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Proso Millet and Oats in Poultry Rations

W. O. Wilson

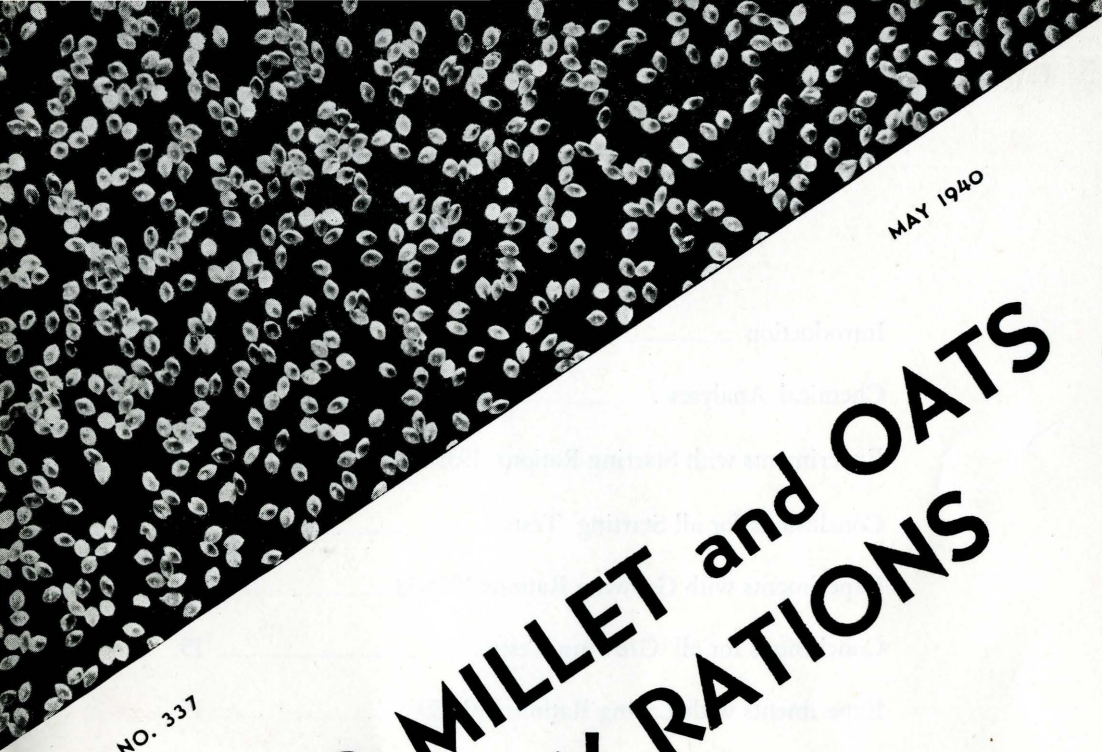
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BULLETIN NO. 337

MAY 1940

PROSO MILLET and OATS in POULTRY RATIONS

AGRICULTURAL EXPERIMENT STATION
South Dakota State College
BROOKINGS, S. D.

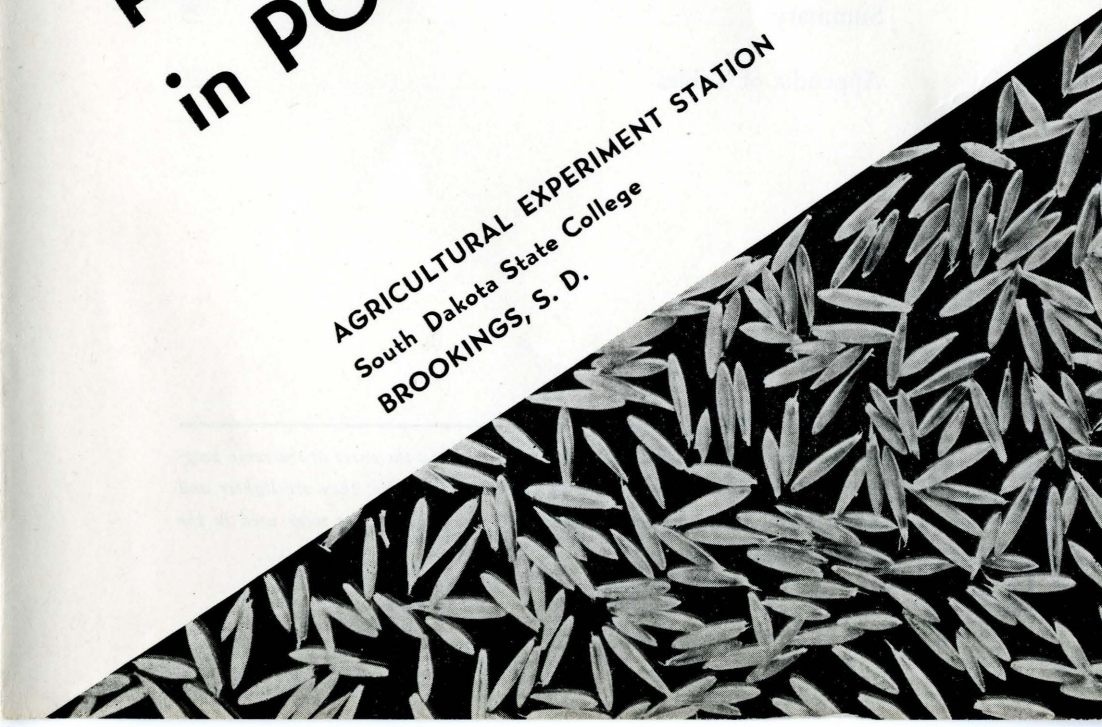


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COVER PAGE. *Red proso millet and oats are shown on the cover at the same magnification. A few of the proso kernels are without hulls; they are lighter and more round. These are representative samples of grains that were used in the different trials.*

Proso Millet and Oats in Poultry Rations

By W. O. Wilson, Assistant Poultry Husbandman,
and W. E. Poley, Poultry Husbandman

Introduction

Proso millet (*Panicum miliaceum*) has been used as a poultry and stock feed in the North Central states for many years. It is a late-sown catch crop for grains grown in the Northern Great Plains area and other sections that have similar climatic conditions.

There has been considerable demand for information regarding the feeding value of proso millet as a substitute for corn, wheat, oats and barley. Accordingly, several experiments were conducted to determine the feeding value of millet in starting, growing, and laying rations for poultry. Results of these experiments are reported in this bulletin.

Proso millet grains are borne in a panicle, like oats, instead of a spike as in the case of foxtail millet. Proso is distinguished from foxtail millet and barnyard millet chiefly by the head or inflorescence (the seed-bearing part). Proso millet is also known by other names such as hog millet, broomcorn millet or "hershey." There are several varieties of proso millet and, from a practical standpoint, they are classified as to red or white, depending upon the color of the hulls. The bran or seed coat is the same color in all varieties. Since Japanese, Hungarian, Siberian and Common millet all belong to the foxtail group, they are not discussed here. The varieties used in poultry feeding experiments conducted at this station include Early Fortune and Hansen White Siberian millet. The former is a red proso and the latter a white proso variety.

In most locations where it is grown, the average yield of proso in pounds of grain per acre is less than that of either wheat, oats or barley. In rather dry seasons, however, proso often out-yields other grains. This grain probably has a lower water requirement than most other grains, but it is not resistant to extreme drought.

Attempts have been made to exploit proso fraudulently as a very high-yielding dry-land crop. The grain has been grown in the United States long enough so that if it were a "wonder" grain by now it would probably be more extensively grown.

Chemical Analyses

The percentage chemical composition of red and white proso millet is given below. An analysis of yellow corn is also given for the purpose of comparison.

	Moisture percent	Protein percent	Ether Extract percent	Crude Fiber percent	Nitrogen- free Extract percent	Ash percent	Calcium per- cent	Phos. P ₂ O ₅ percent	Manganese P.P.M.*
Red proso	9.06	14.66	4.28	7.16	62.07	2.77	.024	.610	9.08
White proso	8.42	14.31	4.26	7.57	62.33	3.11	.024	.670	10.83
Yellow Corn	11.07	10.81	3.92	1.95	70.90	1.35	.015	1.204	6.60

* P.P.M. is parts per million.

These are average analyses made by the South Dakota Agricultural Experiment Station chemistry department and included a few samples of each grain grown in South Dakota.

It will be noted that the chemical composition of the two types of proso is different from corn. For example, corn is lower in protein and fiber than is proso. The higher crude fiber of the millet may be attributed to the outside hulls. Corn is lower in ash and calcium than millet, but is higher in phosphorus. It will also be noted that the millets are low in manganese content, although slightly higher than corn. Like other farm grains, the protein content of proso is low and this grain must be used in feeding chiefly to supply carbohydrates. It is necessary to supplement millet in the mash mixture with protein-, mineral- and vitamin-concentrates in proper amounts if satisfactory growth and egg production are to be obtained.

The photograph on the cover page shows a comparison of the relative size of oats and proso millet kernels with both shown at the same magnification.

The legal weight in South Dakota for proso millet is 50 pounds, compared with 32 pounds per bushel for oats.

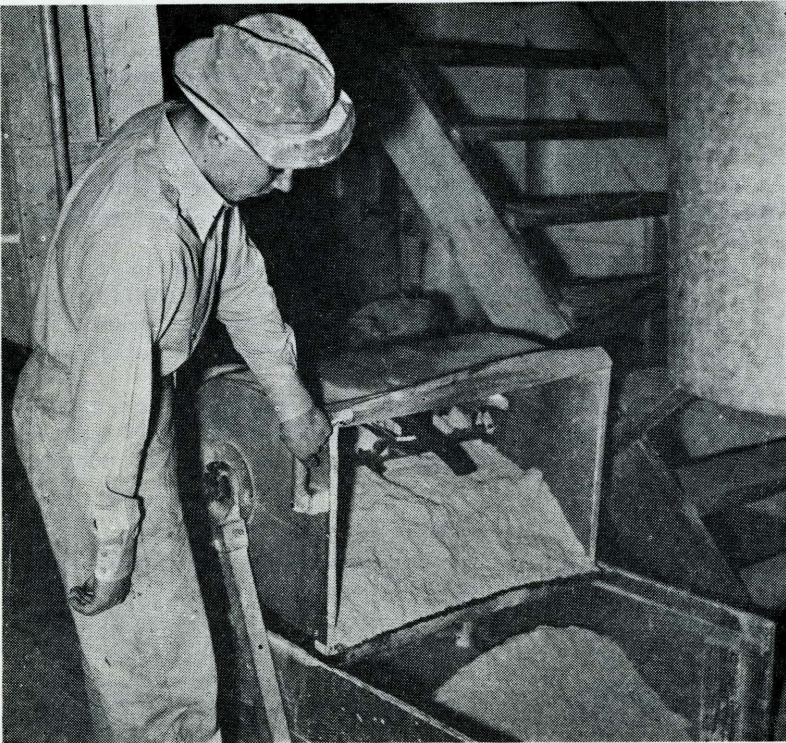


Fig. 1. The feed was thoroughly mixed in a small batch mixer shown above.

Experiments With Starting Rations, 1935-39

The general plan of procedure was the same for all experiments throughout the five years. The starting rations were fed the first eight weeks, beginning with the first day after hatching. The chicks, when selected for the experimental pens, were equalized as to initial weight and breeding. After the first year's work, the ration containing yellow corn with wheat bran and middlings was no longer used as the control or check ration, since it was shown that red proso with wheat bran and middlings gave as good growth as the ration containing corn, therefore this latter combination was used as the control or standard to which all other rations were compared.

Single-comb White Leghorn chicks were used the first year. During the following years, either Barred Plymouth Rocks or Rhode Island Reds were used in the trials. All chicks were hatched from the South Dakota Agricultural Experiment Station flocks. The breed used for each test, number of birds per lot, body weight gains, mortality and feed consumption data are all included in the appendix, Tables 1a and 1b.

The feeding efficiency reported in Table 1b was calculated as the number of pounds of feed required to produce a pound of gain in live weight.

In the tests involving starting rations, red and white proso were used with different combinations of supplementary grains and wheat by-products. It will be noted that the rations used were quite simple and each was fed as an all-mash mixture. The grains were ground in a hammer mill and were mixed in the mixer shown in Fig. 1. Chick weighings were made in grams using the scale shown in Fig. 2.

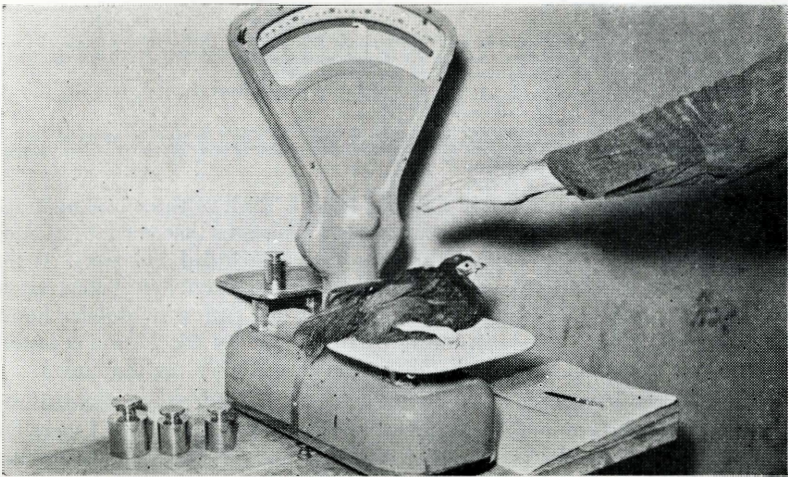


Fig. 2. Each bird was individually weighed in grams. Careful weighing of the chicks at frequent intervals is essential for experimental work.

All experiments were started in electrically heated battery brooders. The room temperature ranged from 65 degrees to 80 degrees F. After the chicks were four weeks of age, they were moved to unheated batteries in the same room.

1935 Starting Tests, Trials 1 and 2, Lots 1-6. The first year's work included a comparison of the feeding values of ground yellow corn, red proso and oats when fed at 44 percent levels. The basal mash mixture, which constituted the remaining 56 percent of each ration is given below. The different lots were fed all-mash rations as follows:

BASAL MASH MIXTURE*

WHEAT BRAN	15
WHEAT MIDLINGS	15
MEAT AND BONE SCRAPS	15
DRIED BUTTERMILK	5
ALFALFA LEAF MEAL	5
COD LIVER OIL CONCENTRATE	0.5
SALT	0.5
	56 percent

	Feed combinations added to the basal mash (percent)	Wt. at 8 wks. MF† (grams)	Percent feeding efficiency‡ of control (C)
Trial 1			
Lot No. 1	Yellow Corn 44	506	100C
Lot No. 2	Red proso 44	532	92
Lot No. 3	Oats 44	521	96
Trial 2			
Lot No. 4	Yellow corn 44	516	100C
Lot No. 5	Red proso 44	574	95
Lot No. 6	Oats 44	596	89

* Basal mash mixture is defined as that portion of the mash mixture including the different ingredients which were fed at the same levels to all lots in any one trial.

† The male and female average weight was determined by dividing the total sums of weights of the males and females by the total number of birds.

‡ Feeding efficiency includes the number of pounds of feed required to produce a pound of gain in live weight. The control ration is given at 100 percent. The actual number of pounds of feed required is given in Table 1a of the appendix.

White Leghorn chicks were used in Trial 1. Each of three lots included 85 chicks divided into two pens at the start. This means that one lot included 42 chicks and the second lot on the same ration included 43 chicks. At the end of four weeks, the two lots receiving the same ration were taken out of the battery brooder, combined, and placed in one pen of a brooder house 40 feet long. Thus, three pens were occupied for the three rations tested. The chicks were kept here until eight weeks of age when the test ended.

The Barred Plymouth Rocks in Trial 2 included 155 chicks divided into three pens for each ration. The same rations as were used in Trial 1 were fed in this test until the chicks were four weeks of age. At that time the amount of meat and bone scraps was reduced from 15 to 10 percent and the ground grain increased accordingly. The birds were confined to batteries for the entire eight-weeks period.

The results of Trials 1 and 2 showed that red proso millet, when added to the same basal ration, gave growth equally as good as either yellow corn or oats. There was a higher mortality, however, in chicks fed the oats ration when compared with those receiving either corn or proso. This may have been because the oats were not ground finely enough. Feed consumption per bird was higher with oats than with millet. This may be attributed to a greater wastage of the ration containing oats.

1936 Starting Tests, Trial 3, Lots 7-11. The second year's test was conducted for the purpose of comparing the supplementary value of alfalfa leaf meal to red proso millet and Amber cane. The experiment was also arranged to provide comparisons between proso and cane. Substitution of ground wheat for wheat bran and middlings in the basal ration was also studied. Basal rations were the same as those used the first year (1935) except that one instead of one-half percent each of cod liver oil and salt were given:

BASAL MASH MIXTURE

WHEAT BRAN	15
WHEAT MIDDLINGS	15
MEAT AND BONE SCRAPS	15*
DRIED BUTTERMILK	5
COD LIVER OIL	1
SALT	1
	52 percent

Feed combinations added to the basal mash (percent)		Wt. at 8 wks.	
		MF (grams)	Percent feeding efficiency of control (C)
Trial 3			
Lot No. 7	Red proso 48, no alfalfa	440	87
Lot No. 8	Red proso 43, alfalfa leaf meal 5	512	100C
Lot No. 9	Amber cane 48, no alfalfa	492	88
Lot No. 10	Amber cane 43, alfalfa leaf meal 5	569	104
Lot No. 11	Red proso 43, alfalfa leaf meal 5 (wheat 30% replacing bran and middlings in basal ration)	439	94

* Reduced at four weeks of age to 10 percent and principal grain increased accordingly

Sixty Barred Plymouth Rock chicks were started in each lot. Subnormal growth occurred in Lots 7 and 11, as will be noted in Table 1a, appendix. The death rate in the Amber cane lots was high. Whether this was due to the ration was not determined.

From Trial 3, it was concluded that (1) Amber cane seed was equal in feeding value to red proso when judged by body weight gains alone, (2) the addition of five percent alfalfa leaf meal increased the growth response when fed as a supplement to either red proso or Amber cane, (3) slower growth resulted when 30 percent of ground wheat instead of 15 percent each of bran and middlings was used as a supplement to red proso millet.

1937 Starting Tests, Trials 4 and 5, Lots 12-21. Comparisons were made between red and white proso when supplemented with wheat or oats instead of wheat bran and middlings. One percent of cod liver oil stearine and one-half percent of salt were fed this year. The rations used are given as follows:

BASAL MASH MIXTURE

MEAT AND BONE SCRAPS	15
DRIED BUTTERMILK	5
ALFALFA LEAF MEAL	5
SALT	0.5
C.L.O. STEARINE	1
	26.5 percent

	Feed combinations added to the basal mash (percent)	Wt. at 8 wks. MF (grams)	Percent feeding efficiency of control (C)
Trial 4			
Lot No. 12	R. proso 43.5, BM* 30	557	100C
Lot No. 13	R. proso 43.5, Oats 30	481	80
Lot No. 14	R. proso 53.5, Oats 20	432	82
Lot No. 15	W. proso 43.5, Oats 30	440	84
Trial 5			
Lot No. 16	R. proso 43.5, BM 30	493	100C
Lot No. 17	R. proso 53.5, Oats 20	383	93
Lot No. 18	W. proso 43.5, Oats 30	467	87
Lot No. 19	W. proso 53.5, Oats 20	390	83
Lot No. 20	R. proso 43.5, Oats 30	478	101
Lot No. 21	W. proso 43.5, BM 30	514	99

* BM 30 means 15 percent each of wheat bran and wheat middlings

To each ration was added 25 parts per million of manganese as manganese sulphate. Barred Plymouth Rock chicks were used in both trials. In Trial 4, 55 chicks were started, while in Trial 5, 68 birds were started on each ration. Higher mortality than was usually experienced occurred in some of the pens in both trials, consequently, definite conclusions were not obtained. Subnormal growth occurred in Lots 14, 15, 17 and 19, as will be noted in Table 1a of appendix. However, the following trends were noted: (1) either ground wheat or oats did not give as good results as did wheat bran and middlings. This was noted in both tests when either red or white proso millet was used as the principal constituent of the ration, (2) white proso was equal to red proso in feeding value.

1938 Starting Tests, Trials 6-12, Lots 22-50. Trials six through nine were conducted for the purpose of testing the feeding values of red proso millet when fed with 20-, 30- and 40-percent levels of either oats, barley, wheat or yellow corn.

The objective of Trial 10 was to determine the effect of different degrees of fineness of grinding of oats when used to supplement red proso millet. When the ground oats would pass through a 1-16 inch screen of the hammer mill used, it was considered coarsely ground. When it passed through a 1-20 inch screen it was considered finely ground. In this same test, one lot was given two percent of grit in the ration.

In Trial 11, growth comparisons were made of combinations of either corn, oats, wheat or barley, which had given the best growth when fed with red proso millet in previous tests.

Trial 12 was conducted to compare the rate of growth with different levels of yellow corn and proso.

The basal ration used in 1938 was similar to that used in 1937. Twenty-nine parts per million of manganese were added to the ration as manganese dioxide. The rations used for each lot are given in percent as follows:

BASAL MASH MIXTURE

MEAT AND BONE SCRAPS	15
DRIED BUTTERMILK	5
ALFALFA LEAF MEAL	5
SALT	0.5
C.L.O. STEARINE*	0.5
	26.0 percent

	Feed combinations added to the basal mash (percent)	Wt. at 8 wks. MF (grams)	Percent feeding efficiency of control (C)
Trial 6			
Lot No. 22	R. proso 54, oats 20	585	97
Lot No. 23	R. proso 44, oats 30	636	100C
Lot No. 24	R. proso 34, oats 40	623	100
Lot No. 25	R. proso 44, oats 20 (10 additional meat scraps)	606	89
Trial 7			
Lot No. 26	R. proso 54, barley 20	528	97
Lot No. 27	R. proso 44, barley 30	606	100C
Lot No. 28	R. proso 34, barley 40	616	100
Trial 8			
Lot No. 29	R. proso 54, wheat 20	423	88
Lot No. 30	R. proso 44, wheat 30	491	100
Lot No. 31	R. proso 34, wheat 40	329	74
Lot No. 32	R. proso 44, BM† 30	598	100C
Lot No. 33	W. proso 44, wheat 30	532	98
Lot No. 34	W. proso 44, BM 30	591	88
Trial 9			
Lot No. 35	R. proso 54, y. corn 20	444	101
Lot No. 36	R. proso 44, y. corn 30	473	103
Lot No. 37	R. proso 34, y. corn 40	521	102
Lot No. 38	R. proso 44, wheat 30	569	112
Lot No. 39	R. proso 44, BM 30	604	100C
Trial 10			
Lot No. 40	R. proso 42, oats 30 (finely ground) grit 2	561	100
Lot No. 41	R. proso 44, oats 30 (finely ground)	584	100C
Lot No. 42	R. proso 44, oats 30 (coarsely ground)	571	100
Trial 11			
Lot No. 43	R. proso 34, y. corn 40	544	111
Lot No. 44	R. proso 44, wheat 30	545	100C
Lot No. 45	R. proso 34, barley 40	561	105
Lot No. 46	R. proso 34, oats 40	575	103
Trial 12			
Lot No. 47	R. proso 52, y. corn 22	563	100
Lot No. 48	R. proso 42, y. corn 32	557	100C
Lot No. 49	R. proso 32, y. corn 42	554	102
Lot No. 50	R. proso 22, y. corn 52	563	94

* In Trial 12 the basal mash mixture was modified to include 0.25 percent cod liver oil concentrate and the principal grain was increased by the same amount.

† 15 percent each of wheat bran and middlings.

The test weights in pounds per bushel for the grains used in the trials conducted in 1938 were as follows: red proso 57½, oats 32½, barley 41½, wheat 59 and yellow corn 54.

All of these grains were ground in a hammer mill on the College Poultry Farm. Unless stated otherwise, the following screens were used in the hammer mill: 1/16 inch screen was used for grinding oats, barley and proso; 1/8 inch screen was used for grinding wheat and corn. It is very important that grain be ground to the proper degree of fineness. For example, the hulls of oats and barley should be finely ground to improve palatability. On the other hand, if wheat is too finely ground it will stick in different parts of the mouth. This will cause serious disturbances. In some cases, the beak actually becomes deformed. Thus, fibrous feeds should be finely ground and those feeds of low fiber content should be coarsely ground.

Barred Plymouth Rock chicks were used for all tests except Trials 9 and 10, which included Rhode Island Reds. Generally, about 50 birds were fed each ration.

The trials are numbered as they occurred. The results of the tests were as follows: (1) Weight gains increased progressively as did the amount of oats in the ration. Forty percent of oats was the highest level of this grain used with 34 percent red proso; this more nearly approached equal parts of the two grains. (2) Growth response also increased progressively as the amount of barley increased. (3) Increasing the amount of meat-scrap from 15 to 25 percent gave inferior results. (4) Unusually high mortality and subnormal growth occurred in the wheat test, and definite conclusions can not be reached. (5) White proso again proved equal in feeding value to red proso, and ground wheat as a supplement to either red or white proso millet again proved to be inferior to wheat bran and middlings when judged by the rate of chick growth secured. (6) Red proso and yellow corn gave practically the same results when fed with the same basal mash mixture. The weight gains did not increase progressively as the level of either corn or proso was increased in the ration. Subnormal growth occurred in Lot 35. (7) Barley, corn and wheat appeared to be equal as supplements for red proso. Oats gave slightly better results, but this probably was not significant. (8) No differences were apparent between finely and coarsely ground oats, and the addition of two percent of grit did not give increased gains or better feeding efficiency. (9) There appeared to be no differences in the feeding efficiency of the following grains tested: corn, wheat, oats, barley and red proso millet.

1939 Starting Tests, Trials 13-16, Lots 51-62. The tests conducted in 1938 showed that except for wheat the best results were obtained on the highest level (40 percent) of each of the grains used in combination with red proso millet. The purpose of these tests was to give additional information regarding the best level of wheat, oats or barley to use with red proso.

It will be recalled that the highest level of each grain fed the previous year with millet was the closest approach to equal parts of the two grains

in the ration. In 1939, three combinations were fed as follows: (1) equal parts (37 percent) of red proso with either wheat, oats or barley. (2) 47 percent proso millet and 27 percent of either wheat, oats or barley. (3) 27 percent of proso millet with 47 percent of either wheat, oats or barley. The rations used are as follows:

BASAL MASH MIXTURE

MEAT AND BONE SCRAPS	15
DRIED BUTTERMILK	5
ALFALFA LEAF MEAL	5
SALT	0.5
C.L.O. CONCENTRATE	0.25
	25.75 percent

	Feed combinations added to the basal mash (percent)	Wt. at 8 wks. MF (grams)	Percent feeding efficiency of control (C)
Trial 13			
Lot No. 51	R. proso 47.25, wheat 27	525	96
Lot No. 52	R. proso 37.25, wheat 37	557	100C
Lot No. 53	R. proso 27.25, wheat 47	549	99
Trial 14			
Lot No. 54	R. proso 47.25, wheat 27	557	94
Lot No. 55	R. proso 37.25, wheat 37	587	100C
Lot No. 56	R. proso 27.25, wheat 47	618	97
Trial 15			
Lot No. 57	R. proso 47.25, oats 27	601	99
Lot No. 58	R. proso 37.25, oats 37	614	100C
Lot No. 59	R. proso 27.25, oats 47	600	97
Trial 16			
Lot No. 60	R. proso 47.25, barley 27	554	81
Lot No. 61	R. proso 37.25, barley 37	569	100C
Lot No. 62	R. proso 27.25, barley 47	505	93

There were 58 parts per million of manganese added to each ration in the form of manganese dioxide.

The test weights of the grains used were red proso 52, oats 33, barley 43 and wheat 59 pounds per bushel. The grains were ground to the same degree of fineness as in the previous year.

Rhode Island Red chicks were used in Trials 13 and 14, and Barred Plymouth Rock chicks in Trials 15 and 16. Not less than 55 chicks were started in each lot for any test during this year.

The results indicate that the best growth and feeding efficiency was obtained when equal parts of proso millet and either wheat, oats or barley were used.

Conclusions for All Starting Tests

1. There were only slight differences in the number of pounds of feed required to produce a pound of gain (feeding efficiency) when corn, wheat, barley and oats were compared with millet. (Trials 1 and 2)

2. From the limited number of tests from which comparisons can be drawn, it would appear that red proso and oats are about 93 percent as effi-

cient as yellow corn when used with the supplements tested in these experiments. (Trials 1 and 2)

3. When fifteen percent each of wheat bran and wheat middlings were used instead of thirty percent ground wheat, gains were appreciably better. (Trials 3, 4, 5, 8 and 9.)

4. When alfalfa leaf meal was omitted from basal ration, growth was affected adversely. (Trial 3)

5. Amber cane was equally as effective as proso millet in promoting growth in chicks for the first eight weeks. However, the mortality rate was higher with Amber cane than with millet. (Trial 3)

6. There appeared to be no difference between red and white proso millet when judged by the rate of growth of chicks during the first eight weeks and the amount of feed required to produce a pound of gain in live weight. (Trials 4, 5, and 8)

7. Using body weight gains as a criterion, proso millet gave as good results as did either yellow corn, oats, barley or wheat with the type of ration tested. Best results were obtained when equal parts of proso and any one of the other grains were fed. (Trials 6-9 and 11-16, inclusive.)

Experiments With Growing Rations, 1935-39

When the birds had completed starting tests, they were divided into different groups after being equalized on the basis of weight and previous feeding. They were then fed the different experimental growing rations for 16 weeks, at which time they were 24 weeks of age. There was one exception, however, when in 1938 the test covered the period from 12 to 20 weeks of age.

In 1935 and 1936, Barred Plymouth Rock pullets were used. In the two subsequent years, Rhode Island Red pullets were used in the growing tests. Not less than 50 birds were started in each lot at the beginning of the test. The date started, body weights, feed consumption data and exact number of the birds for each ration are included in Tables 2a and 2b of the appendix.

The birds were housed in portable colony brooder houses and were given access to green range. The simple rations used in these experiments proved satisfactory in view of the fact that good range conditions and sunshine were provided. These rations probably would not have been so satisfactory had the birds been confined. A scratch grain was used with the mash mixture. All scratch grains were fed whole except corn, which was cracked. The grains as well as the mash and oyster shells were kept in hoppers before the birds at all times.

1935 Growing Test, Trial 1, Lots 1-3. The objective of the first test was to compare yellow corn, red proso and oats as feeds for growing chickens. The rations used were as follows:

BASAL MASH MIXTURE

WHEAT BRAN	15
WHEAT MIDLINGS	15
MEAT AND BONE SCRAPS	10
DRIED BUTTERMILK	5
ALFALFA LEAF MEAL	3
	48 percent

	Ground grain added to the basal mash (percent)		Scratch grain	Av. gain in wt. (8-24 wks.)	Percent feeding efficiency of control (C)
Lot No. 1	Yellow corn	52	Yellow corn	3.38 lbs.	100C
Lot No. 2	Red proso	52	Red proso	3.48 lbs.	87
Lot No. 3	Oats	52	Oats	3.08 lbs.	83

As indicated above, the scratch grain consisted of only one grain, the same as was added to the mash. Green millet range was provided for the chickens in each of the three lots.

From the results of this first test, red proso appeared to be equal to either corn or oats for promoting growth. Slightly higher mortality occurred among the birds fed the ration containing oats. The weight was not equalized in each pen at the start of this test, as it was a continuation of a starting test. The birds receiving corn consumed a larger portion of their total feed as mash, indicating that the corn used was not so palatable for young pullets at this time of the year as either millet or oats.

1936 Growing Test, Trial 2, Lots 4-7. In this experiment, four groups of pullets were fed the growing rations given below:

BASAL MASH MIXTURE

WHEAT BRAN	15
WHEAT MIDLINGS	15
MEAT AND BONE SCRAPS	10
DRIED BUTTERMILK	5
	45 percent

	Ground grain added to the basal mash (percent)		Scratch grain	Av. gain in wt. (8-24 wks.)	Percent feeding efficiency of control (C)
Lot No. 4	Yellow corn	55	Yellow corn	3.25 lbs.	100C
Lot No. 5	Red proso	55	Red proso	3.41 lbs.	113
Lot No. 6	Red proso, wheat replacing BM*	55	Red proso	3.53 lbs.	113
Lot No. 7	Oats	55	Oats	2.80 lbs.	78

* BM means 15 percent each of wheat bran and wheat middlings.

Three percent more of the ground grain to be tested was used in the mash in Trial 2 than was used in Trial 1. This resulted from the omission of alfalfa leaf meal, since good alfalfa range was provided throughout the test for all four pens. Lot 6 was included to determine whether or not 30 percent of ground wheat could be substituted for 15 percent each of wheat bran and wheat middlings. The other rations were fed to secure additional information on the relative feeding value of yellow corn, oats and red proso millet.

A comparison of the weights at the end of this test showed that red proso was again equal to corn. Oats-fed birds were appreciably smaller than the other groups at the end of the test. This confirms the findings in the first experiment, except that the slower growth of the birds receiving oats was not accompanied by higher mortality in the second trial. The corn-fed group of birds again consumed a larger percentage of their total feed as mash. From the results obtained in this growing trial, it would appear as if 30 percent of ground wheat may be successfully substituted for 15 percent each of wheat bran and wheat middlings.

1937 Growing Test, Trial 3, Lots 8-11. The objectives of the experiments conducted the third year were to determine the comparative values of red proso millet, white proso millet and oats. Red proso was also supplemented with ground wheat instead of wheat bran and middlings in the growing mash.

Red proso was used as the scratch grain in every case except with the birds receiving white proso. The birds were reared on a range seeded to rape, which stayed green for practically the entire growing period in all pens.

The following rations were fed:

BASAL MASH MIXTURE

GROUND WHEAT	30
MEAT AND BONE SCRAPS	10
DRIED BUTTERMILK	5
ALFALFA LEAF MEAL	3

		Ground grain added to the basal mash (percent)		Scratch grain	Av. gain in wt. (8-24 wks.)	48 percent Percent feeding efficiency of control (C)
Lot No. 8	Oats	52		Red proso	2.94 lbs.	86
Lot No. 9	Red proso	52,		Red proso	2.83 lbs.	93
	BM* replacing wheat					
Lot No. 10	Red proso	52		Red proso	2.99 lbs.	100C
Lot No. 11	White proso	52		White proso	3.01 lbs.	102

* BM means 15 percent each of wheat bran and wheat middlings.

The result of this season's work showed that red and white proso were of equal feeding value and gave as good results as oats when fed to growing pullets. Thirty percent ground wheat again gave as good results as 15 percent each of wheat bran and middlings. This is in contrast with the results obtained with the starting rations, but confirms the results of the previous test. The differences in response between young and older chickens receiving either wheat or bran and middlings might be explained on the basis of the higher mineral and vitamin content of bran and middlings needed in larger quantities by the younger chicks.

1938 Growing Test, Trial 4, Lots 12-15. The final growing trial was planned to compare oats and proso millet not only in the growing mash but in the scratch grain portion as well. Two different ages (12 and 13½ weeks) were started in each lot in approximately equal numbers. This trial was started later than the other test, and was discontinued when the younger

pullets were 20 weeks of age. This was sooner than in the previous trials which were discontinued when the birds were 24 weeks of age. The birds started laying early and were needed to start a laying test. The pullets were given access to alfalfa range. Below are the rations fed.

BASAL MASH MIXTURE

GROUND WHEAT	30
MEAT AND BONE SCRAPS	14
ALFALFA LEAF MEAL	3
SALT	1
	48 percent

	Ground grain added to the basal mash (percent)		Scratch grain	Av. gain in wt. (12-20 wks.)	Percent feeding efficiency of control (C)
Lot No. 12	Oats	52	Oats	1.28 lbs.	71
Lot No. 13	Oats	52	Red proso	1.39 lbs.	79
Lot No. 14	Oats	52	Equal parts oats & red proso	1.29 lbs.	76
Lot No. 15	Red proso	52	Red proso	1.42 lbs.	100C

The results obtained in this experiment agreed with those of the previous tests in that red proso gave equally as good growth as oats for pullets. It was noted that in each lot where the percentage of proso fed increased, the gain per bird likewise increased. The differences were so small that they were not considered significant, but a trend favoring the growth of chicks receiving more proso millet was indicated. For example, the rate of growth in the different lots ranked in order of Lot 15, Lot 13, Lot 14 and Lot 12.

Conclusions for All Growing Tests

1. The feeding value of red proso was equal to that of yellow corn while oats were about 80 percent the value of corn. (Trials 1 and 2)
2. The growing birds did not consume cracked yellow corn as readily as proso millet. (Trials 1 and 2)
3. Thirty percent ground wheat gave as good results as did 15 percent each of wheat bran and middlings. (Trial 2 and 3)
4. No consistent results were noted in the different experiments for feeding efficiency except that in each trial where oats were used they were not quite as efficient as proso millet. (Trials 1, 2, 3, and 4)

Experiments With Laying Rations, 1934-38

A total of five laying trials were conducted, each trial consisting of three or more groups and each group included one or more pens. The time of starting and the duration varied with the different tests. In general, however, the experiments started when the pullets were about six months old and were continued until they were about seventeen months old. Mash, grain and oyster shells were kept in feeders before the birds at all times.

At the start of the tests, the birds were equalized as to body weight and previous feeding and management. The test pens were all in one laying

house, except when duplicate pens were used. Figures 3 and 4 show the kinds of houses used. Unless stated otherwise, the birds were kept confined to the laying house without range throughout the test period. Cod liver oil was added from November 1 until April 30. When the weather permitted, the windows of the laying houses were kept open. The general interior arrangement of the pens is shown in Figure 5. Trapnest records of egg production were kept for all pens. Eggs laid on the floor were included in the averages. Morning lights were used in each pen from 4 o'clock until daylight from October 15 to March 31. Tables 3a and 3b of the appendix give the following information for each test: Breed, time of starting and duration, mortality, gain in weight, egg production, feed consumption and hatchability data.

The mortality of the birds in all trials was high. The cause may be attributed to tumors, leucosis and neurolymphomatosis.

Hatchability data was obtained for only the last two years. The figures given represent the total of at least three separate hatches.

1934-35 Laying Test, Trial 1, Lots 1-3. The first test was designed to compare the relative feeding value of yellow corn, red proso and oats. The rations fed are given as follows:

BASAL MASH MIXTURE				
	WHEAT BRAN		20	
	WHEAT MIDLINGS		20	
	MEAT AND BONE SCRAPS		15	
	DRIED BUTTERMILK		5	
	ALFALFA LEAF MEAL		5	
	SALT		1	
	COD LIVER OIL		1	
				67 pounds
	Ingredients added to the basal mash (pounds)	Scratch grain	Av. no. eggs produced	Percent feeding efficiency of control (C)
Lot No. 1	Yellow corn 40	Whole yellow corn	165	100C
Lot No. 2	Red proso 40	Whole red proso	161	99
Lot No. 3	Oats 40	Whole oats	144	98

The mash ration is expressed in pounds rather than percent. The total is 107 pounds. The grain added would be 37.3 percent of the total.

The birds were kept in heated duplicate pens in the east wing of the central poultry house, shown in Fig. 3. At the start of the test, 51 White Leghorn pullets were placed on each ration. The mortality amounted to over 50 percent for two of the rations, consequently the results obtained are of doubtful significance. The egg records reported were calculated on the basis of the records of the survivors. Birds receiving red proso millet produced as many eggs as those which were fed yellow corn, while the lowest production was secured with oats. Differences in the amounts of feed consumed by the different lots cannot be explained.

1935-36 Laying Test, Trial 2, Lots 4-6. The second laying trial was similar to the first, in that corn, oats and proso were compared. The basal mash

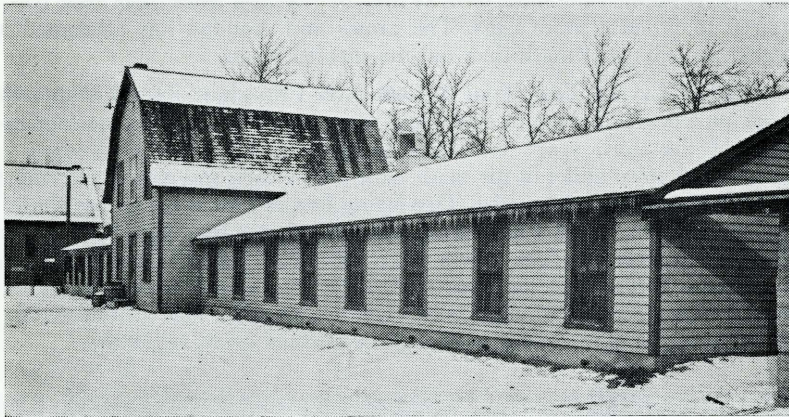


Fig. 3. The laying house which housed three of the five laying trials. The first two years' trials were in the right wing, the last year's was in the left wing. The feed room is in center.

differed, however, in that 30 percent of ground wheat was fed instead of 20 parts each of wheat bran and middlings. This allowed the amount of grain in the mash to be increased by 10 percent. The percentage of the ingredients used in the ration is as follows:

BASAL MASH MIXTURE

GROUND WHEAT	30
MEAT AND BONE SCRAPS	15
DRIED BUTTERMILK	5
ALFALFA LEAF MEAL	5
SALT	1
COD LIVER OIL	1
	57 percent

	Ingredients added to the basal mash (percent)		Scratch grain	Av. no. eggs produced	Percent feeding efficiency of control (C)
Lot No. 4	Yellow corn	43	Whole yellow corn	131	100C
Lot No. 5	Red proso	43	Whole red proso	146	95
Lot No. 6	Oats	43	Whole oats	135	100

The environment of the birds was the same as the previous year. Duplicate pens of Barred Plymouth Rock pullets were fed each ration. The number of birds on each ration varied, the smallest number on a ration being 51 birds. The exact numbers may be found in Table 3 of the appendix. Mortality was high in the oats pens, amounting to 51 percent of the original number started. In the other pens, approximately one-third of the birds died during the experiment.

While the difference in egg production does not appear to be significant, the birds receiving proso millet had the highest average production. This

pen also consumed the most feed, as may be expected since more feed is required to produce more eggs. The proso- and corn-fed lots consumed a higher percentage of mash than did the oats-fed birds.

1936-37 Laying Test, Trial 3, Lots 7-10. Fifty-eight Barred Plymouth Rock pullets (29 in each of two pens) were used with each of the four rations of the third year's test. The purpose of this trial was to compare ground red proso millet in the mash with yellow corn and also either whole red proso or white proso millet. Two laying houses similar to the one shown in Figure 4 were used. Each house was divided into four pens 8 feet wide and 16 feet deep. The four rations were fed in each house. The end pens in the second house were reversed from those in the first house to equalize environmental factors. Both houses were unheated. The ground grains added to the basal mash and scratch grain used are given as follows:



Fig. 4. A laying house 16 feet by 32 feet divided into four equal-sized pens. The third and fourth years' trial birds were kept in houses this size.

BASAL MASH MIXTURE

GROUND WHEAT	30
MEAT AND BONE SCRAPS	15
DRIED BUTTERMILK	5
ALFALFA LEAF MEAL	5
SALT	1
COD LIVER OIL	0.5
	56.5 percent

	Ingredients added to the basal mash (percent)	Scratch grain	Av. no. eggs produced	Percent feeding efficiency of control (C)
Lot No. 7	Ground yellow corn 43.5	Red proso	127	100C
Lot No. 8	Ground red proso 43.5	Red proso	130	104
Lot No. 9	Whole red proso 43.5	Red proso	123	95
Lot No. 10	Ground white proso 43.5	White proso	119	91

The death rate was lower than that of the two previous years. That the birds were rather immature when started on test is revealed by the gain in body weight. From the average number of eggs produced, it may again be noted that red proso was equal to yellow corn.

The birds in all the lots consumed a relatively large percentage of the total feed as grain. There were no appreciable differences in the egg production of the four lots. Birds fed ground red proso in the mash and whole red proso scratch grain produced as many eggs with no greater feed consumption as the birds which were fed ground yellow corn in the mash with whole red proso as scratch grain.

The fact that the ration which contained whole red proso millet in the mash gave as good results as the ration containing ground yellow corn (control) and also was equally as good as the mash containing ground red proso millet offers possibilities. The usual cost of grinding is approximately 8 to 10 cents per hundred pounds. Feeding whole millet in the mash would amount to considerable saving when a large amount of feed is used. However, the feed required to produce a dozen eggs was higher with the birds receiving whole millet instead of ground millet in the mash. This may be because of the fact that some of the whole millet kernels were found in the droppings after passing through the alimentary tract without digestion.

1937-38 Laying Test, Trial 4, Lots 11-14. The purpose of this test was to determine the effect of increasing either the amount of meat and bone scraps or alfalfa leaf meal in the mash. Also, a group receiving white proso millet was again included to repeat the previous trial. Fifty-four Rhode

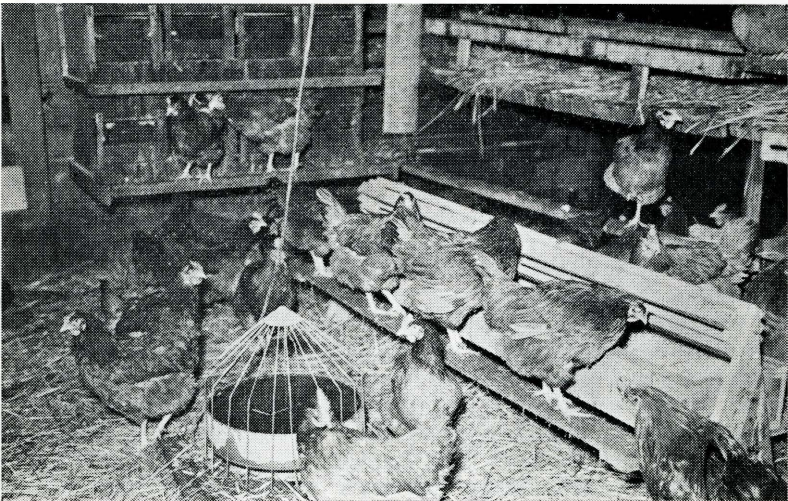


Fig. 5. Interior view of one of the experimental laying pens.

Island Red pullets were divided into four equal groups. Twenty-seven birds were placed in duplicate pens (8 x 16 feet) in two separate houses, following the same system as used the previous year. Each ration was tested in each of the two houses, which were unheated. Each house in reality constituted a separate test.

BASAL MASH MIXTURE

GROUND WHEAT	30
MEAT AND BONE SCRAPS	15
DRIED BUTTERMILK	5
ALFALFA LEAF MEAL	5
SALT	1
COD LIVER OIL	1
	57 percent

	Ingredients added to the basal mash (percent)	Scratch grain	Av. no. eggs produced	Percent feeding efficiency of control (C)
Lot No. 11	Red proso 43	Red proso	88	100C
Lot No. 12	White proso 43	White proso	105	125
Lot No. 13	Red proso 38, alfalfa additional 5	Red proso	94	112
Lot No. 14	Red proso 33, meat additional 10	Red proso	109	128

The pullets were in less than 10 percent production when the test was started. Although the differences in egg production between certain pens appears large, they were not statistically significant, that is, these differences may have been due to chance more than one time out of 20. The difference between egg production from pens on the same ration in the duplicate pens was as great as the difference between pens receiving different rations. The rate of mortality was not influenced by the rations fed. Five percent additional alfalfa leaf meal did not increase egg production nor hatchability.

The birds receiving the control ration (red proso 43 percent) required more feed to produce one dozen of eggs than did those receiving the other rations.

The hatchability data is of interest. The data represent the average of three hatches, two were February hatches and the other was a March hatch. The lowest hatchability occurred on the group receiving additional meat scraps. The chief point that was noted was the difference between two pens on the same feed in different houses. The figures under "A" for each ration represent the results secured from birds kept in the laying house which had a roof with an uneven span and a straw loft. The figures listed under "B" for each ration represent results obtained when the birds were kept in a shed roof type laying house about 30 yards north of the first house mentioned. It had practically no protection from the north. The inside of the roof was insulated with an improvised straw loft. This house was not as warm as the first house. Fertility of the birds in the two houses follows no definite trend. For each ration, the hatchability of the pen kept in the

north house was lower than that of the corresponding pen of the south house. Fertility did not appear to be influenced by the laying house in which birds were kept.

HATCHABILITY DATA FOR 1938 FOR HOUSES A AND B

	No. eggs set		Percent fertility		Percent hatch of fertile eggs		Average of A and B
	A	B	A	B	A	B	
Lot 11—128	178		89.8	75.3	70.4	64.2	67.3
Lot 12—144	192		60.4	89.1	78.2	66.7	72.4
Lot 13—148	183		89.9	82.0	73.7	58.7	66.1
Lot 14—193	244		63.7	79.5	65.9	56.2	61.0

1938-39 Laying Test, Trial 5, Lots 15-18. There were three objectives in this experiment, namely to determine (1) the comparative egg production with rations containing either red or white proso millet, (2) the supplementary value of 30 percent of ground oats used to replace the same amount of ground wheat in the mash, and (3) the effect of increasing the amount of meat scraps in the mash to 25 percent. The last year's tests were conducted in a house supplied with a slight amount of heat. Forty-eight Rhode Island Red pullets were used in each pen for each ration. The test extended for a period of 40 weeks, hence the egg production is lower than that of the other tests reported for longer periods. Grit and oyster shells were fed to all pens. This was the first year that grit was used. Manganese was added to the mash to supply 60 parts per million of manganese in the total ration which was calculated on the basis of equal amounts of mash and grain being consumed. The rations used are included as follows:

BASAL MASH MIXTURE

MEAT AND BONE SCRAPS	15
DRIED BUTTERMILK	5
ALFALFA LEAF MEAL	5
SALT	1
COD LIVER OIL	0.5
	26.5 percent

	Ingredients added to the basal mash (percent)	Scratch grain	Av. no. eggs produced	Percent feeding efficiency of control (C)
Lot No. 15	Red proso 43.5, wheat 30	Red proso	86	100C
Lot No. 16	White proso 43.5, wheat 30	White proso	99	109
Lot No. 17	Red proso 43.5, oats 30	Red proso	100	108
Lot No. 18	Red proso 33.5, wheat 30, meat scraps additional 10	Red proso	72	86

The differences in egg production between the different pens were not significant. The necessity of repetition is brought out strikingly. The lot fed additional meat and bone scraps produced less eggs than any ration tested this year. In the previous test, the lot with additional meat and bone scraps produced more eggs than any of the four pens tested.

All birds consumed a smaller percentage of mash and proportionately more grain in their total feed. This confirms the observations made in previous tests.

The hatchability data for the ration were as follows:

Lot No.	Eggs set	Percent fertile	Percent hatch of fertile eggs
15	317	78.9	76.4
16	580	81.7	75.9
17	414	82.9	71.1
18	311	81.0	65.1

The hatchability of fertile eggs set, again reveals that 10 percent additional meat and bone scraps (25 percent in all) depressed hatchability. The meat and bone scraps may have decreased the availability of the manganese and increased the requirement for this element.

Conclusions for All Laying Tests

1. Red proso millet was found to be equal to either yellow corn or oats for egg production and maintenance of body weight. (Trials 1 and 2)
2. From the limited data, it would appear as if proso millet is approximately 97 percent as efficient as yellow corn and oats for egg production when used with the basal rations tested in these experiments. (Trials 1 and 2)
3. Red and white proso were of equal feeding value. (Trials 3, 4 and 5)
4. Good results were secured when the whole proso millet instead of ground millet was added to the mash. However, more feed was required to produce a dozen eggs with whole millet than when ground millet was used in the mash. (Trial 3)
5. Neither egg production nor hatchability was improved by increasing either the amount of alfalfa leaf meal or meat and bone scraps contained in the mash mixture. In fact, hatchability appeared to be depressed by the addition of meat and bone scraps. (Trials 4 and 5)

Turkey Rations Containing Millet

"Cereal Grains in Turkey Rations," South Dakota Agricultural Experiment Station Bulletin No. 330, reports the use of red proso millet in turkey rations with satisfactory results. The millet was fed in the starting mash and also as scratch grain in growing and finishing rations. In no instance did proso millet constitute the sole grain either in the mash or in the scratch grain. Some millet grains were observed in the droppings of the growing turkeys, which would indicate incomplete digestion.

The experimental all-mash starting rations fed to the turkeys and reported in Station Bulletin 330 were as follows:

BASAL MASH MIXTURE

FISH MEAL	15
MEAT AND BONE SCRAPS	10
DRIED BUTTERMILK	12
ALFALFA LEAF MEAL	6
SALT	1
COD LIVER OIL STEARINE	2
	46 percent

Percentage ingredients added to the basal mash

Lot 1 Ground yellow corn 24, oats, wheat bran and middlings 10 each (control)

Lot 2 Red proso millet, wheat and barley 18 each

Lot 3 Red proso millet, wheat and oats 18 each

Manganese sulfate was added at the rate of one-quarter of a pound per ton.

Equally good results were secured with the rations containing millet as with the control containing yellow corn.

In rations fed to turkeys from 20 to 26 weeks of age, equal parts of red proso, oats and barley were fed as the scratch grain part of the rations. This mixture of grain gave as good results as when either oats or barley were fed as whole grain. A direct comparison with corn was not possible, but the weight gains secured were indicative of normal growth.

Mash rations A and B, which are given below, gave good body weight gains and finish.

Ration A	Ration B
36 ground oats	36 ground barley
30 ground wheat	30 ground oats
10 alfalfa leaf meal	10 alfalfa leaf meal
18 meat and bone scraps	18 meat and bone scraps
5 dried buttermilk	5 dried buttermilk
1 salt	1 salt
100 Total	100 Total

A complete discussion of these results are to be found in Station Bulletin No. 330, "Cereal Grains in Turkey Rations."

Practical Recommendations

1. All-mash starting rations (0 to 8 weeks) for chicks, containing proso millet and oats. The following rations may be fed to chicks with satisfactory results:

Basal mash mixture	Ground feed ingredients to mix with basal mash (Use either mixture A or B below)
75 meat and bone scraps	A
25 dried buttermilk	215 pounds red or white proso millet
25 alfalfa leaf meal	75 pounds wheat bran
5 salt mixture*	75 pounds wheat middlings
5 fish oil	B
135 pounds	185 pounds red or white proso millet
	180 pounds oats, barley or wheat

The standard fish oil may be either sardine or cod-liver oil that has been tested. The potency should be guaranteed. Standard fish oil contains at least 85 A.O.A.C. Chick Units of vitamin D per gram.

The fish oil should be pre-mixed with one of the coarser ingredients in order to prevent lumping.

If liquid skimmed milk or buttermilk is kept before the chicks at all times, the dried buttermilk may be omitted from the ration and the amount of meat scraps reduced to 50 pounds. The ground proso millet would be increased to 265 pounds in mixture A and 235 pounds in mixture B.

* The salt mixture should include 4% pounds of common salt and 1/2 pound of manganese sulfate. The five pounds of salt mixture should then be added to the other ingredients of the mash, making a total of 500 pounds. This should be carefully mixed to insure uniform composition.

If oats or barley are fed in chick rations, they should be finely ground or pulverized, otherwise the hulls are too coarse for the young chicks.

The mash is to be kept in feeders before the birds at all times. Chick-size grit or coarse sand should be provided.

2. Growing rations for chickens (after 8 weeks), containing proso millet and oats. Mash rations and scratch grains which may be fed to growing chicks on range are as follows:

Basal mash mixture	Ground grain to mix with basal mixture (Use either A or B)
150 ground wheat	
70 meat and bone scraps	A
15 alfalfa leaf meal	260 pounds red or white proso millet
5 salt	B
240 pounds	260 pounds oats

The whole grain part of the ration may be either red or white proso millet, or oats, or a combination, or most any of the other cereal grains except rye.

If plenty of green range is available and milk is fed, the alfalfa leaf meal may be omitted from the growing mash.

If liquid skimmed or buttermilk is available, it may be given to the growing birds and the amount of meat and bone scraps in the mash reduced to 50 pounds.

Oyster shells and grit should be kept before the birds in hoppers.

If the birds are confined, 1 percent cod liver oil should be added to the mash.

3. Laying rations for chickens containing proso millet and oats. Mash rations and scratch grains which may be fed to laying hens are as follows:

Basal mash mixture	Ground feed ingredients to be mixed with basal mixture (Use either mixture A or B given below)
75 meat and bone scraps	
25 dried buttermilk	A
25 alfalfa leaf meal	215 pounds red or white proso millet
5 salt mixture*	or corn
5 fish oil	75 pounds wheat bran
135 pounds	75 pounds wheat middlings
	B
	215 pounds red or white proso millet
	150 pounds oats or wheat

If hatching eggs are to be saved, the dried milk should be increased to 40 pounds and the fish oil increased to 10 pounds in 500 pounds of mash mixture. The ground grain will then be reduced by 20 pounds.

The scratch grain may be either whole red or white proso millet, or oats, or corn.

Oyster shells and grit should be kept before the birds in hoppers.

* The salt mixture should include $\frac{4}{100}$ pounds of common salt and $\frac{1}{100}$ pound of manganese sulfate. The five pounds of salt mixture should then be added to the other ingredients of the mash, making a total of 500 pounds. This should be carefully mixed to insure uniform composition.

Summary

The feeding value of red or white proso millet was found to be approximately 95-100 percent that of corn in the starting, growing and laying rations tested with chickens. Comparative values of the grain were based upon rate of growth, feed utilization and egg production.

Starting and Growing Rations

Ground proso millet may be fed in the starting ration to equal 44 percent of the all-mash ration. Ground wheat supplementing proso millet did not give as good results as did 15 percent each of wheat bran and middlings, when measured by rate of growth. The supplementary values of grains when fed with red proso ranked in the order of oats, barley, corn and wheat when based on the rate of growth. The differences, however, were too small to be considered significant. Generally, the best growth and feed utilization occurred with approximately equal amounts of proso millet and either oats, barley, corn or wheat. The feeding efficiency did not appear to be affected by the combinations of other cereal grains fed with red proso millet in the mash mixture.

Ground proso millet may be fed in growing rations to equal 52 percent of the mash ration and up to 100 percent of the scratch grain ration. For growing rations, ground wheat, supplementing proso millet gave as good results as did 15 percent each of wheat bran and middlings when measured by rate of growth. This is in contrast with the results obtained from starting rations. Growing pullets did not consume cracked yellow corn as readily as red proso millet.

Laying Rations

Ground proso millet may be fed in laying rations to equal 43 percent of the mash ration and 100 percent of the scratch grain ration. Proso millet grain, because of its small size, may be added to the laying mash unground. When this was done, about nine percent more feed was required to produce a dozen eggs. Neither egg production nor hatchability was improved by increasing either the amount of alfalfa leaf meal or meat and bone scraps included in the basal mash mixture. In fact, better hatchability was obtained when the mash mixture contained 15 percent of meat and bone scraps instead of 25 percent.

Appendix of Tables

Table 1a. Average Weights of Chicks During Starting Period.

Trial No. and Breed	Lot Date started	No.	Ingredients added to basal mash (percent) †	Body weight in grams ‡						
				0 wks. MF* av.	4 wks. M	F	6 wks. M	F	8 wks. M	F
Trial 1 White Leghorns 3-25-35	1		Yellow corn 44	35	188	179	336	306	540	466
	2		R. proso 44	35	194	188	362	327	573	493
	3		Oats 44	35	217	206	379	367	548	494
Trial 2 Barred Rocks 5-9-35	4		Yellow corn 44	36	216	207	421	384	546	486
	5		R. proso 44	37	211	222	391	402	571	578
	6		Oats 44	37	229	231	450	442	601	591
Trial 3 Barred Rocks 4-1-36	7		R. proso 48, no alfalfa leaf meal	35	179	175	301	291	451	425
	8		R. proso 43 alfalfa leaf meal 5	36	197	204	344	339	531	501
	9		Amber cane 48, no alfalfa leaf meal	35	195	189	331	318	503	483
	10		Amber cane 43 alfalfa leaf meal 5	35	209	207	365	376	563	574
	11		R. proso 43, alfalfa leaf meal 5 wheat 30 replacing BM§	35	186	191	285	294	439	439
Trial 4 R. I. Reds 3-28-37	12		R. proso 44, BM 30	37	148	160	297	315	557	557
	13		R. proso 44, wheat 30	37	148	133	311	270	533	442
	14		R. proso 54, oats 20	36	127	124	239	236	439	425
	15		W. proso 44, oats 30	35	111	112	223	211	427	451
Trial 5 R. I. Reds 4-11-37	16		R. proso 44, BM 30	39	155	161	315	334	482	503
	17		R. proso 54, oats 20	39	122	127	242	260	390	381
	18		W. proso 44, oats 30	39	123	135	288	314	468	466
	19		W. proso 54, oats 20	39	124	123	254	252	407	376
	20		R. proso 44, wheat 30	39	171	174	313	319	476	479
	21		W. proso 44, BM 30	40	152	156	335	342	515	514
Trial 6 Barred Rocks 12-24-37	22		R. proso 54, oats 20	37	205	201	395	375	587	583
	23		R. proso 44, oats 30	37	219	224	414	413	636	636
	24		R. proso 34, oats 40	37	214	205	408	380	654	594
	25		R. proso 44, oats 20, 10 more meat and bone	37	203	199	389	368	626	582
Trial 7 Barred Rocks 1-3-38	26		R. proso 54, barley 20	37	197	188	342	328	560	506
	27		R. proso 44, barley 30	37	214	210	401	375	626	571
	28		R. proso 34, barley 40	37	206	199	411	383	631	595
Trial 8 Barred Rocks 1-28-38	29		R. proso 54, wheat 20	37	145	152	279	275	435	409
	30		R. proso 44, wheat 30	36	144	153	290	289	492	489
	31		R. proso 34, wheat 40	36	152	139	234	212	349	318
	32		R. proso 44, BM 30	37	202	187	398	361	649	591
	33		W. proso 44, wheat 30	36	177	175	334	311	577	498
	34		W. proso 44, BM 30	37	213	204	402	356	647	528
Trial 9 R. I. Reds 2-5-38	35		R. proso 54, yellow corn 20	37	152	135	280	243	477	417
	36		R. proso 44, yellow corn 30	37	167	148	311	259	520	435
	37		R. proso 34, yellow corn 40	37	180	174	324	308	541	499
	38		R. proso 44, wheat 30	36	191	188	354	330	598	546
39		R. proso 44, BM 30	37	212	198	396	356	634	567	
Trial 10 R. I. Reds 3-4-38	40		R. proso 42, oats 30 F. G., grit 2	40	169	174	340	338	551	568
	41		R. proso 44, oats 30 finely ground	40	163	187	332	356	579	589
	42		R. proso 44, oats 30 coarsely ground	40	173	172	348	330	596	539
Trial 11 Barred Rocks 4-8-38	43		R. proso 34, yellow corn 40	39	182	196	312	344	538	558
	44		R. proso 44, wheat 30	40	185	177	329	309	579	507
	45		R. proso 34, barley 40	39	191	201	331	339	568	554
	46		R. proso 34, oats 40	38	189	212	329	365	570	579

(Continued on following page)

Table 1a. Average Weights of Chicks During Starting Period. (Cont.)

Trial No. and Breed Date started	Lot No.	Ingredients added to basal mash (percent)†	Body weight in grams‡							
			0-wks.		4 wks.		6 wks.		8 wks.	
			MF*	av.	M	F	M	F	M	F
Trial 12 Barred Rocks 6-3-38	47	R. proso 52, yellow corn 22	39	187	196	337	344	563	563	
	48	R. proso 42, yellow corn 32	39	187	191	328	330	559	555	
	49	R. proso 32, yellow corn 42	39	170	198	322	355	549	561	
	50	R. proso 22, yellow corn 52	39	168	173	323	319	583	544	
Trial 13 R. I. Reds 2-21-39	51	R. proso 47, wheat 27	38	181	181	345	347	534	513	
	52	R. proso 37, wheat 37	38	205	196	389	364	580	524	
	53	R. proso 27, wheat 47	38	196	189	376	359	556	538	
Trial 14 R. I. Reds 2-22-39	54	R. proso 47, wheat 27	39	190	192	371	363	570	541	
	55	R. proso 37, wheat 37	39	201	207	374	388	587	586	
	56	R. proso 27, wheat 47	39	216	205	417	400	628	601	
Trial 15 Barred Rocks 2-28-39	57	R. proso 47, oats 27	38	202	193	394	384	613	584	
	58	R. proso 37, oats 37	38	238	231	411	403	637	597	
	59	R. proso 47, oats 47	38	224	224	395	399	615	581	
Trial 16 Barred Rocks 3-7-39	60	R. proso 47, barley 27	38	190	190	376	350	581	527	
	61	R. proso 37, barley 37	37	194	195	377	368	580	551	
	62	R. proso 27, barley 47	38	146	149	318	310	515	476	

* M—Males; F—females.

‡ BM 30 means 15 percent each of wheat and bran and wheat middlings.

† Exact figures are given in text.

The percentage of ingredients added to the basal mash are reported to the nearest pound.

‡ 454 grams is equal to 1 pound.

Table 1b. Number of Chicks, Mortality and Feed Consumption Data for Starting Period.

Trial No. and Breed Date started	Lot No.	Ingredients added to basal mash (percent)†	Number of chicks		Av. feed consumed		Feeding efficiency**		
			8 wks.		Mort- ality		per bird		
			Start	M* F*	percent	lbs.	Actual of	Percent control	
Trial 1 White Leghorns 3-25-35	1	Yellow corn 44	85	44	38	3.5	4.47	4.03	***
	2	R. proso 44	85	38	39	9.4	5.15	4.38	92.0
	3	Oats 44	85	37	38	11.8	4.80	4.18	96.4
Trial 2 Barred Rocks 5-9-35	4	Yellow corn 44	155	70	72	8.4	3.32	2.92	***
	5	R. proso 44	154	77	65	8.4	3.89	3.07	95.1
	6	Oats 44	155	70	60	16.1	4.34	3.30	88.5
Trial 3 Barred Rocks 4-1-36	7	R. proso 48, no alfalfa leaf meal	60	30	23	11.7	3.21	3.33	86.5
	8	R. proso 43 alfalfa leaf meal 5	60	22	36	3.3	3.27	2.88	***
	9	Amber cane 48, no alfalfa leaf meal	60	24	27	15.0	3.54	3.26	88.3
	10	Amber cane 43 alfalfa leaf meal 5	60	24	27	15.0	3.47	2.77	104.0
	11	R. proso 43, wheat 30 replacing BM‡, alfalfa leaf meal 5	60	26	28	10.0	2.97	3.07	93.8
Trial 4 R. I. Reds 3-28-37	12	R. proso 44, BM 30	55	23	24	14.5	3.59	2.92	***
	13	R. proso 44, wheat 30	55	13	17	45.4	3.91	3.64	80.2
	14	R. proso 54, oats 20	55	18	18	34.5	3.39	3.56	82.0
	15	W. proso 44, oats 30	55	14	16	45.4	3.38	3.49	83.7
Trial 5 R. I. Reds 4-11-37	16	R. proso 44, BM 30	67	31	31	7.5	3.08	2.84	***
	17	R. proso 54, oats 20	68	13	34	30.9	2.60	3.06	92.8
	18	W. proso 44, oats 30	68	21	28	27.9	3.37	3.27	86.9
	19	W. proso 54, oats 20	68	26	31	16.2	2.96	3.43	82.8
	20	R. proso 44, wheat 30	68	26	41	1.5	2.95	2.80	101.4
	21	W. proso 44, BM 30	68	17	41	14.7	3.24	2.86	99.3

(Continued on following page)

Table 1b. Number of Chicks, Mortality and Feed Consumption Data for Starting period. (Cont.)

Trial No. and Breed Date started	Lot No. Av. feed Feeding	Ingredients added to basal mash (percent)†	Number of chicks			Av. feed consumed per bird		Feeding efficiency** Percent control	
			Start	M*	F*	Mort- ality percent	Actual lbs.		
Trial 6 Barred Rocks 12-24-37	22	R. proso 54, oats 20	58	31	27	0	3.81	2.96	97.0
	23	R. proso 44, oats 30	56	23	32	1.8	4.02	2.87	***
	24	R. proso 34, oats 40	57	27	29	1.8	3.96	2.88	99.7
	25	R. proso 44, oats 20, 10 meat & bone	28	15	12	3.5	4.29	3.22	89.1
Trial 7 Barred Rocks 1-3-38	26	R. proso 54, barley 20	63	24	35	6.4	3.42	2.91	97.3
	27	R. proso 44, barley 30	63	37	21	7.9	3.73	2.83	***
	28	R. proso 34, barley 40	63	36	25	3.2	3.84	2.84	99.6
Trial 8 Barred Rocks 1-28-38	29	R. proso 54, wheat 20	58	26	24	13.8	2.98	3.20	87.5
	30	R. proso 44, wheat 30	58	26	24	13.8	3.03	2.80	100.0
	31	R. proso 34, wheat 40	58	18	33	12.1	2.77	3.77	74.3
	32	R. proso 44, BM‡ 30	58	17	23	31.0	3.74	2.80	***
	33	W. proso 44, wheat 30	58	20	26	20.7	3.40	2.87	97.6
Trial 9 R. I. Reds 2-5-38	34	W. proso 44, BM 30	58	27	24	12.1	4.15	3.20	87.5
	35	R. proso 54, yellow corn 20	47	20	24	6.4	3.00	3.04	101.0
	36	R. proso 44, yellow corn 30	47	20	25	4.3	3.13	2.97	103.4
	37	R. proso 34, yellow corn 40	47	24	22	2.1	3.46	3.02	101.7
Trial 10 R. I. Reds 3-4-38	38	R. proso 44, wheat 30	47	18	22	14.9	3.46	2.74	112.0
	39	R. proso 44, BM 30	47	24	20	6.4	4.07	3.07	***
	40	R. proso 42, oats 30 f.g., grit 2	48	18	24	12.5	3.53	2.86	100.0
Trial 11 Barred Rocks 4-8-38	41	R. proso 44, oats 30 finely ground	48	18	20	20.8	3.69	2.86	***
	42	R. proso 44, oats 30 coarsely ground	48	23	18	14.6	3.57	2.85	100.4
Trial 12 Barred Rocks 6-3-38	43	R. proso 34, yellow corn 40	56	36	17	5.4	3.19	2.64	110.6
	44	R. proso 44, wheat 30	48	24	22	4.2	3.50	2.92	***
	45	R. proso 34, barley 40	49	25	22	4.1	3.43	2.77	105.4
Trial 13 R. I. Reds 2-21-39	46	R. proso 34, oats 40	50	22	23	10.0	3.60	2.84	102.8
	47	R. proso 52, yellow corn 22	43	15	18	23.3	3.31	2.67	100.4
	48	R. proso 42, yellow corn 32	44	19	22	6.8	3.29	2.68	***
	49	R. proso 32, yellow corn 42	45	20	13	26.7	3.23	2.64	101.5
Trial 14 R. I. Reds 2-22-39	50	R. proso 22, yellow corn 52	41	16	17	19.5	3.55	2.86	93.7
	51	R. proso 47, wheat 27	58	33	24	1.7	3.07	2.66	96.2
	52	R. proso 37, wheat 37	58	34	24	0	3.12	2.56	***
Trial 15 Barred Rocks 2-28-39	53	R. proso 27, wheat 47	58	33	21	6.9	3.12	2.59	98.8
	54	R. proso 47, wheat 27	56	30	24	3.6	3.56	2.91	93.8
Trial 16 Barred Rocks 3-7-39	55	R. proso 37, wheat 37	56	31	25	0	3.53	2.73	***
	56	R. proso 27, wheat 47	56	34	20	3.6	3.82	2.82	96.8
	57	R. proso 47, oats 27	65	33	25	10.8	3.91	2.96	99.0
Trial 17 Barred Rocks 2-28-39	58	R. proso 37, oats 37	65	26	37	3.1	3.98	2.93	***
	59	R. proso 27, oats 47	65	28	23	18.5	3.98	3.02	97.0
Trial 18 Barred Rocks 3-7-39	60	R. proso 47, barley 27	56	27	27	3.6	4.29	3.51	81.2
	61	R. proso 37, barley 37	57	35	20	3.5	3.55	2.85	***
	62	R. proso 27, barley 47	55	40	13	3.6	3.35	3.07	92.8

* M—Males; F—females.

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

*** The control pen has 100 percent efficiency.

† Exact figures are given in text.

‡ BM means 15 percent each of wheat bran and wheat middlings.

§ Excessive feed requirements probably due to wastage.

The percentage of ingredients added to the basal mash are reported to the nearest pound.

Table 2a. Average Weights of Pullets. During Growing Periods.

Trial No. and Breed Date started	Lot No.	Ingredients added to basal mash (percent)		Scratch grain	Body weight in pounds				
					8 wks.	12 wks.	16 wks.	20 wks.	24 wks.
Trial 1 Barred Rocks 7-5-35	1	Yellow corn	52	Cracked yellow corn	1.07	2.09	2.67	3.50	4.45
	2	Red proso	52	Red proso	1.28	2.26	2.96	3.77	4.76
	3	Oats	52	Oats	1.31	2.28	2.81	3.49	4.39
Trial 2 Barred Rocks 5-28-36	4	Yellow corn	55	Cracked yellow corn	1.25	2.10	2.71	3.96	4.50
	5	Red proso	55	Red proso	1.25	2.07	3.01	4.06	4.66
	6	Red proso	55, Wheat 30*	Red proso	1.24	2.07	3.07	4.08	4.77
	7	Oats	55	Oats	1.25	1.90	2.88	3.69	4.05
Trial 3 R. I. Reds 6-5-37	8	Oats	52	Red proso	1.21	1.98	3.08	3.48	4.15
	9	Red proso	52, BM 30†	Red proso	1.20	1.91	2.97	3.41	4.03
	10	Red proso	52	Red proso	1.21	1.96	3.02	3.42	4.20
	11	White proso	52	White proso	1.21	2.05	3.05	3.49	4.22
Trial 4 R. I. Reds 5-28-38	12	Oats	52	Oats		2.13	3.00	3.41	
	13	Oats	52	Red proso		2.15	3.00	3.54	
	14	Oats	52	Equal parts oats and red proso		2.15	2.99	3.44	
	15	Red proso	52	Red proso		2.15	3.05	3.57	

* Wheat 30 percent replaced 15 percent bran and 15 percent middlings.

† BM 30 means 15 percent bran and 15 percent middlings replaced 30 percent wheat.

Table 2b. Number of Pullets, Mortality and Feed Consumption Data For the Growing Period.

Trial No. and Breed Date Started	Lot No.	Ingredients added to basal mash (percent)	Scratch grain	Number birds Mor-			Average feed consumed per bird, lbs.			Percent mash of total	Feeding efficiency§		
				Start	ish	Percent	Mash	Grain	Total		Actual	Percent of control	
Trial 1 Barred Rocks 7-5-35	1	Yellow Corn	52	Cr. yel. corn	70	70	0	11.55	6.29	17.84	64.7	5.3	‡
	2	Red proso	52	Red proso	63	63	0	12.61	8.71	21.32	59.1	6.1	86.9
	3	Oats	52	Oats	56	52	7.1	11.79	8.01	19.80	59.5	6.4	82.8
Trial 2 Barred Rocks 5-28-36	4	Yellow corn	55	Cr. yel. corn	64	59	7.8	10.99	6.44	17.43	63.1	5.4	‡
	5	Red proso	55	Red proso	65	60	7.7	9.02	7.46	16.48	54.7	4.8	112.5
	6	Red proso wheat 30*	55,	Red proso	65	63	3.1	10.08	7.03	17.11	58.9	4.8	112.5
	7	Oats	55	Oats	65	61	6.2	11.29	8.10	19.39	58.2	6.9	78.3
Trial 3 R. I. Reds 6-5-37	8	Oats	52	Red proso	63	59	6.4	14.80	6.33	21.13	10.0	7.2	86.1
	9	Red proso BM 30†	52,	Red proso	67	63	6.0	12.75	6.22	18.97	54.7	6.7	92.5
	10	Red proso	52	Red proso	61	49	3.4	12.56	6.05	18.61	67.5	6.2	‡
	11	White proso	52	White proso	65	60	8.3	12.30	6.09	18.39	66.7	6.1	101.6
Trial 4 R. I. Reds 5-28-38	12	Oats	52	Oats	50	48	4.0	9.57	3.19	12.76	75.0	10.0	71.0
	13	Oats	52	Red proso	50	48	4.0	6.11	6.40	12.51	48.8	9.0	78.9
	14	Oats	52	Equal parts oats and red proso	50	50	0	7.57	4.45	12.02	63.0	9.3	76.3
	15	Red proso	52	Red proso	50	48	4.0	6.19	3.93	10.12	61.2	7.1	‡

* 30 percent wheat replaced 15 percent bran and 15 percent middlings.

† 15 percent each of bran and middlings replaced 30 percent wheat

‡ The control pen has 100 percent efficiency.

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

Table 3a. Average Gains in Weight and Egg Production During Laying Periods.

Trial No. and Breed Date started	Lot No.	Ingredients added to basal mash (percent)	Scratch grain	Dura- tion Weeks	Gain in weight per bird (pounds)	Av.no. eggs per bird
Trial 1 White Leghorns 10-20-34	1	Yellow corn 37.3	Yellow corn	51	0.49	164.9*
	2	Red proso 37.3	Red proso		0.07	161.1*
	3	Oats 37.3	Oats		0.15	143.5*
Trial 2 Barred Rocks 11-1-35	4	Yellow corn 43	Yellow corn	43	0.68	131.4
	5	Red proso 43	Red proso		0.51	146.1
	6	Oats 43	Oats		0.60	135.3
Trial 3 Barred Rocks 9-19-36	7	Ground yellow corn 43.5	Red proso	48	1.30	126.7
	8	Ground red proso 43.5	Red proso		1.20	130.0
	9	Whole red proso 43.5	Red proso		1.30	123.1
	10	Ground white proso 43.5	White proso		1.30	118.5
Trial 4 R. I. Reds 9-25-37	11	Red proso 43	Red proso	43	1.30	88.2
	12	White proso 43	White proso		1.20	105.4
	13	Red proso 38, alfalfa leaf meal 5	Red proso		0.80	93.7
	14	Red proso 33, 10 more meat & bone	Red proso		1.40	109.0
Trial 5 R. I. Reds 8-19-38	15	Red proso 43.5	Red proso	40	1.40	86.0
	16	White proso 43.5	White proso		1.50	99.4
	17	Red proso 43.5, oats 30†	Red proso		1.50	100.3
	18	Red proso 33.5, 10 more meat & bone	Red proso		1.30	72.4

* Egg record of survivors.

† 30 percent oats replaced 30 percent wheat.

Table 3b. Number of Birds, Mortality and Feed Consumption Data During Laying Periods.

Trial No. and Breed Date started	Lot† No.	Number			Av. feed con- sumed per bird, lbs.			Percent Feed to Oyster shell total feed			Effi- cien- cy per cent of control
		Start	ish	Mort- ality Percent	Mash	Grain	Total	lbs.	of one doz. lbs.	eggs lbs.	
Trial 1 White Leghorns 10-20-34	1	51	23	54.9	33.08	43.82	76.90	2.2	43.0	5.57	*
	2	51	23	54.9	38.38	36.77	75.15	1.8	51.1	5.61	99.3
	3	51	27	47.1	50.55	17.90	68.45	2.8	73.8	5.71	97.5
Trial 2 Barred Rocks 11-1-35	4	71	47	33.8	40.24	31.39	71.63	2.0	56.2	6.56	*
	5	63	40	36.5	46.66	37.45	84.11	2.3	55.5	6.90	95.1
Trial 3 Barred Rocks 9-19-36	6	51	25	51.0	31.30	42.74	74.04	2.7	42.3	6.56	100.0
	7	58	34	41.4	37.60	46.57	84.17	2.3	44.7	7.95	*
	8	58	39	32.8	33.45	49.34	82.79	2.3	40.4	7.64	104.0
Trial 4 R. I. Reds 9-25-37	9	59	40	32.2	39.84	46.40	86.24	2.2	46.2	8.39	94.7
	10	58	43	25.9	35.63	50.00	85.63	2.2	41.6	8.70	91.4
	11	54	29	46.3	28.64	50.13	78.77	1.7	36.4	10.71	*
	12	54	34	37.0	30.32	44.77	75.09	1.6	40.4	8.57	125.0
Trial 5 R. I. Reds 8-19-38	13	54	28	48.2	28.44	46.66	75.10	1.7	37.9	9.60	111.6
	14	54	40	25.9	28.56	47.78	76.34	1.5	37.4	8.39	127.7
	15	49	34	30.6	25.94	40.47	66.41	1.5	39.1	9.30	*
Trial 5 R. I. Reds	16	49	32	34.7	31.03	39.43	70.46	1.5	44.0	8.51	109.3
	17	48	32	33.3	26.51	45.49	72.00	1.7	36.8	8.63	107.8
	18	49	38	22.5	20.52	44.61	65.13	1.5	31.5	10.82	86.0

* The control pen has 100 percent efficiency.

† The description of the ration fed each lot is given in Table 3a above.