6-1-1941

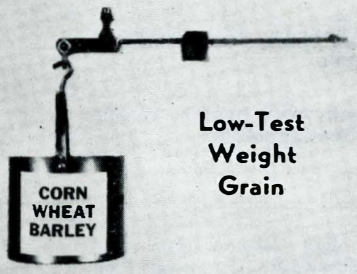
Feeding Values of Low and High Test Weight Grains for Chickens

W. E. Poley

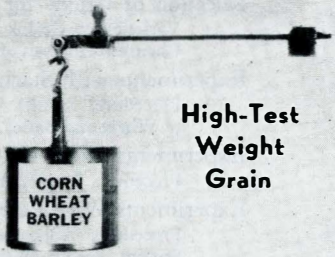
W. O. Wilson

BULLETIN 353 JUNE, 1941

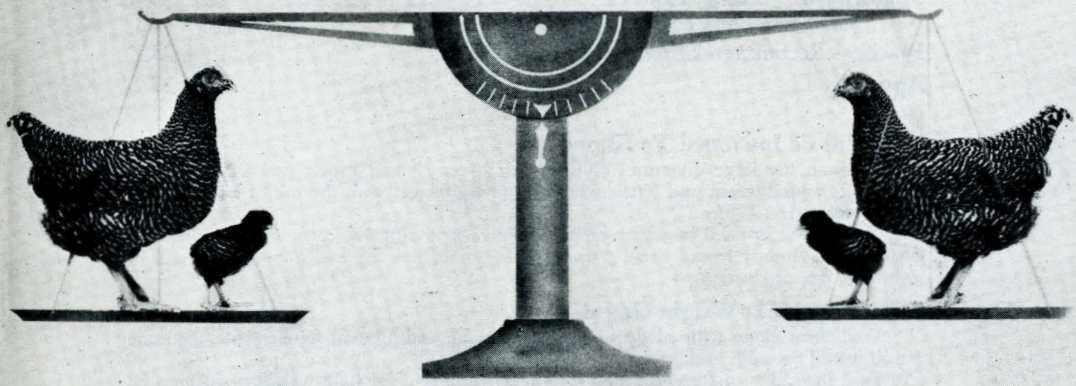
Feeding Values of Low- and High-Test Weight Grains for Chickens



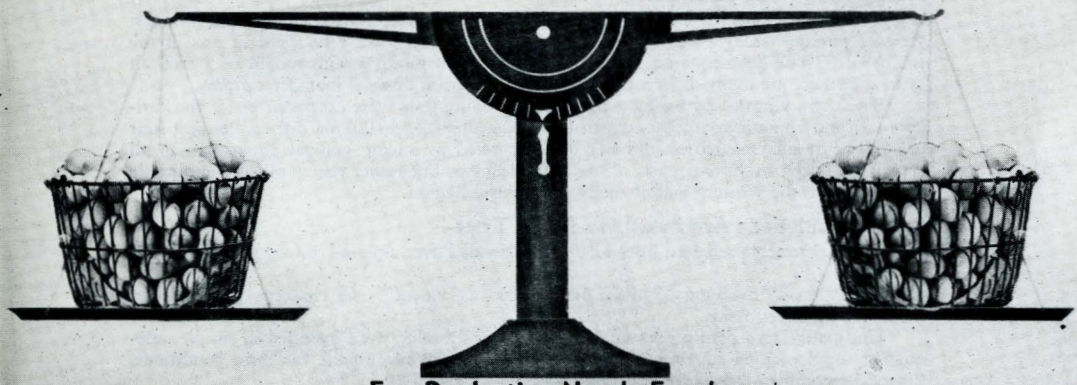
Low-Test Weight Grain



High-Test Weight Grain



Growth Nearly Equal



Egg Production Nearly Equal

Poultry Department
AGRICULTURAL EXPERIMENT STATION
South Dakota State College
Brookings, S. D.

Contents

You Will Be Interested To Know—

You can use large quantities of light-weight cereals and expect practically as good growth, egg production, and hatchability as you would get with the use of heavier corn, wheat, and barley.

You are not justified in paying premium prices for top-quality corn, wheat, and barley, even though slightly less of these grains may be sometimes required to produce a unit of growth or egg production.

If You Use Light-Weight Grains—

Feed them along with adequate protein, vitamin, and mineral supplements, the same as you would use with heavier grains.

Feed them in a mixture of grains to provide variety. These light-weight grains may be fed sparingly at first and the amounts gradually increased as the birds become accustomed to them.

A Few Words Of Caution—

Our experiments included only comparisons of grains having high- and low-test weights per bushel. Apparently there was no evidence of disease or mold in any of the grains used. The determination of the feeding value of moldy grains would be a difficult task since there are many different kinds of molds or plant diseases that affect grains.

The corn, wheat, and barley used in these feeding tests were produced under the variable soil and climatic conditions which have existed in South Dakota during the past four years. The results secured should not be interpreted as having general application to all cereals produced in various parts of the United States, but rather the results are applicable particularly to the Western half of the North Central Region.

Recommendations Are Based On Many Tests—

The experiments reported in this bulletin extended over a period of four years (1937-40 inclusive).

Thirty trials involving 99 different lots and a total of 5,269 chickens were used in these feeding experiments.

Unusually large percentages of corn, wheat, and barley were included in simple, adequately supplemented starting, growing, and laying rations suitable for farm conditions. Practical recommendations are given on pages 25, 26, and 27.

Cover Page shows pictorially the results obtained

Feeding Values of High- and Low-Test Weight Grains for Chickens

W. E. Poley and W. O. Wilson*

Importance of the Problem

Cereal grains often comprise from 80 to 90 percent of all the feed consumed in the growing and laying rations for chickens. Corn, wheat, and barley are the most commonly used grains for poultry in South Dakota. In 1939, these three grains amounted to 75 percent of the value of all the principal grains produced in South Dakota. Variable soil and climatic conditions produce wide differences in the qualities of grain grown in different localities of the North Central area. Lack of sufficent rainfall probably has the most important influence on the production of light-weight cereal grains with a high percentage of shrunken or damaged kernels. Consequently, there are considerable differences in market values. For example, light-weight wheat has relatively little value for milling purposes, and likewise light-weight barley for malting purposes.

There have been practically no experiments reported on the comparative feeding values of grains having high or low test weights when used in starting, growing, and laying rations for chickens.

Objectives of Experiments

The three chief objectives of the experiments reported herein include (1) the determination of the effects of feeding either low-quality corn, wheat, or barley on the rate of growth and egg production in chickens, (2) the relative amounts of high and lower quality grains required to produce a unit of gain in weight, and (3) the amounts of each of these grains needed to produce a dozen eggs. In the final analysis, the different grades of corn, wheat, and barley may be evaluated according to their feeding efficiency.

Selection of Grains for Experiments

Varieties of grains fed. The different varieties of yellow corn, wheat, and barley used in these feeding experiments were selected largely on the basis of their popularity in South Dakota, and also because of their adaptability to the soil and climatic conditions which exist in this state.

Wheat Used. Ceres wheat is a variety of Hard Red Spring wheat and was selected for these experiments as the most suitable representative of

* W. E. Poley, Poultry Husbandman, and W. O. Wilson, Assistant Poultry Husbandman, South Dakota Agricultural Experiment Station.

wheats popularly used for flour. This wheat contains a large quantity of strong elastic gluten, an essential element for making bread which meets with the public favor in the United States. Ceres wheat was tested only in starting rations.

Mindum wheat was the variety of Durum wheat selected for our feeding experiments. The better varieties of durum wheats are used for making semolina, which is especially suited for the manufacture of macaroni, spaghetti, and other products. Other durums are primarily used for poultry and stock feed. Mindum wheat was fed in starting, growing, and laying rations.

Barley Used. Two classes of barley were selected as among the most popular varieties of barley grown in South Dakota. Manchurian-type barley was chosen to include those varieties used for malting purposes. This was tested only in starting rations for chicks. Trebi barley was selected because it was considered the best representative of the barley varieties grown chiefly for livestock feeding. This variety was fed in starting, growing, and laying rations.

Yellow Corn Used. Yellow dent varieties of corn are much more commonly grown in South Dakota than Flint varieties. Yellow dent corn was therefore chosen for these feeding trials involving starting, growing, and laying rations. The samples used included mixed varieties grown in South Dakota.

Quality of Grains Fed. The different lots of yellow corn, wheat, and barley were made up at the local elevator. Each lot was carefully mixed to obtain a uniform distribution of kernels. The grains used in the first experiments were obtained during the years 1937, 1938, and 1939, and all the grains were selected chiefly on the basis of their test weight per bushel.

It should be emphasized that all these different grades of grain were selected for feeding according to official standards*, not only as to test weight, but also as to the percentages of foreign material and damaged or broken kernels. Methods of determining and the apparatus used in determining test weight per bushel are described in Miscellaneous Publication 325 of the U. S. D. A.**

High Quality Wheat and Barley. It was quite difficult to get the different lots of grain to meet these official weight requirements, and there was usually one to two pounds variation per bushel between the test weight of the grains used and the averages calculated from the official grain standards. In order to obtain the desired high grade classification

* **Official Grain Standards of the United States** (June 1934) Service and Regulatory Announcements No. 144, U. S. D. A., Bureau of Agricultural Economics.

** **Grain Grading Primer** (Nov. 1938) Miscellaneous Publication No. 325, U. S. D. A., Bureau of Agricultural Economics.

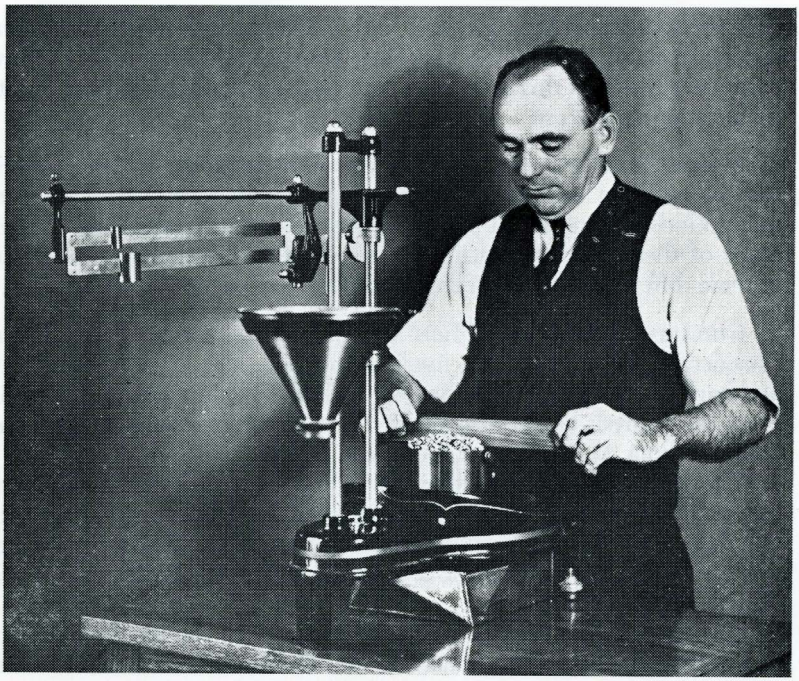


Fig. 1. Determining the Test Weight per Bushel of Grain in a Grain Inspection Laboratory (Courtesy of U. S. D. A.).

for the wheat and barley to be fed, the average minimum test weight per bushel of the three top grades of wheat is 58 pounds, and for barley 45.3 pounds per bushel.

Medium Quality Wheat and Barley. The test weight of the medium-quality wheat and barley was determined by taking the average minimum test weight of grades 4 and 5, as given in the official grain standards. The average minimum test weight of these two grades of wheat was 52½ pounds, and for barley 37½ pounds per bushel.

Low Quality Wheat and Barley. For the lowest quality wheat and barley used for feeding, the test weight was usually below grade 5 of the official grain standards and compares closely in quality with the description reported for the sample grade. That is, there were higher percentages of shrunken, damaged, or cracked kernels, and there was more foreign material such as small inseparable stones.

High and Low Quality Corn. Because it was difficult to obtain a sufficient range of quality, only two grades of yellow corn were tested. The top-quality yellow corn used in these feeding trials graded No. 2 according to the official grain standards, while the low quality yellow

corn fed graded between grades 3 and 4. There was a much larger percentage of small, shrunken, and broken kernels in the low-quality yellow corn used. Much of this low grade corn had not matured because of late planting or early frost.

Moldy Grain Not Tested. There was no apparent evidence of disease or mold in any of the different grades of grain fed. There are many kinds of molds and plant diseases that affect grains, and, within scope of these experiments, it was impossible to determine the effects of these different diseases on chick growth and egg production.

Chemical Analysis of High and Low Grade Cereals. There was considerable variation in the nutritive composition of the corn, wheat, and barley having high and low test weights. Table 1 of the Appendix gives the analysis as determined by the Chemistry Department of the South Dakota Agricultural Experiment Station.

The different grades of yellow corn did not vary so much in composition as did the various grades of wheat and barley. The range in the protein content of the corn used was from 10.8 to 11.7 percent. No explanation can be offered for the wide differences (1.4 to 7.9 percent) in the ash content of the yellow corn.

The Ceres wheat used in 1937 varied in protein content from 16.1 to 21.1 percent. It was rather unusual to find the wheat with the lowest test weight also having lowest in percentage protein. It will be noted from Table 1 of the Appendix that there was a general tendency for the protein content to be inversely proportional to the test weight per bushel. The percentage protein in the Mindum wheat ranged from 19.9 to 22.2. It should be emphasized that the protein content of wheat produced in South Dakota is quite high compared with the amount of protein found in wheat produced in most other areas.

The protein content of Manchurian-type barley ranged from 14.2 to 15.9 percent, while in Trebi barley there was 13.7 to 16.9 percent protein. Generally the light-weight barley had a higher percentage of protein than the heavier barley. The fiber content usually was higher with the light-weight barley. There were minor differences in the composition of other nutrients present with one exception. The ash content of the 44-pound barley was high compared with the percentage of ash in most of the other grades of barley.

Experiments With Starting Rations

Procedure. The general plan of procedure was the same for all experiments. There were 12 trials involving 44 lots of chicks. The starting all-mash rations were fed the first eight weeks, beginning with the first

day after hatching. The chicks when selected were individually banded with numbered wing bands, and equalized as to initial weight and breeding. Either Barred Plymouth Rock or Rhode Island Red chicks were used. They were hatched from eggs produced by the Agricultural Experiment Station's flocks. The breed used in each trial, average live weights, and sex are reported in the Appendix, Table 2. Although the chicks were individually weighed at four, six, and eight weeks, only the average weights at four and eight weeks are reported. Feed weights were taken whenever the chicks were weighed.

All experiments were started in electrically-heated battery brooders. The battery room temperature ranged between 65 and 80 degrees F. After the chicks were four or five weeks of age, battery heating was discontinued.

In Appendix, Table 3, are reported the number of chicks started, the mortality,and the average feed consumption per bird, as well as the number of pounds of feed required to produce a pound of gain in weight.

Starting Rations Fed. The same basal mash was fed to all lots. Each of the different grades of either corn, wheat, or barley was added to the basal mash mixture at the rate of 44 pounds, making a total of 100 pounds of starting mash. The oats and barley were pulverized finely in a hammer mill over a 1/16-inch screen, while the corn and wheat were ground more coarsely over a 1/8-inch screen. The amounts of ingredients included in the basal mash mixture are as follows: Pulverized oats 30 pounds, meat and bone scraps 15 pounds, dried buttermilk and alfalfa leaf meal 5 pounds each, salt and cod liver oil concentrate 0.5 pound each. (Total 56 pounds.)

To prevent "slipped tendons," manganese dioxide was added to the meat and bone scraps, and this, in turn, mixed with the mash at the rate of three ounces of manganese dioxide per ton of ration.

Either cod liver oil stearin (175 D, 1,800 A) or cod liver oil concentrate (400 D, 3,000 A) was used. When the stearin was used, 0.5 of a pound was added, while only 0.25 of a pound of the concentrate was used in 100 pounds of the starting mash.

Approximate Analysis of Starting Mash Mixtures. The chemical analysis of the rations varied somewhat, depending upon whether corn, wheat, or barley was used as the principle grain. The protein content was influenced by the quality of cereal used. For example, the lightweight cereals had a higher protein content than the better grades of the same grain. The range in the percentage protein as influenced by the highest and lowest test weights per bushel used is given below with the average analysis of calcium, phosphorus, and manganese.

Average Percentage Chemical Analysis of Rations

	Corn Trials	Wheat Trials	Barley Trials
Protein	20.0–20.4	24.0–25.0	21.4–22.4
Calcium	1.7	1.8	1.5
Phosphorus	1.0	1.1	1.0
Manganese (parts per million)	44	59	49

Results with Starting Rations. The relative feeding efficiency (feeding values) and growth rates were calculated from the amounts of feed required to produce a pound of gain in live weight. (Appendix, Tables 2 and 3.) The best grade of either corn, wheat, or barley was used as the standard of comparison and given a value of 100. The relative values of the lower grades were calculated and compared to this. For example, there were three trials, each involving two grades of yellow corn. The number of pounds feed required to produce a pound of gain for the two grades of corn used were as follows:

The better grade yellow corn	**The low grade yellow corn**
Trial 1—2.19 lbs.	Trial 1—2.23 lbs.
Trial 2—3.01	Trial 2—2.92
Trial 3—3.22	Trial 3—3.41
Total for 3 trials 8.42	**8.56**
Average for 3 trials 2.806	**2.853**

$$\text{Average percentage feeding efficiency} = \frac{2.806}{2.853} \times 100 = 98$$

The average rate of gain in live weight was calculated for the high and lower grades of grain by the same method.

The average test weight per bushel was calculated by adding together the test weights of the high grade grains used in each trial and dividing this total by number of trials. Thus, from the Appendix, Table 2, with the better grade of yellow corn the test weights per bushel of the samples used were as follows: Trial 1, 55 pounds; Trial 2, 58.5; and Trial 3, 58.5. The average test weight per bushel for the three trials was 57.3 pounds.

Feeding Efficiency and Growth-Rates. For convenience, a summary of all the feeding trials involving the starting rations is given on Page 2. The range (highest and lowest) in feeding values and growth rates are also shown for each trial.

Yellow Corn. From the three trials involving two grades of yellow corn, it is evident that there were practically no differences in either the feeding efficiency or the rate of growth of chicks during the first eight weeks. The values of 98 for the feeding efficiency of the lower grade and 102 for the growth rate should not be considered large enough differences to be called significant.

Summary of Average Feeding Efficiency and Growth-rate Values of Cereals used in Starting Rations

Grain used	Pounds Test Wt.	No. of Trials Conducted	Percentage Feeding Efficiency		Percentage Growth-Rate Efficiency	
			Average	Range	Average	Range
Yellow corn	57.3	3	100	—	100	—
Yellow corn	49.8	3	98	94–103	102	96–106
Mindum wheat	58.0	5	100	—	100	—
Mindum wheat	52.3	5	106	99–121	106	97–118
Mindum wheat	48.8	5	99	90–105	100	97–103
Ceres wheat	56.3	2	100	—	100	—
Ceres wheat	52.2	2	111	94–127	104	91–116
Ceres wheat	46.0	2	106	95–117	102	95–109
Manchurian-type barley	43.3	4	100	—	100	—
Manchurian-type barley	38.5	2	98	92–103	113	107–118
Manchurian-type barley	33.9	4	97	87–105	110	102–128
Trebi barley	45.3	5	100	—	100	—
Trebi barley	38.5	1	100	100	134	—
Trebi barley	35.3	3	102	92–108	114	102–129

Mindum Wheat. In comparing the results of the five trials in which second grade Mindum wheat and the best grade wheat were used, it will be noted that somewhat less feed was required to produce a pound of gain in weight and also the rate of growth was a little faster for the lower grade (52.3-pound test) wheat. The third grade wheat with an average test weight of 48.8 pounds per bushel was practically equal to the best quality wheat (58-pound test) used when judged by the feed requirements and the rate of gain in weight.

Ceres Wheat. There was a wide variation in the results secured in the two trials involving three grades of Ceres wheat, as will be noted from the range in average values reported. Less feed was required per pound of live weight gained and slightly faster growth was obtained for the lower grades of wheat used when the two trials were averaged together. These differences may not be significant, however.

Manchurian-Type Barley. There were only very small differences between the feeding efficiency of the high and lower grades of Manchurian-type tested. The average test weight of the best grades of barley used was 43.3 pounds per bushel, for the medium-grade 38.5, and for the lowest quality 33.9 pounds per bushel. The average feeding efficiency values for each of these grades was 100, 98, and 97, respectively. The range in feeding values for the medium-grade was 92 to 103, and for the low-grade 87 to 105. In all the trials involving the two lower grades of Manchurian-type, the growth-rate was faster than with the best grade of barley used.

Trebi Barley. The three grades of Trebi barley used in the different trials averaged 45.3, 38.5, and 35.3 pounds per bushel, with the feeding

values of 100, 100, and 102, respectively. The average growth-rate values were 100, 134, and 114. From these results, it is apparent that the feeding efficiency of the lower grades was at least equal to that of the best grade (45.3 pounds) barley used, while the growth-rate was faster with the lower grades of Trebi barley used.

Results Secured with the Different Varieties of Wheat and Barley. Two trials were conducted whereby Mindum and Ceres wheat were compared. The feeding efficiency and growth-rates are reported in the Appendix, Tables 2 and 3. A summary of the results secured in the two trials is given below.

Average Feeding Efficiency and Growth-rate Values of Wheat and Barley Varieties

Grain Used	Pounds Test Weight	No. of Trials Conducted	Percentage Feeding Efficiency		Percentage Growth-rate	
			Av.	Range	Av.	Range
Mindum wheat	58.0	2	100	—	100	—
Ceres wheat	55.8	2	94.2	92.9–95.5	96.4	93.1–99.8
Mindum wheat	52.0	2	100	—	100	—
Ceres wheat	52.0	2	94.5	88.4–100.5	95.3	91.6–99
Mindum wheat	49.0	2	100	—	100	—
Ceres wheat	45.5	2	109.3	94.6–123.9	99	94.2–103.8
Trebi barley	46.5	2	100	—	100	—
Manchurian-type barley	43.5	2	129	118–140	113	103.1–122.9
Trebi barley	38.5	1	100	—	100	—
Manchurian-type barley	38.5	1	109	—	97.8	—
Trebi barley	34.8	2	100	—	100	—
Manchurian-type barley	32.5	2	109.9	94.2–125.7	102.1	96.1–108.1

The feeding efficiency and growth-rate obtained from the use of Mindum wheat were given a value of 100, and the results secured with Ceres wheat compared to this. With the two top-grades of Ceres wheat, the feeding efficiency was found to average 94.2 and the growth-rate 96.4 compared to 100 for the two corresponding grades of Mindum wheat.

A comparison of the two middle grades of wheat, with test weights of 52 pounds per bushel each, shows that Ceres wheat has an average value of 94.5 in feeding efficiency and 95.3 in growth-rate, compared to 100 for Mindum wheat.

The third grade of Ceres wheat tested had an average value of 109.3 in feeding efficiency, and 99 in growth-rate, compared to 100 for the corresponding grade of Mindum wheat.

Two trials included tests of the comparative values of the highest and lowest grades of Trebi and Manchurian-type barley, while there was only one trial with the medium grade of these two varieties. The results indicate Manchurian-type barley had a value of 129 in feeding efficiency

and 113 in growth-rate, compared with 100 for the corresponding top-grade of Trebi barley. For the middle grades of barley having a test weight of 38½ pounds per bushel, the feeding efficiency was 109 and the growth-rate 97.8 for Manchurian-type compared with 100 for Trebi barley. With the lowest grades of the two varieties of barley tested, the feeding efficiency was 109.9 and the growth-rate 102.1 for Manchurian-type compared with 100 for Trebi barley.

It should be emphasized that there was considerable variation in the response secured with the two varieties of wheat and barley tested. The range in average feeding efficiency of Ceres wheat shows that in only one out of the three averages reported was this difference consistent for both trials. In other words, in only one case where two trials were conducted did Ceres wheat appear less efficient than Mindum wheat in both trials. In all the other trials, Ceres wheat was more efficient in one trial and less efficient in the other trial when compared with Mindum wheat. This is also true for Manchurian-type barley. The same may be also said of the relative growth rates of the two varieties of wheat and barley.

Conclusions from Feeding Starting Rations. In nearly all the trials, the average feeding values and growth rates obtained with the lower grades of corn, wheat, and barley were practically equal to the feeding values and growth-rates secured when the best grades of these grains were used. In some cases the feeding values and growth-rates were better with the lower grades of these cereals.

The two best grades of Mindum wheat gave slightly more efficient gains in live weight, and produced slightly faster growth than the best grades of Ceres wheat used. On the other hand, the third grade of Ceres wheat gave somewhat more efficient body weight gains than the same grade of Mindum wheat.

Experiments With Growing Rations

Procedure. Eight trials including 22 lots of either Rhode Island Red or Barred Plymouth Rock pullets were used to study the growth-promoting and feeding-efficiency values of different grades of yellow corn, Mindum wheat, and Trebi barley. The experiments were begun when the chicks were usually from 8 to 10 weeks of age and extended over a period of from 11 to 17 weeks. At the end of the growing periods, the pullets were ready for laying rations. The birds were carefully selected for size and health, and were distributed uniformly among the different lots. They were individually numbered with wing bands and each was weighed at four-week intervals and at the end of the test. Mash and grain were kept in feeders and weights of the feed were taken each time the

pullets were weighed. The same quality of grain that was used in the mash was also fed as scratch grain.

In the Appendix, Table 4, are reported the date each trial was started, the breed and age of pullets used, as well as the average body weights at the beginning and end of each trial. The average gain and the percentage gain in body weight are also reported for each quality of grain used. In Table 5, the test weights of the corn, wheat, and barley are given. In addition, the number of pullets started and finished in each trial, the percentage mortality, the average consumption of mash and grain, and the feed requirements per pound of gain in body weight are included.

Growing Rations Fed in Corn and Wheat Tests. There was one trial with two grades of yellow corn, and three trials including nine lots which were fed three different grades of wheat. The percentages of the ingredients used in the corn and wheat rations are as follows:

Basal Growing Mash Mixtures Used in the Corn and Wheat Trials

	Corn Trial 1 Lots 1-2	Wheat Trial 2 Lots 3-5	Wheat Trial 3 Lot 6	Wheat Trial 3 Lots 7-8	Wheat Trial 4 Lots 9-11
Ground oats	20	20	20	20	20
Meat and bone scraps	10	10	5	10	10
Dried buttermilk	5	5	5	—	—
Alfalfa leaf meal	—	—	5	5	5
Salt	1	1	1	1	1
Number pounds	36	36	36	36	36
Added to Basal Mash Mixtures					
Ground yellow corn (2 grades)	64				
Ground wheat (3 grades)		64	64	64	64
Total number pounds	100	100	100	100	100

Two grades of yellow corn (55 and 49½ pounds per bushel test weights) were used in the first trial. Sixty-four pounds of the better grade of ground yellow corn were added to the basal mash mixture fed to Lot 1. The same grade of yellow corn that was fed in the mash was also kept before the birds in the hoppers. Lot 2 received the lower grade of corn in both the mash and grain. The corn that was used in the scratch grain was fed cracked until the birds were 16 weeks of age, after which it was fed whole.

Sixty-four pounds of ground wheat were added to the basal mash mixtures used in Trials 2, 3, and 4. The same quality that was used in the mash was also kept in hoppers. Trial 3 was used not only to test the feeding efficiency of different grades of wheat, but also to determine whether or not it was necessary to use dried buttermilk in the mash, so five percent of meat and bone scraps was used to replace the milk in Lots 7 and 8.

High and low grades of wheat were used in these two lots. Since it was found unnecessary to use dried buttermilk, this was omitted from the rations fed in Trial 4.

Growing Rations Fed in Barley Tests. Trials 5-8 were used to test the feeding values of high and low grades of Trebi barley. The percentages of the ingredients used in these experiments are as follows:

Growing Basal Mash Mixtures Used in Barley Trials

	Trial 5		Trials 6-8
	Lot 12	Lots 13-14	Lots 15-22
Ground wheat	30	30	30
Meat and bone scraps	9	14	14
Dried buttermilk	5	—	—
Alfalfa leaf meal	3	3	3
Salt	1	1	1
Number pounds	48	48	48
Added to the Basal Mash Mixture			
Ground barley (3 grades)	52	52	52
Total number pounds	100	100	100

The barley was ground over a ⅛-inch screen. The same quality that was used in the mash was also kept before the birds in hoppers. This was fed whole.

Approximate Analysis of Growing Mash Mixtures. The chemical analysis varied, depending upon the test weight of the corn, wheat, or barley added to the basal mash. With the light-weight cereal grains, the protein content was higher. The range in protein content as influenced by the different grades of grain used are included in these figures.

Average Percentage Chemical Analysis

	Corn Trial	Wheat Trials	Barley Trials
Protein	17.4–17.8	22.6–23.9	21.4–23.0
Calcium	1.2	1.2	1.5
Phosphorus	0.8	0.9	1.0
Manganese (parts per million)	58	58	58

Trial 5 was used to determine the necessity of adding dried buttermilk to the mash. Lots 13 and 14 received an additional five percent of meat scraps and no milk. Since there were no differences between the growth rates of the birds receiving milk and those receiving no milk, this was omitted from the rations used in Trials 6, 7, and 8.

Manganese dioxide was added to each mash mixture at the rate of approximately three ounces to each ton of feed used in all the experiments involving the different grades of corn, wheat, and barley.

The birds were placed in colony brooder houses with access to good green range which had been seeded to Red proso millet and rape. Each lot was confined to an individual ⅛-acre yard. Usually during the latter

part of the summer season the range became dry and it was then not so satisfactory. Consequently, in all except Trials 1 and 2, sun-cured alfalfa leaf meal was used in the mash mixture to provide sufficient vitamin A.

Results with Growing Rations. With either high or lower grades of corn, wheat, and barley individually fed free choice with mash containing the same quality grain, it was possible to determine the relative palatability of these grains. For example, if the chickens consumed the same percentage of high and low quality grain in their total feed, or if they consumed approximately the same ratios of grain to mash, it was presumed that there were no differences in palatability between the two grades of grain used.

Percentage of Grain Consumed. High-quality yellow corn was consumed at the rate of 83.1 percent, while low-grade corn amounted to 84.6 percent of the total feed. This difference is too small to be considered significant. Therefore, the low-quality corn used in this experiment was equally as palatable as the better grade corn used.

High, medium, and low quality wheat were consumed at the rates of 85.8, 87.1, and 85.3 percent, respectively, of the total feed ingested. These differences were not significant.

Summary of Average Percentages of Cereal Grain Consumed During Growing Period

	Average	Range
High grade yellow corn	83.1	One trial only
Low grade yellow corn	84.6	One trial only
High grade wheat	85.8	84.1–86.8
Medium grade wheat	87.1	86.0–87.7
Low grade wheat	85.3	80.5–87.3
High grade barley	68.0	61.4–78.1
Medium grade barley	60.8	59.1–62.6
Low grade barley	68.6	62.0–78.2

Averages of 68.0, 60.8, and 68.6 percent of the total ration consumed were high, medium, and low grades of barley, respectively. This includes all the trials in which each grade of barley was used, and direct comparisons can not be made. There were two trials, however, where all three grades of barley were fed at the same time under uniform environmental conditions. The average percentages of these grains consumed were 63.6, 61.4, and 62.9 for the high, medium, and low grades of barley fed. The average test weights were 45, 40, and 36½ pounds per bushel for the three grades used in the two trials. From these results, it is evident that there were no significant differences in the percenages of the three grades of grain consumed. The test weight per bushel apparently had no appreciable influence on the palatability of the grains used.

Feeding Efficiency and Growth-Rates—Corn Trials. From Trial 1 of the Appendix, Tables 4 and 5, it is evident that there were no appreciable

differences in the rate of growth, feeding efficiency, and viability between the birds receiving the 55-pound yellow corn and those receiving the 49½-pound yellow corn.

Mindum Wheat Trials. The results of Trials 2, 3, and 4, in which different grades of Mindum wheat were tested, indicate that there was considerable variation among the different lots. No benefits were apparent from the use of dried buttermilk in the basal mash fed in Trial 3, so this was not used in Trial 4. In two out of the three trials, the 48- or 50-pound wheat was nearly as good as the 57½- and 58½-pound wheat. In the last wheat trial, the rate of growth obtained from the 50-pound wheat was only 82 percent, while the feeding efficiency obtained was 83 percent of the 58½-pound wheat. With the sample of low-grade wheat used in this trial, the birds consumed about 10 percent less wheat and proportionately more mash than those receiving the 58½-pound wheat. Lot 10, receiving the 52½-pound wheat, on the other hand, consumed about five percent more grain than Lot 9, receiving the 58½-pound wheat. It is possible that the particular sample of 50-pound wheat used may not have been as palatable as the two other grades of wheat, although in Trial 3 where the same samples of high and low grades of wheat were used, there were no appreciable differences between the ratios of mash and grain consumed. It is, therefore, probable that the differences secured in Trial 4 were not especially significant. This is borne out by the fact that when all trials are considered together there are only small differences in the average percentages of grain consumed with the different grades of wheat.

There were no large differences among the mortality rates on any of the rations tested.

Trebi Barley Trials. In Trial 5, two grades of Trebi barley were fed. The basal mash fed to Lot 12 included five percent dried buttermilk with 43-pound barley, while Lot 13 received the same grade of barley with five percent of meat scraps replacing the same amount of dried milk. Lot 14 received 36½-pound barley with the same basal ration (no milk). The use of dried milk did not appreciably improve either the feeding efficiency or growth-rate when fed with 43-pound barley and practically the same results were obtained with the 36½-pound barley; therefore, an additional five percent of meat and bone scraps was used, and the milk omitted from the basal mash mixtures fed in Trials 6, 7, and 8. In both the trials where 47- and 42-pound barley were used, the mortality was slightly higher, and the feeding efficiency and the growth-rates lower with the 42-pound barley. In Trial 8, Lot 22 received 36½-pound barley which gave a slightly higher feeding efficiency and growth-rate than the 47-pound barley. The results on the whole seem to indicate that test

weight per bushel may not be so important as some other properties in promoting growth, which is closely associated with feeding efficiency.

Below is a summary of feeding efficiency and growth-promoting values of yellow corn, wheat, and barley used in growing rations. These average values were calculated by the same methods described for the experiments with starting rations (Page 8).

Summary of Average Feeding Efficiency and Growth-Rate Values of Cereals Used in Growing Rations

Grain Used	Test Wt.	Number of Trials Conducted	Percentage Feeding Efficiency*		Percentage Growth Rate*	
			Av.	Range	Av.	Range
Yellow corn	55.0	1	100	—	100	—
Yellow corn	49.5	1	100	—	98	98
Mindum wheat	58.2	4	100	—	100	—
Mindum wheat	52.3	2	99	98–100	98	97–98
Mindum wheat	49.3	3	93	83–100	93	82–99
Trebi barley	45.0	5	100	—	100	—
Trebi barley	40.8	3	92	88–98	98	97–99
Trebi barley	36.5	3	101	97–109	102	95–108

* Number of pounds of feed required to produce a pound of gain in live weight. (The best grade of grain used in each test was given a value of 100 and the other values reported as percentages of this. The same applies to growth-rate, or the number of pounds of weight gained during the test period.)

With yellow corn fed free choice and 64 percent of the same quality also fed in the mash mixture, the feeding efficiency and growth-rate were practically equal when corn weighing 49.5 pounds per bushel was compared with 55-pound corn.

Equal feeding efficiency and growth rates were obtained with wheat weighing 58.2 and 52.3 pounds per bushel. With the lowest grade wheat weighing 49.3 pounds, the feeding efficiency and growth-rate averaged 93 compared with 100 for the 58.2-pound wheat.

The feeding efficiency was 92 and the growth-rate 98 with barley weighing an average of 40.8 pounds per bushel compared with 100 for 45-pound barley. The lowest grade of barley tested weighed 36½ pounds per bushel. The feeding efficiency and growth-rate obtained was practically the same as the results secured with 45-pound barley.

Conclusions from Growth Studies. *Corn.* There were no appreciable differences either in the amounts of feed required to produce a unit of gain in weight or in the rate of growth obtained with the high and low grades of yellow corn used.

Judging by the ratios of grain to mash consumed, there were no differences between the palatability of yellow corn having high and low test weights per bushel. No appreciable differences in the amounts of mortality were noted.

Wheat. High and medium grades of Mindum wheat were found to be equal when judged on the basis of feed needed to produce a unit of

gain in weight and growth-rate. Seven percent more of the lowest grade wheat was necessary per unit of gain and correspondingly slower growth was obtained when compared with the best quality wheat used. These differences are unimportant from a practical standpoint.

Apparently the light-weight wheat used in these experiments was equally as palatable as the heavier wheat used.

There were no significant differences in the mortality rate.

Barley. There were no appreciable differences in either the amounts of feed required to produce a pound of gain in weight or in the rates of growth obtained when the high and lowest grades of Trebi barley were compared. With the medium-grade of barley, however, eight percent more feed was required per unit of gain, but the growth rate was nearly equal to that obtained with the best quality barley fed.

There were no significant differences in the palatability of the light and heavy barley used in these experiments.

Differences in mortality rates could not be attributed to the rations fed.

Experiments With Laying Rations

Procedure. Ten trials were conducted with laying rations, extending over a period of three years. There were 33 lots including from 29 to 68 birds each. Most of the tests included either Barred Plymouth Rock or Rhode Island Red pullets. One trial included Buff Orpingtons and White Leghorns. All the experiments were begun in the fall when the pullets were about six to seven months of age, and covered a period from 24 to 44 weeks. The birds were kept confined in the laying houses, several types of which were used. Most of the laying houses had a capacity of about 125 birds and were divided into four pens of equal size. Some of the houses were, however, divided into only two pens each, having about a 65-bird capacity. The pens were equipped with trapnests and individual egg records were kept for each hen. Live weights and feed weights were taken at 8- or 12-week intervals.

Mash, grain, oyster shells, and grit were kept before the birds in feeders. Water was also provided.

In the Appendix, Table 6, is included the following information concerning each of the 10 trials conducted: (1) Number of birds started, (2) number surviving at the end of the test, (3) percentage mortality, (4) average number of pounds of mash and grain consumed (5) percentage of the total feed consumed as mash, (6) oyster shell consumption, (7) feed required to produce one dozen eggs, and (8) feeding efficiency which is reported as percentage of the control ration containing the top-quality grain tested.

Fig. 2. A laying house 16 feet by 32 feet divided into four equal-sized pens.

Table 7, in the Appendix, shows (1) the test weight per bushel of each grain fed, (2) the length of the feeding trial, (3) average gain in live weight, (4) the average number of eggs produced per bird, and (5) the calculated production-rate which is reported as percentage of the control.

Laying Rations Fed. Two grades of yellow corn were fed in three trials, three grades of Mindum wheat were used in four trials, three grades of Trebi barley were used in two trials, and two grades of barley were fed in a third trial.

The percentage of ingredients used in the laying rations are as follows:

Basal Laying Mash Mixtures Used

	Yellow Corn tests	Wheat tests	Barley tests
Ground oats	30	30	
Ground wheat			30
Meat and bone scraps	10	10	10
Dried buttermilk	5	5	5
Alfalfa leaf meal	5	5	5
Salt	1	1	1
Totals	51 lbs.	51 lbs.	51 lbs.
Added to Basal Mash Mixtures			
Ground yellow corn (2 grades)	49 lbs.		
Ground wheat (3 grades)		49 lbs.	
Ground barley (3 grades)			49 lbs.
Total number pounds	100	100	100

Oyster shells, grit, and the scratch grain which corresponded to the quality of the grain in the mash, were hopper-fed.

Fish oil concentrate (3,000 A and 400 D) was added to the mash at the rate of 0.5 percent, beginning November 1 and ending April 1 each laying year.

Manganese dioxide was added in varying amounts, depending upon which grain was used. Approximately three ounces per ton of mash were needed.

Approximate Analysis of Laying Mash Mixtures. The analyses given below indicate the approximate amounts of protein, calcium, phosphorus, and manganese present in the laying mash fed. The protein content varied somewhat, depending upon the quality of grain used, usually the lower the test weight per bushel the higher the protein content. For example, the top-grade Mindum wheat included 20.2 percent protein, while the light-weight wheat contained 22.2 percent protein. The range in protein content is, therefore, reported so as to include the cereal grains with the highest and lowest protein values.

Average Percentage Chemical Analysis of Laying Mash

	Corn Trials	Wheat trials	Barley trials
Protein	17.8–18.3	22.3–23.3	20.8–22.2
Calcium	1.2	1.2	1.2
Phosphorus	1.0	1.1	1.1
Manganese (parts per million)	55	52	55

Hatchability Studies. The different pens receiving high and lower grades of corn, wheat, and barley were mated in the fall. Eggs were saved for hatching purposes at irregular intervals, usually beginning in December and extending through May, with most of the eggs being incubated during the winter months. Usually the eggs were set in one incubator having a capacity of about 6,000 eggs. On the 18th day of incubation, the eggs were tested and those infertile were removed, after which the fertile eggs were placed in a 2,000-egg hatcher. Both the incubator and hatcher were of the agitated air type. The number of hatches, number of eggs incubated, the percent fertility and hatchability are reported in the Appendix, Table 8.

Results with Laying Rations. *Percentage of Grain Consumed.* The percentage of grain consumed was calculated from the feed consumption records that were kept. With the 55-pound yellow corn, an average of 74.5 percent of the total ration consumed was corn, while with the corn having an average test weight of 49.5 pounds per bushel, 77.1 percent of the total feed was corn. This indicates that the lower grade corn was at least equally as palatable as the better quality corn.

Practically the same percentages of high, medium, and low grades of wheat were consumed; these grains amounted to 80.9, 81.5, and 82.9 per-

cent respectively. Apparently, there were no appreciable differences in the palatability of the high and lower grades of wheat used.

Summary of Average Percentages of Cereal Grain Consumed During Laying Period

	Average	Range
High grade yellow corn	74.5	72.1-77.3
Low grade yellow corn	77.1	72.9–82.7
High grade Mindum wheat	80.9	77.9–83.4
Medium grade Mindum wheat	81.5	78.1–84.3
Low grade Mindum wheat	82.9	80.4–85.3
High grade Trebi barley	78.2	77.2–79.0
Medium grade Trebi barley	76.5	75.0–77.9
Low grade Trebi barley	76.9	76.2–77.4

The percent of Trebi barley consumed was 78.2, 76.5, and 76.9 for the high, medium, and low grades, respectively. These small differences are not significant and the low quality barley should be considered equally as palatable as the higher quality used.

Feeding Efficiency and Rates of Egg Production. The relative feeding efficiency was calculated by determining the number of pounds of feed required to produce a dozen eggs for each ration used. The best quality grain fed in each trial was used as a standard and given a value of 100. The results obtained with each of the lower grades were compared to this. For example, in Trial 1, Appendix, Table 6, the birds in Lot 2 consumed an average of 9.63 pounds of feed for each dozen eggs produced, while the better quality corn fed to the birds in Lot 1 required 10.14 pounds of feed to produce a dozen eggs. Thus:

$$\text{Feeding Efficiency} = \frac{10.14}{9.63} \times 100 = 105$$

In other words, it required about 5 percent less feed to produce a dozen eggs when 49½-pound corn was used in comparison with the 55-pound corn.

The relative rates of egg production were determined in the same manner as the feeding efficiency values and are reported in the Appendix, Table 7.

Feeding values for all the tests including corn, wheat, and barley are summarized on the next page. The average values for all the trials conducted with each grain were determined by the same method used with the starting rations described on Page 8.

Yellow Corn. An analysis of the summary of feeding values shows that in the five trials where two grades of yellow corn were used, there was considerable variation in the percentage feed requirements (75-112)

and the rates of egg production (72-110). The averages for all trials in which the lower grade corn was fed was 95 for the percentage feeding efficiency and 94 for the percentage rate of egg production compared to 100 for the high grade yellow corn.

Average Feeding Efficiency and Egg Production-Rate Values of Cereals Used in Laying Rations

Grain Used	Test Wt.	Number of Trials Conducted	Percentage Feeding Efficiency*		Percentage Egg Production Rate*	
			Av.	Range	Av.	Range
Yellow corn	55.6	5	100	—	100	—
Yellow corn	52.4	5	95	75–112	94	72–110
Mindum wheat	59.4	5	100	—	100	—
Mindum wheat	52.8	4	103	82–112	92	84–108
Mindum wheat	50.0	5	90	81– 99	91	76–104
Trebi barley	44.3	3	100	—	100	—
Trebi barley	40.0	2	102	97–109	103	103
Trebi barley	36.5	3	102	97–112	98	87–114

* The number of pounds of feed required to produce a dozen eggs. The results obtained with the best quality grain were given a value of 100 and each of the values reported as a certain percentage of this. The same applies to the rate of egg production or the number of eggs laid for each ration during the test period.

Mindum Wheat. In experiments involving wheat the average feeding efficiency of the 52.8-pound wheat was 103, and 92 for the 50-pound wheat compared with 100 for the wheat weighing 59.4 pounds per bushel. The average rate of egg production for all trials gives the medium grade wheat a value of 92 and the lowest grade wheat 91 compared with 100 for the best quality wheat used. As will be noted, there was considerable variation in response. In none of the five trials, however, was the lowest grade wheat equal to the best wheat in feeding efficiency. In one out of five trials the rate of egg production exceeded that of the control group receiving the best grade of wheat.

Trebi Barley. The best grade of barley used averaged 44.3 pounds per bushel for the three trials. This grade was given a value of 100 and the medium and low grades of barley compared with this. The medium-grade barley, weighing 40 pounds per bushel, was calculated to have a feeding efficiency of 102, while the low-grade barley had the same feeding value. The 40-pound barley gave a slightly higher rate of production (103) while the 36.5-pound low-grade barley had an average value of 98 with a range of 87-114. Because of the wide variation in response obtained from these different grades of barley, these differences should not be considered as significant.

Hatchability Results. The number of eggs set during each of the seasons, the percentage fertility and hatchability are recorded in the Appendix, Table 8. It will be noted that there was considerable variation in the results obtained. Some difficulty was experienced with low fertility,

and occasionally the hatchability of fertile eggs was particularly low with some pens. There were, however, no trends in either fertility or hatchability that could be traced to the rations used. Low fertility and hatchability is quite common, particularly during the cold winter months in this area, and since most of the eggs for hatching were obtained during January, February, and March, this variability probably should be expected, especially in view of the fact that the laying houses used were not so very well insulated.

Summary of Hatchability Results Obtained with High and Lower Grades of Cereals

Grain Used	Av.Test Wt. of Grain Used (Lbs. per bu.)	Total No. of Eggs Incubated	Percent Fertility	Percent Hatchability Fertile Eggs
Yellow corn	55.7	1939	72.2	69.4
Yellow corn	51.3	2138	74.6	71.2
Mindum wheat	59.0	2045	62.3	53.9
Mindum wheat	52.7	2158	67.8	57.3
Mindum wheat	50.0	2073	62.0	60.6
Trebi barley	45.0	1219	61.0	59.1
Trebi barley	42.0	672	63.5	68.2
Trebi barley	36.5	1215	57.3	69.3

From the summary of hatchability results obtained for all eggs incubated during the three hatching seasons prior to 1941, it will be noted that there were no appreciable differences in either the percentage fertility or hatchability when corn averaging 51.3 pounds per bushel is compared with the 55.7-pound corn fed in laying rations.

When the results of feeding three different grades of Mindum wheat are compared, it is evident that the 50-pound wheat produced an average of nearly seven percent higher hatchability than the 59-pound wheat, with no differences in the average fertility. The middle grade wheat, with an average test weight of 52.7 pounds per bushel was intermediate in the average percentage hatchability when compared with the top and bottom grades of wheat used. The fertility with the medium-grade wheat was 5.5 percent higher than that obtained with the 50-pound wheat.

In two out of three seasons the 50-pound wheat gave better hatchability than was secured with 58½-pound wheat, while in the 1940 season the reverse was true.

An average of about 10 percent higher hatchability was obtained when the lowest quality barley was compared with the best grade used during the two hatching seasons. During the first season, the low-grade barley resulted in only 2.3 percent better hatchability, while in the second season 13.8 percent higher hatchability was secured when compared with the hatchability obtained with the high-grade barley. Hatchability data were obtained on the medium-grade of barley for only one season (1940).

While the fertility was lower, the hatchability of fertile eggs was about 11 percent higher than when the high-quality barley was fed.

Conclusions From Feeding Laying Rations. Approximately the same percentages of either high or low grades of corn, wheat, or barley were consumed in the laying rations tested. It is, therefore, assumed that the light-weight grains were equally as palatable as the heavier grains used.

Slightly better hatchability of fertile eggs was secured with the light-weight wheat and barley used in these experiments, while there were no appreciable differences in the hatchability secured with the different grades of corn.

Corn. Approximately five percent more low-grade corn was required to produce a dozen eggs. The total number of eggs produced was six percent lower than the number secured from the high-quality corn used. It is probable that these differences are not of much practical significance.

Wheat. Three percent less feed was required to produce a dozen eggs with the medium-grade wheat. Eight percent more eggs were produced when the high-grade wheat was compared with the medium-grade used. With the lowest quality wheat fed, 10 percent more feed was required and nine percent less eggs were produced during the experimental period.

Barley. There were no practical differences in either the amounts of barley required to produce a dozen eggs or in the rates of egg production secured with the different grades of barley.

Summary of Feeding Values

Starting Rations. High and low grades of ground yellow corn, wheat, and barley were fed to chicks for the first eight weeks at a level of 44 percent of the all-mash starting rations.

Practically the same amount of light-weight corn, weighing 49.8 pounds per bushel was required to produce a unit of gain in weight (feeding efficiency) when compared with corn weighing 57.3 pounds per bushel. There were no differences in the average growth-rates of chicks receiving the two grades of corn.

Several trials included comparisons of high and low grades of Mindum wheat. The lowest grade of wheat, with an average test weight of 48.8 pounds per bushel, was equally as efficient as 58-pound wheat when judged by the amount of feed required to produce a unit of gain in weight. The rates of gain in live weight were also equal for rations containing high and low quality wheat. The medium grade of wheat (52.3

pounds per bushel) produced slightly more efficient and more rapid gains in weight than the 58-pound wheat used.

The test weights for the high, medium, and low quality Ceres wheat used were 56.3, 52.2, and 46.0 pounds per bushel, respectively. With Ceres wheat tested, both the medium and lower grades produced somewhat more efficient gains in weight than the best grade used, although the rates of gain were practically equal.

Three grades of Manchurian-type barley with average test weights of 43.3, 38.5, and 33.9 pounds per bushel were found to be practically equal when judged by the amount of feed needed to produce a pound of gain in weight. Somewhat faster gains were, however, obtained from the lower grades of these grains.

The average weights of the three grades of Trebi barley tested were 45.3, 38.5, and 35.3 pounds per bushel. There were no differences in the feeding values of these three qualities, but faster growth was obtained from the lower grades used in these starting rations.

Growing Rations. High and lower grades of yellow dent corn and Mindum wheat were used in growing mash mixtures at a level of 64 percent. The same quality of grain that was used in the mash was also kept before the birds in hoppers as the only grain. Different grades of Trebi barley were fed at a level of 52 percent of the mash and also fed in hoppers as the only grain. The pullets were fed over a period beginning at 8 to 10 weeks of age and ending at laying time.

Of the total ration consumed, 83.1 percent was 55-pound yellow corn, while the lower quality corn amounted at 84.6 percent of the total feed ingested. There were no differences either in the amounts of feed required to produce a pound gain in weight or in the rate of growth obtained with these two grades of corn used.

The high, medium, and low grades of wheat made up an average of from 85.3 to 87.1 percent of the total ration consumed by the pullets during the growing period. There were no appreciable differences between either the feeding efficiency or the growth-rate obtained when medium quality wheat weighing 52.3 pounds was compared with a high grade wheat weighing 58.2 pounds per bushel. Seven percent more of the lowest grade wheat weighing 49.3 pounds per bushel was required per unit of gain and at the end of the growing period the pullets weighed seven percent less than those receiving the highest quality wheat.

An average of from 61.4 to 63.6 percent of the total ration consumed included the three different grades of Trebi barley fed. The feeding efficiency and rates of growth obtained with the high and lowest grades of barley used were practically equal. About eight percent more of the medium-grade barley was required to produce a unit of gain in weight,

but the growth-rate was nearly equal to that obtained with the highest quality barley fed.

Laying Rations. Different grades of yellow corn, Mindum wheat, and Trebi barley were fed in laying mash mixtures at a level of 49 percent. The same quality grain that was used in the mash was also kept before the birds in hoppers. The feeding period began in the fall at the end of the growing period and extended for 24 to 44 weeks. The feeding efficiency is figured on the basis of the number of pounds of feed required to produce a dozen eggs.

An average of 74.5 percent of the total ration consumed was yellow corn with an average test weight of 55 pounds per bushel, while 77.1 percent of 49.5 pound corn was consumed. Five percent more feed was required to produce a dozen eggs and the rate of egg production was six percent lower for the corn weighing 49.5 pounds per bushel compared with results secured with the 55-pound corn.

The average consumption of the different grades of wheat varied from 80.9 to 82.9 percent of the total ration. The average feeding efficiency was 103, and the rate of egg production 92 percent for Mindum wheat with an average weight of 52.8 pounds per bushel compared with 100 for wheat weighing 59.4 pounds per bushel. The third grade wheat, weighing 50 pounds, had average values of 90 for the feeding efficiency and 91 percent for the rate of egg production.

The different grades of Trebi barley made up from 76.5 to 78.2 percent of the total ration consumed. The average test weights for the high, medium, and low quality barley used were 44.3, 40.0, and 36.5 pounds per bushel. There were no practical differences in either the amounts of barley required to produce a dozen eggs or in the rates of egg production secured with these different grades of barley.

Slightly better hatchability of fertile eggs was secured with the light-weight wheat and barley used in these experiments while there were no appreciable differences in the hatchability obtained with the different grades of corn.

Practical Recommendations for Farm Feeding

For poultry growers who may have access to large amounts of corn, wheat, and barley, formulae and directions for feeding starting, growing, and laying rations are included below. With these rations, and under the farm conditions that usually exist, light-weight grains may be used in place of high-test-weight grains and there will be no appreciable differences in the results obtained.

All Mash Starting Rations Fed the First Eight Weeks

Basal Mixture		
Finely pulverized oats	150	220 pounds of one of the following grains may be added to this basal mixture:
Meat and bone scraps	75	
Dried buttermilk	25	
Alfalfa leaf meal	25	1. Coarsely ground yellow corn
Salt mixture*	2.5	2. Coarsely ground wheat
Fish liver oil (100 D)	2.5	3. Finely ground barley
Total	280.0 lbs.	Total 500 pounds of starting mash.

* One ounce of manganese sulphate should be added to 2.5 pounds of salt to obtain a salt mixture suitable to mix with 500 pounds mash. If manganese dioxide is fed use one-half the amount.

A 1/8-inch screen will be satisfactory for coarsely grinding corn and wheat, while a 1/16-inch screen will be necessary for finely grinding oats and barley.

Use a fish oil that has a guaranteed vitamin D potency. Proportionately less will be needed if it contains more than 100 vitamin D units per gram. For example, about 0.7 of a pound of 400-vitamin-D-oil would be needed in 500 pounds of starting mash.

Growing Rations Fed from Eight Weeks to Laying Time

Basal Mash Mixture No. 1 (to be used with ground corn or wheat)		Basal Mash Mixture No. 2 (to be used with ground barley)	
Ground oats	100	Ground wheat	150
Meat and bone scraps	50	Meat and bone scraps	70
Alfalfa leaf meal	25	Alfalfa leaf meal	25
Salt	5	Salt	5
Total	180 pounds	Total	250 pounds
320 pounds of either ground yellow corn or wheat should be added to basal mixture No. 1 to make a total of 500 pounds of growing mash.		250 pounds of ground barley should be added to basal mixture No. 2 to make a total of 500 pounds of growing mash.	

All of these grains for growing rations may be ground over a ⅛-inch screen.

Scratch Grain. Either yellow corn, wheat, or barley may be fed alone or in any combination. Whole oats also may be used with these grains to make up a large percentage of the scratch mixture.

The yellow corn should be fed cracked until the birds are 12 to 16 weeks of age, after which it may be fed whole.

The mash and scratch grains should be fed free choice in hoppers.

Other Feeds. Oyster shells and grit also should be kept before the birds.

If there is plenty of young green grass, no alfalfa leaf meal need be included in the mash.

If the birds are confined, it will be necessary to use fish oil in the mash at the same level that is recommended for the starting mash.

Laying Rations

Basal Mash Mixture No. 1 (to be used with ground corn or wheat)		Basal Mash Mixture No. 2 (to be used with ground barley)	
Ground oats	150	Ground wheat	150
Meat and bone scraps	50	Meat and bone scraps	50
Dried buttermilk	25	Dried buttermilk	25
Alfalfa leaf meal	25	Alfalfa leaf meal	25
Salt mixture*	5	Salt mixture*	5
Total	255 pounds	Total	255 pounds

* Salt mixture includes 4⅞ pounds of salt and ⅛ of a pound of manganese sulphate mixed and added to 495 pounds of mash. If manganese dioxide is fed use one-half ounce with 2.5 pounds of salt.

245 pounds of either ground yellow corn or wheat should be added to basal mash mixture No. 1 (Total 500 pounds laying mash).	245 pounds of ground barley added to basal mixture No. 2 (Total 500 pounds laying mash).

Add 10 pounds or pints of fish oil (100 vitamin D units per gram) to each 500 pounds of mash during the fall and winter months (November through March).

Scratch Grain. Either whole yellow corn, wheat, or barley may be fed alone or in any combination. Whole oats also may be used with these grains to make up a large percentage of the scratch mixture.

The mash and grain may be fed free choice in feeders. If, however, there is a tendency for the birds to eat excessive amounts of scratch grain, this may be limited so that approximately equal quantities of mash and grain are consumed daily.

Oyster shells and grit should be kept before the birds.

Appendix Tables

Table 1. Percentage Chemical Analysis of Corn, Wheat, and Barley Used

Grain Used	Year Purchased	Test Wt. per bu. (lbs.)	Moisture	Ash	Ether Extract (Fat)	Crude Fiber	Crude Protein	Nitrogen Free Extract
Yellow Corn	1937	55	9.1	7.3	4.1	2.5	11.0	65.9
	1937	49½	9.7	7.9	4.4	2.5	10.8	64.7
Yellow Corn	1939	56	8.3	1.4	4.3	2.5	11.0	72.5
	1939	54	8.4	1.5	3.8	2.6	11.7	72.0
Ceres Wheat	1937	57	8.7	7.6	1.7	4.7	19.3	58.0
	1937	52	9.1	7.9	2.3	3.9	21.1	55.7
	1937	42	9.5	7.4	1.6	5.4	16.1	60.0
Mindum Wheat	1937	57½	8.6	7.7	1.9	3.4	20.2	58.2
	1937	52	8.5	8.0	2.1	4.0	22.0	55.4
	1937	48	8.3	7.9	2.7	4.1	22.2	54.8
Mindum Wheat	1939	58½	7.7	2.0	1.9	2.9	19.9	65.7
	1939	52½	7.8	2.3	1.9	3.4	22.0	62.7
	1939	50	7.6	2.5	2.2	3.3	22.2	62.3
Manchurian Type Barley	1937	44	8.8	8.0	2.7	5.3	14.2	61.0
	1937	38½	8.1	3.3	2.0	8.4	15.9	62.3
	1937	31	8.4	6.1	2.2	11.7	15.1	56.5
Trebi Barley	1937	50	9.6	2.1	1.7	4.5	13.7	68.5
	1937	38½	9.3	3.1	1.9	7.8	15.7	62.2
	1937	33	8.8	3.1	1.9	9.4	15.0	61.9
Trebi Barley	1939	43	8.2	3.3	2.7	9.5	13.9	62.6
	1939	38½	8.0	3.2	1.4	10.8	14.1	62.6
	1939	36½	7.9	3.3	1.8	9.3	16.9	60.8

Table 2. Average Weights of Chicks During Starting Period

Trial No. and Breed Date Started	Lot No.	Grain Used	Test Wt.	Body weight in grams† 4 wks. M*	4 wks. F*	8 wks. M	8 wks. F	Av. Gain MF	% of control‡
Trial 1									
Barred Rocks	1	Yellow corn	55	158	152	481	447	432	100
3-7-37	2		49½	159	132	546	438	456	106
Trial 2									
Barred Rocks	3	Yellow corn	58½	241	241	659	605	600	100
1-31-39	4		50	251	248	682	645	631	105
Trial 3									
R. I. Reds	5	Yellow corn	58½	267	218	552	505	493	100
2-7-39	6		50	220	218	504	504	472	96
Trial 4	7	Mindum wheat	57½	161	163	444	462	421	100
Barred Rocks	8		52	184	169	475	422	410	97
2-27-37	9		48	173	162	482	450	434	103
Trial 5	10	Mindum wheat	57½	155	165	478	494	451	100
Barred Rocks	11		52	157	157	525	523	492	109
3-7-37	12		48	174	177	488	462	442	98
	13	Ceres wheat	57	172	170	456	459	420	100
	14		52	161	164	528	513	487	116
	15		42	157	165	470	511	459	109
Trial 6	16	Mindum wheat	58½	174	164	624	526	544	100
R. I. Reds	17		52	183	172	613	524	537	99
3-3-38	18		50	166	179	590	573	548	101
	19	Ceres wheat	54½	166	179	576	575	543	100
	20		52	159	159	544	507	492	91
	21		47	172	169	555	543	516	95
Trial 7	22	Mindum wheat	58½	217	192	657	542	555	100
Barred Rocks	23		52½	240	224	717	651	655	118
1-27-39	24		49	229	191	631	512	549	99
Trial 8	25	Mindum Wheat	58½	226	226	651	614	601	100
Barred Rocks	26		52½	248	254	694	632	628	105
3-14-41	27		49	267	261	627	605	584	97
Trial 9	28	Manchurian-type barley	44	157	149	530	457	462	100
Barred Rocks	29		38½	154	162	523	527	493	107
3-21-37	30		31	143	155	484	506	466	101
	31	Trebi barley	50	129	143	376	424	376	100
	32		38½	153	156	529	544	504	134
	33		33	160	161	528	508	485	129
Trial 10	34	Manchurian R. I. R.	43	199	211	533	550	506	100
R. I. Reds	35		34	196	203	558	532	515	102
and	36	B. Rocks	43	189	200	551	563	525	100
Barred Rocks	37		34	221	206	608	570	562	107
4-8-38	38	Trebi barley B. Rock	43	176	177	550	533	509	100
	39		36½	187	182	569	533	520	102
Trial 11	40	Trebi barley	43	223	212	553	534	515	100
R. I. Reds	41		36½	248	228	627	583	569	110
2-7-39									
Trial 12	42	Manchurian Type barley	43	154	136	392	323	321	100
Barred Rocks	43		38½	157	158	434	395	378	118
3-15-40	44		34	166	170	462	433	411	128

* M—Males; F—females

† 454 grams is equal to one pound.

‡ The control pen received the grain having the highest test weight and has 100 percent efficiency.

Table 3. Number of Chicks, Mortality, and Feed Consumption Data for Starting Period

Trial No. and Breed Date started	Lot No.	Grain added to basal mash (44%)	Test Wt.	No. of Chicks 8 wks. Start	M*	F*	Mortality %	Av. feed consumed per bird (lbs.)	Feeding efficiency** Actual lbs.	% of control
Trial 1										
Barred Rocks	1	Yellow corn	55	43	19	18	12	2.08	2.19	100
3-7-37	2		49½	45	17	20	18	2.23	2.23	98
Trial 2										
Barred Rocks	3	Yellow corn	58½	44	22	21	2	3.97	3.01	100
1-31-39	4		50	44	21	22	2	4.06	2.92	103
Trial 3										
R. I. Reds	5	Yellow corn	58½	70	28	38	6	3.51	3.22	100
2-7-39	6		50	70	26	41	4	3.55	3.41	94
Trial 4	7	Mindum wheat	57½	55	21	21	24	2.69	2.89	100
Barred Rocks	8		52	55	15	24	29	2.91	3.23	90
2-27-37	9		48	55	19	20	29	2.72	2.83	102
Trial 5	10	Mindum wheat	57½	44	21	17	14	2.50	2.53	100
Barred Rocks	11		52	44	21	20	7	2.27	2.10	121
3-7-37	12		48	45	19	21	11	2.72	2.80	90
	13	Ceres wheat	57	44	17	20	16	2.44	2.65	100
	14		52	45	17	25	7	2.24	2.09	127
	15		42	46	21	22	7	2.28	2.26	117
Trial 6	16	Mindum wheat	58½	49	22	21	12	3.16	2.63	100
R. I. Reds	17		52	48	23	23	4	3.14	2.66	99
3-3-38	18		50	48	16	23	19	3.42	2.83	93
	19	Ceres wheat	54½	48	21	21	13	3.39	2.83	100
	20		52	48	20	23	10	3.25	3.01	94
	21		47	49	23	24	4	3.41	2.99	95
Trial 7	22	Mindum wheat	58½	59	22	24	22	4.32	3.54	100
Barred Rocks	23		52½	59	24	20	25	4.38	3.04	116
1-27-39	24		49	59	21	15	39	4.14	3.42	104
Trial 8	25	Mindum wheat	58½	60	27	25	13	3.86	2.92	100
Barred Rocks	26		52½	60	25	31	7	3.62	2.62	112
3-14-39	27		49	60	20	36	7	3.60	2.79	105
Trial 9	28	Manchurian-type barley	44	55	25	24	11	3.06	3.00	100
Barred Rocks	29		38½	55	27	17	20	3.55	3.26	92
3-21-37	30		31	57	20	31	11	3.57	3.47	87
	31	Trebi barley	50	55	17	33	9	2.94	3.54	100
	32		38½	55	21	19	27	3.10	3.55	100
	33		33	55	21	29	9	3.27	3.27	108
Trial 10	34	Manchurian-type barley	43	57	41	14	4	4.73	4.26	100
R. I. Reds and	35		34	57	30	22	9	4.56	4.04	105
Barred Rocks	36	B. R.	43	45	20	22	7	2.90	2.50	100
4-8-38	37	B. R.	34	45	28	16	2	3.29	2.65	94
	38	Trebi barley B. R.	43	49	20	19	20	3.92	3.50	100
	39	B. R.	36½	49	21	20	16	3.80	3.33	105
Trial 11										
R. I. Reds	40	Trebi barley	43	66	43	19	6	3.41	3.02	100
2-7-39	41		36½	66	26	36	6	4.11	3.29	92
Trial 12	42	Manchurian-type barley	43	74	23	30	28	2.89	4.07	100
Barred Rocks	43		38½	76	26	39	14	3.29	3.96	103
3-15-40	44		34	76	20	36	26	3.65	4.01	102

* M—males; F—females

** Pounds of feed required to produce a pound of gain.

Table 4. Average Weights of Pullets During Growing Periods

Trial No. and Breed Date Started	Lot No.	Grain Used*	Test Wt.	Age at Start Wks.	Age at End Wks.	Body Weight in lbs. Start	Body Weight in lbs. End	Gain in weight in lbs.	Gain in weight % of Control†
Trial 1									
Barred Rocks	1	Yellow corn	55	8	25	1.18	4.00	2.82	100
5-15-37	2		49½			1.18	3.94	2.76	98
Trial 2	3	Wheat	57½	8	24	1.11	3.97	2.86	100
Barred Rocks	4		52			1.12	3.91	2.79	98
5-1-37	5		48			1.13	3.96	2.83	99
Trial 3	6	Wheat-with milk	58½	8	20	1.25	3.79	2.54	100
Barred Rocks	7	without milk	58½			1.25	3.75	2.50	98
6-14-38	8	without milk	50			1.25	3.72	2.47	98
Trial 4	9	Wheat	58½	9	21	1.40	3.68	2.28	100
R. I. Reds	10		52½			1.36	3.58	2.22	97
4-20-39	11		50			1.42	3.57	2.15	94
Trial 5	12	Barley-with milk	43	8	24	1.06	4.39	3.33	100
Barred Rocks	13	without milk	43			1.06	4.35	3.29	99
3-25-38	14	without milk	36½			1.06	4.21	3.15	95
Trial 6	15	Barley	43	9	21	1.55	3.41	1.86	100
R. I. Reds	16		38			1.56	3.41	1.85	99
5-16-39	17		36½			1.58	3.49	1.91	103
Trial 7									
Barred Rocks	18	Barley	47	11	23	1.76	3.64	1.88	100
6-11-40	19		42			1.77	3.59	1.82	97
Trial 8	20	Barley	47	9	20	1.12	3.31	2.19	100
Barred Rocks	21		42			1.11	3.27	2.16	99
6-7-40	22		36½			1.11	3.48	2.37	108

* Grain of the same test weight also used in the scratch as the only grain kept in hoppers before the birds.

† The control pen received the grain having the highest test weight and has 100 percent efficiency.

Table 5. Number of Pullets, Mortality, and Feed Consumption Data for the Growing Periods

Trial No. and Breed Date started	Lot No.	Grain Used	Test Wt.	No. birds Start	No. birds End	Mortality %	Average feed consumed per bird, lbs. Mash	Grain	Total	% Mash of total feed	Feeding efficiency** Actual lbs.	Feeding efficiency** % control
Trial 1												
Barred Rocks	1	Yellow corn	55	79	71	10	8.97	10.18	19.15	46.8	6.8	100
5-15-37	2		49½	81*	65	20	8.01	10.74	18.75	42.7	6.8	100
Trial 2	3	Wheat	57½	75*	65	13	6.82	11.10	17.92	38.1	6.3	100
Barred Rocks	4		52	74*	64	15	5.90	11.54	17.44	33.8	6.3	100
5-1-37	5		48	72	69	4	6.60	12.16	18.76	35.2	6.6	95
Trial 3	6	Wheat-with milk	58½	47	41	13	5.26	9.08	14.34	36.7	5.7	100
Barred Rocks	7	without milk	58½	47	45	4	4.63	8.00	12.63	36.7	5.1	112
6-14-38	8	without milk	50	48	43	10	5.00	9.13	14.13	35.4	5.7	100
Trial 4	9	Wheat	58½	66	65	2	5.19	6.59	11.78	44.1	5.2	100
R. I. Reds	10		52½	66	57	14	4.61	7.24	11.85	38.9	5.3	98
4-20-39	11		50	66	65	2	7.37	6.16	13.50	54.6	6.3	83
Trial 5	12	Barley-with milk	43	53	46	13	8.62	9.11	17.73	48.6	5.3	100
Barred Rocks	13	without milk	43	53	45	15	7.86	9.37	17.23	45.6	5.2	102
3-25-38	14	without milk	36½	53	43	19	7.75	9.31	17.06	45.4	5.4	98
Trial 6	15	Barley	43	62	62	0	11.22	2.74	13.96	80.4	7.5	100
R. I. Reds	16		38	65	65	0	11.00	3.13	14.13	77.8	7.6	99
5-16-39	17		36½	64	61	5	11.52	3.03	14.55	79.2	7.6	99
Trial 7												
Barred Rocks	18	Barley	47	69	69	0	10.32	3.50	13.82	74.7	7.4	100
6-11-40	19		42	69	65	6	11.65	2.03	13.68	85.2	8.4	88
Trial 8	20	Barley	47	47	45	4	9.85	4.02	13.87	71.0	6.3	100
Barred Rocks	21		42	48	41	15	10.40	3.83	15.22	68.3	7.1	89
6-7-40	22		36½	48	47	2	10.38	3.38	13.76	75.4	5.8	109

* In Lot 2 there were 11 missing, in Lot 3 there were 5 missing, and in Lot 4 there were 8 missing during the first weight period. These were presumed to have been stolen.

** Pounds of feed required to produce a pound of gain. The control pen has 100 percent efficiency.

Table 6. Number of Birds, Mortality, and Feed Consumption Data During Laying Periods

Trial No. and Breed Date started	Lot No.	No. Birds Start	No. Birds End	Mortality %	Av. feed consumed per bird, lbs. Mash	Grain	Total	Oyster shell lbs.	% Mash of total feed	Feed to produce 1 doz. eggs (lbs.)	Efficiency % of control*
Trial 1											
Barred Rocks	1	49	29	41	23.27	21.44	44.71	0.94	52.0	10.14	100
10-13-37	2	50	35	30	21.73	20.85	42.58	0.81	51.0	9.63	105
Trial 2	3	30	25	17	32 83	40.87	73.70	1.55	44.5	9.34	100
Buff Orp. &	4	30	15	50	39.76	45.48	85.24	1.86	46.6	7.60	100
White Leg.	5	30	18	40	32.45	45.39	77.84	1.51	41.7	10.50	89
9-12-38	6	29	17	45	27.88	54.32	82.20	2.23	33.9	10.17	75
Trial 3	7	50	36	28	36 62	31.08	67.70	1.47	54.1	7.73	100
Barred Rocks	8	50	36	28	35.30	31.18	66.48	1.76	53.1	6.90	112
& R. I. Reds	9	60	47	22	38.02	31.51	69.53	1.31	54.7	6.69	100
10-17-39	10	60	44	27	34.41	36.06	70.47	1.17	48 8	7.30	92
Trial 4	11	49	31	37	28.00	23.30	81.30	2.47	34.4	9.38	100
Barred Rock	12	49	29	41	24.61	55.23	79.84	3.06	30.8	10.65	88
8-21-37	13	49	31	37	22.23	54.76	76.99	2.65	28.9	11.65	81
	14	49	27	45	21.65	54.22	75.87	2.50	28.5	9.41	100
Trial 5	15	68	29	57	22.46	46.62	69.08	2.21	32.5	8.17	100
Barred Rock	16	68	33	51	25.18	45.98	71.16	2.41	35.4	9.98	82
9-26-38	17	68	32	53	25.05	49.06	74.11	3.25	33.8	10.15	81
Trial 6	18	30	20	33	26.01	38.51	64.52	1.43	40.3	7.06	100
R. I. Reds	19	30	18	40	24.50	38.32	62.82	1.43	39.0	6.39	111
12-8-39	20	30	21	30	26.05	41.58	67.63	1.80	38.5	7.10	99
Trial 7	21	30	21	30	28.11	36.73	64.84	1.67	43.4	6.26	100
R. I. Reds	22	30	26	13	22.64	30.02	52.66	1.76	43.0	5.61	112
12-8-39	23	30	20	33	21.37	41.51	62.88	1.90	34.0	6.30	99
	24	30	25	17	24.68	35.15	59 83	1.67	41.3	6.43	97
Trial 8	25	52	38	27	33.32	41.30	74.62	1.87	44.7	8.75	100
R. I. Reds	26	53	27	49	38.75	40.34	79.09	2.59	49.0	9.03	97
8-2-37	27	52	41	21	33.87	42.17	76.04	1.93	44.5	7.84	112
	28	52	30	42	34.42	43.00	77.42	2.59	44.5	7.74	113
Trial 9											
Barred Rock	29	55	39	29	33.75	45.33	79.08	3.07	42.7	8.14	100
7-28-38	30	55	26	53	33.27	41.64	74.91	3.29	44.4	8.82	99
Trial 10	31	54	33	39	37.79	53.99	91.78	2.05	41.2	8.19	100
Barred Rock	32	54	31	43	37.43	48.82	86.25	2.45	43.4	7.50	109
11-2-39	33	54	33	39	40.83	46.59	87.42	2.38	46.7	8.49	97

* The control pen has 100 percent efficiency.

Table 7. Average Gain in Weight and Egg Production During Laying Periods

Trial No. and Breed Date started	Lot No.	Grain Used	Test Wt.	Duration Wks.	Gain in weight per bird (lbs.)	Av.no. eggs per bird	Rate of production % of control*
Trial 1							
Barred Rocks	1	Yellow corn	56	24	0.61	52.9	100
10-13-37	2		54		0.92	53.0	100
Trial 2	3	Yellow corn	B.O. 56	40	1.37	94.7	100
Buff Orp. &	4		W.L. 56		0.86	134.5	100
White Leg.	5		B.O. 54		1.28	88.9	94
9-12-38	6		W.L. 54		0.74	97.0	72
Trial 3	7	Yellow corn	B.R. 55	32	0.71	105.1	100
Barred Rocks	8		B.R. 50		0.78	115.7	110
& R. I. Reds	9		R.I.R. 55	36	0.71	124.9	100
10-17-39	10		R I.R. 50		0.57	115.8	93
Trial 4	11	Wheat	58½	44	1.30	104.0	100
Barred Rocks	12		52½		1.37	90.9	87
8-21-37	13		50		1.16	79.3	76
	14	20% meat scraps	50		1.64	80.6	78
Trial 5	15	Wheat	58½	40	0.99	101.6	100
Barred Rocks	16		52½		1.26	85.5	84
9-26-38	17		50		1.00	87.6	86
Trial 6	18	Wheat	60	32	0.50	109.7	100
R I. Reds	19		53		0.74	117.9	107
10-27-39	20		50		0.70	114.3	104
Trial 7	21	Wheat	60	32	lost 0.24	124.3	100
R. I. Reds	22		53		0.05	112.7	91
12-8-39	23		50		lost 0.21	119.8	96
	24	with soyean oil meal	60		lost 0.25	111.6	90
Trial 8	25	Barley	43	44	0.85	102.3	100
R. I. Reds	26		38		0.80	105.1	103
8-2-37	27		36½		0.87	116.4	114
	28	20% meat scraps	36½		0.83	120.1	117
Trial 9							
Barred Rocks	29	Barley	43	40	0.96	116.6	100
7-28-38	30		36½		1.02	101.9	87
Trial 10	31	Barley	47	40	lost 0.11	134.4	100
Barred Rocks	32		42		lost 0.06	137.9	103
11-2-39	33		36½		0.16	123.5	92

* The control pen has 100 percent value

Table 8. Hatchability Results Obtained with High and Low Grade Cereals

Year	Grain Used	Test Wt. (Lbs. per bushel)	No. of Hatches	No. of Eggs Incubated	Percent Fertility Av.	Percent Hatchability of Fertile Eggs Av.
1937-38	Yellow corn	56.0	3	263	52.9	62.6
1937-38	Yellow corn	50.0	3	214	29.9	70.3
1938-39	Yellow corn	56.0	5	477	77.6	75.9
1938-39	Yellow corn	54.0	5	631	82.9	64.4
1940	Yellow corn	55.0	7	1199	74.2	67.8
1940	Yellow corn	50.0	7	1293	78.0	74.8
1937-38	Mindum wheat	58.5	7	248	72.2	52.5
1937-38	Mindum wheat	52.5	7	229	60.7	47.5
1937-38	Mindum wheat	50.0	7	424	53.1	61.3
1938-39	Mindum wheat	58.5	10	1215	58.1	43.8
1938-39	Mindum wheat	52.5	10	1315	65.6	53.0
1938-39	Mindum wheat	50.0	10	1091	57.9	55.1
1940	Mindum wheat	60.0	4	582	66.8	72.8
1940	Mindum wheat	53.0	4	614	75.1	68.3
1940	Mindum wheat	50.0	4	558	76.9	68.3
1938-39	Trebi barley	43.0	4	553	44.7	63.2
1938-39	Trebi barley	36.5	4	442	45.9	65.5
1940	Trebi barley	47.0	3	666	74.8	57.0
1940	Trebi barley	42.0	3	672	63.5	68.2
1940	Trebi barley	36.5	3	773	63 8	70.8