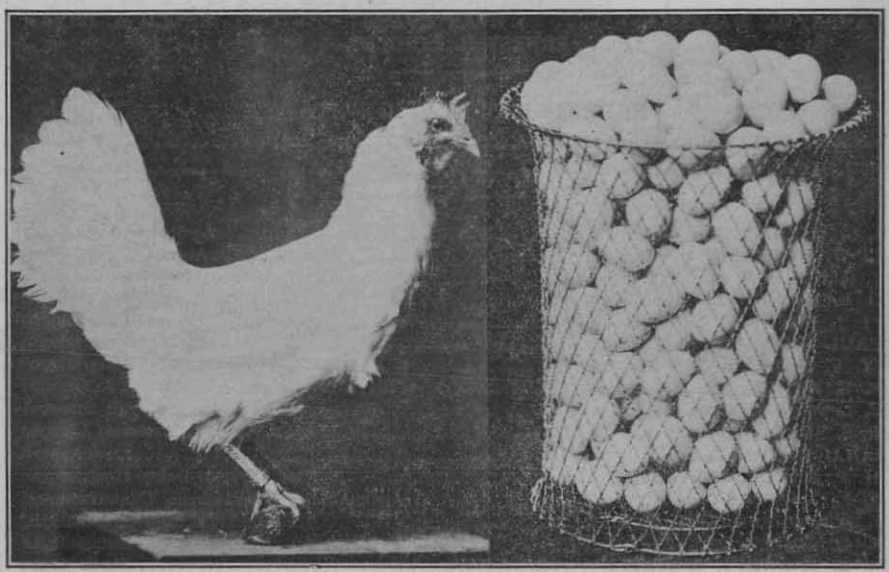
UNIVERSITY OF IDAHO
AGRICULTURAL EXPERIMENT STATION
Department of Poultry Husbandry

Feeding For Egg Production

Vegetable versus Animal Protein in Egg Production



NUMBER E0226 AND HER PRODUCT FOR ONE YEAR

263 eggs, weighing 32½ pounds. The hen weighed 3½ pounds. She produced 9 2-7 times her body weight in eggs in one year. This record was made in her second laying year. She was fed a ration the same as the one fed to pen No. 4 in the experiment, with the sour milk added.

By
PREN MOORE

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† In cooperation with the U. S. Department of Agriculture.

VEGETABLE VERSUS ANIMAL PROTEIN IN EGG PRODUCTION

The relative value of vegetable and animal protein in egg production is a question that has been much discussed by poultrymen. It is generally supposed that animal protein in some form is absolutely necessary for the profitable production of eggs. There are those, however, who maintain that vegetable protein is equally efficient. They believe that vegetable protein will produce as many eggs as animal protein if the rations are narrowed to the proper proportion of proteins to carbohydrates. It is claimed also that eggs are produced more economically when only vegetable protein is used in the ration than when animal protein is used.

PLAN OF EXPERIMENT

In order to determine the relative value of vegetable as compared with animal protein, an experiment was started at the Agricultural Experiment Station of the University of Idaho, November 1, 1915.

The plan of the experiment contemplated three years of work. Four pens of fowls, 25 Single Comb White Leghorn pullets to a pen, were selected and started on experiment November 1, 1915. The fowls were housed in a continuous laying house having board floors. The yards were small and were covered with six inches of cinders to insure that the fowls received only such feed as was given them.

All fowls were trapnested and the number and weight of each fowl's eggs was carefully recorded in order to determine the influence of the feed upon both the number and the weight of the eggs. At the beginning and close of each year's feeding trial and at stated periods between, the fowls in each pen were weighed.

Four rations were prepared, two of which had a nutritive ratio of 1 to 4.2; one containing only vegetable protein and the other, part animal protein. The other two rations had a nutritive ratio of 1 to 5.5; one containing only vegetable protein and the other, part animal protein. The proportion of the various constituents in the rations were varied in order to obtain like nutritive ratios. The composition of the different rations is as follows:

Pen No. 4.

Grain.	*Mash.*
10 parts peas	3 parts wheat bran
14 parts wheat	3 parts wheat shorts
6 parts corn	1 parts corn meal
	1 part wheat meal
	1 part pea meal
	6 parts linseed oil meal
	1% charcoal

Nutritive Ratio 1:4.2

Pen No. 5.

6 parts corn
10 parts wheat
2 parts wheat bran
1 part wheat shorts
1 part corn meal
1 part wheat meal
3 parts beef scrap
1% charcoal

Nutritive Ratio 1:4.2

Pen No. 6.

1 part peas
5 parts corn
10 parts wheat
1 part wheat bran
1 part wheat shorts
1 part corn meal
1 part wheat meal
1 part pea meal
3 parts linseed oil meal
1% charcoal

Nutritive Ratio 1:5.5

Pen No. 7.

6 parts corn
10 parts wheat
2 parts wheat bran
2½parts wheat shorts
1 part corn meal
1 part wheat meal
1½ parts beef scrap
1% charcoal

Nutritive Ratio 1:5.5

The proportions are based upon weight.

The grain was fed in a deep litter of straw at the rate of two quarts per day for each 25 hens. The mash was fed in open hoppers and kept before the fowls at all times. The term "meal" as used in these rations means very finely ground grain. The meat scrap was also in the form of meal. All rations were supplemented with grit, shell, bone and green food. Pens number 4 and 5 received rations having the same nutritive ratio; that of number 4 containing only vegetable proteins; that of number 5 containing some animal proteins in the form of beef scrap. Pens 6 and 7 received rations having identical nutritive ratios, but differing from each other in the same way that pens 4 and 5 differed. The rations represent the practical extremes in wide and narrow nutritive ratios for rations fed to laying hens. In the calculation of the rations, Idaho Experiment Station analytical data for wheat, wheat bran, and shorts were used. All other data and digestive co-efficients were taken from "Feeds and Feeding" by Henry and Morrison.

During the first year of the experiment pen number 5, narrow animal protein ration, laid 126.31 per cent more eggs than pen number 4, narrow vegetable protein ration, —104.67 per cent more eggs than pen

number 6, wide vegetable ration, and 54.30 per cent more eggs than pen number 7, wide animal protein ration. Under the conditions of the trial, rations containing only vegetable protein were not as efficient for profitable egg production as those containing some animal protein.

Table I shows the influence of the different rations upon the weight of eggs laid.

Table I.—Weights of Eggs 1915-1916.

Pen No.	Feed—Chief source of protein	Nutritive ratio	Eggs weighing less than two ounces	Eggs weighing two ounces *	Eggs weighing more than two ounces
			Percent	Percent	Percent
4	Vegetable	1:4.2	46.5	52.7	.8
5	Animal	1:4.2	15.2	72.7	12.1
6	Vegetable	1:5.5	41.9	56.3	1.8
7	Animal	1:5.5	17.5	79.7	2.9

Only eggs weighing 1½ ounces or over were included. There were a very small number of eggs weighing under this weight and these were discarded as being unmarketable.

The weight of the fowls for this period by pens is shown in Table II.

Table II.—Weights of Fowls by Pens, 1915-1916.

Pen No.	Date of weighing Nov. 1, 1915	Date of weighing Feb. 1, 1916	Date of weighing May 1, 1916	Date of weighing Aug. 1, 1916	Date of weighing Oct. 31, 1916	Average weights
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
4	55.50	59.25	64.50	62.00	67.75	61.80
5	55.75	67.75	84.50	78.50	77.00	72.70
6	56.25	57.75	58.75	62.50	67.75	60.50
7	58.25	65.50	75.25	71.50	74.25	68.95

There was a marked difference in production between pens number 4 and number 6 and pens number 5 and 7 both in the number and the weight of eggs laid; and also in the weight of the fowls. Apparently under the circumstances of the trial animal protein in some form is essential for heavy egg production. The fact, however, that pen number 5 was fed a ration the mash of which contained 37½ per cent of beef scrap and produced 54.31 per cent more eggs than pen number 7, which received a ration the mash of which contained only 18¾ per cent beef scrap, suggested the advisability of trying out a ration with an intermediate percentage of beef scrap. A new pen, number 8, was added and fed a ration the mash of which contained 28 per cent beef scrap. The ration used appears below.

* Weights of eggs in this column varied from 2 ounces to 2½ ounces. Eggs weighing the larger limit were placed in the last column.

Pen No. 8.

Grain.	*Mash.*
6 parts corn	2 parts wheat bran
10 parts wheat	1¾ parts wheat short
	1 part corn meal
	1 part wheat meal
	2½ parts beef scrap
	1% charcoal

Nutritive Ratio 1:4.8

The second year's work bore out the results of the first season. During the second year, pen number 5 laid 150.82 per cent more eggs than pen number 6; 158.15 per cent more eggs than pen number 6; 32.21 per cent more eggs than pen number 7 and 2.21 per cent less eggs than pen number 8. The weight of eggs is shown in Table III.

Table III.—Weights of Eggs, 1916-1917.

Pen No.	Feed—Chief source of protein	Nutritive ratio	Eggs weighing less than two ounces	Eggs weighing two ounces	Eggs weighing more than two ounces
			Percent	Percent	Percent
4	Vegetable	1:4.2	32.03	67.14	.83
5	Animal	1:4.2	11.26	79.26	9.48
6	Vegetable	1:5.5	34.67	64.72	.61
7	Animal	1:5.5	17.00	76.44	6.56
8	Animal	1:4.8	5.53	89.30	5.17

The weight of the fowls for the second year is shown in Table IV.

Table IV.—Weights of Fowls by Pens, 1916-1917.

	Date of weighing	Date of weighing	Date of weighing	Date of weighing	Date of weighing	Average weights
Pen No.	Nov. 1, 1916	Feb. 1, 1917	May 1, 1917	Aug. 1, 1917	Oct. 1, 1917	
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
4	76.50	72.50	68.50	72.50	75.00	73.00
5	77.75	84.25	89.25	85.50	81.00	83.75
6	76.00	71.50	69.75	73.75	76.00	73.40
7	74.00	82.25	87.75	77.50	78.00	79.00
8	77.25	86.50	91.50	82.75	80.00	83.00

The death rate for the three years was greater in pen number 5 than in any other and was least in numbers 4 and 6 as is shown in Table V.

Table V.—Death Rate by Pens.

Year	Pen No. 4 No. of deaths	Pen No. 5 No. of deaths	Pen No. 6 No. of deaths	Pen No. 7 No. of deaths	Pen No. 8 No. of deaths
1915-16	2	5	2	3	
1916-17	3	6	1	3	2
1917-18	2	6	1	5	3

Just what caused the death of some of the fowls was not determined. Two deaths in pen 4 were caused by accident. The other deaths in this pen occurred among fowls that were too low in vitality. The hens in pens 4 and 6 could not be kept up to normal in flesh, at any time, until the sour milk was added to their ration. The death rate was about normal in pen 4 and below normal in pen 6. The loss in pen 5 was the result of bowel trouble. Lack of vitality appeared to be the cause of the deaths in pen 6. Three fowls in pen 7 died from accident, one from hemorrhage and the other seven from bowel trouble. Two fowls in pen 8 died from hemorrhage, one from accident, one bled to death from an injured comb, and the cause of the other deaths is not known.

A study of Table V and a comparison of the rations of the several pens seems to indicate that the ration for pen number 5 was too rich in beef scrap. There was noticeably more bowel trouble, as indicated by the droppings, in pen number 5 than in any other pen. Blood clots in the droppings in pen number 5 were also noticeable. Pens 4 and 6 had a low death rate and a study of the tables show that they also were low in flesh and in egg production. The ration for pen number 8 was medium in its percentage of beef scrap, the mortality was normal, the weights of fowls ran high, and the egg production was the highest of any pen in the experiment.

Conditions relating to poultry feeding changed greatly between the time that this experiment was started, November 1, 1915, and the close of the second year's work, October 31, 1917, due to the war. Shorts which had been used in the mash formula up to that time could not be obtained. At the beginning of the third year's work, on November 1, 1917, there was on hand only shorts enough to feed well into August, 1918. The results of the first two year's work seemed to indicate that the object of the experiment had been accomplished. The necessity of animal protein in some form for profitable egg production had apparently been established. In view of the fact that there was not a sufficient quantity of shorts on hand to carry the experiment thru the year, it appeared advisable to follow a plan that promised information regarding feed formulas that would be of immediate value. It was therefore, decided to continue the experiment as originally planned, only until March 1, 1918, an additional period of 120 days, and then introduced certain modifications described below.

It was evident that the rations of pens 4 and 6 were not giving satisfactory results. While there was ample protein in thes rations, it seemed that it was not sufficiently digestible, or for some other reason was not effective. There was some element lacking. The hens did not lay many eggs and, altho their health appeared good, they did not maintain body flesh. Since sour milk, either skim or buttermilk,

is considered to be an aid to digestion in fowls, it was decided that beginning March 1st, sour milk should be added to the rations for these pens.

The fowls were weighed on November 1, 1917, and weighed again on March 1, 1918. Egg records, including weights of eggs, were kept as before. Pens 4 and 6, after March 1, 1918, were fed 6 pounds of sour milk (skim milk or buttermilk) daily. The milk was fed as a drink and not mixed with the feed. No other changes in rations or conditions were made. From March 1, 1918, to June 1, 1918, the fowls were given no water to drink. This seemed necessary in order that the fowls might be forced to drink sufficient milk. After June 10, 1918, the weather was appreciably warmer, and the fowls required more liquid. For the rest of the experiment they were watered each afternoon.

On August 18, 1918, it became necessary to discontinue the experiment entirely, because the supply of shorts had become exhausted. The experiment can be divided into two parts, namely:

Part I, November 1st to March 1st—a period of 120 days—during which the feeding plan was the same as during the two previous years. Part II, March 1st to August 18th, a period of 170 days—during which time the same fowls were fed the same formulas—except that six pounds of sour milk per day were added and fed as a drink to pens 4 and 6.

The weight of fowls for these periods are shown in Table VI.

Table VI.—Weights of Fowls, 1917-1918.

Pen No.	Date of weighing Nov. 1, 1917	Date of weighing Mar. 1, 1918	Date of weighing June 1, 1918	Date of weighing Aug. 1, 1918
	Lbs.	Lbs.	Lbs.	Lbs.
4	75	65.25	85.50	89.75
5	73	83.25	87.75	85.50
6	74	63.75	83.75	87.50
7	75	84.25	88.50	77.50
8	74	85.75	92.50	85.25

The results of the experiment for these two periods are shown in the following tables:

Table VII.—Production-Profit or Loss, 1917-1918.

November 1, 1917, to March 1, 1918—120 Days.

Pen No.	Number eggs laid	Average number eggs per hen	Value of eggs	Production cost of eggs	Profit	Loss	Average profit per hen	Average loss per hen
4	179	7.16	$ 6.75	$19.29	.....	$12.54	.....	$ .5216
5	769	30.76	28.84	22.15	6.67	.....	$ .2676	.....
6	221	8.84	8.35	19.30	.....	10.95	.....	.4380
7	736	29.44	27.60	21.13	6.47	.....	.2584	.....
8	1023	40.92	38.36	22.34	16.02	.....	.6408	.....

Table VIII.—Weights of Eggs.

November 1, 1918, to March 1, 1918—120 Days.

Pen No.	No. weighing less than two ounces	No. weighing two ounces	No. weighing more than two ounces	Total No. of eggs laid
4	95	83	1	179
5	156	526	87	769
6	164	57	....	221
7	42	651	43	736
8	221	749	53	1023

Table IX.—Production-Profit or Loss, 1917-1918.

March 1, 1918, to August 18, 1918—170 Days.

Pen No.	No. eggs laid	Average No. eggs per hen	Value of eggs	Production cost of eggs	Profit	Average profit per hen
4	2559	102.36	$85.30	$29.99	$55.31	$2.2124
5	2104	84.16	70.13	30.89	39.24	1.5736
6	2518	100.72	83.85	30.00	53.85	2.1540
7	2357	94.28	78.57	28.93	48.64	1.9456
8	2691	107.64	89.70	31.29	57.41	2.2964

The weight of the eggs laid from March 1, 1918, to August 18, 1918, is shown in Table X.

Table X.—Weights of Eggs.

March 1, 1918, to August 18, 1918—170 Days.

Pen No.	No. weighing less than two ounces	No. weighing two ounces	No. weighing more than two ounces	Total No. of eggs laid
4	372	2067	120	2559
5	114	1693	297	2104
6	338	2114	66	2518
7	161	1977	219	2357
8	163	2223	305	2691

A discussion of the tables is not necessary, further than to note the influence of sour milk on the rations of pens 4 and 6, as far as the body weights of fowls, and in numbers and weights of eggs laid, are concerned. A study of the tables makes it clear that sour milk is very valuable as food for laying hens. It can scarcely be the extra protein contined in the sour milk that caused the great increase in egg production by pens 4 and 6 because, according to all rules for feeding hens, there was ample protein in the ration already. It does appear, however, that the milk acts as an assimilating agency, makes foods more digestible, and in so doing renders a service of an importance vastly greater than the actual food value of the milk.

The rations for pens 4 and 6 were made up largely of peas and oil meal. For the first two years, and for the first period of the third year's feeding, the ration failed to produce profitable results. With the addition of sour milk to the ration in the second period, egg production increased very rapidly, and the hens were transformed in a very few days from unprofitable to highly profitable flocks. These results seem to indicate that peas and sour milk in combination with other feeds are highly productive when fed to laying hens, but, that peas fed with other grain, without sour milk or some animal protein, will not produce satisfactory results.

The question may quite naturally be asked if the season did not have something to do with the increased production of pens 4 and 6 in the last period. There can be no doubt but that the season influences egg production, but it should influence all fowls alike, especially, when they have like living conditions. Pen number 8 laid 1023 eggs during the first period, while pens 4 and 6 laid only 179 and 221 eggs respectively. During the second period pen 8 laid 2691 eggs, or an increase of 163 per cent over the first period, while pens 4 and 6 laid 2559 and 2518 eggs respectively, or a percentage increase of 1330 per cent, and 1039 per cent respectively. The addition of sour milk to their rations undoubtedly caused the great increase in the production of pens 4 and 6.

To the summary of the first two years work of this experiment, it should be added that sour milk fed to laying hens increases egg production; and that peas and sour milk are a splendid combination for laying hens if mixed with other feeds.

QUANTITY OF FEED CONSUMED

An incidental item of information was obtained from this experiment, namely, the quantity of the different kinds of feed White Leghorn hens consume. This is contained in Table XI, which covers the work carried on in the third year of this experiment, from November 1, 1917, to August 18, 1918, a period of 290 days.

Table XI.—Quantity of Feed Consumed, 1917-1918.

	Scratch food or coarse grains	Mash or fine feeds	Oyster or clam shell	Grit	Granulated bone
Pen No.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
4	845	418	36	17.50	29.25
5	896	425	40	17.50	25.75
6	888	279	41	12.50	24.25
7	909	362	43	17.00	31.75
8	941	404	44	23.50	29.75

The prices of feeds per hundred pounds, for this period, are contained in Table XII.

Table XII.—Price of Feed per 100 Pounds.

	Scratch feed	Mash	Oyster or clam shell	Grit	Granulated bone	Skim milk or butter milk
4	$4.10	$3.10	$1.50	$1.25	$3.00	$ .50
5	3.59	3.79	1.50	1.25	3.00	.....
6	3.76	3.67	1.50	1.25	3.00	.....
7	3.59	3.16	1.50	1.25	3.00	.....
8	3.59	3.48	1.50	1.25	3.00	.....

Labor items are not included in cost of this experiment for the reason that it was practically impossible to keep an accurate account of the time spent on the work.

SUMMARY

The results of the experiment indicate that:

1. Animal protein in some form appears to be necessary for profitable egg production, under the conditions of the experiment.

2. Animal protein, however, must be fed in proper proportions for satisfactory egg production.

3. Over feeding of beef scrap apparently caused a high death rate among laying hens.

4. Hens must maintain their body weight in order to lay many eggs.

5. Fowls that were perfectly healthy did not always lay well.

6. Sour milk fed to laying hens increased egg production materially.

7. Hens did not require water when they had plenty of sour milk to drink.

8. Rations in which cracked peas and pea meal furnished the bulk of the protein, when fed with sour milk, gave excellent results.

9. It is very profitable to feed milk (skim or buttermilk) to laying hens.

10. Sour milk, fed to hens, acts as an assimilating agency for other foods.

ANIMAL PROTEIN APPEARED TO BE SUPERIOR TO VEGETABLE PROTEIN IN RATIONS FOR LAYING HENS. WHILE THE MINIMUM QUANTITY WAS NOT EXACTLY DETERMINED IT SEEMS SAFE TO SAY THAT ABOUT 28 PER CENT OF THE MASH SHOULD BE BEEF-SCRAP OF HIGH PROTEIN CONTENT. OVER FEEDING OF PROTEIN, HOWEVER, APPEARED TO CAUSE DIGESTIVE TROUBLE AND A HIGH DEATH RATE.

SOUR MILK, EITHER SKIM MILK OR BUTTERMILK, WHEN ADDED TO THE VEGETABLE PROTEIN RATION SERVED TO MEET ALL DEFICIENCIES AND SUPPLY A COMPLETELY SATISFACTORY RATION.