fourth week on the same day of the week and at the same time of day. The weights and losses or gains of the hens for the different periods are given only for the hens living at the close of the respective periods.

**Male birds in lots.**—During the breeding seasons, male birds were kept in the lots in all experiments except *Ib* (first period), *Ic* and Leghorns in III. Since it was not practicable to feed the male birds separately, the feed they consumed is included with that of the hens. However, the same number of male birds were kept in each lot in the different experiments so that the figures showing average feed consumption per hen for the various lots are comparable, even though they are not exactly accurate. The feed consumed by male birds was a very small percentage of that consumed by the lots.

## RANGE VS. CONFINEMENT FOR LAYING HENS

### OBJECT OF THE EXPERIMENT

The object of this series of experiments was to compare the egg production of hens kept in close confinement with that of hens allowed practically free range. This series of experiments was conducted at the Southeastern Test Farm, Carpenter, Ohio.

### EXPERIMENT *Ia*

#### PLAN OF THE EXPERIMENT

**Duration.**—This experiment was begun May 5, 1912, and closed October 3, 1914, lasting 882 days. The results are presented for three periods—May 5 to December 4, 1912 (214 days); December 5, 1912, to December 4, 1913 (365 days); December 5, 1913, to October 3, 1914 (303 days)—with a summary showing the results of the experiment as a whole.

**Description of fowls.**—The hens used in this experiment were S. C. White Leghorns hatched in the spring of 1910. At the beginning of the experiment there were 99 hens in the confined lot and 103 in the lot on range. During their first year of production these hens were used in an experiment to study the variation in production of apparently uniform lots of fowls when treated alike (reported in Bulletin 262). From December 5, 1910 to May 4, 1912 (516 days), when both lots of hens were accorded the same treatment as that given the hens kept in confinement during this experiment, the hens kept on range produced 4.2 percent fewer eggs per hen than did those continued in confinement. The feed

consumption per hen was almost exactly the same during this period, there being less than one-half of 1 percent difference between the two lots. This would seem to indicate that so far as the ability to produce eggs is concerned, the lot in confinement may have had a very slight advantage. The fact that the hens in confinement had become accustomed to the treatment accorded them in this experiment, whereas the hens on range had to adjust themselves to new conditions at the beginning of the experiment may also have given the confined hens some advantage.

**Quarters.**—Each lot of hens had access to two pens each 13 by 20 feet in size in a house of the half-monitor type, 20 by 60 feet in size. The lot in confinement had access to two yards each 13 by 60 feet in size. These yards were covered with gravel and furnished no green feed. The lot on range had access to a plot of bluegrass containing approximately 2 acres. A cow and some sheep were also pastured on this plot throughout the spring, summer and autumn.

**Ration.**—The grain mixture given these hens was composed of 3 parts, by weight, of cracked corn, and 1 part of wheat; and the mash mixture was composed of 4 parts of ground corn, 2 parts of wheat bran, 2 parts of meat scrap and 1 part of linseed oilmeal. The percentage of each feed in the ration used in these experiments, when half as much mash as grain is consumed, is as follows: corn, 64.8 percent; wheat, 16.7 percent; bran, 7.4 percent; meat scrap, 7.4 percent; linseed oilmeal, 3.7 percent.

In addition to the foregoing mixtures the hens had access to oyster shells and grit. The method of feeding is described on page 186.

#### RESULTS OF THE EXPERIMENT

**Mortality.**—Table I shows the number and percentage of hens that died during each period of the experiment, with a summary for the entire experiment.

TABLE I.—Mortality

Lot	Number in lot at beginning of experiment	First period, May 5— Dec. 4, 1912		Second period, Dec. 5, 1912— Dec. 4, 1913		Third period, Dec. 5, 1913— Oct. 3, 1914		Entire experiment, May 5, 1912— Oct. 3, 1914	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent
Confined...	99	6	6.06	15	16.13	2	2.56	23	23.23
On range..	103	4	3.88	5	5.05	7	7.45	16	15.53

During this experiment the mortality was considerably heavier for the lot in confinement. This increased mortality may not have

been due entirely to the fact that the hens were closely confined. During July, 1913, seven hens died in the confined lot and none in the range lot. This heavy mortality was due, in part at least, to the unintentional feeding of moldy wheat and to the use of water from a cistern that had become very foul. While this of course is not conclusive evidence, yet it at least indicates that hens having free range are more nearly able to resist the effects of feed or water of poor quality than are those kept closely confined. This statement is given, not to advise the use of feeds or water of poor quality for poultry, but to suggest that should such, through an oversight on the part of the feeder, be given to hens, the results are less likely to prove disastrous if the hens have range.

**Weights.**—Table II gives the average weight at the beginning and close of each period and the average loss or gain in weight per hen for the hens living at the close of the period.

TABLE II.—Average weight and loss or gain per hen

Lot	Average initial weight of all hens	Number living at close of period	Average weight at beginning of period	Average weight at close of period	Average loss (-) or gain in weight
May 5—Dec. 4, 1912 (214 days)					
Confined .....	Pounds 3.79	93	Pounds 3.80	Pounds 3.68	Pound -0.12
On range.....	3.85	99	3.87	3.60	-.27
Dec. 5, 1912—Dec. 4, 1913 (365 days)					
Confined.....	....	78	3.71	3.59	-.12
On range.....	....	94	3.59	3.61	.02
Dec. 5, 1913—Oct. 3, 1914 (303 days)					
Confined.....	....	76	3.59	3.66	.07
On range.....	....	87	3.63	3.78	.15
Summary: May 5, 1912—Oct. 3, 1914 (882 days)					
Confined.....	....	76	3.82	3.66	-.16
On range.....	....	87	3.87	3.78	-.09

The hens in both lots maintained a fairly uniform weight throughout the experiment. The greatest variation in weight at division between periods was 5.5 percent of their initial weight for the hens in confinement and 7 percent for those on range.

**Feed consumed.**—The average amount and cost of feed, shells and grit consumed per hen, and the cost of feed per dozen eggs produced, for each period, are shown in Table III.

TABLE III.—Feed consumed per hen and cost of feed

Lot	Average number in lot	Materials consumed per hen					Cost of feed per hen*	Cost of feed per dozen eggs produced
		Grain	Mash	Grain and mash	Shells	Grit		
May 5—Dec. 4, 1912 (214 days)								
Confined.....	96.29	Pounds 27.54	Pounds 10.75	Pounds 38.29	Pounds 0.74	Pound 0.05	Dollars 0.51	Cents 8.42
On range.....	100.46	24.72	12.57	37.29	1.32	.06	.51	7.54
Dec. 5, 1912—Dec. 4, 1913 (365 days)								
Confined.....	86.51	42.85	17.13	59.98	1.47	.06	.80	10.94
On range.....	97.03	41.51	19.73	61.24	1.74	.07	.83	9.19
Dec. 5, 1913—Oct. 3, 1914 (303 days)								
Confined.....	76.24	33.20	14.73	47.93	1.52	.52	.65	9.80
On range.....	91.25	32.27	14.49	46.76	1.59	.25	.63	8.52
Summary: May 5, 1912—Oct. 3, 1914 (882 days)								
Confined.....	85.35	104.15	42.64	146.79	3.69	.59	1.96	9.75
On range.....	95.87	98.63	46.93	145.56	4.66	.38	1.97	8.49

\*See p. 185 for prices used in calculations.

The figures given in Table III show that hens on range consumed as much feed (in addition to that secured from the range) as did those in confinement. This point is also shown in Experiments Ib and Ic of this series, reported in the following pages. The cost of feed per dozen eggs produced was 14.8 percent higher for the confined lot than for the range lot. No charge has been made for range in these calculations.

**Egg production.**—The average egg production per hen, and the average value of eggs per hen and per dozen based on the assumed prices (see p. 186) are presented in Table IV.

The average production of the hens on range was 15.4 percent higher than that of those in confinement. Because of the fact that the hens in confinement produced a slightly larger proportion of their eggs during the period of higher prices than did those on range, the value of eggs per hen is only 14.9 percent higher for the hens on range.

**Value of range.**—By crediting the greater difference between the cost of feed per hen and the value of eggs per hen for the range lot to the range, the value of range per hen on the basis of prices for feeds and eggs as used in this publication was 16 cents, 31 cents and 18 cents, respectively, for each of the three periods into which this experiment has been divided. The value of range per hen for the entire experiment was 62 cents. In view of the fact that the hens utilized only a part of the grass from the approximately 2 acres of range to which they had access, this would provide a very satisfactory rental for land used in supplying range for laying hens.



TABLE IV.—Egg production

Lot	First period, May 5—Dec. 4, 1912			Second period, Dec. 5, 1912—Dec. 4, 1913			Third period, Dec. 5, 1913—Oct. 3, 1914			Entire experiment, May 5, 1912—Oct. 3, 1914		
	Average eggs per hen	Average value of eggs		Average eggs per hen	Average value of eggs		Average eggs per hen	Average value of eggs		Average eggs per hen	Average value of eggs	
		Per dozen	Per hen		Per dozen	Per hen		Per dozen	Per hen		Per dozen	Per hen
Confined.....	72.3	Cents 21.1	Dollars 1.27	87.5	Cents 21.2	Dollars 1.54	79.3	Cents 20.8	Dollars 1.37	241.1	Cents 21.0	Dollars 4.22
On range.....	80.7	21.2	1.43	107.8	20.9	1.88	88.9	20.7	1.53	278.3	20.9	4.85

**Summary.**—For greater convenience in studying the results of this experiment, a summary of the important points in each of the preceding tables is presented in Table V. These figures are for the entire experiment, May 5, 1912—October 3, 1914 (882 days).

TABLE V.—Summary of results

Lot	Average number in lot	Mortality	Loss in weight per hen	Grain and mash consumed per hen	Cost of feed per hen*	Eggs produced per hen	Cost of feed per dozen eggs produced	Value of eggs per hen*	Difference between cost of feed and value of eggs
		Percent	Pound	Pounds	Dollars		Cents	Dollars	Dollars
Confined .	85.35	23.23	0.16	146.79	1.96	241.1	9.75	4.22	2.26
On range .	95.87	15.53	.09	145.56	1.97	278.3	8.49	4.85	2.88

\*See pp. 185, 186 for prices used in calculations.

## EXPERIMENT 16

## PLAN OF THE EXPERIMENT

**Duration.**—The second experiment to study the effects of range and confinement on laying hens was begun November 30, 1913, and closed November 27, 1915, lasting 728 days. Results are reported in two periods of 364 days each with a summary for the entire experiment.

**Description of fowls.**—The birds used in this experiment were hatched at the Station in April and May, 1913. They were kept at the Station until October 15, 1913, when they were shipped to the Southeastern Test Farm at Carpenter, a distance of approximately 200 miles. They were divided into two uniform lots and kept in confinement until November 27. On this date one lot was given access to range as described below. The confined lot had produced 118 eggs and the range lot, 188 eggs prior to the time this experiment was begun. The average weight per pullet in each lot at the beginning of the experiment was 3.14 pounds.

**Quarters.**—Each lot of 57 pullets was kept in a house of the shed-roof type 10 by 24 feet in size. The lot on range had access to a plot of bluegrass containing 1.4 acres. Some other livestock was also pastured on this plot. The hens in confinement had a run 12 by 60 feet in size. This lot was covered with gravel and furnished no green feed.

**Rations.**—The same ration used in Experiment Ia (see p. 188) was used in this experiment.

## RESULTS OF THE EXPERIMENT

**Mortality.**—The number and percentage of hens that died during each period and during the entire experiment are shown in Table VI.

TABLE VI.—Mortality

Lot	Number in lot at beginning of experiment	First period, Nov. 30, 1913—Nov. 28, 1914		Second period, Nov. 29, 1914—Nov. 27, 1915		Entire experiment, Nov. 30, 1913—Nov. 27, 1915	
		Number	Percent	Number	Percent	Number	Percent
Confined.....	57	*3	5.3	7	13.7	*10	17.5
On range ....	57	4	7.0	3	5.7	7	12.3

\*In addition to this, 3 pullets were killed in trap nests.

The mortality in this experiment was somewhat higher in the confined lot than in the lot on range. This difference was not very great, however, and may have been due to causes other than the difference in the treatment of the fowls.

**Weights.**—Table VII shows the average weight per hen at the beginning and close of each period and the gain or loss in weight per hen for each period. Only the weights of hens living at the close of each period are considered for that period.

TABLE VII.—Average weight and loss or gain per hen

Lot	Average initial weight of all hens	Number living at close of period	Average weight at beginning of period	Average weight at close of period	Average loss (—) or gain in weight
Nov. 30, 1913—Nov. 28, 1914 (364 days)					
	Pounds		Pounds	Pounds	Pound
Confined.....	3.14	51	3.15	2.95	—0.20
On range.....	3.14	53	3.13	2.99	— .14
Nov. 29, 1914—Nov. 27, 1915 (364 days)					
Confined.....	....	44	2.92	3.17	.25
On range.....	....	50	2.99	3.17	.18
Summary: Nov. 30, 1913—Nov. 27, 1915 (728 days)					
Confined.....	....	44	3.15	3.17	.02
On range.....	....	50	3.13	3.17	.04

As will be noted in this table, the average weights of the hens in each lot were almost the same at the beginning and at the close of each period.

**Feed consumed.**—The average amount and cost of feed, shells and grit consumed per hen and the cost of feed per dozen eggs produced, are given in Table VIII.

TABLE VIII.—Feed consumed per hen and cost of feed

Lot	Average number in lot	Materials consumed per hen					Cost of feed per hen*	Cost of feed per dozen eggs produced
		Grain	Mash	Grain and mash	Shells	Grit		
Nov. 30, 1913—Nov. 28, 1914 (364 days)								
Confined.....	54.54	Pounds 45.08	Pounds 20.46	Pounds 65.54	Pounds 1.75	Pound 0.28	Dollars 0.88	Cents 7.60
On range.....	56.16	45.79	21.32	67.11	2.57	.53	.91	6.04
Nov. 29, 1914—Nov. 27, 1915 (364 days)								
Confined.....	47.82	40.54	19.10	59.64	1.24	.06	.80	9.40
On range.....	51.86	40.61	19.86	60.47	2.28	.21	.82	7.40
Summary: Nov. 30, 1913—Nov. 27, 1915 (728 days)								
Confined.....	51.18	85.92	39.65	125.57	3.03	.35	1.69	8.31
On range.....	54.01	86.60	41.24	127.84	4.86	.76	1.74	6.59

\*See p. 185 for prices used in calculations

In this experiment the average feed consumption per hen (grain and mash) was 1.8 percent higher for the lot on range than for the confined lot. The cost of feed per dozen eggs produced was 26.1 percent higher for the confined lot than for the lot on range. This includes no charge for range.

**Egg production.**—The data presented in Table IX show the average egg production, and the average value of eggs per dozen and per hen for each division of the experiment and for the experiment as a whole.

TABLE IX.—Egg production

Lot	First period, Nov. 30, 1913— Nov. 28, 1914		Second period, Nov. 29, 1914— Nov. 27, 1915		Entire experiment, Nov. 30, 1913— Nov. 27, 1915				
	Average eggs per hen	Average value of eggs		Average eggs per hen	Average value of eggs		Average eggs per hen	Average value of eggs	
		Per dozen	Per hen		Per dozen	Per hen		Per dozen	Per hen
Confined...	139.2	Cents 23.2	Dollars 2.69	102.1	Cents 21.4	Dollars 1.82	243.7	Cents 22.5	Dollars 4.57
On range..	181.2	23.7	3.58	133.3	21.5	2.39	316.4	22.8	6.01

The average egg production per hen for the lot in confinement was 36.3 percent higher and for the lot on range, 35.9 percent higher during the first period than during the second. On account of the heavier winter production during the first year, the average value of eggs per hen was 47.8 percent more for the confined lot, and 49.8 percent more for the range lot during the first period than during the second. During the 2 years of the experiment the average egg production per hen was 29.8 percent higher, and the average value of eggs per hen was 31.5 percent more for the range lot than for the confined lot.

The egg production of the hens used in this experiment, especially that of the lot on range, was unusually high. Twenty of the fifty-three hens in the range lot that were living at the close of the year and one that died before the year closed produced 200 eggs or more in 365 days from the time they started laying; their average production was 222.5 eggs. Fourteen of the fifty hens living at the close of the second year and one that died before the close of the second year produced more than 350 eggs each in 2 years, their average being 390.6 eggs. Eleven of these, or 22 percent of the flock averaged 402.2 eggs in 2 years. The data in Table X are for hens producing 200 eggs or more during the first year or more than 300 eggs in 2 years. The hens are arranged in the order of 2-year records. Only eggs laid in trap nests are considered in this table. Some floor eggs were secured, and it is probable that some of these were produced by the hens whose records are given in this table.

The individual records given in Table X, as well as the average production for the entire lot, are all the more remarkable when it is considered that no special effort was made to produce high records. The ration used is relatively simple when compared with rations that are used by many when an effort is made to produce a maximum egg yield. No green feed other than that secured from the range was supplied. In short, the hens received no pampering of any sort. It is not known whether the use of a more complicated ration, use of green feed in winter, and so forth, would have increased the egg production of these hens. It is rather doubtful, however, if the production could have been materially increased.

**Value of range.**—The value of range per hen was 86 cents for the first period of the experiment, and 55 cents for the second period, or \$1.39 for the entire experiment. (See p. 190 for method of computing value of range.) Even if we assume that the hens utilized all the range to which they had access, giving the range no credit for the other livestock that was pastured during the spring,

TABLE X.—Individual records

Hen No.	Egg production			Date of				Length of laying period		Average weight	
	First year	Second year	Total	First egg	Last egg, first year	First egg, second year	Last egg, second year	First year	Second year	First year	Second year
				1913	1914	1915	1915	Days	Days	Pounds	Pounds
1120.....	269	193	462	Nov. 22	Nov. 21	Jan. 25	Oct. 19	365	268	2.85	2.99
1033.....	247	*208	*455	Dec. 1	Nov. 20	Jan. 21	Dec. 11	355	325	2.62	2.85
1092.....	245	159	404	Nov. 26	Nov. 20	Jan. 21	Sept. 16	361	239	3.80	4.02
1353.....	223	177	400	Nov. 21	Nov. 6	Jan. 15	Nov. 5	351	295	2.72	2.90
1089.....	240	157	397	Nov. 29	Nov. 18	Feb. 2	Oct. 16	355	257	3.34	3.45
1071.....	228	169	397	Dec. 19	Dec. 19	Mar. 12	Oct. 23	366	226	2.78	2.98
1122.....	209	187	396	Nov. 24	Oct. 17	Jan. 31	Nov. 2	328	276	3.35	3.39
1079.....	212	181	393	Dec. 2	Oct. 20	Jan. 16	Sept. 29	323	257	3.21	3.37
1105.....	211	168	379	Dec. 6	Oct. 31	Feb. 24	Oct. 16	330	235	3.24	3.40
1135.....	234	§139	§373	Dec. 1	Nov. 10	Jan. 14	Dec. 16	345	337	2.99	2.88
1041.....	227	141	368	Nov. 22	Oct. 28	Jan. 19	Aug. 8	341	202	2.95	3.05
1075.....	218	149	367	Nov. 24	Oct. 27	Feb. 21	Oct. 10	338	232	3.25	3.48
1107†.....	215	†144	359	Nov. 2	Oct. 16	Jan. 27	Aug. 8	349	194	3.22	3.52
1052.....	214	143	357	Nov. 22	Nov. 13	Jan. 21	Sept. 20	357	243	3.09	3.11
1104.....	237	115	352	Dec. 10	Dec. 12	Feb. 3	Oct. 22	368	262	3.42	3.68
1051.....	204	141	345	Dec. 1	Sept. 16	Feb. 3	Aug. 29	290	208	3.35	3.58
1088.....	204	126	330	Nov. 11	Oct. 21	Jan. 27	Sept. 23	345	240	3.11	3.16
1095.....	199	131	330	Nov. 22	Sept. 16	Feb. 26	Aug. 27	299	183	3.96	4.05
1130.....	194	134	328	Nov. 24	Sept. 15	Feb. 21	Sept. 5	296	197	3.41	3.58
1144†.....	219	†81	300	Nov. 24	Nov. 13	Jan. 14	Aug. 6	355	205	3.35	3.47
1125.....	207	88	295	Nov. 17	Sept. 19	Jan. 21	Oct. 11	307	264	3.15	3.42
1083.....	204	59	263	Nov. 29	Oct. 24	Jan. 25	Oct. 2	330	251	2.92	3.36
1148‡.....	‡206	.....	...	Nov. 24	Sept. 28‡	.....	.....	309	...	3.25	.....

\*Includes 5 eggs produced Dec. 1 to 11, 1915, after close of second year.  
 †Includes 8 eggs produced Dec. 1 to 16, 1915, after close of second year.

‡Died Aug. 11, 1915.  
 †Died Nov. 10, 1914.

summer and autumn, the land would have produced an annual rental of more than \$26 per acre. When it is considered that this range would have accommodated three to five times as many hens if no other livestock had been pastured thereon, it will be realized that a poultryman can well afford to provide range for his hens, even on exceptionally high-priced land.

**Summary.**—A summary of the results of this experiment for November 30, 1913 to November 27, 1915 (728 days) is given in Table XI.

TABLE XI.—Summary of results

Lot	Average number in lot	Mortality	Gain in weight per hen	Grain and mash consumed per hen	Cost of feed per hen*	Eggs produced per hen	Cost of feed per dozen eggs produced	Value of eggs per hen*	Difference between cost of feed and value of eggs
Confined...	51.18	Percent 17.5	Pounds 0.02	Pounds 125.57	Dollars 1.69	243.7	Cents 8.31	Dollars 4.57	Dollars 2.88
On range..	54.01	12.3	.04	127.84	1.74	316.4	6.59	6.01	4.27

\*Prices used in calculations are given on pp. 185, 186.

EXPERIMENT I<sub>c</sub>

## PLAN OF THE EXPERIMENT

**Duration.**—The results secured during the first year with the third lot of hens in the study of the relative effects of range and confinement on laying hens are presented below. This experiment was begun November 29, 1914, and lasted until November 27, 1915 (364 days).

**Description of fowls.**—The pullets used in this experiment were S. C. White Leghorns hatched at the Experiment Station during April and May, 1914. They were shipped to Carpenter, October 29, 1914. The pullets in confinement produced four eggs and those on range three eggs before the beginning of the experiment. These pullets were not as thrifty, and were not so well matured at the time the experiment was begun as were those used in the experiment just discussed. As will be noted in the following pages, the egg production was considerably lower and the mortality much higher than in the preceding experiment. The average weight per pullet at the beginning of the experiment was 2.69 and 2.68 pounds, for the lots in confinement and on range, respectively. There were 100 pullets in the confined lot and 101 in the range lot at the beginning of the experiment.

**Quarters.**—The pullets in this experiment occupied the pens and yards described on page 188, that had been occupied by the hens in Experiment Ia.

**Ration.**—The ration used in this series of experiments is described on page 188.

#### RESULTS OF THE EXPERIMENT

**Mortality.**—The number and percentage of pullets that died in each lot are shown in Table XII.

TABLE XII.—Mortality

Lot	Number in lot at beginning of experiment	Pullets that died during year	
		Number	Percent
Confined.....	100	*20	20.0
On range.....	101.	22	21.8

\*In addition to this, 1 pullet was killed by a skunk.

The mortality in this experiment was very heavy. There was very little difference between the two lots, however, as is shown in the table above.

**Weights.**—The average weight per pullet at the beginning and close of the experiment, for the pullets that were living at the close, and their average gain in weight are given in Table XIII.

TABLE XIII.—Average weight and gain per pullet

Lot	Average initial weight of all pullets	Number living at close of experiment	Average weight at beginning of experiment, Nov. 29, 1914	Average weight at close of experiment, Nov. 27, 1915	Average gain in weight, 364 days
Confined.....	Pounds 2.69	79	Pounds 2.74	Pounds 3.15	Pound 0.41
On range.....	2.68	79	2.72	3.19	.47

The average weight per pullet at the beginning and close of this experiment was almost the same for each lot. The pullets each gained almost half a pound during the experiment, which indicates that they were not as fully matured at the time the experiment was begun as is desirable at that time of the year.

**Feed consumed.**—Table XIV shows the average amount and cost of feed, shells and grit consumed per pullet and the average cost of these materials per dozen eggs produced on the basis of prices used in this publication.



TABLE XIV.—Feed consumed per pullet and cost of feed

Lot	Average number in lot	Materials consumed per pullet, Nov. 29, 1914—Nov. 27, 1915 (364 days)					Cost of feed per pullet*	Cost of feed per dozen eggs produced
		Grain	Mash	Grain and mash	Shells	Grit		
Confined.....	91.20	Pounds 38.28	Pounds 17.41	Pounds 55.69	Pounds 0.99	Pound 0.09	Dollar 0.74	Cents 9.95
On range.....	92.67	39.82	18.45	58.27	1.69	.15	.79	7.30

\*See p. 185 for prices used in calculations.

The lot on range consumed 4.6 percent more grain and mash than did the confined lot. This small amount of additional feed was well paid for, however, as the cost of feed per dozen eggs was 26.6 percent lower for the range lot than for the lot in confinement.

**Egg production.**—The average number of eggs produced per pullet, and the average value of eggs per dozen and per pullet are shown in Table XV.

TABLE XV.—Egg production

Lot	Average eggs per pullet, Nov. 29, 1914—Nov. 27, 1915 (364 days)	Average value of eggs	
		Per dozen	Per pullet
Confined.....	89.7	Cents 22.6	Dollars 1.69
On range.....	129.1	22.4	2.41

The average production per pullet for the range lot was 43.9 percent higher than for the lot in confinement. The average value of the eggs per pullet was 42.6 percent higher for the lot on range. The difference in average production per pullet between the lots on range and in confinement, was much greater in this experiment than in the preceding one. This greater difference is probably due to the fact that the pullets used in this experiment were less vigorous than those used in the preceding experiment, indicating that pullets with low vitality will give relatively better returns if kept under the most favorable conditions.

**Value of range.**—The value of range per pullet in this experiment was 67 cents. (See p. 190 for method of computing value of range.)

**Summary.**—A summary of the results of this experiment for November 29, 1914 to November 27, 1915 (364 days) is shown in Table XVI.

TABLE XVI.—Summary of results

Lot	Average number in lot	Mortality	Gain in weight per pullet	Grain and mash consumed per pullet	Cost of feed per pullet*	Eggs produced per pullet	Cost of feed per dozen eggs produced	Value of eggs per pullet*	Difference between cost of feed and value of eggs
Confined...	91.20	Percent 20.0	Pound 0.41	Pounds 55.69	Dollar 0.74	89.7	Cents 9.95	Dollars 1.69	Dollars 0.95
On range..	92.67	21.8	.47	58.27	.79	129.1	7.30	2.41	1.62

\*See pp. 185, 186 for prices used in calculations.

## VARIETY VS. SIMPLE RATIONS FOR LAYING HENS

### OBJECT OF THE EXPERIMENT

Realizing that rations generally recommended and used by many poultrymen for laying hens are subject to some criticism because of the large variety of feeds used, thus making it necessary to keep a relatively small supply of so many different feeds, a series of experiments was begun at the Ohio Experiment Station in 1912 to determine whether rations containing a large variety of feeds give enough better returns to justify the extra trouble and expense involved in providing them. These experiments were also planned to show the effects of a ration of corn, supplemented with a nitrogenous feed, upon laying hens, in order to determine whether the common opinion that corn is too "heating" or too "fattening" for any extensive use in rations for laying hens is based on fact or on hearsay.

### EXPERIMENT II<sub>a</sub>

#### PLAN OF THE EXPERIMENT

**Duration.**—This experiment was begun November 24, 1912, and ended October 6, 1915, a period of 1,047 days. In order that the progress of the experiment may be noted, the results are shown for three periods—November 24, 1912 to December 3, 1913 (375 days); December 4, 1913 to December 2, 1914 (364 days); December 3, 1914 to October 6, 1915 (308 days)—with a summary showing results for the entire experiment.

**Description of fowls.**—S. C. White Leghorns hatched at the Experiment Station in the spring of 1912 were used in this experiment. There were 24 pullets in each lot at the beginning of the experiment. The average initial weight per pullet was 2.84 pounds for Lot 1, 2.89 pounds for Lot 2 and 2.94 pounds for Lot 3.

**Quarters.**—From the beginning of the experiment to August 15, 1913, each lot was housed in a colony house 10 by 12 feet in size, and had access to two yards each 38 by 200 feet in size. After this date each lot occupied only half of a house of the size mentioned above, and had access to one of the yards. About half of each of these yards was closely planted to trees, which furnished an abundance of shade. The yards supplied grass throughout the spring and summer. The fowls had access to the yards at all times except when the ground was covered with snow.

**Rations.**—The following grain and mash mixtures were used in this experiment (proportions are by weight) :

- Lot 1. Grain—Shelled corn.  
Mash—Ground corn, 16¾; meat scrap, 10.  
After Jan. 28, 1914: Ground corn, 8; meat scrap, 5.
- Lot 2. Grain—Shelled corn.  
Mash—Ground corn, 11; bran, 4; meat scrap, 8.
- Lot 3. Grain—Shelled corn, 2; wheat, 3; oats, 1.  
Mash—Ground corn, 10; bran, 10; meat scrap, 7.

The hens had access to hoppers containing grit, oyster shells and charcoal.

The percentage of each feed in the ration, if half as much mash as grain is consumed, is as follows :

		Percentage of feed in ration				
		Corn	Wheat	Oats	Bran	Meat scrap
Lot 1	Before Jan. 29, 1914.....	87.3	....	....	....	12.7
	Beginning Jan. 29, 1914..	87.2	....	....	....	12.8
Lot 2	.....	82.6	....	....	5.8	11.6
Lot 3	.....	84.6	33.3	11.1	12.3	8.6

#### RESULTS OF THE EXPERIMENT

**Mortality.**—The following table shows the number and percentage of hens that died during this experiment.

TABLE XVII.—Mortality

Lot	First period, Nov. 24, 1912— Dec. 3, 1913		Second period, Dec. 4, 1913— Dec. 2, 1914		Third period, Dec. 3, 1914— Oct. 6, 1915		Entire experiment, Nov. 24, 1912— Oct. 6, 1915	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	3	12.5	1	4.8	3	15.0	7	29.2
2	4	16.7	2	10.0	3	16.7	9	37.5
3	1	4.2	1	4.3	6	27.3	8	33.3

The mortality was lower during the first year with Lot 3 than with Lots 1 and 2, but for the entire experiment there was very little difference in the mortality in the three lots.

**Weights.**—The hens were weighed individually every fourth week. Table XVIII shows the weight at the beginning and close of each period, and the loss or gain per hen, for the hens living at the close of the respective periods.

TABLE XVIII.—Average weight and loss or gain per hen

Lot	Average initial weight of all hens	Number living at close of period	Average weight at beginning of period	Average weight at close of period	Average loss (—) or gain in weight
Nov. 24, 1912—Dec. 3, 1913 (375 days)					
	Pounds		Pounds	Pounds	Pound
1	2.84	21	2.85	3.23	0.38
2	2.89	20	2.96	3.34	.38
3	2.94	23	2.92	3.04	.12
Dec. 4, 1913—Dec. 2, 1914 (364 days)					
1	....	20	3.22	3.36	.14
2	....	18	3.42	3.61	.19
3	....	22	3.08	3.49	.41
Dec. 3, 1914—Oct. 6, 1915 (308 days)					
1	....	17	3.40	3.34	— .06
2	....	15	3.69	3.58	— .11
3	....	16	3.54	3.36	— .18
Summary: Nov. 24, 1912—Oct. 6, 1915 (1,047 days)					
1	....	17	2.86	3.34	.48
2	....	15	3.05	3.58	.53
3	....	16	3.02	3.36	.34

A study of Table XVIII will show that there was some difference in the three rations, so far as their effect upon the loss or gain in weight of the hens is concerned. During the entire experiment, the hens in Lots 1 and 2 gained about 50 percent more in weight than did those in Lot 3.

**Feed consumed.**—The average amount of feed and other materials consumed per hen, and the average cost of feed per hen and per dozen eggs produced are shown in Table XIX.

TABLE XIX.—Feed consumed per hen and cost of feed

Lot	Average number in lot	Materials consumed per hen						Cost of feed per hen*	Cost of feed per dozen eggs produced
		Grain	Mash	Grain and mash	Shells	Grit	Charcoal		
Nov. 24, 1912—Dec. 3, 1913 (375 days)									
1	23.20	Pounds 38.23	Pounds 24.19	Pounds 62.42	Pounds 1.86	Pounds 0.09	Pounds 0.07	Dollars 0.82	Cents 6.59
2	21.35	35.69	26.64	62.33	1.88	.21	.23	.84	7.42
3	23.74	44.10	24.22	68.32	2.89	.43	.45	1.00	7.34
Dec. 4, 1913—Dec. 2, 1914 (364 days)									
1	20.16	41.63	18.52	60.15	1.35	.40	.56	.76	9.02
2	18.93	39.87	18.20	58.07	1.29	.62	.66	.74	11.00
3	22.99	44.40	22.14	66.54	1.79	.80	.29	.96	10.21
Dec. 3, 1914—Oct. 6, 1915 (308 days)									
1	18.85	31.31	20.72	52.03	1.16	.50	.25	.69	8.46
2	16.91	33.52	14.56	48.08	1.04	.51	.27	.60	10.18
3	19.20	35.34	20.48	55.82	1.30	.82	.19	.81	10.83
Summary: Nov. 4, 1912—Oct. 6, 1915 (1,047 days)									
1	20.86	111.03	63.52	174.55	4.42	.94	.84	2.27	7.74
2	19.20	108.50	60.38	168.88	4.22	1.30	1.14	2.19	8.99
3	22.14	124.02	66.70	190.72	6.09	2.00	.95	2.77	8.98

\*See p. 185 for prices of feeds used in calculations.

During the entire experiment, the average feed consumption per hen was 9.3 percent higher for Lot 3, and 3.2 percent lower for Lot 2 than for Lot 1. The cost of feed per hen was 3.3 percent lower for Lot 2, and 22.4 percent higher for Lot 3 than for Lot 1. The cost of feed per dozen eggs produced was 16.1 percent higher for Lots 2 and 3 than for Lot 1.

**Egg production.**—Table XX shows the average egg production per hen, the value of eggs per hen on the basis of prices shown on page 186, and the average value of eggs per dozen.

TABLE XX.—Egg production

Lot	First period, Nov. 24, 1912— Dec. 3, 1913		Second period, Dec. 4, 1913— Dec. 2, 1914		Third period, Dec. 3, 1914— Oct. 6, 1915		Entire experiment, Nov. 24, 1912— Oct. 6, 1915					
	Average value of eggs		Average value of eggs		Average value of eggs		Average value of eggs					
	Average eggs per hen	Per dozen	Per hen	Per dozen	Per hen	Per dozen	Per hen	Per dozen	Per hen			
1	148.3	Cents 22.9	Dollars 2.84	101.3	Cents 21.5	Dollars 1.81	97.7	Cents 21.0	Dollars 1.71	351.2	Cents 22.1	Dollars 6.45
2	135.2	22.5	2.53	80.8	21.2	1.43	71.1	20.3	1.20	292.6	21.7	5.28
3	163.5	23.1	3.15	112.9	22.0	2.07	89.9	20.8	1.56	370.5	22.3	6.88

During the entire experiment the average egg production per hen for Lot 1, receiving a ration of corn and meat scrap, was 5.2 percent lower than for Lot 3, receiving a ration of corn, wheat, oats, bran and meat scrap, and 20 percent higher than for Lot 2, receiving a ration of corn, bran and meat scrap.

In this experiment, the average value of eggs per hen was 43 cents higher for Lot 3, which received the variety ration, than for Lot 1, which received the ration made up of corn and meat scrap, whereas the cost of feed was 50 cents per hen higher for Lot 3, showing that at the prices for feeds and eggs used in this publication, the simple ration gave better financial returns than did the variety ration.

**Summary.**—A summary of the results of this experiment for November 24, 1912 to October 6, 1915 (1,047 days) is given in Table XXI.

TABLE XXI.—Summary of results

Lot	Average number in lot	Mortality	Gain in weight per hen	Grain and mash consumed per hen	Cost of feed per hen*	Eggs produced per hen	Cost of feed per dozen eggs produced	Value of eggs per hen*	Difference between cost of feed and value of eggs
		Percent	Pound	Pounds	Dollars		Cents	Dollars	Dollars
1	20.86	29.2	0.48	174.55	2.27	351.2	7.74	6.45	4.18
2	19.20	37.5	.53	168.88	2.19	292.6	8.99	5.28	3.09
3	22.14	33.3	.34	190.72	2.77	370.5	8.98	6.88	4.11

\*See pp. 185, 186 for prices used in calculations.

## EXPERIMENT IIb

## PLAN OF THE EXPERIMENT

**Duration.**—On December 4, 1913, the second experiment to compare simple and variety rations was begun. This experiment extended over a period of 672 days, ending October 6, 1915. The results are reported in two periods—one of 364 days, the other of 308 days—with a summary of the entire experiment.

**Description of fowls.**—S. C. White Leghorns hatched in the spring of 1913 were used in this experiment. There were 25 pullets in each lot. They were apparently good, thrifty pullets, and the reason for the rather low production secured from these lots is not known. It may have been due in part to the small amount of house room available for them. However, the lots were uniform, and it is believed that results secured from the various lots are comparable.

The pullets were divided into lots, August 13, 1913, and gradually accustomed to the rations used during this experiment. Beginning August 27, the complete rations as outlined below were used. The experiment as reported in the following pages was begun December 4. The average weight per pullet at the beginning of the experiment was 3 pounds for Lot 1, 2.94 pounds for Lot 2 and 3.1 pounds for Lot 3. Some eggs had been produced by each lot prior to this date as follows: Lot 1, 6 eggs; Lot 2, 12 eggs; Lot 3, 121 eggs.

**Quarters.**—Each lot of hens was housed in half of a colony house, 10 by 12 feet in size. When there was snow on the ground the hens were confined to the houses. The hens were also confined to the houses from April 1 to June 27, 1915, in order to permit the grass in the lots to get some growth. At other times each lot had access to a yard similar to the ones described on page 201.

**Rations.**—The following rations were used in this experiment:

- Lot 1. Grain—Shelled corn.  
Mash—Ground corn, 8; meat scrap, 5.
- Lot 2. Grain—Shelled corn.  
Mash—Ground corn, 7; bran, 3; meat scrap, 5.
- Lot 3. Grain—Shelled corn, 1; wheat, 4; oats, 1.  
Mash—Ground corn, 3; bran, 4; middlings, 4; oilmeal, 1; meat scrap, 2.

The percentage of each feed in the rations, if half as much mash as grain is consumed, is shown in the following tabulation:

Percentage of feed in ration							
Lot	Corn	Wheat	Oats	Bran	Middlings	Oilmeal	Meat scrap
1	87.2	....	....	....	....	....	12.8
2	82.2	....	....	6.7	....	....	11.1
3	18.3	44.4	11.1	9.5	9.5	2.4	4.8

#### RESULTS OF THE EXPERIMENT

**Mortality.**—The number and percentage of hens that died during the experiment are shown in Table XXII.

TABLE XXII.—Mortality

Lot	First period, Dec. 4, 1913—Dec. 2, 1914		Second period, Dec. 3, 1914—Oct. 6, 1915		Entire experiment, Dec. 4, 1913—Oct. 6, 1915	
	Number	Percent	Number	Percent	Number	Percent
1	4	16	1	4.8	5	20
2	4	16	4	19.0	8	32
3	1	4	1	4.2	2	8

In this experiment the mortality was much lower in Lot 3, receiving the variety ration, than in Lots 1 and 2. The mortality in Lot 3, however, was unusually low.

**Weights.**—The hens were weighed individually every fourth week. Table XXIII gives the weight at the beginning and close of each period, and the loss or gain in weight per hen. Only the weights of hens living at the close of each period are considered in the calculations for that period.

TABLE XXIII.—Average weight and loss or gain per hen

Lot	Average initial weight of all hens	Number living at close of period	Average weight at beginning of period	Average weight at close of period	Average loss (-) or gain in weight
Dec. 4, 1913—Dec. 2, 1914 (364 days)					
1	Pounds 3.00	21	Pounds 3.05	Pounds 3.35	Pound 0.30
2	2.94	21	2.97	3.35	.38
3	3.10	24	3.11	3.18	.07
Dec. 3, 1914—Oct. 6, 1915 (308 days)					
1	....	20	3.39	3.45	.06
2	..	17	3.39	3.35	-.04
3	....	23	3.20	3.23	.03
Summary: Dec. 4, 1913—Oct. 6, 1915 (672 days)					
1	....	20	3.09	3.45	.36
2	....	17	2.99	3.35	.36
3	....	23	3.12	3.23	.11

In this experiment, as in the preceding one, the hens in Lots 1 and 2 made a much larger gain in live weight than did those in Lot 3.

**Feed consumed.**—Table XXIV shows the average amount of feed and other materials consumed per hen, and the average cost of feed per hen and per dozen eggs produced.

TABLE XXIV.—Feed consumed per hen and cost of feed

Lot	Average number in lot	Materials consumed per hen						Cost of feed per hen*	Cost of feed per dozen eggs produced
		Grain	Mash	Grain and mash	Shells	Grit	Charcoal		
Dec. 4, 1913—Dec. 2, 1914 (364 days)									
1	22.39	Pounds 39.60	Pounds 18.31	Pounds 57.91	Pounds 1.43	Pounds 0.57	Pound 0.46	Dollars 0.74	Cents 8.65
2	22.42	37.76	18.09	55.85	1.18	.41	.48	.71	9.21
3	24.27	44.32	21.97	66.29	1.99	.97	.56	.99	10.02
Dec. 3, 1914—Oct. 6, 1915 (308 days)									
1	20.67	32.12	16.01	48.13	.93	.75	.17	.61	8.83
2	18.83	32.18	18.00	50.18	.97	.66	.20	.65	7.80
3	23.53	38.83	19.25	53.08	1.24	1.21	.17	.86	12.33
Summary: Dec. 4, 1913—Oct. 6, 1915 (672 days)									
1	21.60	71.78	34.29	106.07	2.37	1.30	.64	1.35	8.73
2	20.77	69.92	35.84	105.76	2.15	1.04	.69	1.35	8.54
3	23.93	83.13	41.21	124.34	3.24	2.17	.74	1.84	10.96

\*See p. 185 for prices of feeds used in calculations.



Lots 1 and 2 consumed almost the same amount of feed per hen, and Lot 3 consumed 17.4 percent more per hen than did Lots 1 and 2. At the prices used in this bulletin, the cost of feed per hen was 36.2 percent higher, and the cost of feed per dozen eggs produced was 27 percent higher for Lot 3, than for Lots 1 and 2.

**Egg production.**—In Table XXV figures are given to show the average egg production per hen, value of eggs per hen on the basis of the assumed prices, and average value of eggs per dozen for each period and for the entire experiment.

TABLE XXV.—Egg production

Lot	First period, Dec. 4, 1913–Dec. 2, 1914			Second period, Dec. 3, 1914–Oct. 6, 1915			Entire experiment, Dec. 4, 1913–Oct. 6, 1915		
	Average eggs per hen	Average value of eggs		Average eggs per hen	Average value of eggs		Average eggs per hen	Average value of eggs	
		Per dozen	Per hen		Per dozen	Per hen		Per dozen	Per hen
1	102.3	Cents	Dollars	83.5	Cents	Dollars	185.9	Cents	Dollars
2	92.4	22.6	1.93	99.4	21.6	1.50	189.8	22.2	3.44
3	118.1	22.6	1.74	83.3	21.6	1.79	201.6	22.1	3.50
		23.7	2.33		21.3	1.48		22.7	3.82

For the entire experiment, the average egg production per hen was 2.1 percent higher for Lot 2, and 8.4 percent higher for Lot 3 than for Lot 1. At prices for feeds and eggs as used in these calculations, the difference between the value of eggs per hen and the cost of feed per hen was \$2.09, \$2.15 and \$1.98 for Lots 1, 2 and 3, respectively.

**Summary.**—Figures giving a summary of this experiment for December 4, 1913 to October 6, 1915 (672 days) are shown in Table XXVI.

TABLE XXVI.—Summary of results

Lot	Average number in lot	Mor- tality	Gain in weight per hen	Grain and mash consumed per hen	Cost of feed per hen*	Eggs produced per hen	Cost of feed per dozen eggs produced	Value of eggs per hen*	Difference between cost of feed and value of eggs
1	21.60	Percent	Pound	Pounds	Dollars		Cents	Dollars	Dollars
2	20.77	20	0.36	106.07	1.35	185.9	8.73	3.44	2.09
3	23.93	32	.36	105.76	1.35	189.8	8.54	3.50	2.15
		8	.11	124.34	1.84	201.6	10.96	3.82	1.98

\*See pp. 185, 186 for prices used in calculations.

**VARIOUS AMOUNTS OF PROTEIN IN RATIONS  
FOR LAYING HENS**

**EXPERIMENT III**

**OBJECT OF THE EXPERIMENT**

The object of this experiment was to study the effect of rations containing approximately 10, 15 and 20 percent of crude protein upon the rate and economy of egg production by pullets.

**PLAN OF THE EXPERIMENT**

**Duration.**—This experiment was begun December 13, 1914 and closed December 11, 1915 (364 days).

**Description of fowls.**—Three lots of Barred Plymouth Rocks and three lots of S. C. White Leghorns hatched at the Station in the spring of 1914 were used in this experiment. The pullets were divided into uniform lots early in November and on November 15 were started on rations similar to those used in this experiment. During this 4-week period before the experiment began, the Barred Rocks produced 85, 81 and 68 eggs and the Leghorns 231, 319 and 265 eggs for Lots 1, 2 and 3 of each variety, respectively. At the beginning of the experiment there were 59 pullets in Lots 1 and 3 and 57 in Lot 2 of Barred Rocks, and 60 in each lot of Leghorns.

**Quarters.**—Each lot of pullets was housed in a pen 15 by 24 feet in size in the large laying house illustrated in Bulletin 262, and had access to a well-sodded yard one-fourth of an acre in size. Trees have been planted in these yards, but at the time of this experiment were too small to provide any appreciable amount of shade. During severe weather in winter and when there was snow on the ground, the pullets were confined to the house.

**Rations.**—The grain mixture for all lots was made up of 3 parts, by weight, of shelled corn, and 1 part of wheat. The mash mixtures for the different lots of each breed were composed of ground corn, bran and meat scrap in the following proportions:

- Lot 1—Ground corn, 11; bran, 3; meat scrap, 1.
- Lot 2—Ground corn, 6; bran, 3; meat scrap, 6.
- Lot 3—Ground corn, 1; bran, 3; meat scrap, 11.

The percentage of each feed in the ration for each lot, when consuming half as much mash as grain, is shown below:

Lot	Percentage of feed in ration			
	Corn	Wheat	Bran	Meat scrap
1 .....	74.4	16.7	6.7	2.2
2 .....	63.3	16.7	6.7	13.3
3 .....	52.2	16.7	6.7	24.4

All lots had constant access to hoppers containing grit, oyster shells and charcoal.

## RESULTS OF THE EXPERIMENT

**Mortality.**—The number and percentage of pullets that died in each lot are shown in Table XXVII.

TABLE XXVII.—Mortality

Lot	Barred Plymouth Rocks			S. C. White Leghorns		
	Number in lot at beginning of experiment	Died during year		Number in lot at beginning of experiment	Died during year	
		Number	Percent		Number	Percent
1	59	17	28.8	60	5	8.3
2	57	14	24.6	60	8	13.3
3	59	20	33.9	60	4	6.7

The mortality with the Leghorns was no higher than is to be expected with good, thrifty pullets fed to produce a heavy egg yield. The heavier mortality in Lot 2 than in Lots 1 and 3, was in all probability not directly traceable to the ration used. Mortality with the Rocks was very heavy. As there is no pathologist on the Station staff, expert opinion as to the exact cause of this mortality is not available. A number of deaths were caused by enlarged livers. Some deaths were probably caused by excessive fatness. Many of the hens, however, were emaciated at time of death. Twenty of the fifty-one hens that died weighed less than 4 pounds at time of death. The mortality in no one lot was especially heavy as compared with that in the other two lots, so that, for the purposes of this experiment, the mortality does not interfere with a comparison of the rations as affecting rate and economy of production.

**Weights.**—Figures showing the average weight per pullet at the beginning and close of the experiment and the average loss or gain per pullet for the pullets living at the close of the experiment are given in Table XXVIII. The average weight of all pullets in the lot at the beginning of the experiment is also shown.

TABLE XXVIII.—Average weight and loss or gain per pullet

Lot	Average initial weight of all pullets	Number living at close of period	Average weight at beginning of period, Dec. 13, 1914	Average weight at close of period, Dec. 11, 1915	Average loss (–) or gain in weight, 364 days
Barred Plymouth Rocks					
	Pounds		Pounds	Pounds	Pound
1	5.05	42	5.07	5.62	0.55
2	5.19	43	5.24	5.84	.60
3	5.05	39	4.98	5.82	.84
S. C. White Leghorns					
1	3.19	55	3.21	3.38	.17
2	3.33	52	3.32	3.13	–.19
3	3.18	56	3.19	3.21	.02

At the time these pullets were divided into lots, there was only a slight variation in average weight per pullet for each lot. The fact that Lot 2, during the 4 weeks just preceding this experiment, received a ration similar to that used during the growing period, while Lot 1 received a ration containing a much smaller amount and Lot 3, a ration containing a much larger amount of protein than the ration they had received, probably accounts for the heavier initial weight per pullet in Lot 2 than in Lots 1 and 3, both of Leghorns and of Rocks. The average gain per pullet for the Rocks was rather large, amounting to 10.8, 11.4 and 16.9 percent of their average initial weight for Lots 1, 2 and 3, respectively. The Leghorns in Lot 2 lost 5.8 percent in weight; those in Lot 3 gained less than 1 percent, and those in Lot 1 gained 5.3 percent.

**Feed consumed.**—Figures showing the amount and cost of feed consumed per pullet and the cost of feed per dozen eggs produced are given in Table XXIX.

TABLE XXIX.—Feed consumed per pullet and cost of feed

Lot	Average number in lot	Materials consumed per pullet, Dec. 13, 1914-Dec. 11, 1915 (364 days)						Cost of feed per pullet*	Cost of feed per dozen eggs produced
		Grain	Mash	Grain and mash	Shells	Grit	Charcoal		
Barred Plymouth Rocks									
1	51.64	Pounds 49.32	Pounds 25.00	Pounds 74.32	Pounds 1.77	Pounds 0.55	Pound 0.35	Dollars 0.90	Cents 10.26
2	51.10	55.43	29.00	84.43	1.70	.69	.05	1.17	8.88
3	50.06	53.44	26.71	80.15	1.73	.49	.10	1.25	12.16
S. C. White Leghorns									
1	58.32	35.80	18.84	54.64	1.36	.48	.06	.66	8.51
2	57.17	40.75	20.23	60.98	1.49	1.03	.03	.85	7.17
3	58.20	40.96	20.66	61.62	1.50	.80	.19	.97	8.79

\*See p. 185 for prices of feeds used in calculations.

Lot 2 of Rocks consumed 13.6 percent more feed per pullet than Lot 1, and 5.3 percent more than Lot 3. The cost of feed per dozen eggs produced was 15.5 percent higher for Lot 1, and 36.9 percent higher for Lot 3 than for Lot 2. Lots 2 and 3 of Leghorns consumed practically the same amount of feed, while Lot 1 consumed 10.9 percent less than Lots 2 and 3. The cost of feed per dozen eggs produced was 18.7 percent higher for Lot 1, and 22.6 percent higher for Lot 3 than for Lot 2.

**Egg production.**—The average egg production per pullet from December 13, 1914 to December 11, 1915 (364 days) and the average value of eggs per pullet and per dozen are shown in Table XXX.

TABLE XXX.—Egg production

Lot	Barred Plymouth Rocks			S. C. White Leghorns		
	Average eggs per pullet	Average value of eggs		Average eggs per pullet	Average value of eggs	
		Per dozen	Per pullet		Per dozen	Per pullet
		Cents	Dollars		Cents	Dollars
1	104.7	22.8	1.99	92.5	22.1	1.70
2	158.0	22.6	2.95	141.5	22.3	2.63
3	123.6	22.3	2.30	132.7	22.0	2.44

Lot 2 of Rocks produced 50.9 percent more eggs per pullet than Lot 1 and 27.8 percent more than Lot 3. Lot 2 of Leghorns produced 53 percent more eggs per pullet than Lot 1 and 6.6 percent more than Lot 3. The difference between the cost of feed and the value of eggs on the basis of the assumed prices was \$1.09, \$1.81 and \$1.05 per pullet for the Rocks and \$1.04, \$1.78 and \$1.47 for the Leghorns. The difference between the cost of feed and the value of eggs was in favor of the Rocks in Lots 1 and 2 and in favor of the Leghorns in Lot 3. However, the Leghorns are at a slight disadvantage in this comparison because they matured a little earlier than the Rocks, and produced more eggs during the 4 weeks preceding this experiment than did the Rocks, but produced very few eggs during the last 4 weeks of the experiment. If the time of the experiment had been advanced 4 weeks for the Leghorns so as to include their maximum production in 364 days, the difference between the cost of feed and value of eggs would have been in favor of the Leghorns in each case.

The Leghorns were more economical producers of eggs than the Rocks. This point is well illustrated in the last column of Table XXIX, which shows the cost of feed per dozen eggs produced, and in Table XXXV, which shows the crude nutrients consumed per dozen eggs produced. The cost of feed per dozen eggs produced was 27.4 percent higher for the Rocks than for the Leghorns.

This discussion is not intended to apply to Rocks and Leghorns as breeds, but rather to the types represented by these breeds. When egg production is the important consideration, it is rather plainly evident that one of the lighter-weight breeds will give more economical returns than one of the heavier, so-called general purpose breeds. The actual feed required for egg production may be no more with the heavier than with the lighter breeds, but their feed requirement for body maintenance is probably higher. However, in selecting a breed for general farm flocks, there are points other than economy of egg production that need to be considered.

**Summary.**—A summary of the results secured in this experiment is shown in Table XXXI.

TABLE XXXI.—Summary of results

Lot	Average number in lot	Mortality	Loss (—) or gain in weight per pullet	Grain and mash consumed per pullet	Cost of feed per pullet*	Eggs produced per pullet	Cost of feed per dozen eggs produced	Value of eggs per pullet*	Difference between cost of feed and value of eggs
Barred Plymouth Rocks									
		Percent	Pound	Pounds	Dollars		Cents	Dollars	Dollars
1	51.64	28.8	0.55	74.32	0.90	104.7	10.26	1.99	1.09
2	51.10	24.6	.60	84.43	1.17	158.0	8.88	2.98	1.81
3	50.06	33.9	.84	80.15	1.25	123.6	12.16	2.30	1.05
S. C. White Leghorns									
1	58.32	8.3	.17	54.64	.66	92.5	8.51	1.70	1.04
2	57.17	13.3	-.19	60.98	.85	141.5	7.17	2.63	1.78
3	58.20	6.7	.02	61.62	.97	132.7	8.79	2.44	1.47

\*See pp. 185, 186 for prices used in calculations.

**Composition of feeds used.**—The Department of Chemistry of this Station reported the following analyses for the feeds used in this experiment.

TABLE XXXII.—Percentage composition of feeds

Sample	Dry matter	Water	Ash	Crude protein	Fiber	Nitrogen-free extract	Fat	Undetermined	Date sampled
<b>Corn</b>									
1	84.57	15.43	1.49	8.72	2.44	68.00	3.82	....	Jan. 5
2	88.68	11.32	1.45	8.75	1.42	72.40	4.66	....	Jan. 25
3	85.56	14.44	1.30	8.90	1.82	70.79	2.75	....	Apr. 5
4	88.04	11.96	1.63	9.03	2.16	72.52	2.70	....	July 12
5	88.42	11.58	1.19	9.37	1.73	72.53	3.60	....	Sept. 13
6	89.51	10.49	1.46	10.25	1.76	72.38	3.66	....	Sept. 13
7	89.10	10.90	1.20	9.84	1.82	72.71	3.53	....	Nov. 10
<b>Wheat</b>									
1	85.66	14.34	2.10	12.50	2.89	66.88	1.29	....	Jan. 5
2	84.01	15.99	2.04	10.56	2.80	66.75	1.86	....	Apr. 5
3	89.29	10.71	2.22	10.54	1.67	73.29	1.57	....	July 12
4	89.34	10.66	1.91	12.31	2.22	71.64	1.26	....	Sept. 13
<b>Bran</b>									
1	82.52	17.48	7.01	13.50	10.88	46.71	4.42	....	Jan. 5
2	84.85	15.15	7.26	15.31	11.87	46.93	3.48	....	Apr. 5
3	89.63	10.37	6.12	15.71	10.69	55.98	1.13	....	July 12
4	90.74	9.26	7.30	16.75	10.24	51.74	4.71	....	Sept. 13
<b>Meat Scrap</b>									
1	89.83	10.17	23.86	53.49	....	....	9.84	2.64	Jan. 5
2	91.83	8.17	22.21	57.10	....	....	11.31	1.21	Apr. 5
3	93.18	6.82	27.03	48.62	....	....	17.18	.35	Sept. 13
4	95.21	4.79	24.37	56.38	....	....	11.43	3.03	Nov. 10

**Chemical composition of rations.**—Table XXXIII shows the percentage composition of the feeds consumed by each lot during the experiment. Grit, shells, charcoal and feed secured from the range are of course not included in making these calculations.

TABLE XXXIII.—Percentage composition of rations

Lot	Dry matter	Ash	Crude protein	Fiber	Nitrogen-free extract	Fat	Undetermined
Barred Plymouth Rocks							
1.....	87.31	2.40	10.90	2.52	68.12	3.34	0.03
2.....	87.83	5.03	16.02	2.31	59.92	4.33	.21
3.....	88.30	7.53	20.60	2.09	52.33	5.37	.37
S. C. White Leghorns							
1.....	87.40	2.42	10.94	2.53	68.16	3.30	.04
2.....	87.80	4.90	15.81	2.30	60.32	4.24	.22
3.....	88.40	7.57	20.70	2.08	52.28	5.40	.36

**Nutrients consumed.**—In Table XXXIV are presented figures showing the nutrients contained in the average feed consumed per pullet during this experiment. The reader should bear in mind that figures on this and the following page represent total rather than digestible nutrients.

TABLE XXXIV.—Nutrients in grain and mash consumed per pullet (pounds)

Lot	Dry matter	Ash	Crude protein	Fiber	Nitrogen-free extract	Fat	Undetermined
Barred Plymouth Rocks							
1.....	64.89	1.79	8.10	1.87	50.62	2.48	0.03
2.....	74.15	4.24	13.52	1.95	50.59	3.65	.18
3.....	70.77	6.03	16.51	1.67	41.94	4.31	.30
S. C. White Leghorns							
1.....	47.75	1.32	5.98	1.38	37.24	1.80	.02
2.....	53.54	2.99	9.64	1.40	36.79	2.59	.13
3.....	54.47	4.66	12.75	1.28	32.21	3.33	.22

Figures showing the nutrients consumed by each lot per dozen eggs produced are given in Table XXXV.

TABLE XXXV.—Total nutrients in grain and mash consumed per dozen eggs produced (pounds)

Lot	Dry matter	Ash	Crude protein	Fiber	Nitrogen-free extract	Fat	Undetermined
Barred Plymouth Rocks							
1.....	7.44	0.21	0.93	0.21	5.80	0.28	0.003
2.....	5.63	.32	1.03	.15	3.84	.28	.01
3.....	6.87	.59	1.60	.16	4.07	.42	.03
S. C. White Leghorns							
1.....	6.19	.17	.78	.18	4.83	.23	.003
2.....	4.54	.25	.82	.12	3.12	.22	.01
3.....	4.93	.42	1.15	.12	2.91	.30	.02

Lot 1 of Rocks consumed 32.1 percent more and Lot 3, 22 percent more dry matter per dozen eggs produced than did Lot 2. Lot 1 of Leghorns consumed 36.3 percent more dry matter per dozen eggs produced, and Lot 3, 8.6 percent more than did Lot 2.

It will be noted that the lots receiving only 10 percent of protein in the ration required less protein per dozen eggs produced than did the lots receiving 15 and 20 percent of protein. However, the egg production of the former lots was too low to yield a maximum profit per pullet as is shown in Table XXXI, page 212.

## SUMMARY

### RANGE VS. CONFINEMENT

**Experiment Ia.**—This experiment was begun May 4, 1912, and lasted 882 days. The fowls used were S. C. White Leghorns hatched in the spring of 1910.

The mortality was 23.23 percent for the confined lot and 15.53 percent for the lot on range.

There was practically no difference between the two lots in the amount of grain and mash consumed per hen.

The average egg production of the hens on range was 15.4 percent higher than that of the hens that were confined.

The cost of feed per dozen eggs produced was 14.8 percent higher for the confined lot than for the lot on range. No charge for the range is included in these calculations.

The difference between cost of feed and value of eggs was 27.4 percent greater for the range lot than for the confined lot.

The value of range in this experiment was 62 cents per hen.



Both lots of hens were kept in confinement from the time they began to produce eggs in December, 1910 until the beginning of this experiment. This doubtless accounts for the relatively small difference in the egg production by the two lots.

**Experiment Ib.**—This experiment was begun November 30, 1913, with S. C. White Leghorn pullets and was continued for 728 days.

The mortality was 17.5 percent for the confined lot and 12.3 percent for the lot on range.

The average grain and mash consumption per hen was 1.8 percent higher for the range lot than for the confined lot.

The average egg production per hen was 29.8 percent higher for the range lot than for the lot in confinement. The egg production of the range lot was unusually high. The average production per hen for the first year was 181.2 eggs, and for the second year, 133.3 eggs.

The cost of feed per dozen eggs produced was 26.1 percent higher for the confined lot than for the range lot.

The difference between cost of feed and value of eggs was 48.3 percent greater for the lot on range than for the confined lot.

The value of range was 86 cents per hen during the first year and 55 cents per hen during the second year.

**Experiment Ic.**—S. C. White Leghorn pullets were used in this experiment, which was begun November 29, 1914, and lasted 364 days. The pullets gained almost half a pound in weight during the experiment, indicating that they were not as well matured as is desirable at the time of the year when this experiment was begun.

The mortality was practically the same for both lots.

The pullets on range consumed 4.6 percent more grain and mash than did those that were confined.

The average egg production was 43.9 percent higher for the range lot than for the lot in confinement.

The cost of feed per dozen eggs produced was 36.3 percent higher for the confined lot than for the lot on range.

The difference between cost of feed and value of eggs was 70.5 percent higher for the lot on range than for the confined lot.

The value of range per pullet in this experiment was 68 cents.

#### VARIETY VS. SIMPLE RATIONS

**Experiment IIa.**—This experiment was begun with S. C. White Leghorn pullets, November 24, 1912, and closed October 6, 1915, lasting 1,047 days.

The mortality was slightly higher for Lot 2, receiving a ration of corn, bran and meat scrap, and Lot 3, receiving a ration of corn, wheat, oats, bran and meat scrap, than for Lot 1, receiving a ration of corn and meat scrap. This difference in mortality may not have been due to the rations fed. The mortality was lower for Lot 3 during the first 2 years, but much higher during the last period, than for Lots 1 and 2.

The average feed consumption per hen was 9.3 percent more for Lot 3, and 3.2 percent less for Lot 2 than for Lot 1.

The egg production for Lot 1 was 5.2 percent lower than for Lot 3 and 20 percent higher than for Lot 2.

The cost of feed per dozen eggs was 16.1 percent higher for Lots 2 and 3 than for Lot 1.

The difference between cost of feed per hen and value of eggs per hen was \$4.18, \$3.09 and \$4.11 for Lots 1, 2 and 3, respectively.

**Experiment IIb.**—In this experiment, which was begun December 4, 1913, and covered 672 days, S. C. White Leghorns hatched in the spring of 1913 were used.

The mortality was 20, 32 and 8 percent for Lots 1, 2 and 3, receiving rations of corn and meat scrap; corn, bran and meat scrap; and corn, wheat, oats, bran, middlings, oilmeal and meat scrap, respectively.

The average feed consumption per hen was 17.4 percent more for Lot 3 than for Lots 1 and 2.

The average egg production per hen was 2.1 percent higher for Lot 2, and 8.4 percent higher for Lot 3 than for Lot 1.

The cost of feed per dozen eggs produced was 27 percent higher for Lot 3 than for Lots 1 and 2.

The difference between cost of feed and value of eggs was \$2.09, \$2.15 and \$1.98 per hen, for Lots 1, 2 and 3, respectively.

## VARIOUS AMOUNTS OF PROTEIN IN RATIONS

### FOR BARRED PLYMOUTH ROCKS

Pullets hatched in the spring of 1914 were used in this experiment, which was begun December 13, 1914, and lasted 364 days.

The mortality was 28.8, 24.6 and 33.9 percent for Lots 1, 2 and 3, receiving rations carrying approximately 10, 15 and 20 percent of crude protein, respectively.

The feed consumption per pullet for Lot 2 was 13.6 percent higher than for Lot 1 and 5.3 percent higher than for Lot 3.

Lot 2 produced 50.9 percent more eggs per pullet than Lot 1 and 27.8 percent more than Lot 3.

The cost of feed per dozen eggs produced was 15.5 percent higher for Lot 1 and 36.9 percent higher for Lot 3 than for Lot 2.

The difference between the cost of feed and the value of eggs was \$1.09, \$1.81 and \$1.05 per pullet for Lots 1, 2 and 3, respectively.

Lot 1 consumed 32.1 percent more, and Lot 3, 22 percent more dry matter per dozen eggs produced than did Lot 2.

#### FOR S. C. WHITE LEGHORNS

The mortality was 8.3, 13.3 and 6.7 percent for Lots 1, 2 and 3, respectively.

The feed consumption was practically the same for Lots 2 and 3. Lot 1 consumed 10.9 percent less feed per pullet than did Lots 2 and 3.

The egg production per pullet was 53 percent higher for Lot 2 than for Lot 1 and 6.6 percent higher than for Lot 3.

The cost of feed per dozen eggs produced was 18.7 percent higher for Lot 1 and 22.6 percent higher for Lot 3 than for Lot 2.

The difference between cost of feed and value of eggs was \$1.04, \$1.78 and \$1.47 for Lots 1, 2 and 3, respectively.

Lot 1 consumed 36.3 percent more dry matter per dozen eggs produced, and Lot 3, 8.6 percent more than did Lot 1.

The Leghorns required less feed per unit of eggs produced than did the Rocks. The cost of feed per dozen eggs produced was 27.4 percent higher for the Rocks than for the Leghorns.

The dry matter required per dozen eggs produced was also approximately 27 percent higher for the Rocks than for the Leghorns.

Experiments similar to those discussed in this bulletin are being continued, and results secured will be published later.