# The Development and Testing Of High Energy Layer Rations For Use in Oklahoma

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EXPERIMENT STATION

## CONTENTS

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# INTRODUCTION

Need for increasing the levels of certain B-complex vitamins in high-energy layer-breeder rations was indicated in preliminary feeding tests completed at the Oklahoma Agricultural Experiment Station in 1951. These tests showed that the maximum rate of egg production was not maintained if the ration contained no more than recommended allowances for riboflavin, pantothenic acid, niacin, and folic acid. In making a further investigation of this problem, two lines of study were pursued as follows: (1) A series of experiments was conducted over a three-year period, 1952-1955, to check the need for increasing these vitamin levels and for supplying protein, energy and minerals in amounts which would more adequately meet the hen's needs during periods of high egg production. Data obtained in these experiments were used in formulating improved high-energy layer-breeder rations which were then tested under practical feeding conditions in the Oklahoma Egg Laying Test. (2) Data accumulated in the Oklahoma Egg Laying Test from 1937 to 1955 were used in making a comparison of the low-energy layer-breeder rations fed prior to 1951 and the high-energy layer-breeder rations fed to the Oklahoma Egg Laying Test hens during the four-year period from 1951 through 1955. The results of these two studies[1] are reported in this bulletin.

[1] These two studies were supported by a grant-in-aid from Merck and Company, Inc., Rahway, New Jersey.

# Feeding Experiments

## Introduction

A series of three feeding tests, designated as Experiments I, II, and III, was conducted over a three-year period from 1952 through 1955.

## General Procedure

Eight pens, 10 feet wide and 20 feet long, were used to house the pullets in this series of feeding tests. The rations fed in each test were assigned at random to the eight experimental pens, with each ration fed in duplicate. In order to distribute the pullets so that maximum uniformity of egg production among the eight pens would be achieved, trapnest egg production records on the individual pullets were kept for four weeks prior to the start of the feeding test. At the end of this four-week period, the individual pullets were divided into groups according to the number of eggs laid. The pullets within each egg production group were assigned at random into the eight experimental pens.

The experimental rations fed were all-mash, layer-breeder rations. The formulas for each ration are given in the following discussion under each experiment. Trapnest records were kept on each pullet during the entire test period. The pullets were wighed individually at four-week intervals. Residual feed was weighed back at the same time and feed consumption calculated. Mortality was recorded daily.

## Experiment I

## 1952-53

### Procedure

New Hampshire pullets hatched from the Oklahoma Agricultural Experiment Station flocks were housed on November 1, 1952, under the experimental conditions described in "General Procedure." At the start of the experimental test period there were 31 pullets in each of the eight laying pens. The feeding test was terminated on September 4, 1953, at the end of a 44-week laying period.

The formulas of the four rations fed and the computed composition of each ration are shown in Tables 1a and 1b. The low energy 1 NRC ration was a typical layer ration which had been recommended for use prior to 1952. The only vitamin supplement which it contained was 360 I. C. U. of vitamin D-3 per pound of ration. The ration levels of riboflavin, niacin, choline, pantothenic acid, and folic acid were those provided by the feed ingredients. The three high-energy rations designated as high energy 1 NRC, high energy 2 NRC, and high energy 3 NRC contained feed ingredients similar to those used in the low-energy 1 NRC ration. However, productive energy in these three rations had been increased by approximately five percent by reducing the level of high-fiber, low-energy ingredients and by increasing the level of ground yellow corn. Each of the three high-energy rations was supplemented with 2080 I. U. of vitamin A, 600 I. C. U. of vitamin D-3, and 341 mg. of choline per pound of feed. In addition, each of the high energy rations was supplemented with riboflavin, niacin, pantothenic acid and folic acid as follows:

| | High Energy 1 NRC | High Energy 2 NRC | High Energy 3 NRC |
|---|---|---|---|
| Riboflavin mg./lb. | 0.33 | 1.6 | 3.2 |
| Niacin mg./lb. | 0.0 | 4.0 | 8.0 |
| Pantothenic Acid mg./lb. | 1.36 | 6.8 | 12.24 |
| Folic Acid mg./lb. | 0.67 | 1.96 | 3.09 |

The level of each vitamin in each of the four rations (Table 1) represents the amount provided by the feed ingredients and vitamin supplement combined. The riboflavin and pantothenic acid levels in the three high-energy rations were approximately one, two, and three times the 1946 recommended allowances of the National Research Council. Since no allowances for pullets for niacin and folic acid were available two vitamins were added to the high-energy rations in the amounts indicated in order to provide an excess ration level of each.

**TABLE 1a.—Basal Rations (Percent) in Experiment I, 1952-53**

| | Low Energy Basal | High Energy Basal |
|---|---|---|
| Ground yellow corn | 48.2 | 60.8 |
| Wheat shorts | 12 | 12 |
| Wheat bran | 6 | 8 |
| Pulverized oats | 14 | |
| Alfalfa meal (17%) | 6 | 3 |
| Fish meal (60%) | 3 | 3 |
| Soybean oil meal (44%) | 6 | 7.5 |
| Meat and bone scrap (50%) | 3 | 3 |
| Calcium carbonate | 1.2 | 1.2 |
| Di-calcium phosphate | | 1.2 |
| Salt | 0.6 | 0.3 |
| Manganese sulfate | 3.6 mg. | 3.6 mg. |
| Vitamin supplement[1] | | |

[1] A vitamin supplement was added to each basal in order to provide the vitamin levels as listed for each ration in the calculated composition shown in Table 1-b.

**TABLE 1b.—Computed Compositions of Rations in Experiment I, 1952-53**

| | Low Energy 1 NRC | High Energy 1 NRC | High Energy 2 NRC | High Energy 3 NRC |
|---|---|---|---|---|
| Protein-percent | 16.56 | 16.74 | 16.74 | 16.74 |
| Productive energy-(Calories per lb.) | 869 | 905 | 905 | 905 |
| Vitamin A—IU/lb. | 6206 | 6621 | 6621 | 6621 |
| Vitamin $D_3$—ICU/lb. | 360 | 600 | 600 | 600 |
| Riboflavin—mg/lb. | 1.2 | 1.31 | 2.57 | 4.18 |
| Niacin—mg/lb. | 19.6 | 14.7 | 18.7 | 22.7 |
| Choline—mg/lb. | 416 | 745 | 745 | 745 |
| Pantothenic acid—mg/lb. | 4.79 | 5.11 | 10.6 | 15.99 |
| Folic acid—mg/lb. | .70 | 1.21 | 2.50 | 3.63 |

## Results

The egg production during successive four-week periods is summarized in Figure 1. The high-energy 2 NRC and the high-

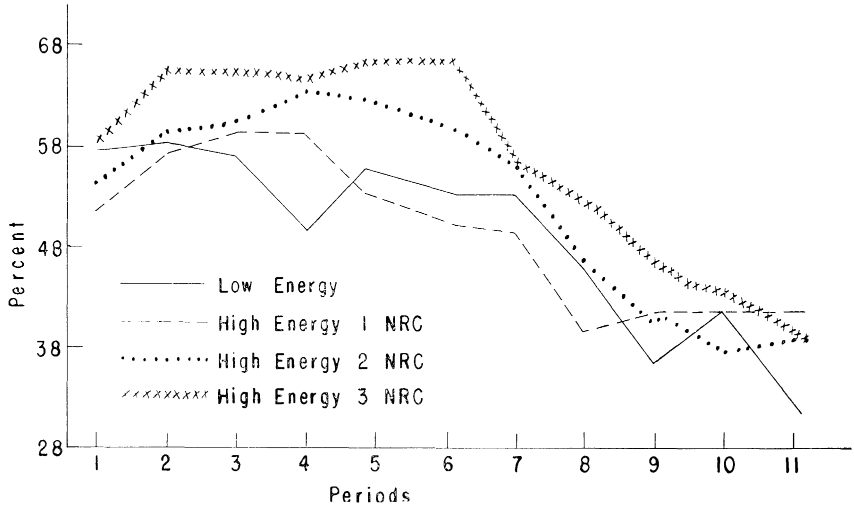


**Figure 1. Percent egg production by four-week periods, Experiment I, 1952-53.**

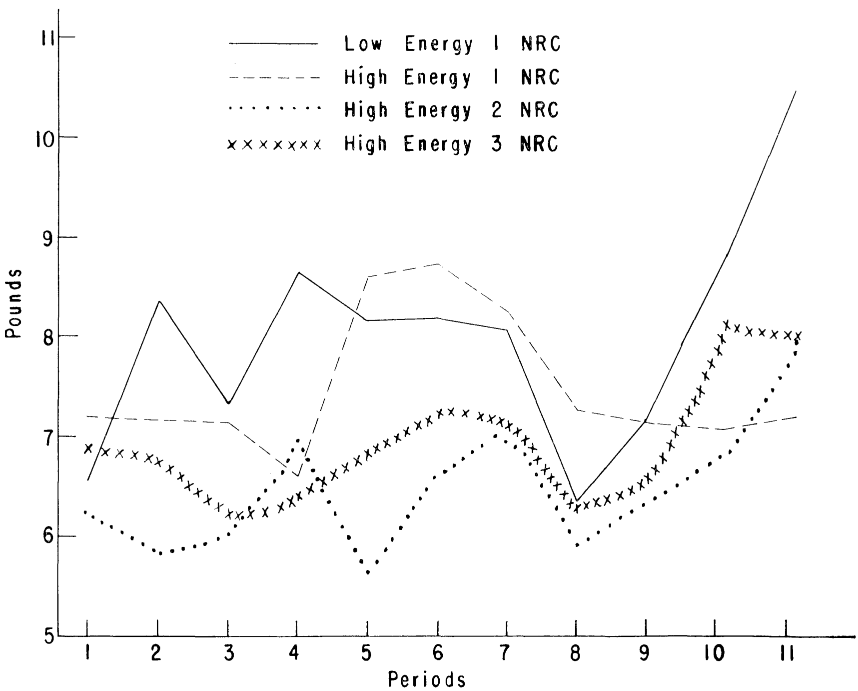


**Figure 2. Pounds of each ration per dozen eggs by four-week periods, Experiment I, 1952-53.**

energy 3 NRC rations supported the highest rate of egg production. In addition, these rations maintained egg production at a higher rate for a longer period of time than did the low-energy 1 NRC ration and the high-energy 1 NRC ration. Pullets fed the high-energy 1 NRC ration showed a gradual decline in egg production after the first 16 weeks of the feeding test. Although egg production gradually declined when the high-energy 2 NRC and the high-energy 3 NRC rations were fed, the decline did not begin until the pullets had been in production for approximately 24 weeks. The pullets fed the low-energy 1 NRC ration showed a gradual over-all decline in egg production, with sharp increases and decreases from four-week period to four-week period.

The pounds of each ration required to produce a dozen eggs are summarized in Figure 2. The pounds of feed per dozen eggs fluctuated over a wide range from four-week period to four-week period in those lots fed the low-energy 1 NRC and the high-energy 1 NRC rations. The pullets fed the high-energy 2 NRC and 3 NRC rations consumed less feed per dozen eggs produced, and the variation in egg production from period to period was less pronounced. This fluctuation in feed consumption suggests that the nutritive requirements of the pullets were not being adequately met with the low-energy 1 NRC and the high-energy 1 NRC rations.

Body weight changes during successive four-week periods are shown in Figure 3. Accumulative gain in body weight of pullets for the 44-week period was about equal, regardless of ration.

Mortality during successive four-week periods is shown in Table 2.

## Experiment II
## 1953-54

### Procedure

New Hampshire pullets hatched from the Oklahoma Agricultural Experiment Station flocks were housed on November 5, 1953. The experimental conditions under which the pullets were held and the experimental procedure followed are described under "General Procedure." Each experimental pen consisted of 38 pullets. The 36-week test period was terminated on July 14, 1954.

The four experimental rations and their computed compositions are shown in Tables 3a and 3b. These four high-energy, all-mash rations were similar in composition to the high-energy rations fed in Experiment I. They were designated as high energy 1 NRC, high energy 2 NRC, high energy 3 NRC, and high energy 2 NRC + XB. The symbol XB represents the vitamins thiamin, pyridoxine, vitamin K, biotin, vitamin E, inositol, and para-amino-benzoic acid, which were added to the high energy 2 NRC + XB ration at the levels indicated in Table 3. The National Research Council Allowances as recommended in 1946 were used as the basis for determining the levels of vitamin A, vitamin D-3, riboflavin, and pantothenic acid to be added

**TABLE 2.—Cumulative Mortality by Four-Week Periods, Experiment I, 1952-53**

| | Period | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Low Energy—1 NRC | 4.84 | 6.45 | 8.06 | 8.06 | 12.75 | 14.36 | 15.92 | 19.05 | 20.61 | 23.79 | 28.53 |
| High Energy—1 NRC | 1.56 | 1.56 | 4.74 | 9.53 | 11.14 | 15.82 | 15.92 | 20.56 | 23.74 | 28.48 | 31.65 |
| High Energy—2 NRC | 0 | 0 | 3.22 | 4.84 | 6.45 | 8.06 | 12.85 | 12.85 | 19.15 | 19.15 | 23.94 |
| High Energy—3 NRC | 1.61 | 3.23 | 4.84 | 4.84 | 8.06 | 9.67 | 9.67 | 11.29 | 16.13 | 16.13 | 17.74 |

Note: Percents reported are the average for 2 pens.

to each ration. The high-energy 1 NRC ration contained the above-named vitamins at the levels recommended by the National Research Council. The levels of these vitamins in the other three rations were increased, as indicated in Table 3, to two and three times those in the high energy 1 NRC ration. The high energy 1 NRC ration contained more vitamin A than was recommended by the National Research Council because the vitamin A provided by the feed ingredients exceeded the recommended allowance for the entire ration. Niacin was provided at a level of 8 milligrams per pound of ration as recommended by the National Research Council for growing chicks. The high energy 1 NRC ration exceeded this amount, as was the case with vitamin A, because the feed ingredients in the ration contained an

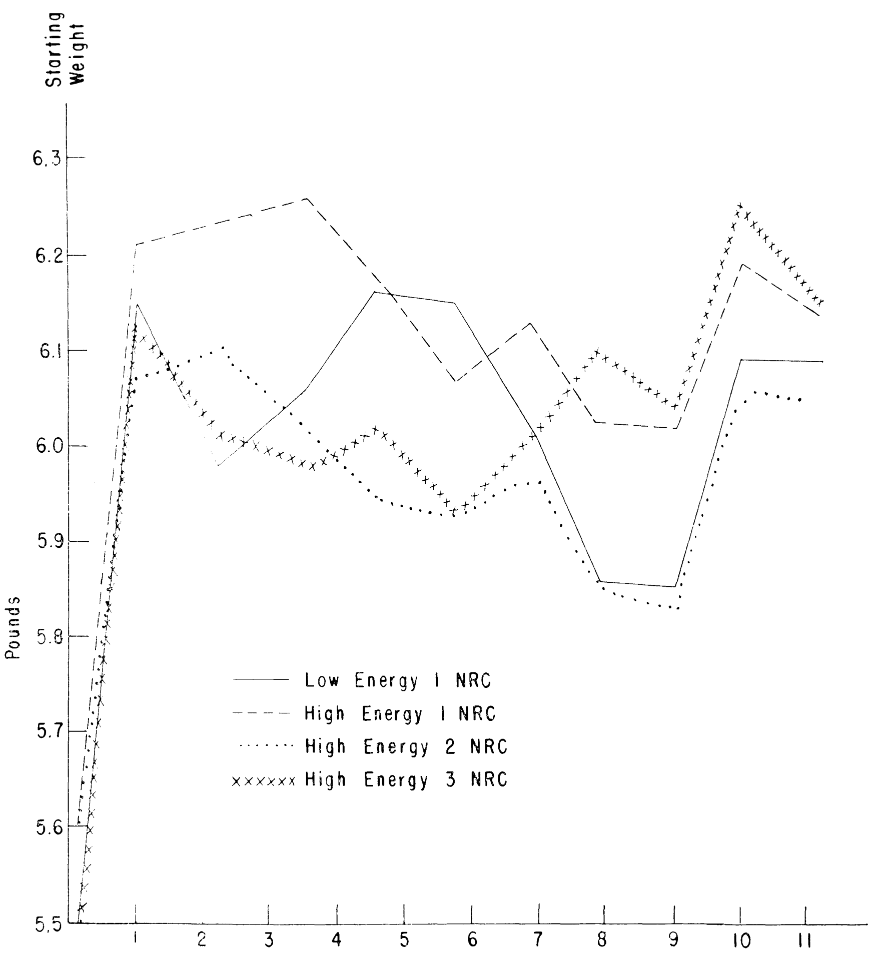


**Figure 3. Body weight changes during successive four-week periods, Experiment I, 1952-53.**

excess of niacin. Niacin was added to the other three rations in sufficient quantities to supply niacin levels of two and three times the recommended allowance of 8 milligrams per pound.

## Results

Average egg production figures for the pullets fed the four experimental rations are shown in Figure 4. No real differences in egg production were noted at any time during the test period. However, the high energy 2 NRC + XB ration did appear to have a slight advantage over the other three rations.

The pounds of feed required to produce a dozen eggs with each ration are summarized in Figure 5. The amount of feed required per dozen eggs was fairly uniform from four-week period to four-week period in those pens fed the high-energy 2 NRC and the high-energy 2 NRC + XB rations. The pullets fed the high-energy 1 NRC and the high-energy 3 NRC rations showed a wide variation in this respect from four-week period to four-week period. Four-week periods in which feed intake progressively increased were followed by four-week periods in which feed consumption progressively decreased. This abnormal

**TABLE 3a.—Basal Rations in Experiment II, 1953-54**

| | *High Energy Basal* (Percent) |
|---|---|
| Ground yellow corn | 58.2 |
| Ground oats | 8 |
| Wheat shorts | 12 |
| Alfalfa meal (17%) | 3 |
| Soybean oil meal (44%) | 8.1 |
| Fish meal (60%) | 3 |
| Meat and bone scrap (50%) | 3 |
| Di-calcium phosphate | 0.9 |
| Calcium carbonate | 1.5 |
| Salt | 0.3 |
| Manganese sulfate | 0.0125 |
| Vitamin supplement | 2.0 |
| The XB vitamins and the amount of each added per pound of ration were: | |
| Thiamin | 1.5 mg |
| Pyridoxine | 2.66 mg |
| Vitamin K | 1.66 mg |
| Biotin | 0.116 mg |
| Vitamin E | 15 mg |
| Inositol | 21.3 mg |
| Para-amino-benzoic acid | 66.6 mg |

**TABLE 3b.—Computed Composition of Rations in Experiment II, 1953-54**

| | High Energy 1 NRC | High Energy 2 NRC | High Energy 3 NRC | High Energy 2 NRC + XB |
|---|---|---|---|---|
| Protein-Percent | 16.3 | 16.3 | 16.3 | 16.3 |
| Productive energy-Calories/lb. | 905 | 905 | 905 | 905 |
| Vitamin A IU/lb. | 5341 | 6600 | 9899 | 6600 |
| Vitamin $D_3$ ICU/lb. | 375 | 750 | 1125 | 750 |
| Riboflavin mg/lb. | 1.5 | 2.6 | 3.9 | 2.6 |
| Niacin mg/lb. | 13.8 | 16.0 | 24.0 | 16.0 |
| Choline mg/lb. | 500 | 500 | 500 | 500 |
| Pantothenic Acid mg/lb. | 5.0 | 10.0 | 15.0 | 10.0 |
| Folic Acid mg/lb. | 1.3 | 2.6 | 3.9 | 2.6 |
| Vitamin B-12 added-mcg/lb. | 0.5 | 2.0 | 3.0 | 2.0 |

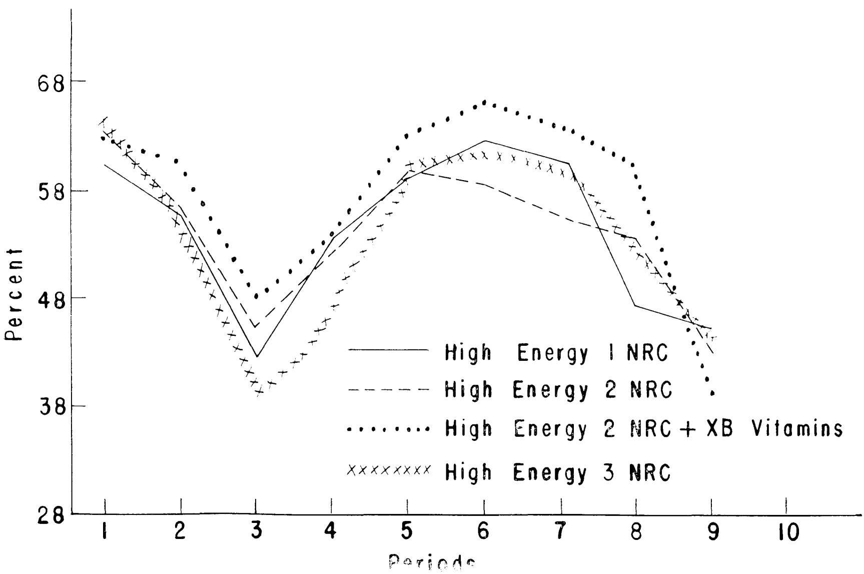


**Figure 4. Percent egg production by four-week periods, Experiment II, 1953-54.**

**TABLE 4.—Cumulative Mortality by Four-Week Periods, Experiment II, 1953-54.**

| | Period | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| High Energy—1 NRC | 1.35 | 4.06 | 4.06 | 5.37 | 6.72 | 8.07 | 9.43 | 10.78 | 12.09 |
| High Energy—2 NRC | 0 | 4.02 | 5.37 | 6.68 | 9.38 | 10.70 | 17.36 | 21.41 | 24.08 |
| High Energy—2 NRC—Plus Less Common Vitamins | 0 | 0 | 0 | 0 | 1.32 | 3.94 | 3.94 | 5.26 | 9.41 |
| High Energy—3 NRC | 0 | 2.63 | 2.63 | 2.63 | 9.21 | 10.52 | 13.16 | 13.16 | 25.00 |

* Percents reported are the average for 2 pens.

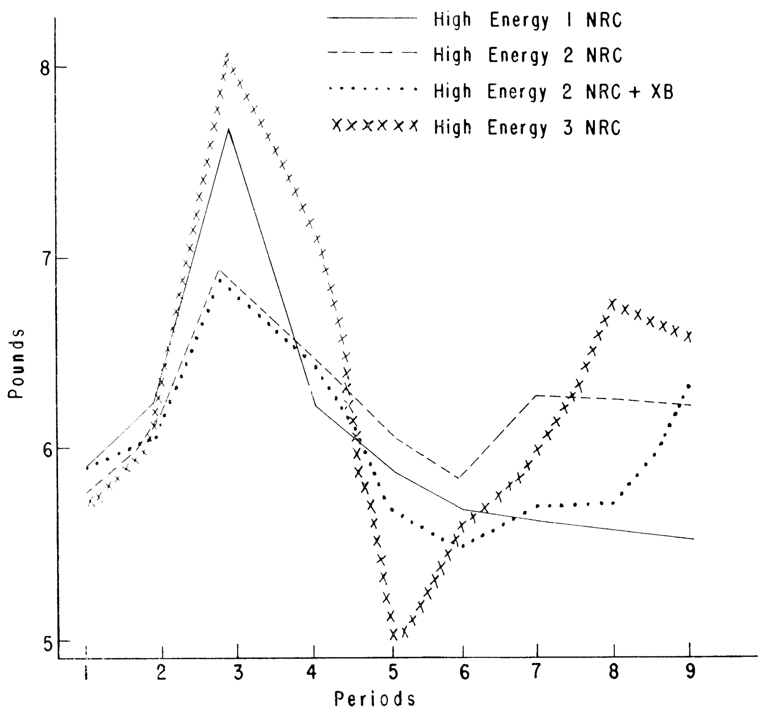


**Figure 5. Pounds of each ration per dozen eggs by four-week periods, Experiment II, 1953-54.**

pattern in feed consumption persisted during the entire test period. The fluctuation in feed consumption observed with high-energy 3 NRC ration covered a wider range than was observed with the high-energy 1 NRC ration. An imbalance in vitamin supplementation may be responsible for this feed consumption pattern.

Body weight changes are shown in Figure 6. Pullets fed the high-energy 2 NRC, the high-energy 2 NRC + XB, and the high-energy 3 NRC rations maintained approximately the same body weights. The high-energy 1 NRC ration was apparently the equal of the others for the first 20 weeks, but failed to maintain body weight effectively after that time. Mortality data are summarized in Table 4. The differences in mortality could not be attributed to the rations.

## Experiment III

## 1954-55

## Introduction

Experiment III, in which four rations were fed, consisted of two feeding tests which were conducted simultaneously. The feeding test described in Part I was carried out under floor conditions and was similar to those outlined in Experiments I and II. The feeding test described in Part II was carried out in laying cages. Collection and analysis of fecal material and analysis of rations[1] permitted the calculation of the relative efficiency with which different nutrients were utilized.

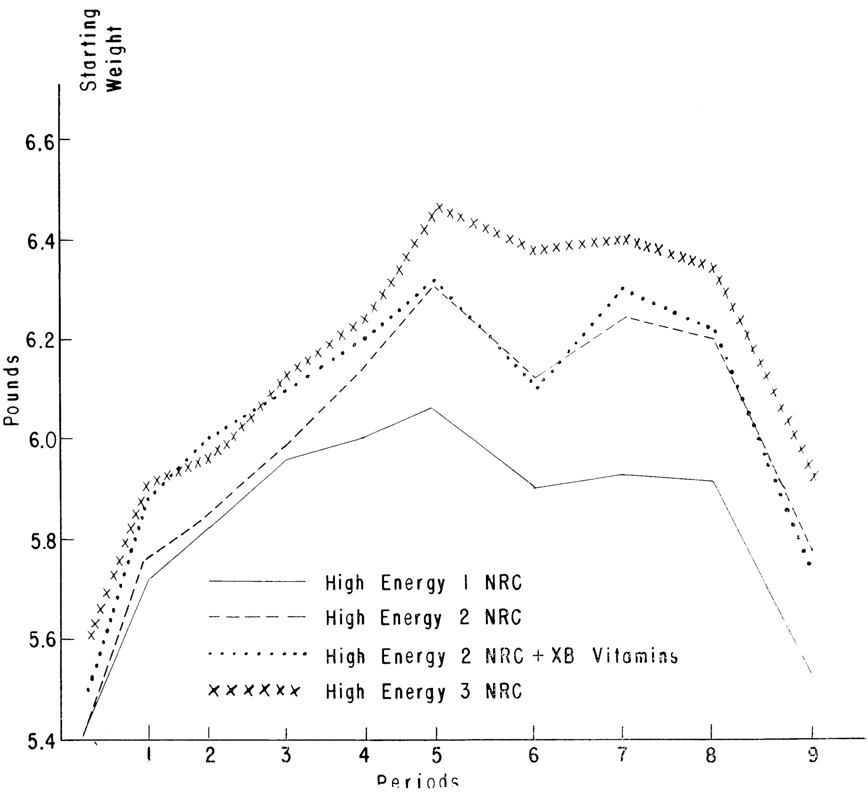


**Figure 6. Body weight changes during successive four-week periods, Experiment II, 1953-54.**

## Part I

**Procedure**—Single Comb White Leghorn pullets hatched from the Oklahoma Agricultural Experiment Station flocks were housed on October 23, 1954. The general experimental procedure was the same as outlined for the preceding two experiments. Thirty-three pullets were assigned to each of the eight pens at the beginning of the 48-week test period. The test period was terminated on September 23, 1955.

The ration formulas and the computed composition of each ration are listed in Tables 5a and 5b. The ration designated as low energy

[1] Technical assistance in making these chemical analyses was provided by Lester Laudick and Harold Norlin, Department of Agricultural Chemistry.

1 NRC was similar in composition to the low-energy ration in Experiment I and contained the same vitamin fortification as has been described in Experiment I. The rations designated as high energy 1 NRC and high energy 2 NRC (1) were supplemented with vitamins at levels equal to those listed in Experiment II. The high energy 2 NRC (2) ration provided niacin, riboflavin, pantothenic acid, and folic acid at approximately the same levels as were provided in the high-energy 2 NRC (1) ration. This ration was made more adequate from a nutritional standpoint (1) by increasing productive energy through the addition of fat, (2) by improving over-all protein quality by using a variety of high-quality animal and vegetable concentrates, (3) by providing calcium, phosphorus and trace minerals at levels in excess of recommended allowances, and (4) by incorporating materials which are sources of unknown growth factors.

**TABLE 5a.—Basal Rations in Experiment III, 1954-55.**

| | Low Energy 1 NRC Percent | High Energy 1 NRC Percent | High 2 NRC (1) Percent Energy | High Energy 2 NRC (2) |
|---|---|---|---|---|
| Ground yellow corn | 45 | 56 | 56 | 56.6 |
| Ground oats | 14 | 8 | 8 | 8 |
| Wheat shorts | 12 | 12 | 12 | 6 |
| Wheat bran | 6 | | | |
| Alfalfa meal | 6 | 3 | 3 | 3 |
| Fish meal | 3 | 3 | 3 | 6 |
| Soybean oil meal | 6 | 8.1 | 8.1 | 6 |
| Meat and bone scrap | 3 | 3 | 3 | |
| Dried brewers yeast | | | | 1.2 |
| Dried whey | | | | 1.8 |
| Dried fish solubles | | | | 1.8 |
| Dried butyl solubles | | | | 1.8 |
| Di-calcium phosphate | | 0.9 | 0.9 | 2.4 |
| Calcium carbonate | 4.4 | 3.7 | 3.7 | 3.0 |
| Salt | 0.6 | 0.3 | 0.3 | 0.3 |
| Trace mineral mix[1] | | | | 0.03 |
| Vitamin supplement[2] | | | | |
| Feed grade fat | | | | 1.8 |
| Manganese sulfate | 5.4 gm | 8 gm | 8 gm | |
| Vitamin $D_3$ (3000 I.C.U./gm) | 12 gm | | | |

[1] The trace mineral mix supplies per pound of ration: manganese 27.5 mg., iodine 0.88mg., cobalt 0.59 mg., iron 18.3 mg., copper 1.65 mg., and zinc 1.52 mg.

[2] A vitamin supplement was added to each high energy ration to supply the ration vitamin levels listed below in the computed composition.

**TABLE 5b.—The Computed Composition of Rations in Experiment III, 1954-55.**

| | Low Energy 1 NRC | High Energy 1 NRC | High Energy 2 NRC (1) | High Energy 2 NRC (2) |
|---|---|---|---|---|
| Protein-Percent | 16.5 | 16.3 | 16.3 | 15.8 |
| Productive Energy Calories/lb. | 869 | 906 | 905 | 940 |
| Vitamin A IU/lb. | 6206 | 5341 | 6600 | 4032 |
| Vitamin $D_3$ ICU/lb. | 360 | 375 | 750 | 450 |
| Riboflavin mg/lb. | 1.2 | 1.5 | 2.6 | 2.23 |
| Niacin mg/lb. | 19.6 | 13.8 | 16.0 | 16.4 |
| Choline mg./lb. | 416 | 500 | 500 | 419 |
| Pantothenic Acid mg/lb. | 4.79 | 5.0 | 10.0 | 12.0 |
| Folic Acid mg/lb. | 0.7 | 1.3 | 2.6 | 2.6 |
| Vitamin B-12 Added mcg/lb. | 0.0 | 0.5 | 2.0 | 3.3 |
| Vitamin E Added mg/lb. | 0.0 | 0.0 | 0.0 | 0.8 |

**Results**—Percent egg production during successive four-week periods is shown in Figure 7. The highest rate of egg production during the first 24 weeks of the test period was made by the pullets fed the high-energy 2 NRC (1) and the high-energy 2 NRC (2) rations. A difference in egg production in favor of the high-energy 2 NRC (1) ration was evident at the end of the test period, even though a gradual decline was observed with all rations. The high-energy 1 NRC ration, as was the case in Experiment I, supported egg production at a high level during the early part of the test period. Egg production by the pullets fed this ration, however, declined sharply during the last three months of the laying period. This decline in egg production seems to indicate that vitamin levels were not adequate to support high, sustained egg production over an extended laying period. Over-all egg production with the low-energy 1 NRC ration was never as high as with the high-energy rations. In addition, production fluctuations were more noticeable from four-week period to four-week period.

The pounds of each ration utilized in the production of a dozen eggs are shown in Figure 8. The variation in the pounds of feed required per dozen eggs was again the greatest from four-week period to four-week period on the low-energy 1 NRC and the high-energy 1 NRC rations. The pullets fed the high-energy 1 NRC ration followed a feed consumption pattern similar to that observed in Experiments I and II. Feed intake progressively increased up to the fifth

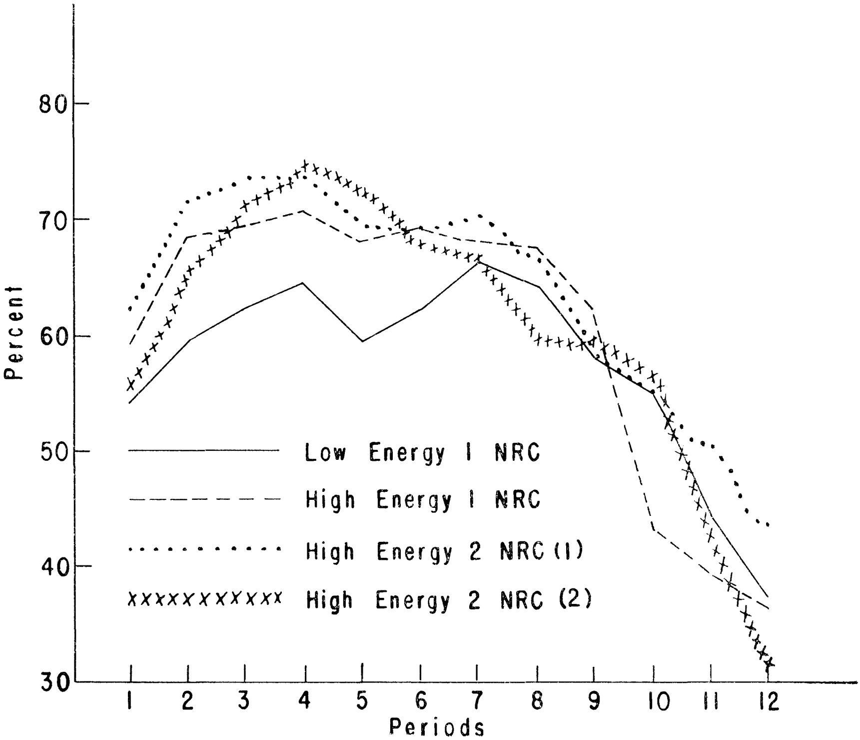


**Figure 7. Percent egg production by four-week periods, Experiment III, 1954-55.**

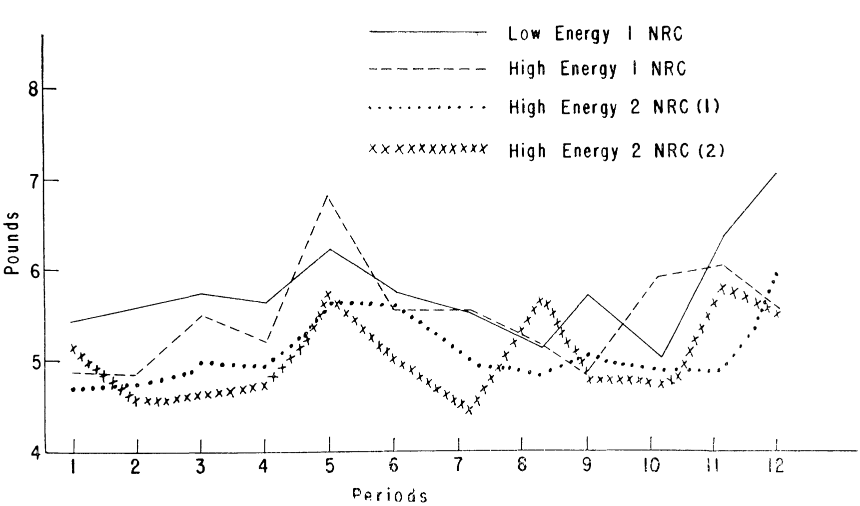


**Figure 8. Pounds of each ration per dozen eggs by four-week periods, Experiment III, 1954-55.**

four-week period. A gradual decline then took place, with a sharp increase becoming evident after the ninth four-week period.

Body weight fluctuations are summarized in Figure 9, and mortality data in Table 6. All rations were effective in maintaining body weight at or near the initial level. Accumulative gain was the greatest for the high-energy 2 NRC (2). Since the average body weight was about equal in all lots at the beginning of the test period, the high-energy 2 NRC (2) ration maintained average body weight at a much higher level than did the other rations. Mortality apparently was not affected by the rations.

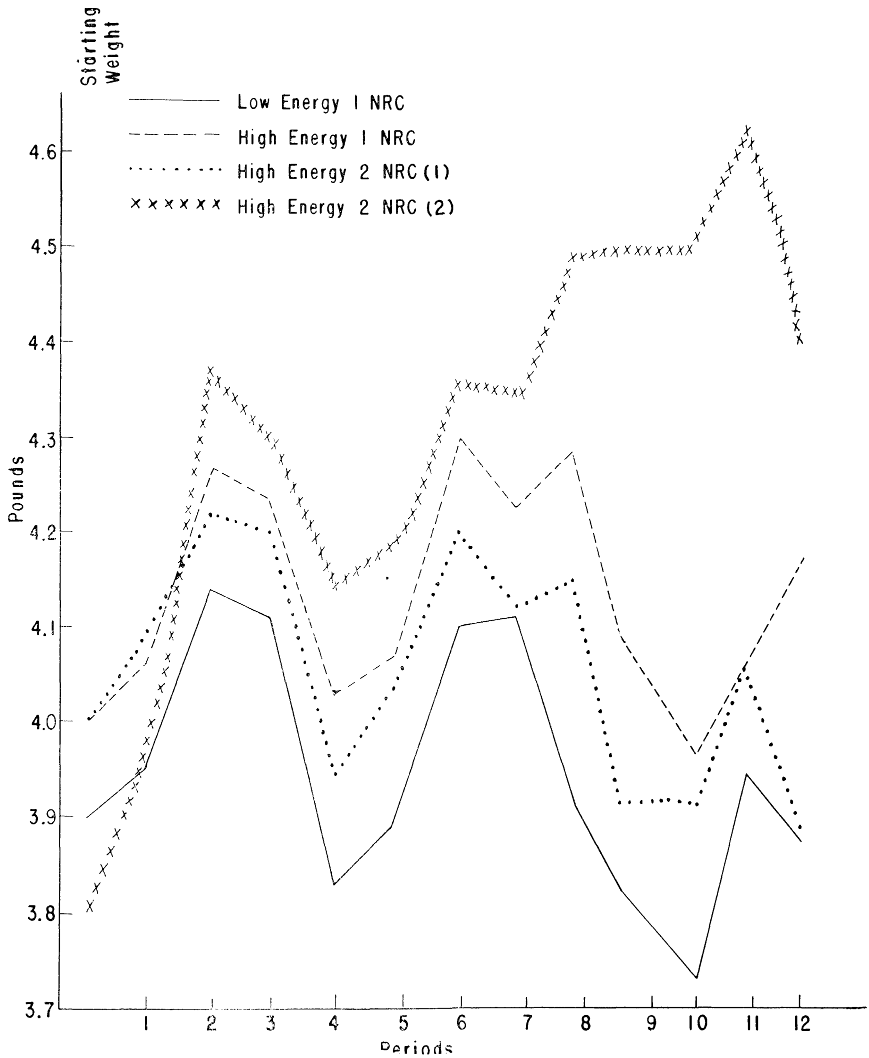


**Figure 9. Body weight changes during successive four-week periods, Experiment III, 1954-55.**

TABLE 6.—Cumulative Mortality by Four-Week Periods, Experiment III, 1954-55.

| | Period | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ration | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Low Energy—1 NRC | 1.56 | 1.56 | 1.56 | 3.08 | 4.64 | 6.20 | 6.20 | 6.20 | 7.72 | 10.84 | 12.40 | 16.99 |
| High Energy—1 NRC | 1.66 | 8.33 | 8.33 | 8.33 | 9.99 | 9.99 | 9.99 | 11.66 | 13.33 | 13.33 | 14.99 | 14.99 |
| High Energy—2 NRC (2) | 0 | 1.51 | 3.03 | 6.06 | 6.06 | 6.06 | 6.06 | 9.09 | 9.09 | 9.09 | 10.60 | 12.12 |
| High Energy 2 NRC (1) | 1.51 | 3.03 | 3.03 | 3.03 | 6.06 | 7.57 | 9.09 | 9.09 | 9.09 | 12.12 | 13.63 | 18.18 |

## Part II

**Procedure**—Single Comb White Leghorn pullets from the same group from which pullets were selected for use in Part I of this experiment were distributed at random into laying cages. These pullets made up four experimental groups with 20 pullets in each group. As was the case in Experiments I and II and in Part I of this experiment, pullet distribution among the four groups was based upon the egg production of each pullet during the month preceeding the beginning of the experiment. The duration of this cage-feeding test was from October 28, 1954 to August 15, 1955.

The same four all-mash rations described in the procedure in Part I were fed to the four experimental groups. Additional amounts of calcium were added to these rations in order to provide an adequate amount of this mineral without having to feed supplemental calcium in the form of oyster shell. Each cage was equipped with an individual feeder, and a daily feed consumption record was kept for each pullet.

At intervals during the test period, each pullet was moved to a metabolism cage where she was fed during a three-day fecal collection period. The time intervals between collection periods varied. The initial fecal collections were made in November 1954, with subsequent fecal collections being made in December 1954, in the latter part of January 1955 and early February 1955, in March 1955, in April 1955, in June 1955, and in the latter part of July and early August 1955. During any given three-day collection period, only four pullets out of the 20 in each group could be placed in metabolism cages. Thus each time fecal collections were made, 15 to 20 days elapsed between the time the first four samples in each group were collected and the time the final four samples were taken.

The metabolism cages consisted of regular laying cages equipped with glass trays under the wire floor. The glass tray under each cage was so located that all of the droppings voided by the pullet were collected. During the three-day collection period, each tray was kept moistened with ethyl alcohol in order to reduce bacterial growth. The assumption was made that the feed moved through the digestive tract of each pullet at about the same rate from day to day. Under this assumption, the fecal material voided on any given day would be equal in amount and composition to the fecal material actually produced by the amount of feed eaten on this same given day. Thus, the fecal material voided during each three-day collection period was taken as representative of the feed eaten during the same time interval. At the end of each three-day collection period, the feathers which had accumulated in the collection trays were removed and the fecal material was placed in polyethylene bags, the bags sealed, and the sample frozen and stored at 0° F. until analyzed.

Daily egg production records were made for each pullet during the entire feeding period. In addition, all of the eggs which were produced were weighed. Each pullet was weighed at the start of the experiment and at the same time intervals during the test period at which fecal samples were collected. Mortality was recorded as it occurred.

At the termination of the feeding period on August 15, 1955, the total number of eggs and total weight of eggs produced by each pullet were computed. Seven pullets, each of which had produced an equal weight of eggs, were selected from each of the four groups. The fecal samples from these seven pullets constituted the samples used in determining the percentage utilization of total nitrogen, total energy, calcium and phosphorus for each experimental ration.

Prior to analysis, the fecal sample was thawed and thoroughly mixed in a Waring Blender. Water was added to bring the fecal mixture to a final volume of one liter. The fecal mixture was again thoroughly mixed and a 300 ml. aliquot was taken with a modified transfer pipette. This aliquot was placed in an aluminum evaporating dish and dried overnight on a steam hot plate. The drying procedure was completed in a forced draft oven at a temperature of 130° F. The dry weight of each sample was then determined and the dried material was ground and thoroughly mixed.

Chemical analyses were made on each sample for total nitrogen, calcium and phosphorus. Standard feed analysis methods as outlined by the A. O. A. C. (1950) were used for nitrogen and calcium. The method of Koenig and Johnson (1942) was used in determining the phosphorus content. A bomb calorimeter was used to measure the gross energy of samples. Representative samples of each of the four rations fed were analyzed for the same constituents.

These data were used in computing the percentage of nitrogen, energy, calcium and phosphorus which had been utilized by the individual pullets from each ration for growth and egg production. Covariance techniques as outlined by Snedecor (1946) were applied to the data in order to obtain adjusted means for each constituent based upon a uniform level of feed intake.

Data on feed consumption, body weight, and egg weight for the 20 pullets fed each of the four experimental rations were used in computing the relative efficiency with which each ration was utilized. The relative efficiency was computed by comparing the observed rate of feed consumption with that predicted by the Byerly (1941) partition equation, using the method outlined by Hill (1956).

$$\text{Relative Efficiency} = \mathbf{100 \times \frac{Predicted\ Feed\ Consumption}{\text{Observed Feed Consumption}}}$$

The predicted rate of feed consumption was computed from the Byerly equation in the following form:

$$F = 0.523W^{0.653} = 1.126\Delta W + 1.135E$$

in which

F=feed consumption in grams per hen per day

W=average weight in grams

$\Delta$W=average daily weight change in grams

E=grams of egg produced per hen per day.

**Results**—The adjusted percentage utilization values for energy, total nitrogen, calcium and phosphorus for four of the seven collection periods are shown in Figure 10. The levels of significance of the F values for this data are listed in Table 7.

**TABLE 7.—Level of Significance of F Values for Adjusted Energy, Total Nitrogen, Calcium and Phosphorus Values, Part II, Experiment III, 1954-55.**

| | Periods | | | |
|---|---|---|---|---|
| | November | December | April | June |
| Energy | 99.8 | 98 | 99.5 | 50 |
| Total Nitrogen | 88 | 50 | 54 | 83.5 |
| Calcium | 50 | 50 | 91 | 50 |
| Phosphorus | 54 | 82 | 91 | 50 |

There was a statistically significant difference in the utilization of energy between the high- and low-energy rations during the first three periods. Apparently an increase in the levels of riboflavin, pantothenic acid, niacin and folic acid in the high-energy rations had no effect on the efficiency with which the energy was utilized.

Except for the first and last period, no statistically significant differences were obtained in nitrogen utilization. It should be pointed out, however, that the most efficient utilization was always obtained with the high-energy 2 NRC (2) ration. Apparently the amino acid requirements of the pullets for egg production were more nearly met by the combination of proteins in this ration.

No consistent pattern in calcium and phosphorus utilization was observed from collection period to collection period. The data obtained in this study give no indication that the utilization of calcium and phosphorus was influenced by the energy and vitamin levels which were fed.

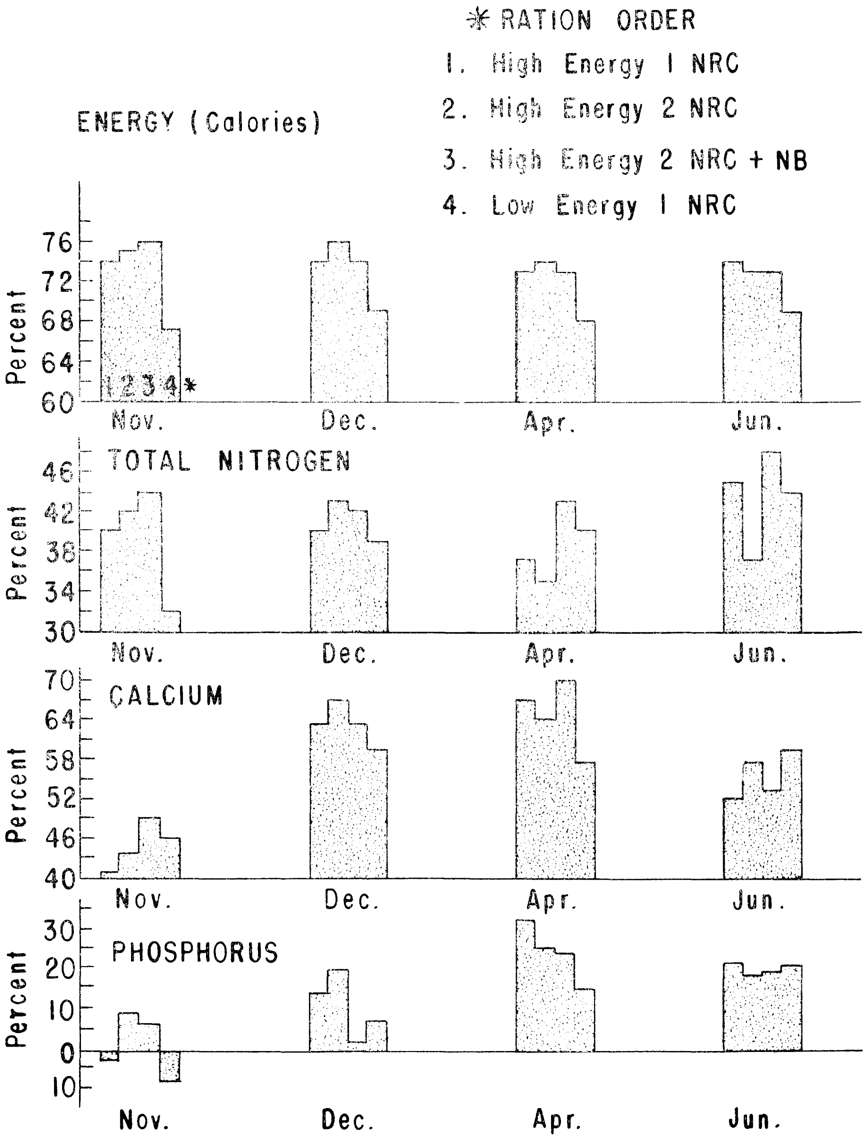


**Figure 10. Effect of energy andvitamin evels on the percentage utilization of energy, nitrogen, calcium and phosphorus. Part II, Experiment III, 1954-55.**

The relative efficiency values as calculated by the method of Hill (1956) are shown in Figure 11. With two exceptions, the most efficient utilization was obtained, for every period for which measurements were made, with the high-energy 2 NRC (1) and the high-energy 2 NRC (2) rations. The low energy 1 NRC ration gave the poorest results for the first five periods, but seemed to improve during the summer months of June and July-August. The results obtained with the high-energy 1 NRC ration were approximately equal to those obtained with the high-energy 2 NRC (1) and the high-energy 2 NRC (2) rations during the first months of the test. During the last three or four months, however, a difference in relative efficiency in favor of the 2 NRC (1) and the 2 NRC (2) rations became progressively greater. This decline in efficiency of utilization obtained with the high energy 1 NRC ration during the latter part of the production period parallels the rapid drop in egg production which was observed with this ration in Part I of this experiment.

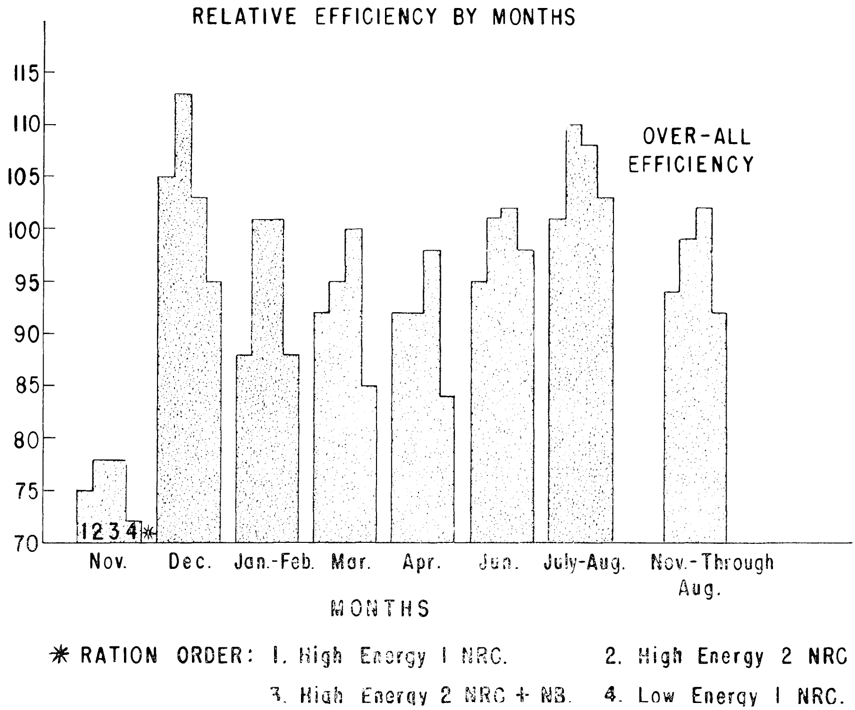


**Figure 11. Effect of energy and vitamin levels on relative efficiency. Part II, Experiment III, 1954-55.**

Over-all efficiency for the entire test period indicates that the high-energy 1 NRC ration is no better than the low-energy 1 NRC ration. The addition of riboflavin, pantothenic acid, niacin and folic acid made a marked improvement in the efficiency with which the high energy 1 NRC ration was utilized. A further improvement in efficiency of utilization was made by improving protein quality and by increasing the levels of available calcium and phosphorus, as was done in the high-energy 2 NRC (2) ration.

# Analysis of Data From the Oklahoma Egg Laying Test

## Introduction

In this study the reproductive performance of the low-energy layer rations fed in the Oklahoma Egg Laying Test prior to 1951 was compared to the reproductive performance obtained by feeding the high-energy layer rations developed after 1951. The three best years when low-energy rations were fed (1939-40, 1940-41, 1948-49) and the three years when high-energy rations were fed (1951-52, 1952-53, 1953-54) formed the basis upon which the comparison was made. Data for the year 1954-55 were not included in computing the average performance figures for the high-energy rations. They are presented, however, to show the improvement made through the use of improved high-energy rations during the 1954-55 test year.

The Oklahoma Egg Laying Test is a standard egg laying test. Since it was organized in 1923, production data have been accumulated by months and by years on egg production; pounds of feed per dozen eggs produced; pounds of mash, grain, and grit required per hen per year by breeds; changes in body weight during the laying year; mortality; and cost of production.

## General Procedure

### Housing

The Oklahoma Egg Laying Test entries were housed in two buildings, each of which was 20 feet wide and 162 feet long. Each house contained 25 individual pens 6 feet by 16 feet in size. The pens were arranged along the south side of each house and a 4-foot service aisle ran the length of the north side of each building. The pens were separated by poultry wire and board partitions and there was free exchange of air between the pens in each house. One man took care of all entries in both houses, doing the feeding and trapnesting.

#### Entries

Poultry breeders and flock owners from Oklahoma and from other states in the United States entered pullets in the Oklahoma Egg Laying Test during the test years included in this study. Thirteen pullets of the same breed and variety constituted an entry and were housed in one pen. The pullets were placed in the laying house on October 1 of each year and remained there until the termination of the laying test the following September. The number of pullets of each breed and variety entered in each of the three highest production years of low-energy rations and the three years of high-energy rations, which were compared in this study, are listed in Table 8.

**TABLE 8.—Number of Each Breed Entered in the Oklahoma Egg Laying Test During Test Years Reported**

| Breed | 1939-1940 | 1940-1941 | 1948-1949 | 3-yr. Total | 1951-1952 | 1952-1953 | 1953-1954 | 3-yr. Total | 1954-1955 |
|---|---|---|---|---|---|---|---|---|---|
| White Leghorn | 325 | 299 | 286 | 910 | 260 | 312 | 351 | 923 | 429 |
| White Plymouth Rock | 91 | 104 | 104 | 299 | 143 | 91 | 104 | 338 | 78 |
| Rhode Island Red | 117 | 130 | 26 | 273 | 26 | 26 | 52 | 104 | 52 |
| New Hampshire | 0 | 13 | 117 | 130 | 78 | 91 | 78 | 247 | 52 |
| Australorp | 13 | 0 | 13 | 26 | 52 | 52 | 52 | 156 | 26 |
| Brown Leghorn | 0 | 0 | 13 | 13 | 26 | 26 | 13 | 65 | 13 |
| White Wyandotte | 52 | 39 | 26 | 117 | 13 | 13 | 0 | 26 | 0 |
| Barred Plymouth Rock | 39 | 52 | 13 | 104 | 0 | 0 | 0 | 0 | 0 |
| Black Minorca | 0 | 0 | 13 | 13 | 13 | 13 | 0 | 26 | 0 |
| Buff Orpington | 0 | 0 | 13 | 13 | 13 | 0 | 0 | 13 | 0 |
| Jersey White Giant | 0 | 0 | 26 | 26 | 13 | 0 | 0 | 13 | 0 |
| California Gray | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 13 | 0 |
| Buff Leghorn | 13 | 13 | 0 | 26 | 0 | 0 | 0 | 0 | 0 |
| W. L. Red Cornish | 0 | 0 | 0 | 0 | 13 | 13 | 0 | 26 | 0 |
| Total | 650 | 650 | 650 | 1,950 | 650 | 650 | 650 | 1,950 | 650 |
| Number of total pullets entered by Okla. poultrymen | 195 | 195 | 416 | 806 | 390 | 299 | 247 | 936 | |

## Rations

The rations fed are listed and explained in Table 9. The low-energy ration consisted primarily of mash and oats fed **ad libitum,** and a hand-fed grain mixture of yellow corn, wheat, and kafir or milo. Oats were restricted slightly after the first year to control consumption to less than one-third of the total ration. The high-energy mash was also fed **ad libitum;** and the grain mixture of corn, oats, and kafir or milo was hand fed. Supplements were added to both the high-energy and the low-energy rations at different times of the year and under specific feeding schedules.

## Test Year

### 1939-40

One pint of liquid buttermilk or skimmilk was fed per 15 hens per day.

**TABLE 9.—Rations Fed Oklahoma Laying Test Entries During Test Years Reported (percent)**

| | 1939-40 | 1940-41 | 1948-49 | 1951-52 | 1952-53 | 1953-54 | 1954-55 |
|---|---|---|---|---|---|---|---|
| | | *Laying Mash* | | | | | |
| | Low energy laying mashes | | | High energy laying mashes | | | |
| Ground yellow corn | 17 | 18 | 28 | 18 | 43 | 38 | 44 |
| Kafir | | | | 20 | | | |
| Wheat bran | 28 | 18 | 10 | 10 | | | |
| Wheat shorts | 15 | 18 | 20 | 20 | 20 | 20 | 10 |
| Pulverived barley | 15 | 18 | 10 | | | | |
| Alfalfa meal (17%) | 7 | 6 | 10 | 5 | 5 | 5 | 5 |
| Meat and bone scrap (45%) | 10 | 10 | 5 | 5 | 5 | 5 | |
| Dried butyl solubles | | | | | | | 3 |
| Distillers dried solubles or dried buttermilk | | | 5 | | | | |
| Dried Whey | | | | | 2 | | 3 |
| Hidrolex | | | | | | 6 | |
| Fish meal (60%) | | | 5 | 5 | 5 | 5 | 10 |
| Dried fish solubles | | | | | | | 3 |
| Soybean oil meal (44%) | 3 | 5 | 5 | 12.5 | 12.5 | 12.5 | 10 |
| Cottonseed meal | 3 | 5 | | | | | |
| Dried brewers yeast | | | | | 2 | 2 | 2 |
| Fat | | | | | | | 3 |
| Salt | 1.0 | 1.0 | 1.0 | 0.5 | 0.5 | 0.5 | 0.5 |
| Calcium carbonate | 1.0 | 1.0 | 1.0 | 2.0 | 3.0 | 3.0 | 3.0 |
| Steamed bone meal | | | | 2.0 | | | |
| Mono-calcium phosphate | | | | | 2.0 | | |
| Di-calcium phosphate | | | | | | 2.0 | 3.0 |
| Trace mineral mix | | | | | | | 0.05 |
| Vitamin A and D feeding oil (2000A-400D) | 0.1 | 0.5 | | | | | |
| Dry vitamin $D_3$ (1500 AOACU/gm) | | | .025 | | | | |
| Carotene-riboflavin | | | | | | | |
| Mn $SO_4$ concentrate | | | 0.2 | | | | |
| Vitamin concentrate No. 4* | | | | 1.0 | 1.0 | | |
| Vitamin concentrate No. 12* | | | | | | 1.0 | |
| Vitamin concentrate VC-54* | | | | | | | 0.5 |
| Special vitamin mix** | | | | | | | 0.1 |
| | | *Scratch Grain* | | | | | |
| Yellow corn | 35 | 40 | 40 | 22 | 80 | 80 | 80 |
| Barley | 35 | 10 | 20 | | | | |
| Kafir | 15 | 30 | 40 | 64 | | | |
| Wheat | 15 | 20 | | | | | |
| Oats | Free choice | Free choice | Free choice | 14 | 20 | 20 | 20 |

* Vitamin concentrates add per pound of mash the following amounts:

| | No. 4 | No. 12 | VC-54 |
|---|---|---|---|
| Vitamin A | 4222 I.U. | 4358 I.U. | 3000 USP Units |
| Vitamin D-3 | 750 A.O.A.C.U. | 1280 I.C.U. | 750 I.C.U. |
| Riboflavin | 1.8 mg. | 2.07 mg. | 2 mg. |
| Pantothenic Acid | 3 mg. | 8.9 mg. | -- |
| Niacin | 8 mg. | 11.4 mg. | 13 mg. |
| Choline | 200 mg. | 340 mg. | 200 mg. |
| Vitamin B-12 | 3 micrograms | 3 micrograms | 2 micrograms |
| Procaine Penicillin | 2 mg. | 2 mg. | 2 mg. |
| Manganese | 35 ppm | 35 ppm | -- |
| Menadione | -- | -- | 3 mg. |

**The special vitamin mix adds per pound of mash 0.7 mg. of vitamin E and 0.8 mg. of folic acid.
Note—Supplements were added to each ration as indicated in text.

**1940-41**

Five percent of dried buttermilk replaced part of the cottonseed meal and soybean meal during the test period from October 1 to April 1.

**1948-49**

Ration-Ayd, manufactured by the Borden Company, was used at a level of 15 percent to replace the dried buttermilk or Distillers dried solubles.

**1951-52**

Sulfaquinoxaline was fed at a level of 0.0125 percent in the total ration during the months of October and November.

**1952-53**

The vitamin concentrate was used at a two percent level until March 1. The mono-calcium phosphate was increased from one to two percent on March 1.

Booster pellets were fed starting May 1.

E-emulsion was fed in block form during October and November.

Sulfaquinoxaline was fed at a level of 0.0125 percent in the total ration during the months of October and November.

**1953-54**

E-emulsion was fed in block form during October and November.

Regular mash in pellet form was fed as a noon lunch during the entire test year. Pellets were fortified with extra vitamins and protein starting in April.

Aureomycin at a level of 200 milligrams per pound of total ration was fed according to the following schedule: October—continuous, November—2 days per week; December—1 day per week; January and February—1 day every 2 weeks; Remainder of test year—as needed to stimulate egg production.

**1954-55**

E-emulsion was fed in block form during October, November, December and March.

Regular mash in pellet form was fed as a noon lunch during the entire test year. Pellets were fortified with extra vitamins and protein starting in April.

Aureomycin at a level of 200 milligrams per pound of total ration was fed according to the following schedule: October continuous, November —2 days per week; December—1 day per week; January and February —1 day every 2 weeks; Remainder of test year—as needed to stimulate egg production.

NFZ was fed as recommended for the first month of the test year.

**Data Accumulated**

The records kept in the operation of the laying test included the amount of mash, grain, grit and shell consumed by pens by months; mortality by days; and egg production for the individual hens. The body weight of the pullets was recorded in October at the beginning of the test year and in September at the close of the year. At the end of each month and at the end of each year, these records were summarized and a monthly or annual report was compiled.

The cost of each type of feed for each pen for each month was calculated, using the retail price of ingredients from the local mill in Stillwater, Oklahoma. No charge was made for mixing. Where feed costs and egg sales of the low-energy and high-energy rations were compared, the 1951-52, 1952-53, and 1953-54 egg prices and feed prices were used for both types of rations.

The feed consumption per hen and the hen-day egg production were figured on the actual number of living hens each month. The hen-housed egg production was calculated by dividing the total production at any given time by the 650 original pullets entered each year on October 1. The pounds of feed and the cost of feed per dozen eggs each month and for the year were determined for each pen and for the entire test by dividing the total pounds of feed consumed and the total cost of the feed by the number of dozens of eggs produced. The value of the eggs produced from each pen was determined each month, using the farm cash price of current receipts at Stillwater. The difference between egg sales and the cost of feed was calculated and reported as margin over feed cost.

In addition to the data listed above, the number, duration, and percent of weeks paused were calculated. In making these calculations, a period of seven continuous days or more without laying was termed as a pause. The percent of weeks paused was calculated by using the following formula:

$$\text{Percent weeks paused} = \frac{\text{Number of weeks paused}}{\text{Number of living hens} \times \text{Number of weeks in month or year}} \times 100.$$

Only the five most popular breeds were used in making the pause analysis. The records of those pens in which egg production ceased during a respiratory outbreak were not included in the pause analysis.

**Production Standards Used**

Data from the national standard egg-laying tests and from the R. O. P. entries throughout the United States were used as a standard of comparison in this study. From 1937 through 1946, the annual summary of egg production and mortality of all the national egg-laying tests was prepared each year under the auspices of the **American Poultry Journal** and published under the title of, "Who's Who in

U. S. Egg Laying Tests." This information was based on the actual published records of the various tests. Since 1947, the **Council of American Official Poultry Tests** has published the summary.

The R. O. P. data were obtained from the **Annual R. O. P.** Summaries, published by the United States Department of Agriculture, Bureau of Animal Industry. The R. O. P. pullets were trapnested 365 days, while the egg-laying-test birds were trapnested 357 days for the years 1937 to 1950 and 350 days from 1950 to date.

## Results and Discussion

### Egg Production

Table 10 shows the average annual hen-housed egg production by years for the seventeen years (1937-38 through 1953-54) of the Oklahoma Egg Laying Test, of all entries in all of the nation's standard egg-laying tests (including the Oklahoma Test), and of all U.S. R.O.P. breeders' entries.

**TABLE 10.—Annual Hen-Housed Egg Production for the Oklahoma Egg Laying Test, all Standard Egg Laying Tests in the Nation and all U. S. R. O. P. Candidates**

| | Average Egg Production Per Hen | | |
|---|---|---|---|
| Year | Oklahoma Test | All U. S. Tests | All R. O. P. Entries |
| 1937-38 | 175.7 | 186.8 | -- |
| 1938-39 | 171.7 | 176.0 | -- |
| 1939-40 | 199.0 | 193.1 | 164* |
| 1940-41 | 195.4 | 197.2 | 171* |
| 1941-42 | 181.6 | 198.0 | 176* |
| 1942-43 | 170.1 | 197.7 | 171* |
| 1943-44 | 178.1 | 201.2 | 173* |
| 1944-45 | 175.2 | 196.8 | 179* |
| 1945-46 | 167.8 | 208.5 | 179* |
| 1946-47 | 179.7 | 209.3 | 175 |
| 1947-48 | 187.7 | 208.0 | 185 |
| 1948-49 | 201.3 | 211.6 | 187 |
| 1949-50 | 196.7 | 211.8 | 189 |
| 1950-51 | 190.5 | 211.6 | 198 |
| 1951-52 | 218.2 | 216.5 | 198 |
| 1952-53 | 230.0 | 224.4 | 189 |
| 1953-54 | 234.4 | 224.8 | 197 |

*The averages for the R. O. P. entries for the years 1939-40 through 1945-46 are not comparable with the averages for the years 1946-47 through 1953-54, because the former period does not include all R. O. P. breeders.

Yearly production for the Oklahoma Test in 1937-38 was 175.7 eggs per hen and by 1953-54 it had increased to 234.4 eggs. The number of eggs per hen in the Oklahoma Test ranged from a low of 170.1 eggs in 1942-43 to a high of 234.4 eggs in 1953-54. The yearly average for all national tests was 186.8 eggs per hen in 1937-38, which increased to an average of 224.8 eggs per hen by 1953-54. The all-national egg-laying test average ranged from a low of 176 eggs per hen in 1938-39 to a high of 224.8 eggs in 1953-54. The all-national egg-laying tests production includes the Oklahoma Test production.

There was a gradual increase in egg production with fluctuations in both the Oklahoma Test and all tests from 1937-38 until 1951-52. Egg production increased from 175.7 eggs per hen in 1937-38 to 190.5 eggs in 1950-51 in the Oklahoma Test, which is a total increase of 14.9 eggs per hen for the 14-year period. The 14-year average annual egg production per hen in the Oklahoma Test was 183.6 eggs. For the same period, the nation's tests increased from 186.8 eggs to 211.6 eggs per hen, which is an increase of 24.8 eggs per hen. The all-tests average was 200.5 eggs per hen for the period from 1938 through 1951.

Average egg production for all of the pullets in the Oklahoma Test in 1951-52, the first year that high-energy rations were fed, increased 27.7 eggs per hen over that obtained the previous year. This was 16.9 eggs per hen over the average for the 1948-49 Test year, which had been the highest hen-housed production average for all of the years prior to 1951-52. The 13 standard tests' average for 1951-52 increased 4.9 eggs per hen over 1950-51, which included the 27.7 eggs per hen increase of the Oklahoma Test.

During the three years following 1950-51, when high-energy rations were used in the Oklahoma Test, the production per hen in the Oklahoma Test increased from 190.5 eggs per hen to 234.4 eggs. This is an increase of 43.9 eggs per hen during the three-year period. The three-year, hen-housed average during the 1951-54 period was 227.53 eggs per hen.

The average of the three highest years on record (1939-40, 1940-41, and 1948-49) when low-energy rations were fed was 198.57 eggs per hen. The hen-housed average of the three years immediately prior to 1951-52 was 196.17 eggs, which is 31.36 eggs less per hen when compared with the record three-year average for high-energy rations.

The entries in the standard tests in the nation averaged 211.7 eggs per hen during the three-year period of 1949-51 and 221.9 eggs during the three-year period of 1951-54. This is an increase of 10.2 eggs per hen as compared to an increase of 31.36 eggs per hen for the Oklahoma Test.

The R.O.P. entries, for the same two three-year periods, averaged 191.33 eggs and 194.70 eggs per hen, respectively. This is an increase of only 3.37 eggs per hen as compared to the 31.36 eggs per hen increase for the Oklahoma Test. The R.O.P. average number of eggs per hen of all entries for 1950-51 and 1951-52 was 198 eggs each year. The Oklahoma Test hens increased 27.7 eggs per hen to an average of 218.2 eggs in 1951-52. The R.O.P. production decreased one egg per hen during the period of 1951-52 through 1953-54 as compared to the increase of 43.9 eggs in the Oklahoma Egg Laying Test for the same three-year period.

**TABLE 11.—Egg Production, Pounds of Feed per Dozen Eggs, and Body Weight per Hen of Most Popular Breeds Participating in the Oklahoma Egg Laying Test by Three-Year Averages of the Best Years of Low-Energy Rations and the Three Years of High-Energy Rations**

| | LOW-ENERGY RATION 1939-40, 1940-41, 1948-49 | | | | | | HIGH-ENERGY RATION 1951-52, 1952-53, 1953-54 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Egg Production 3-Year Average | | Pounds of Feed | Body Weights 3-Year Average | | | Egg Production 3-Year Average | | Pounds of Feed | Body Weights 3-Year Average | | |
| | Hen Day | Hen Housed | Per Doz. Eggs | Oct. (Start) | Sept. (End) | Gain | Hen Day | Hen Housed | Per Doz. Eggs | Oct. (Start) | Sept. (End) | Gain |
| White Leghorn | 224.57 | 206.57 | 5.00 | 4.07 | 4.62 | .55 | 259.25 | 247.57 | 4.39 | 4.52 | 5.11 | .59 |
| Rhode Island Red | 226.05 | 205.67 | 5.67 | 5.33 | 6.11 | .78 | 257.77 | 249.60 | 4.50 | 5.19 | 5.62 | .43 |
| White Ply. Rock | 201.72 | 187.40 | 6.00 | 5.55 | 6.29 | .74 | 222.76 | 212.61 | 5.30 | 6.30 | 5.58 | .72 |
| New Hampshire | 184.25 | 175.14 | 6.41 | 5.02 | 6.00 | .98 | 212.80 | 205.85 | 5.51 | 5.37 | 6.03 | .66 |
| Australorp | 223.10 | 199.79 | 5.42 | 5.01 | 5.88 | .87 | 230.26 | 215.15 | 5.04 | 6.11 | 5.46 | .65 |
| All Breeds | 217.42 | 201.87 | 5.41 | 4.64 | 5.30 | .64 | 242.77 | 231.82 | 4.79 | 5.18 | 5.39 | .62 |

The White Leghorns and Rhode Island Reds had the highest egg production of all the breeds participating in the Oklahoma Test (Table 11). The three-year-average hen-housed egg production for White Leghorns when the high-energy rations were used (1951-54) was 247.57 eggs and for Rhode Island Reds was 249.6 eggs per hen. This is an increase of 41.16 eggs per hen for Leghorns over the three highest years prior to 1951-52 and an increase of 43.93 eggs per hen for the Rhode Island Reds. The difference is even greater when the 1951-54 average is compared with the 1948-51 three-year-average production. The increase in egg production for these two breeds when high-energy rations were fed was proportionately greater than the all-beeds average.

Thus the high-energy rations were of more benefit to the higher producing breeds and strains of layers. This indicates that a commercial egg-producing enterprise could profit more from using the high-energy rations than could the general-purpose type of poultry enterprise, but that the lower-producing flocks could expect some benefit.

It is recognized that these comparisons have no experimental controls; but research workers Gerry **et al.** (1952), Singsen **et al.** (1952), Skinner **et al.** (1951), and Lillie **et al.** (1951), among others, have obtained significant increases in egg production by altering rations to increase energy and protein, to decrease fiber, to improve nutritive balance, and to increase vitamins. Similar results were obtained in the feeding tests reported earlier in this bulletin. From the comparisons made, it can be concluded that the changes in breeders and breeds which participated from year to year in the Oklahoma Egg Laying Test, and the improvement in egg production which can be expected from year to year as shown by R.O.P. records, could not account for all of the increase in egg production when the high-energy rations were adopted.

**Mortality**

Table 12 shows the percent mortality by years for the seventeen years, 1937-38 through 1953-54, for the Oklahoma Test and for the average of all entries in all the nation's egg laying tests. Yearly mortality in the Oklahoma Test ranged from a high of 28.5 percent in 1938-39, to a low of 10.3 percent in 1954-55. The mortality in all the standard egg laying tests ranged from a high of 23.3 percent in 1937-38 to a low of 11.3 percent in 1954-55.

When the high-energy rations were used in the Oklahoma Test for the years of 1951-52, 1952-53, and 1953-54, the mortality was 13.1, 12.6, and 14.2 percent, respectively, with an average of 13.3 percent. All the standard tests averaged 13.5 percent for the same three years. Mortality for all the years prior to 1951-52 in the Oklahoma Test was higher than the standard test averages each year, with the exception of the year 1939-40 when the Oklahoma average was 20.3 and the all-tests average was 20.4 percent.

The nature of the egg-laying test operation made it necessary to transport the pullets to the test and to house pullets from different farms in adjacent pens in the same building. In many instances the pullets were not in good physical condition when they arrived at the Test and had previously been exposed to respiratory infections. As a result, respiratory disorders were a serious problem thoughout the majority of pens in each year of this study prior to 1951-52.

For this reason high-energy rations with additional quantities of vitamins were adopted by the Oklahoma test in 1951-52. In addition, sulfaquinozaline was added to the test mash during the months of October, November, and December in 1951-52 and 1952-53. In the 1953-54 Oklahoma test, sulfaquinoxaline was not fed in the ration. Instead, aureomycin was used continuously at the rate of 400 gm. per ton of ration during the first month, one day per week during the second month, one day each two weeks during the third month, and once per month in January and February.

When high energy rations supplemented with high levels of vitamins, sulfa drugs, and antibiotics were fed there was an immediate increase both in egg production and in October through January feed consumption. Health and viability of the layers were also improved. The severe respiratory symptoms, which became evident during the month of October, were confined to six or eight pens.

**Production Summary by Breeds**

The three years of highest production in the Oklahoma Egg Laying Test prior to the use of high-energy rations (1939-40, 1940-41 and 1948-49) and the four years of 1951-52, 1952-53, 1953-54, and 1954-55, when high-energy rations were used, are summarized in Tables 13, and 14.

**TABLE 12.—Annual Mortality for the Oklahoma Egg Laying Test and all Standard Egg Laying Tests in the Nation**

| | *PERCENT MORTALITY* | |
|---|---|---|
| | Oklahoma Tests | All U. S. Tests |
| 1937-38 | 24.7 | 23.3 |
| 1938-39 | 28.5 | 21.4 |
| 1939-40 | 20.3 | 20.4 |
| 1940-41 | 20.8 | 19.4 |
| 1941-42 | 19.7 | 17.6 |
| 1942-43 | 27.7 | 19.1 |
| 1943-44 | 22.3 | 17.7 |
| 1944-45 | 18.9 | 17.1 |
| 1945-46 | 26.0 | 14.5 |
| 1946-47 | 23.4 | 14.9 |
| 1947-48 | 16.8 | 13.9 |
| 1948-49 | 14.8 | 14.6 |
| 1949-50 | 15.7 | 14.2 |
| 1950-51 | 16.8 | 14.5 |
| 1951-52 | 13.1 | 14.8 |
| 1952-53 | 12.6 | 13.1 |
| 1953-54 | 14.2* | 12.7 |
| 1954-55 | 10.3 | 11.3 |

* Mortality due to heat prostration was increased by the extremely high summer temperatures during 1954.

**TABLE 13.—Feed Consumed, Egg Production, Pounds of Feed per Dozen Eggs and Body Weight per Hen by Breeds — Oklahoma Egg Laying Test**
**Low-Energy Ration**

| | Pounds of Feed Consumed | | | | | | Egg Production | | Lbs. Feed | Body Weight (Lbs.) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oats | Mash | Grit | Shell | Grain | Total | Hen Day | Hen Housed | Per Doz. Eggs* | Beginning | Ending | Gain |
| *1939-40* | | | | | | | | | | | | |
| Rhode Island Red | 36.85 | 35.00 | 1.78 | 3.28 | 30.90 | 108.10 | 217.00 | 208.0 | 5.70 | 5.15 | 6.03 | .88 |
| White Ply. Rock | 36.70 | 35.24 | 1.85 | 3.24 | 31.10 | 108.20 | 201.20 | 181.7 | 6.15 | 5.38 | 6.32 | .94 |
| White Wyandotte | 32.90 | 29.90 | 1.59 | 3.20 | 30.21 | 98.00 | 200.10 | 189.8 | 5.59 | 5.06 | 5.83 | .77 |
| Barred Ply. Rock | 38.90 | 32.13 | 1.76 | 3.57 | 34.50 | 110.60 | 225.70 | 203.7 | 5.60 | 5.48 | 6.79 | 1.31 |
| Australorp | 33.27 | 28.56 | 1.52 | 3.66 | 29.67 | 96.62 | 211.40 | 200.9 | 5.19 | 4.91 | 5.83 | .92 |
| Buff Leghorn | 32.10 | 18.44 | 1.06 | 2.46 | 29.18 | 74.05 | 158.40 | 151.3 | 5.34 | 3.01 | 3.66 | .65 |
| White Leghorn | 29.50 | 31.90 | 1.43 | 3.75 | 34.10 | 100.70 | 226.40 | 203.2 | 5.06 | 4.00 | 4.49 | .49 |
| All Breeds | 32.60 | 32.40 | 1.58 | 3.52 | 32.63 | 102.78 | 217.78 | 199.0 | 5.39 | 4.57 | 5.27 | .70 |
| *1940-41* | | | | | | | | | | | | |
| Rhode Island Red | 31.80 | 40.74 | 1.70 | 3.75 | 39.14 | 117.13 | 244.45 | 208.72 | 5.48 | 5.45 | 6.05 | .60 |
| White Ply. Rock | 27.70 | 31.50 | 1.80 | 3.00 | 37.52 | 101.52 | 191.88 | 182.66 | 6.04 | 5.59 | 6.23 | .64 |
| White Wyandotte | 21.99 | 31.82 | 1.39 | 2.96 | 37.93 | 96.09 | 199.48 | 189.25 | 5.51 | 4.97 | 6.03 | 1.06 |
| Barred Ply. Rock | 34.92 | 27.41 | 2.61 | 3.67 | 40.18 | 108.79 | 218.48 | 172.26 | 5.63 | 5.39 | 6.52 | 1.13 |
| Buff Leghorn | 23.29 | 20.61 | 1.06 | 2.83 | 31.02 | 78.81 | 176.30 | 176.30 | 5.10 | 3.40 | 4.02 | .62 |
| New Hampshire | 24.20 | 34.00 | 1.02 | 2.71 | 36.47 | 98.40 | 170.41 | 157.30 | 6.66 | 4.98 | 6.03 | 1.05 |
| White Leghorn | 19.22 | 32.94 | 1.14 | 3.56 | 35.09 | 91.95 | 217.41 | 201.41 | 4.81 | 3.83 | 4.40 | .57 |
| All Breeds | 24.46 | 33.46 | 1.47 | 3.44 | 36.72 | 99.55 | 216.64 | 195.43 | 5.27 | 4.64 | 5.32 | .68 |
| *1948-49* | | | | | | | | | | | | |
| Rhode Island Red | 25.9 | 41.2 | 2.4 | 3.2 | 38.1 | 110.8 | 216.70 | 200.03 | 5.82 | 5.38 | 6.25 | .87 |
| White Ply. Rock | 26.4 | 36.5 | 2.7 | 3.6 | 39.6 | 108.8 | 212.12 | 197.84 | 5.80 | 5.69 | 6.31 | .62 |
| White Wyandotte | 27.1 | 42.6 | 2.5 | 3.7 | 41.6 | 117.5 | 190.21 | 182.29 | 7.04 | 5.84 | 6.62 | .78 |
| Barred Ply. Rock | 25.8 | 38.3 | 1.8 | 3.9 | 38.3 | 108.1 | 235.76 | 235.76 | 5.21 | 5.31 | 6.01 | .70 |
| New Hampshire | 25.9 | 37.5 | 1.9 | 3.3 | 38.3 | 106.9 | 198.10 | 193.02 | 6.16 | 5.07 | 5.96 | .89 |
| Buff Orpington | 24.4 | 33.4 | 2.2 | 3.7 | 34.6 | 98.3 | 195.53 | 195.53 | 5.67 | 5.01 | 5.95 | .94 |
| Black Minorca | 27.6 | 37.1 | 2.3 | 4.1 | 38.4 | 109.5 | 202.25 | 186.69 | 6.11 | 4.48 | 4.89 | .41 |
| Jersey W. Giant | 25.4 | 31.1 | 3.0 | 3.6 | 38.8 | 101.9 | 169.91 | 156.84 | 6.73 | 5.92 | 5.30 | .62 |
| Australorp | 30.9 | 41.3 | 2.2 | 5.2 | 38.7 | 118.3 | 234.81 | 198.69 | 5.66 | 5.09 | 5.93 | .84 |
| Brown Leghorn | 22.1 | 31.9 | 2.1 | 3.3 | 36.1 | 95.5 | 172.75 | 159.46 | 6.26 | 4.27 | 4.81 | .54 |
| White Leghorn | 26.4 | 36.3 | 2.6 | 4.1 | 35.9 | 105.3 | 229.90 | 214.63 | 5.14 | 4.37 | 4.97 | .60 |
| All Breeds | 26.0 | 37.4 | 2.4 | 3.8 | 37.1 | 106.8 | 213.90 | 201.36 | 5.64 | 4.91 | 5.55 | .64 |

* Does not include grit and shell, and hen-day egg production is used.

**TABLE 14.—Feed Consumed, Egg Production, Pounds of Feed per Dozen Eggs and Body Weight per Hen by Breeds—Oklahoma Egg Laying Test
High-Energy Ration**

| | Pounds of Feed Consumed | | | | | Egg Production | | Lbs. Feed Per Doz. Eggs* | Body Weight (Lbs.) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mash | Grit | Shell | Grain | Total | Hen Day | Hen Housed | | Beginning | Ending | Gain |
| *1951-52* | | | | | | | | | | | |
| Rhode Island Red | 45.60 | .87 | 2.96 | 46.48 | 96.01 | 222.48 | 213.92 | 4.97 | 5.21 | 5.57 | .36 |
| White Ply. Rock | 53.17 | 2.34 | 3.35 | 49.46 | 108.32 | 215.08 | 202.65 | 5.72 | 5.41 | 6.22 | .81 |
| White Wyandotte | 45.60 | .87 | 2.96 | 46.58 | 96.01 | 211.83 | 195.54 | 5.22 | 5.21 | 5.57 | .36 |
| Buff Orpington | 49.40 | 3.25 | 5.00 | 47.62 | 105.27 | 220.90 | 220.33 | 5.27 | 5.36 | 6.07 | .71 |
| Australorp | 54.33 | 1.91 | 3.61 | 50.03 | 109.88 | 246.19 | 227.25 | 5.09 | 5.34 | 6.03 | .69 |
| Jersey W. Giant | 52.82 | 4.16 | 4.00 | 48.25 | 109.26 | 194.90 | 194.07 | 6.22 | 5.45 | 6.10 | .65 |
| W. L. Red Cornish | 34.67 | 3.10 | 3.91 | 45.16 | 86.84 | 104.61 | 104.61 | 9.15 | 5.02 | 6.07 | 1.05 |
| Black Minorca | 61.27 | 2.64 | 4.69 | 44.95 | 113.55 | 184.00 | 183.92 | 6.92 | 4.80 | 5.69 | .89 |
| New Hampshire | 51.09 | 1.92 | 3.56 | 46.91 | 103.48 | 203.71 | 203.25 | 5.63 | 5.20 | 6.00 | .80 |
| Brown Leghorn | 44.83 | 2.57 | 4.07 | 43.23 | 94.70 | 189.12 | 181.85 | 5.59 | 4.01 | 4.76 | .75 |
| White Leghorn | 54.58 | 2.59 | 4.73 | 44.88 | 106.78 | 254.75 | 242.99 | 4.50 | 4.44 | 5.18 | .74 |
| All Breeds | 52.93 | 2.44 | 4.06 | 46.88 | 106.31 | 226.96 | 218.15 | 5.28 | 4.91 | 5.67 | .76 |
| *1952-53* | | | | | | | | | | | |
| Rhode Island Red | 56.58 | 2.54 | 3.34 | 41.29 | 103.75 | 279.08 | 268.34 | 4.21 | 5.10 | 5.87 | .77 |
| White Ply. Rock | 55.06 | 2.57 | 3.43 | 42.37 | 103.43 | 229.64 | 224.52 | 5.09 | 5.53 | 6.60 | 1.07 |
| White Wyandotte | 52.10 | 1.18 | 3.35 | 38.50 | 95.13 | 221.30 | 221.30 | 4.91 | 4.92 | 5.78 | .86 |
| New Hampshire | 55.46 | 2.27 | 3.29 | 42.43 | 103.45 | 216.52 | 204.69 | 5.43 | 5.35 | 6.14 | .79 |
| Australorp | 53.80 | 1.62 | 4.10 | 41.25 | 100.77 | 224.59 | 211.63 | 5.08 | 5.46 | 6.23 | .77 |
| W. L. Red Cornish | 28.90 | 1.45 | 2.45 | 40.90 | 73.70 | 96.00 | 81.23 | 7.27 | 4.60 | 5.44 | .84 |
| California Gray | 45.60 | 2.16 | 4.51 | 39.10 | 91.37 | 231.00 | 231.00 | 4.40 | 5.13 | 6.13 | 1.00 |
| Black Minorca | 57.10 | 2.17 | 3.95 | 39.10 | 102.32 | 202.76 | 202.76 | 5.69 | 5.22 | 5.98 | .76 |
| Brown Leghorn | 50.20 | 1.13 | 3.30 | 39.80 | 94.43 | 180.39 | 159.58 | 5.99 | 4.21 | 4.98 | .77 |
| White Leghorn | 56.64 | 2.23 | 5.11 | 37.41 | 101.39 | 260.90 | 252.77 | 4.33 | 4.52 | 5.21 | .69 |
| All Breeds | 54.91 | 21.17 | 4.28 | 39.51 | 100.87 | 239.49 | 230.05 | 4.74 | 4.90 | 5.68 | .78 |

**TABLE 14.—(Continued)**

| | Pounds of Feed Consumed | | | | | Egg Production | | Lbs. Feed Per Doz. Eggs* | Body Weight (Lbs.) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mash | Grit | Shell | Grain | Total | Hen Day | Hen | | Beginning | Ending | Grain |
| | | | | | *1953-54* | | | | | | |
| Rhode Island Red | 62.51 | .96 | 3.57 | 35.42 | 102.47 | 271.76 | 266.54 | 4.32 | 5.26 | 5.42 | .16 |
| Australorp | 56.68 | 1.12 | 2.84 | 34.12 | 94.76 | 220.10 | 206.56 | 4.95 | 5.60 | 6.07 | .47 |
| New Hampshire | 61.24 | 1.21 | 2.74 | 35.42 | 100.61 | 212.38 | 209.60 | 5.46 | 5.57 | 5.96 | .39 |
| White Ply. Rock | 57.92 | 1.33 | 2.64 | 36.92 | 98.81 | 223.56 | 210.66 | 5.09 | 5.81 | 6.09 | .28 |
| Brown Leghorn | 56.53 | 1.08 | 3.35 | 30.97 | 91.93 | 215.85 | 215.85 | 4.86 | 4.18 | 4.00 | .18 |
| White Leghorn | 63.50 | 1.54 | 4.52 | 31.58 | 101.14 | 262.09 | 246.96 | 4.35 | 4.60 | 4.95 | .35 |
| All Breeds | 61.57 | 1.38 | 3.77 | 33.39 | 100.11 | 244.55 | 234.38 | 4.66 | 5.03 | 5.36 | .33 |
| | | | | | *1954-55* | | | | | | |
| White Leghorn | 59.54 | 1.66 | 4.16 | 31.41 | 96.78 | 255.11 | 243.72 | 4.28 | 4.27 | 4.91 | .64 |
| Bn. Leghorn | 57.33 | 1.50 | 3.96 | 31.16 | 93.96 | 205.38 | 205.38 | 5.17 | 4.00 | 4.73 | .73 |
| S.C.R.I. Red | 59.07 | 1.57 | 3.44 | 34.98 | 99.07 | 269.10 | 253.57 | 4.19 | 5.01 | 5.73 | .72 |
| Australorp | 57.41 | 1.33 | 2.92 | 33.66 | 95.33 | 228.00 | 219.23 | 4.79 | 5.15 | 5.91 | .76 |
| New Hampshire | 61.03 | 1.51 | 2.91 | 34.84 | 100.30 | 184.74 | 177.65 | 6.29 | 5.48 | 6.28 | .80 |
| White Ply. Rock | 57.75 | 1.26 | 3.09 | 34.97 | 97.09 | 220.00 | 211.60 | 5.05 | 5.58 | 6.56 | .98 |
| All Breeds | 53.88 | 1.50 | 3.82 | 32.48 | 97.17 | 242.83 | 233.68 | 4.56 | 4.61 | 5.31 | .71 |

* Does not include grit and shell, and hen-day egg production is used.

The feed consumption for the low-energy rations is given in Table 13, for the oats, mash, grit, and shell, each of which was fed **ad libitum,** and for the grain mixture which was hand-fed in the late afternoon. During the first year, no restriction was made on the oats consumption; and the amount of oats, mash, and grain consumed per hen was 32.60, 32.40, and 32.63 pounds, respectively, for the year. During the other two years during which the low-energy rations were fed, the oats were slightly restricted to 24.46 and 26.0 pounds and the mash and grain consumption increased.

There was practically no difference between the low-energy and the high-energy rations in the three-year-average amount of total feed consumed per hen, as shown in Tables 13 and 14. Table 14 shows, however, that the mash consumption increased and total grain consumption decreased when high-energy rations were used. Mash consumption increased and grain consumption decreased progressively each year from 1951-52 to 1953-54. This was due to both the improvements which were made in the high-energy rations and the yearly increase in egg production. However, the large increase in egg production resulted in a decrease in pounds of feed per dozen eggs for the high-energy feed.

The pounds of feed per dozen eggs for the low-energy rations in 1938-39, 1939-40, and 1948-49 were 5.39, 5.27 and 5.64, respectively, for the average of all breeds. By comparison, the pounds of feed per dozen eggs for the high-energy years were 5.28 in 1951-52, 4.74 in 1952-53, and 4.66 in 1953-54, as shown in Table 14.

The three-year average reduction in pounds of feed per dozen eggs was 0.62 for the five most popular breeds represented as shown in Table 11. The five popular breeds averaged 5.41 pounds of feed per dozen eggs for the three highest years prior to 1951-52 and 4.79 pounds for the years 1951-54. White Leghorns fed the low-energy feeds consumed 5.00 pounds of feed per dozen eggs, compared to 4.39 pounds on high-energy feeds. When high-energy rations were used, the Rhode Island Reds, White Plymouth Rocks, and New Hampshires had a slightly larger reduction than did the White Leghorns in pounds of feed per dozen eggs produced. However, the three heavy breeds required 5.10 pounds of feed per dozen eggs on the high-energy ration, as compared to 4.39 pounds per dozen eggs for the White Leghorns.

The average body weights of all breeds as listed in Tables 13 and 14 reveal little difference in gain during the year on the two types of rations, with the exception of 1953-54. The 1953-54 test year included a record-breaking summer from the standpoint of high temperatures, which decreased feed consumption. This partially accounts for the poorer weight gains during this year. The pullets in the 1953-54 test were also the heaviest in October as compared to other years, which gave them less opportunity to gain weight after they arrived at the laying test. The average yearly gain in body weight for all breeds ranged from a low of 0.64 pounds in 1948-49 to a high of 0.78 pounds in 1952-53.

The high-energy rations cost 64 cents more per 100 pounds than did the low-energy rations, when the same ingredient prices were used. Cost of feed per dozen eggs was higher for the years when high-energy rations were used. The feed cost for each dozen eggs produced was 1.51 cents more for the high-energy rations than for the low-energy rations. This points out the fact that the cost of feed per dozen eggs is not necessarily a criterion for measuring the profitableness of two different rations. This study shows that the amount of margin between the total sales and the total feed cost for the year determines the profitableness. When the high-energy rations were used in 1951-54, egg production increased and the additional number of dozens of eggs sold resulted in additional returns over the feed costs.

The number of eggs produced during the months of October, November, and December, when egg prices are usually highest, was another important factor influencing net income in this study. The greatest difference in egg production, between the years when low-energy and high-energy rations were fed, occurred during the period from October through January. The greater production secured from the high-energy rations in October, November and December resulted in larger returns from more eggs and higher egg prices.

The feed cost and egg sales comparisons made in this study for the low-energy rations consisted of the three best production years prior to 1951-52. If the egg production of the three years just prior to 1951-52 had been used, the differences in favor of the high-energy rations would have been still greater.

**Production Summary of Five Popular Breeds**

Table 11 shows the three-year average egg production, pounds of feed per dozen eggs, and the body weights of the five most popular breeds for the three best years with low-energy rations and for the three years with high-energy rations.

As a breed, the Rhode Island Reds and the White Leghorns had the highest three-year-average hen-housed egg production on both types of rations. The Rhode Island Reds produced 249.60 eggs and the White Leghorns 247.57 on the high-energy rations and 205.67 eggs and 206.41 eggs per hen, respectively, for the three highest production years on the low-energy rations. This is a difference of 44.93 eggs per hen for Rhode Island Reds and 41.16 eggs per hen for White Leghorns in favor of the high-energy rations.

The hen-housed egg production of all five breeds averaged 29.95 more eggs per hen during the three years when high-energy rations were fed than the average for the three best years when low-energy rations were fed.

The three-year average, 1951-52 through 1953-54, for pounds of high-energy feed per dozen eggs for all five popular breeds was 4.79

pounds as compared to an average of 5.41 pounds for the three best years when low-energy rations were fed.

The White Leghorns averaged 4.39 pounds and the Rhode Island Reds averaged 4.50 pounds of feed per dozen eggs during the years from 1951 to 1954. The average pounds of feed per dozen eggs was 5.00 pounds for White Leghorns and 5.67 for the Rhode Island Reds during the three best years with low-energy rations. This indicates that the Rhode Island Reds consumed proportionately more feed per dozen eggs on the low-energy formulas than did the White Leghorns, even though there was little difference in the egg production of the two breeds.

## Total Feed Costs and Egg Sales by Months for Each Year

Pounds of feed consumed, total cost of the feed per dozen eggs, receipts from sale of eggs, eggs produced, egg prices, and the difference

**TABLE 15.—Highest Hen-Day Record Year**

| Month | Feed Consumed (Pounds) | Cost of feed | Flock Margin Over Feed | Egg Sales | Egg Prices | Feed Cost Per Dozen | Eggs Produced |
|---|---|---|---|---|---|---|---|
| | | | Low-Energy Rations 1939-40 650 Pullets Housed | | | | |
| Oct. | 5,618.90 | $ 191.23 | $ 243.32 | $ 434.55 | $.4620 | $.2033 | 11,287 |
| Nov. | 5,405.00 | 195.59 | 237.01 | 432.60 | .4500 | .2035 | 11,536 |
| Dec. | 5,776.10 | 210.43 | 242.93 | 453.36 | .4561 | .2117 | 11,928 |
| Jan. | 5,587.30 | 200.79 | 202.34 | 403.13 | .4300 | .2142 | 11,250 |
| Feb. | 5,615.40 | 212.95 | 175.03 | 387.98 | .3950 | .2175 | 11,757 |
| Mar. | 5,295.70 | 201.13 | 155.29 | 356.42 | .3312 | .1835 | 12,914 |
| Apr. | 5,336.50 | 207.73 | 66.41 | 273.14 | .2716 | .2062 | 12,090 |
| May | 5,441.90 | 211.56 | 58.43 | 269.99 | .2692 | .2111 | 12,031 |
| Jun. | 5,874.60 | 165.15 | 41.04 | 206.19 | .2350 | .1844 | 10,520 |
| Jul. | 4,907.30 | 185.46 | 95.62 | 281.08 | .3390 | .2253 | 9,932 |
| Aug. | 4,357.80 | 179.90 | 83.36 | 263.26 | .3564 | .2435 | 8,864 |
| Sept.* | 1,913.20 | 71.99 | 30.41 | 102.40 | .3500 | .2463 | 3,507 |
| Total | 60,129.70 | $2,233.91 | $1,631.19 | $3,864.10 | .3601 | .2101 | 127,616 |

The average cost of the low-energy ration (including grit and shell) per 100 lbs. was $3.71. Components were made with the 1953-54 egg and feed prices.

| Month | Feed Consumed (Pounds) | Cost of feed | Flock Margin Over Feed | Egg Sales | Egg Prices | Feed Cost Per Dozen | Eggs Produced |
|---|---|---|---|---|---|---|---|
| | | | High-Energy Rations 1953-54 650 Pullets Housed | | | | |
| Oct. | 6,281.80 | $ 356.43 | $ 214.71 | $ 571.14 | $.4620 | $.2886 | 14,828 |
| Nov. | 6,480.00 | 267.80 | 294.73 | 562.53 | .4500 | .2183 | 15,216 |
| Dec. | 6,370.50 | 272.88 | 317.71 | 590.59 | .4561 | .2107 | 15,542 |
| Jan. | 6,127.20 | 258.75 | 274.47 | 533.23 | .4300 | .2085 | 14,893 |
| Feb. | 5,443.80 | 232.78 | 216.25 | 449.03 | .3950 | .2058 | 13,571 |
| Mar. | 5,908.90 | 243.54 | 157.85 | 401.39 | .3312 | .2009 | 14,544 |
| Apr. | 5,348.60 | 230.21 | 87.88 | 317.09 | .2716 | .1962 | 14,081 |
| May | 5,587.30 | 260.55 | 41.38 | 301.93 | .2692 | .2319 | 13,479 |
| Jun. | 5,035.30 | 212.54 | 29.94 | 241.94 | .2350 | .2161 | 12,371 |
| Jul. | 3,817.80 | 184.99 | 107.17 | 292.17 | .3390 | .2145 | 10,322 |
| Aug. | 3,987.14 | 201.21 | 82.98 | 284.20 | .3564 | .2540 | 9,511 |
| Sep.* | 1,933.80 | 97.28 | 19.08 | 116.36 | .3500 | .2920 | 4,000 |
| Total | 62,321.10 | $2,818.96 | $1,844.15 | $4,663.12 | .3601 | .2281 | 152,347 |

The average cost of high-energy ration (including grit and shell) per 100 pounds was $4.52.
*Only the first half of September was included in the test year.

between the cost of feed and egg sales, which is called the "flock margin over feed cost," are recorded in Tables 15, 16, and 17.

The egg production and feed consumption figures are the actual records for each of the three highest production years on the low-energy rations and the three years with high-energy rations. The egg and feed prices used in Table 15 for both types of rations are for the year 1953-54. The feed consumption and the cost of feed per dozen eggs were higher for the high-energy ration as shown in Table 20. However, the increased egg production when high-energy rations were fed resulted in a greater flock margin over feed cost for the months of November through April, for July, and for the entire year. Returns from egg sales for both years were higher during the fall and winter months because of higher egg prices. The flock margin over feed cost for the year 1953-54 was $1,844.15 as compared to $1,631.19 in 1939-40 for the low-energy feed.

**TABLE 16.—Second Highest Hen-Day Record Year**

| Month | Feed Consumed (Pounds) | Cost of feed | Flock Margin Over Feed | Egg Sales | Egg Prices | Feed Cost Per Dozen | Eggs Produced |
|---|---|---|---|---|---|---|---|
| | | | Low-Energy Ration 1940-41 650 Pullets Housed | | | | |
| Oct. | 5,281.9 | $ 185.42 | $ 211.14 | $ 396.56 | $.4560 | $.2132 | 10,436 |
| Nov. | 4,304.4 | 188.01 | 196.62 | 384.63 | .5006 | .2447 | 9,220 |
| Dec. | 5,264.8 | 184.76 | 241.77 | 426.53 | .5100 | .2209 | 10,036 |
| Jan. | 5,634.6 | 197.95 | 244.67 | 442.62 | .4280 | .1914 | 12,410 |
| Feb. | 5,172.1 | 182.44 | 183.51 | 365.95 | .3720 | .1854 | 11,805 |
| Mar. | 5,525.9 | 195.89 | 219.90 | 415.79 | .3819 | .1799 | 13,065 |
| Apr. | 5,256.9 | 180.49 | 218.26 | 398.75 | .3840 | .1738 | 12,461 |
| May | 5,309.5 | 182.90 | 238.85 | 421.75 | .4115 | .1784 | 12,299 |
| Jun. | 5,032.4 | 171.17 | 162.29 | 333.46 | .3620 | .1858 | 11,054 |
| Jul. | 3,912.4 | 137.28 | 230.96 | 368.24 | .4320 | .1610 | 10,229 |
| Aug. | 4,167.6 | 145.96 | 184.23 | 330.19 | .4450 | .1967 | 8,904 |
| Sep.* | 2,049.9 | 70.34 | 57.38 | 127.72 | .4500 | .2478 | 3,406 |
| Total | 57,912.4 | $2,022.61 | $2,389.58 | $4,412.19 | .4277 | .1937 | 125,325 |
| | | | High-Energy Ration 1952-53 650 Pullets Housed | | | | |
| Oct. | 5,830.9 | $ 314.62 | $ 184.65 | $ 499.27 | $.4560 | $.2870 | 13,155 |
| Nov. | 6,367.4 | 266.78 | 315.39 | 582.17 | .5006 | .2293 | 13,963 |
| Dec. | 6,144.1 | 258.63 | 355.86 | 614.49 | .5100 | .2146 | 14,460 |
| Jan. | 6,260.4 | 257.41 | 261.91 | 519.32 | .4280 | .2110 | 14,543 |
| Feb. | 5,447.1 | 225.58 | 174.50 | 400.08 | .3720 | .2097 | 12,906 |
| Mar. | 5,823.5 | 217.28 | 242.39 | 459.67 | .3819 | .1804 | 14,455 |
| Apr. | 5,496.8 | 212.56 | 222.28 | 434.84 | .3840 | .1877 | 13,589 |
| May | 5,574.5 | 230.80 | 231.99 | 462.79 | .4115 | .2052 | 13,494 |
| Jun. | 4,338.1 | 184.81 | 175.85 | 360.66 | .3620 | .1857 | 11,983 |
| Jul. | 4,858.2 | 210.24 | 204.96 | 415.20 | .4320 | .2187 | 11,534 |
| Aug. | 4,666.1 | 198.14 | 198.90 | 397.04 | .4450 | .2216 | 10,731 |
| Sep.* | 2,071.1 | 88.34 | 86.70 | 175.04 | .4500 | .2265 | 4,680 |
| Total | 62,878.2 | $2,665.19 | $2,655.38 | $5,320.57 | $.4277 | $.2139 | 149,493 |

The average cost of the low-energy ration (including grit and shell) per 100 pounds was $3.49. Computations were made with 1952-53 egg and feed prices.
The average cost of the high-energy ration (including grit and shell) per 100 pounds was $4.23.
*Only the first half of September was included in the test year.

In Table 16, egg and feed prices for 1952-53 were used in calculating costs and returns for both 1940-41 and 1952-53. Results were similar to those reported in Table 15, except that higher egg prices netted considerably more margin over feed cost. The low-energy feed returned a flock margin over feed cost of $2,389.58 for the year, and the high-energy feed returned $2,655.38 above the feed cost. This indicates that the high-energy rations return a proportionately greater net income than the low-energy rations when normal or above normal egg prices exist.

Table 17 shows the cost and return records for the low-energy ration in 1948-49 and for the high-energy ration in 1951-52, using the 1951-52 egg and feed prices. Low egg prices prevailed which resulted in less margin over feed cost, but the difference again favored the high-energy, higher-cost ration. Superior production on the high-energy ration was responsible for this advantage each year.

## TABLE 17.—Third Highest Hen-Day Record Year

| Month | Feed Consumed (Pounds) | Cost of feed | Flock Margin Over Feed | Egg Sales | Egg Prices | Feed Cost Per Dozen | Eggs Produced |
|---|---|---|---|---|---|---|---|
| | | | Low-Energy Ration 1948-49 650 Pullets Housed | | | | |
| Oct. | 5,746.7 | $ 208.75 | $ 309.37 | $ 518.12 | $.5213 | $.2100 | 11,927 |
| Nov. | 6,397.2 | 238.51 | 221.89 | 460.40 | .5330 | .2761 | 10,366 |
| Dec. | 6,065.6 | 233.66 | 210.45 | 444.11 | .4630 | .2436 | 11,511 |
| Jan. | 6,358.5 | 239.45 | 75.45 | 314.90 | .3241 | .2464 | 11,659 |
| Feb. | 6,040.6 | 222.41 | 50.03 | 272.44 | .2851 | .2327 | 11,462 |
| Mar. | 5,988.1 | 227.43 | 85.75 | 313.18 | .2858 | .2075 | 13,150 |
| Apr. | 5,518.8 | 208.59 | 87.33 | 295.92 | .2900 | .2044 | 12,245 |
| May | 5,897.3 | 218.98 | 71.08 | 290.06 | .2809 | .2121 | 12,392 |
| Jun. | 5,130.4 | 189.96 | 88.16 | 278.12 | .3133 | .2140 | 10,653 |
| Jul. | 4,689.6 | 184.83 | 121.54 | 306.39 | .3576 | .2157 | 10,282 |
| Aug. | 4,526.5 | 180.21 | 173.56 | 353.77 | .4450 | .2267 | 9,540 |
| Sep.* | 2,052.3 | 84.02 | 70.02 | 154.04 | .4850 | .2645 | 3,812 |
| Total | 64,411.6 | $2,436.82 | $1,564.63 | $4,001.45 | $.3820 | $.2267 | 128,999 |
| | | | High-Energy Ration 1951-52 650 Pullets Housed | | | | |
| Oct. | 5,816.5 | $ 294.55 | $ 245.45 | $ 540.00 | $.5213 | $.2837 | 12,454 |
| Nov. | 6,923.1 | 280.58 | 293.93 | 574.51 | .5330 | .2603 | 12,937 |
| Dec. | 5,940.1 | 240.06 | 268.76 | 508.82 | .4630 | .2176 | 13,206 |
| Jan. | 7,159.8 | 287.09 | 78.19 | 365.28 | .3241 | .2546 | 13,530 |
| Feb. | 6,070.9 | 245.74 | 69.65 | 315.39 | .2851 | .2216 | 13,309 |
| Mar. | 6,505.8 | 267.39 | 67.35 | 334.74 | .2858 | .2268 | 14,152 |
| Apr. | 6,061.3 | 239.46 | 80.38 | 319.84 | .2900 | .2171 | 13,240 |
| May | 5,903.9 | 230.61 | 77.22 | 307.83 | .2809 | .2102 | 13,179 |
| Jun. | 5,098.0 | 196.75 | 109.80 | 306.55 | .3133 | .2010 | 11,746 |
| Jul. | 4,624.8 | 195.19 | 131.58 | 326.77 | .3576 | .2153 | 10,966 |
| Aug. | 4,467.9 | 192.75 | 151.85 | 344.60 | .4450 | .2481 | 9,298 |
| Sep.* | 2,012.6 | 92.61 | 64.09 | 156.70 | .4850 | .2937 | 3,783 |
| Total | 66,584.7 | $2,762.78 | $1,638.27 | $4,401.05 | $.3820 | $.2338 | 141,821 |

The average cost of the low-energy ration (including grit and shell) per 100 pounds was $3.78. Computations were made with 1951-52 egg and feed prices.
The average cost of the high-energy ration (including grit and shell) per 100 pounds was $4.14.
*Only the first half of September was included in the test year.

**Three-Year Averages of Feed Costs and Egg Sales with Low-Energy and High-Energy Rations, by Months and by Years**

Table 18 shows the three-year averages of the combined data of Tables 15, 16, and 17 for the feed consumption and cost, egg sales, prices, egg production, and flock margin over feed cost by months. These include the two years of unfavorable egg-feed price ratios and the one favorable year, as were shown in Tables 15, 16, and 17.

**TABLE 18.—Average of 3 Best Years on Low-Energy Ration and 3 Years on High-Energy Ration**

| Month | Feed Consumed (Pounds) | Cost of feed | Flock Margin Over Feed | Egg Sales | Egg Prices | Feed Cost Per Dozen | Eggs Produced |
|---|---|---|---|---|---|---|---|
| Low-energy ration 1939-40, 1940-41, 1948-49 (650 pullets housed each year) | | | | | | | |
| Oct. | 5,549.2 | $ 195.13 | $ 254.61 | $ 449.74 | $.4798 | $.2088 | 11,217 |
| Nov. | 5,702.2 | 207.37 | 218.51 | 425.88 | .4945 | .2414 | 10.374 |
| Dec. | 5,702.2 | 209.62 | 231.72 | 441.33 | .4764 | .2251 | 11,158 |
| Jan. | 5,860.1 | 212.73 | 174.15 | 386.88 | .3940 | .2173 | 11,773 |
| Feb. | 5,609.4 | 205.93 | 136.19 | 342.12 | .3507 | .2119 | 11,675 |
| Mar. | 5,603.2 | 204.82 | 153.65 | 358.47 | .3330 | .1903 | 13,043 |
| Apr. | 5,370.7 | 198.94 | 123.66 | 322.60 | .3152 | .1948 | 12.265 |
| May | 5,549.5 | 204.48 | 122.55 | 327.03 | .3205 | .2005 | 12,241 |
| Jun. | 5,345.8 | 175.43 | 97.16 | 272.59 | .3034 | .1947 | 10,742 |
| Jul. | 4,503.1 | 169.20 | 149.37 | 318.57 | .3762 | .2007 | 10,148 |
| Aug. | 4,350.6 | 168.69 | 147.05 | 315.74 | .4155 | .2223 | 9,103 |
| Sep.* | 2,005.1 | 75.45 | 52.60 | 128.05 | .4283 | .2529 | 3,575 |
| Total | 60,817.9 | $2,227.79 | $1,861.22 | $4,089.00 | $.3899 | $.2102 | 127,314 |
| High-energy ration 1951-52, 1952-53, 1953-54 (650 pullets housed each year) | | | | | | | |
| Oct. | 5,976.4 | $ 321.87 | $ 214.94 | $ 536.80 | $.4798 | $.2864 | 13,479 |
| Nov. | 6,590.2 | 271.72 | 301.35 | 573.07 | .4945 | .2359 | 14,039 |
| Dec. | 6,151.6 | 257.19 | 314.11 | 571.30 | .4764 | .2143 | 14,403 |
| Jan. | 6,515.8 | 267.75 | 204.86 | 472.61 | .3940 | .2247 | 14,322 |
| Feb. | 5,653.9 | 234.56 | 153.47 | 388.03 | .3507 | .2124 | 13,262 |
| Mar. | 6,079.4 | 242.74 | 155.86 | 398.60 | .3330 | .2027 | 14,384 |
| Apr. | 5,635.6 | 227.08 | 130.18 | 357.26 | .3152 | .2003 | 13,637 |
| May | 5,688.6 | 240.65 | 116.86 | 357.52 | .3205 | .2158 | 13,384 |
| Jun. | 4,823.8 | 198.03 | 105.20 | 303.23 | .3034 | .2009 | 12,033 |
| Jul. | 4,433.6 | 196.81 | 147.90 | 344.71 | .3762 | .2162 | 10,941 |
| Aug. | 4,373.7 | 197.37 | 144.58 | 341.95 | .4155 | .2412 | 9,847 |
| Sep.* | 2,005.8 | 92.74 | 56.62 | 149.37 | .4283 | .2707 | 4,154 |
| Total | 63,928.4 | $2,748.51 | $2,045.93 | $4,794.44 | $.3899 | $.2253 | 147,885 |

The average cost of all low-energy rations (including grit and shell) per 100 pounds was $3.66.
The average cost of all high-energy rations (including grit and shell) per 100 pounds was $4.30.
*Only the first half of September was included in the test year.

The three-year average for 1951-54 in the Oklahoma Egg Laying Test, when high-energy rations were used, shows a greater return in egg sales for each month of the year. The cost of feed and egg production were also higher for 1951-54. The average flock margin over feed cost was higher when high-energy rations were used for all months in the year with the exception of October, May, and July.

## TABLE 19.—Three-Year Averages of Yearly Totals Low-Energy and High-Energy Rations 650 Pullets Housed Each Year October 1

| Ration | Feed Consumed (Pounds) | Cost of Feed | Flock Margin Over Feed | Egg Sales | Egg Prices | Feed Cost Per Dozen | Percent Production | Eggs Produced |
|---|---|---|---|---|---|---|---|---|
| High Energy[1] | 63,928.4 | $2,748.51 | $2,045.93 | $4,794.44 | 38.99¢ | 22.53¢ | 65.00% | 147,885 |
| Low Energy[2] | 60,817.9 | 2,227.79 | 1,861.22 | 4,089.00 | 38.99¢ | 21.02¢ | 55.96% | 127,314 |
| Difference | 3,110.5 | $ 520.72 | $ 184.71 | $ 705.44 | 0.0 | 1.51¢ | 9.04% | 20,571 |

[1] High-energy rations were fed during 1951-52, 1952-53, and 1953-54.
[2] Low-energy rations were fed during 1939-40, 1940-41, and 1948-49, which were the three years of highest egg production prior to the use of high-energy rations.

Table 19 gives the grand average for the years 1939-40, 1940-41, and 1948-49 when low-energy rations were used, as compared to the three-year average of 1951-54 when high-energy rations were fed.

The entire flock of 650 pullets consumed an average of 3,110.5 pounds more of feed per year on the high-energy rations than when the flock was fed the low-energy ration. The feed cost for the high-energy-fed flock averaged $520.72 more per year than for the low-energy fed flock. Cost of feed per dozen eggs also averaged 1.51 cents per dozen more for the high-energy ration during 1951-54.

The Oklahoma test flock during the 1951-54 period averaged laying 20,571 more eggs per year than during the low-energy years, which resulted in $705.44 more per year in egg sales. The yearly average flock margin over feed cost from the high-energy rations was $2,045.93. This amounted to $184.71 more per year for the high-energy ration years than for the average of the three best years of the Oklahoma Test when low-energy rations were used.

**Number of Pauses and Duration of Pauses in Laying, for Leghorns and Heavy Breeds, by Years and Months**

Geneticists have found in recent years that fall or winter pauses and neck molting are greatly influenced by environment. Lernor and Taylor (1947) reported that the heritability of winter pause appeared to be low. Hays (1949) found that pause duration is highest in birds starting the pause before January. Hays (1951) again reported that season was the only environmental factor studied that did have a significant effect on incidence of winter pause, and further stated that the very low degree of heritability of winter pause incidence simply emphasized that inheritance of a complex physiological character may be almost completely obscured by environmental factors.

Prior to 1951-52, the largest number of weeks paused or pauses started for any month in the Oklahoma Tests was always in November. The three-year average for November, in percent of weeks paused, on a hen-week basis, was 27.68 percent for the White Leghorns and 19.21 percent for the heavy breeds, for the highest production years during the period of low-energy rations. The high-energy rations apparently reduced the weeks paused in November to 6.54 percent for Leghorns and 7.64 percent for heavy breeds during 1951-54. This fact caused the year's peak of egg production from high-energy rations to occur in November. March was the peak of production during the years of low-energy rations.

As Table 18 shows, the 650 pullets on the high-energy rations in 1951-54 produced an average of 14,039 eggs in November, whereas the pullets during the three highest years when low-energy rations were being used, produced an average of 10,374 eggs. This reduction in fall and winter pauses which resulted in higher egg production had a greater influence on returns over feed cost than any other single factor.

As shown in Tables 20 and 21 there was a reduction in the number of weeks paused during the 1951-55 period as compared to the three high years prior to 1951-52. The three-year-average percent of weeks paused for the heavy breeds when the low-energy rations were used was 11.30 percent. The percent of weeks paused by the heavy breeds decreased to 7.96 percent in 1953-54. The percent of weeks paused in egg production for the same years in White Leghorns decreased from 10.47 to 5.77 percent.

**TABLE 20.—Percent of Weeks Paused and Average Length of Pauses for the Three-Year Average of the Best Years of Low-Energy Rations and for Each of the Years of High-Energy Rations**

| Year | Percent of Weeks Paused* | | Average Length of Pauses (Weeks) | |
|---|---|---|---|---|
| | Heavy Breeds | Leghorns | Heavy Breeds | Leghorns |
| Low-Energy Ration | | | | |
| 1939-1941 1948-1949 (Average) | 11.30 | 10.47 | 3.94 | 3.70 |
| High-Energy Ration | | | | |
| 1951-1952 | 9.59 | 6.43 | 3.44 | 3.43 |
| 1952-1953 | 7.53 | 5.32 | 3.11 | 3.50 |
| 1953-1954 | 7.96 | 5.77 | 2.85 | 2.86 |
| 1954-1955 | 6.67 | 4.73 | 2.97 | 2.70 |

$$\text{* Percent of weeks paused} = \frac{\text{Number of Weeks Paused}}{\text{Number of Hen Weeks}} \times 100$$

A comparison of the totals for all breeds showed that the three-year-average percent of weeks paused for the low-energy years, which was 10.74 percent, decreased to 7.10 percent when high-energy rations were used. Table 22 shows that the range by months, when low-energy rations were used, was from a high of 23.45 percent for November to a low of 3.69 percent for February. Percent of weeks paused with the high-energy rations ranged by months from 13.83 percent in July to a low of 3.88 percent in January and March. When a pause continued into the following month, the entire pause was charged to the month in which it started.

The average length of each pause also decreased in the 1951-54 period when compared with the best years prior to 1951-52. The length of pause per hen was reduced in 1953-54 by slightly more than one week for heavy breeds and by 0.9 of a week for the Leghorns. The average length of each pause for all breeds was 3.84 weeks for the low-energy rations and 3.18 weeks for the high-energy rations. In Table 22, the slight difference in pauses for July in favor of the low-energy rations can be explained on the basis of the unusually high temperatures in June and July of 1952 and 1954.

## TABLE 21.—Percent of Weeks Paused and Average Length of Pauses

| | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun. | July. | Aug. | Sept. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LEGHORNS | | | | | | | | | | | | |
| Number Pauses | 12 | 16 | 20 | 17 | 17 | 14 | 34 | 30 | 31 | 24 | 36 | 31 |
| Percent Number Pauses | 3.55 | 4.73 | 5.91 | 5.07 | 5.13 | 4.29 | 10.55 | 9.37 | 9.78 | 7.86 | 11.84 | 10.33 |
| Av. Length | 1.58 | 3.00 | 3.25 | 2.88 | 2.70 | 2.28 | 2.58 | 3.26 | 3.19 | 2.58 | 3.00 | 1.54 |
| Percent Weeks Paused | 1.27 | 3.31 | 4.34 | 3.30 | 3.47 | 2.21 | 6.37 | 6.91 | 7.29 | 4.59 | 8.02 | 3.73 |
| HEAVIES | | | | | | | | | | | | |
| Number Pauses | 6 | 15 | 12 | 6 | 14 | 10 | 16 | 23 | 27 | 14 | 28 | 25 |
| Percent Number Pauses | 3.29 | 8.28 | 6.66 | 3.35 | 7.90 | 5.71 | 9.14 | 13.29 | 15.78 | 8.38 | 16.96 | 15.24 |
| Av. Length | 1.66 | 1.80 | 3.26 | 3.16 | 2.28 | 3.30 | 2.68 | 3.56 | 3.92 | 2.21 | 4.21 | 1.76 |
| Percent Weeks Paused | 1.24 | 3.48 | 4.93 | 2.39 | 4.51 | 4.25 | 5.73 | 10.70 | 14.48 | 4.19 | 16.16 | 6.26 |
| ALL BREEDS | | | | | | | | | | | | |
| Number Pauses | 18 | 31 | 32 | 23 | 31 | 24 | 50 | 53 | 58 | 38 | 64 | 56 |
| Percent Number Pauses | 3.42 | 6.51 | 6.29 | 4.21 | 6.52 | 5.00 | 9.85 | 11.33 | 12.78 | 8.12 | 14.40 | 12.79 |
| Av. Length | 1.62 | 2.40 | 3.25 | 3.02 | 2.49 | 2.79 | 2.64 | 3.41 | 3.56 | 2.39 | 3.61 | 1.65 |
| Percent Weeks Paused | 1.26 | 3.40 | 4.69 | 2.85 | 3.99 | 3.97 | 6.50 | 8.81 | 10.89 | 4.39 | 12.14 | 4.50 |

| | PERCENT NO. PAUSES | AV. LENGTH | PERCENT WEEKS PAUSED |
|---|---|---|---|
| YEARLY AVERAGE | 8.43 | 2.73 | 5.61 |

**TABLE 22.—Percent Number of Pauses, Percent of Weeks Paused, and Average Length of Pauses for Low-Energy and High-Energy Rations By Months in the Oklahoma Egg Laying Test**

| | Percent Number of Pauses | Percent of Weeks Paused | Average Length Per Pause in Weeks |
|---|---|---|---|
| October | | | |
| Low-Energy | 13.20 | 12.84 | 4.29 |
| High-Energy | 10.12 | 5.83 | 2.84 |
| November | | | |
| Low-Energy | 18.15 | 23.45 | 5.61 |
| High-Energy | 8.34 | 7.09 | 3.62 |
| December | | | |
| Low-Energy | 7.81 | 6.75 | 4.04 |
| High-Energy | 6.67 | 5.27 | 3.54 |
| January | | | |
| Low-Energy | 16.34 | 12.60 | 3.41 |
| High-Energy | 5.73 | 3.88 | 2.98 |
| February | | | |
| Low-Energy | 6.37 | 3.69 | 2.26 |
| High-Energy | 5.33 | 4.81 | 3.24 |
| March | | | |
| Low-Energy | 8.20 | 6.12 | 3.30 |
| High-Energy | 5.56 | 3.88 | 3.25 |
| April | | | |
| Low-Energy | 9.65 | 8.83 | 4.07 |
| High-Energy | 7.04 | 5.06 | 3.03 |
| May | | | |
| Low-Energy | 8.04 | 10.41 | 5.69 |
| High-Energy | 8.67 | 6.67 | 3.36 |
| June | | | |
| Low-Energy | 13.20 | 12.01 | 4.23 |
| High-Energy | 11.19 | 8.94 | 3.42 |
| July | | | |
| Low-Energy | 13.88 | 10.40 | 3.30 |
| High-Energy | 16.65 | 13.83 | 3.87 |
| August | | | |
| Low-Energy | 18.14 | 13.02 | 3.09 |
| High-Energy | 18.17 | 12.50 | 3.03 |
| September | | | |
| Low-Energy | 9.16 | 3.32 | 1.55 |
| High-Energy | 8.98 | 3.71 | 1.95 |
| Yearly Average | | | |
| Low-Energy | 10.18 | 10.74 | 3.84 |
| High-Energy | 9.70 | 7.10 | 3.18 |

* Low-Energy years were highest production years prior to 1951-52.
High-Energy years were the last three years, 1951 to 1954.

## Conclusions from Feeding Experiments

1. Vitamin levels in excess of the National Research Council allowances as recommended in 1946 were required in high-energy layer rations to maintain maximum egg production under Oklahoma feeding conditions. The vitamins for which increased levels were indicated in this study included niacin, riboflavin, pantothenic acid and folic acid.

2. In general, less feed was required per dozen eggs when the high energy rations contained these vitamins at levels in excess of the National Research Council allowances. Feed consumption and the amount of feed required per dozen eggs fluctuated over a wide range during successive four-week periods when the low-energy and the high-energy layer rations contained no more than the National Research Council allowances for these vitamins.

3. In general, body weight was maintained at about the same level regardless of the type of ration fed.

4. In these feeding tests, the level of vitamin fortification did not appear to have any effect on mortality.

## Summary of Laying Test Comparisons

1. Average annual egg production when low-energy rations were being used increased from 175.7 eggs per hen in 1937-38 to 190.5 eggs in 1950-51. This was an increase of 14.8 eggs for the 14-year period, or an average yearly increase of 1.06 eggs per hen. The 14-year average production was 183.6 eggs per hen.

2. Average annual egg production when high-energy rations were used increased from 190.5 eggs per hen in 1950-51 to 234.4 eggs in 1953-54. This is an increase of 43.9 eggs per hen during the three-year period, or an average yearly increase of 14.6 eggs per hen. The three-year average production was 227.53 eggs per hen housed.

3. The three-year average annual egg production for the years 1951-1954, when high-energy rations were used, was 31.36 eggs more per hen than the average production for 1948-49, 1949-50, and 1950-51 when low-energy rations were used. The average for the three years from 1951 to 1954 was 227.53 eggs per hen and the average for the three years from 1948 to 1951 was 196.17 eggs per hen.

4. The three-year average annual egg production was 198.57 eggs per hen for the three highest production years (1939-40, 1940-41, and 1948-49) when low-energy rations were used, as compared to 227.53 eggs per hen for the three years of high-energy rations.

5. The three-year average annual egg production of the five popular breeds was 201.87 eggs per hen when low-energy rations were used. The average egg production was 231.82 eggs per hen for the years when high-energy rations were used. By the same comparison, the Rhode Island Reds averaged 205.67 and 249.60 eggs, and the White Leghorns averaged 206.41 and 247.57 eggs, respectively, for the two types of rations.

6. Mortality averaged 21.2 percent for the years 1937 through 1951 and 13.3 percent during 1951 through 1954.

7. The three-year average annual margin over feed cost for the 650 pullets housed each year was $184.71 more for the years when high-energy rations were fed than when low-energy rations were fed. Feed consumption and feed cost were higher for the high-energy rations. The same feed and egg prices were used in comparing both types of rations.

8. The cost of feed per dozen eggs was not a measure of the economical value of the two types of rations. The margin over feed cost for the year depended upon total egg production and number of eggs produced during the period of highest egg prices.

9. The pounds of feed per dozen eggs averaged 5.41 pounds for the best three low-energy-ration years and 4.79 pounds for the three years of high-energy rations. The average cost of feed per dozen eggs for the best three low-energy-ration years was 21.02 cents, with a cost of 22.53 cents per dozen for the three years of high-energy rations.

10. The average body weight gain for all of the six years compared was 0.63 of a pound per hen. Although the White Leghorns gained slightly more on the high-energy rations, there was no significant difference in the all-breed, three-year averages for each type of ration.

11. The peak production for each year when the low-energy rations were fed occurred in March. November was the month of highest production during the years when high-energy rations were used. The large increase in egg production for the months of October, November, and December during the 1951-54 period had the greatest influence on the increase in margin over feed cost when high-energy rations were used.

12. The hen-week percent of weeks paused and the duration of each pause were less during the years when high-energy rations were used. The percent of weeks paused during the three highest egg production years of the low-energy rations averaged 10.88 percent each year for all breeds as compared to 7.10 percent for the three years when high-energy rations were used. The heavy breeds averaged 11.30 percent and 8.36 percent, and the White Leghorns averaged 10.47 percent and 5.84 percent, respectively, for the two periods. The average duration of each pause was

3.84 weeks when the low-energy rations were used and 3.18 weeks when the high-energy rations were used.

13. Hen-housed average egg production in the Oklahoma Egg Laying Test was compared with the average of all the official standard egg laying tests and the average of all R. O. P. entries in the United States. The results were as follows:

    A. The annual egg production of the Oklahoma Test increased 43.9 eggs per hen during the three years of 1951-54 when high-energy rations were used. The production of all standard tests increased 13.2 eggs per hen during the same years. The average of all the standard tests included the Oklahoma Test production.

    B. The average number of eggs produced by all R. O. P. entries in the United States decreased one egg per hen during the period of 1951-54. During the same period, egg production in the Oklahoma Test increased 43.9 eggs per hen.

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