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Pasture fertilization experiments at Reymann Memorial Farm

F. W. Schaller

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SOYBEAN OIL MEAL IN POULTRY RATIONS

by
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SOYBEAN OIL MEAL IN POULTRY RATIONS *

by T. B. Clark and C. J. Cunningham

SOYBEAN OIL MEAL has become the most widely used protein concentrate for all types of poultry mashes. Before recent wartime feed shortages, animal proteins were, as a class, considered to be superior to plant proteins, and it was common practice to supply at least one-half the total protein in poultry mashes in the form of animal-protein concentrates. The supply of these concentrates was inadequate to meet the demand of the greatly expanded poultry industry; and the greater use of plant-protein concentrates became a necessity. The necessity for conserving animal-protein concentrates and using all the soybean oil meal possible suggested studies relating to the possibility of eliminating protein concentrates derived from animal sources.

In 1942, when the investigations reported herein were started, there was ample evidence showing that for poultry, soybean oil meal was one of the best plant-protein concentrates available. Earlier work at this station had shown that the protein of soybean oil meal was utilized to a greater extent than that of meat scrap and equal to and in some cases superior to that of menhaden fish meal. From these results VanLandingham, Clark, and Schneider *(10)* reported that soybean oil meal supplemented meat scrap; in other words, it increased the utilization of the protein of meat scrap. In these experiments plant proteins actually supplemented animal proteins.

In growth trials with chicks Clark, Runnels, and VanLandingham *(6)* found that supplementary protein, supplied by soybean oil meal alone, produced greater growth up to 10 weeks of age than did meat scrap, as well as growth comparable with that obtained from menhaden fish meal. A combination of soybean oil meal and menhaden fish meal, however, gave better growth and greater feed efficiency than obtained from either of these concentrates fed alone. Experiments at other stations have shown that an addition of as little as 2 percent of animal protein increased the feed efficiency when soybean oil meal is fed as the principal protein concentrate. Most investigators agree that this amount of animal protein will give satisfactory results for growth. There is some disagreement as to the relative merits of different animal-protein concentrates for supplementing soybean oil meal. In general, however, fish meal has been found to be superior to meat scrap and to dried milk products. Some investigators have found meat scrap superior to dried milk;

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others have found the reverse to be true. The differences in the results obtained are due probably to the variability in quality among different lots of animal-protein concentrates. Recent information suggests that the supplemental effect of a small amount of meat scrap on soybean oil meal is due to vitamins and not to protein itself. Results at this and other stations suggest that if soybean oil meal is properly processed and supplemented with the known vitamins, it can compete favorably with animal proteins for growth.

Numerous experiment stations have shown that soybean oil meal can be used to replace part of the animal protein in laying rations, but in some of the earlier work it was found that the former should not be relied on as a total substitute. Work at this Station has shown that equal parts of fish meal or meat scrap and soybean oil meal is as satisfactory as fish meal alone. Norris and Heuser *(8)* reported that just as many eggs were laid by hens receiving only soybean oil meal for the supplementary protein as by hens getting some animal protein. They found, however, that the oil meal alone did not maintain body weight when fed in an all-mash ration. Body weight was maintained when 2 percent of meat scrap was included in the ration. All-mash rations are not generally used under practical conditions, and body weight conceivably could be maintained by feeding a laying mash with scratch grains in addition.

Some experimental evidence suggests that lowered hatchability can be expected when soybean oil meal is the only protein concentrate in the ration. Animal-protein concentrates, especially dried-milk products, have been found to improve hatchability markedly. That this increased hatchability is due largely to riboflavin as found in milk and not to animal protein, has been shown by Christiansen *et al.* *(5)*. Furthermore, it has also been shown by Card *(2)* that as much as 25 percent of soybean oil meal in the ration does not have a depressing effect on hatchability as was generally supposed.

Variability in the feeding value of soybean oil meal may be explained partly by the variability in treatment during processing. Undoubtedly this condition is aggravated under wartime conditions. Low-quality meals are likely to be commoner, a fact experienced while the laying trials reported herein were being conducted.

A shortage of animal-protein concentrates in general and fish meal in particular in 1942 made it desirable to know to what extent these concentrates could be replaced by soybean oil meal in poultry rations. It is the purpose of this bulletin to present the results of studies dealing with the use of soybean oil meal, produced under wartime conditions, at different levels in the mash for growth, for egg production, and for hatchability in chickens. No attempt was made to purchase a specially processed meal, but comparable lots were fed the same meal.

Growth Trials

Procedure—The growth trials were started in September 1942. New Hampshire chicks from a strain bred at the Reymann Memorial Farms were used. A lack of sufficient chicks necessitated running the trials in two series, each series a week apart. Three hundred seven chicks were started in each of the first two lots, and 310 in each of the second two lots. Group weighings were made at one day old and at 4, 8, and 16 weeks of age. The birds were weighed individually at 12 and 20 weeks. The feed consumed was recorded by 4-week periods. At 12 weeks of age the sexes were separated and the pullets continued on the same mash mixtures to 20 weeks. The chicks were brooded in 10 x 12-foot rooms with access to 6 x 10-foot sunporches. Heat was supplied by wood-burning brooder stoves. Ground corn cobs were used for litter.

The mash formulas and the analyses are given in Table 1. Ration 1, a starting and growing mash, was fed to Lots 1 and 3, which served as the controls for both series. Ration 1 contained fish meal and meat scrap, while in Ration 2 the fish meal was omitted. In Ration 3, the principal protein supplement was soybean oil meal except for 5 percent of dried whey. In Rations

TABLE 1—*Ingredients and Analysis of Starting and Growing Mashes*

Ration	Control 1 and 3	2	4
	(percent)	*(percent)*	*(percent)*
Ingredients			
Yellow corn meal	23.95	20.45	17.95
Ground oats	5.00	5.00	5.00
Ground barley	5.00	5.00	5.00
Corn D. D. grains	5.00	5.00	5.00
Corn gluten meal	5.00	5.00	5.00
Wheat bran	10.00	10.00	10.00
Wheat standard middlings	15.00	15.00	15.00
Alfalfa meal	7.50	7.50	7.50
Soybean oil meal	12.50	17.50	20.00
Fish meal	2.50		
Meat scrap	2.50	2.50	...
Dried whey	2.50	2.50	5.00
Riboflavin concentrate	1.00	1.00	1.00
Limestone	2.00	2.00	2.00
Bone meal		1.00	1.00
Salt	0.50	0.50	0.50
Manganese sulphate	0.0125	0.0125	0.0125
D-activated animal sterol	0.0375	0.0375	0.0375
TOTAL	100.00	100.00	100.00
Calculated analysis			
Protein—(percent)	20.45	20.88	20.70
Calcium—(percent)	1.35	1.29	1.13
Phosphorus—(percent)	0.63	0.68	0.61
Vitamin A—units per lb.	8728	8626	8551
Vitamin D—units per lb.	338	338	338
Riboflavin—units per lb.	1946	1944	2200

2 and 3 appropriate quantities of soybean oil meal were added. The mash mixtures were kept before the birds continuously. After 8 weeks of age heavy whole oats and equal parts of cracked corn and wheat were kept in separate hoppers.

Symptoms of coccidiosis appeared in all lots when the chicks were about 8 weeks of age, Lot 3 having the severest attack. Flushing mash was fed for two days.

Results and Discussion—The results for the growth trials are summarized in Table 2. Lots 1 and 3, receiving the control ration, were the heaviest in both sexes at 12 weeks of age. Even though Lot 3 appeared to have the severest attack of coccidiosis, the average body weight was higher at 12 weeks than any of the other lots. Lots 3 and 4 are not strictly comparable with Lots 1 and 2 because of the week's difference in age. If we disregard this difference, it will be noted that Lot 3 was heavier than Lot 1 at 12 weeks and that Lot 4 is comparable with Lot 2. At 20 weeks there was no difference in average weight between the pullets in the first two lots, while the difference between Lots 3 and 4 at this age was barely significant.

To 12 weeks of age, Lots 1 and 3 on the control ration consumed the least pounds of feed per pound of gain. The first two lots maintained the same relative position between 12 and 20 weeks as in the first period, but Lot 3 consumed more feed per pound of gain than Lot 4 for this period. The pullets consumed large quantities of grain during the second growth period. This probably accounts for the change in feed efficiency for Lots 3 and 4 between the two growth periods.

The results show that, when the animal protein was removed from Rations 2 and 3, slower growth was obtained and

TABLE 2—*Average Live Weight at 12 and at 20 Weeks of Age and Average Feed Consumed per Pound of Gain to 12 Weeks of Age and from 12 to 20 Weeks of Age*

Ration no.	Lot no.	Average live weight			Pounds of feed consumed per pound of gain	
		12 weeks		20 weeks	Pullets	
		Pullets	Cockerels	Pullets	to 12 weeks	12 to 20 weeks
		(pounds)	*(pounds)*	*(pounds)*	*(pounds)*	*(pounds)*
1	1	2.18	2.72	4.07	4.16	6.63
2	2	2.07	2.32	4.06	4.75	6.96
Difference		.11*	.40†	.01		
1	3	2.35	2.90	3.97	3.91	7.30
3	4	1.92	2.40	3.70	4.41	7.06
Difference		.43†	.50†	.27*		

†—Difference significant at 1 percent level.
*—Difference significant at 5 percent level.

that the feed efficiency was lowered. While this would be a serious objection for the broiler producer, it would not be a handicap when the pullets are to be grown for egg production. The low average weight for all lots was probably due to overcrowding. Normally, pullets are grown on range after 8 weeks of age, and any deficiency in the ration would be made up from green, succulent grass. Under these conditions satisfactory results would be expected from a ration similar to that fed Lot 4, containing very little animal protein.

Previous work at the University Poultry Farm, where the chicks were grown in batteries, showed that satisfactory results followed a ration similar to that fed Lot 4, in which soybean oil meal was the principal source of protein, and 5 percent of dried whey was the only animal protein supplied. Removing the fish meal had been found to decrease the efficiency of the rations, whereas soybean oil meal alone gave better results than a combination of meat scrap and soybean oil meal. In the present trials, removing the fish meal decreased the growth as much as when the animal protein was removed entirely. The results obtained probably were due to variability of the supplemental feeds. This suggests that some animal protein and preferably fish meal should be included in starting rations.

Summary of Growth Trials—A control ration containing 2.5 percent each of fish meal and meat scrap and 12.5 percent of soybean oil meal was compared with a ration containing 2.5 percent of meat scrap and 17.5 percent of soybean oil meal in the first series and with one containing 20 percent of soybean oil meal as the principal protein concentrate in the second series. The control ration produced a significantly greater growth in both sexes with less feed per pound of gain than the other rations up to 12 weeks of age in both series. At 20 weeks the differences in body weight between the lots of pullets in the first series were reduced to a negligible amount, while in the second series the chicks on the control ration were slightly larger than those on the all-soybean-oil-meal ration. The feed efficiency between 12 and 20 weeks was not consistent with the first growth period in that the control ration was the most efficient in the first series, while the reverse was true in the second series.

Laying Trials

Procedure—Two laying trials were conducted with three lots of New Hampshire pullets in each trial. The pullets were confined to the laying pens. The first or November (1942-43) trial was started with 64 range-reared pullets in each lot that had been divided on the basis of body weight and condition at 6 months of age. Three days later, after further culling for disqualifications and after removal of reactors, the numbers were reduced to 53, 58, and 49 in Lots 1, 2, and 3, respectively. The initial body weight in Table 5 is that of the remaining pullets.

The pullets used in the March (1943-44) trial were taken from those used in the growth trials. The most mature pullets in each of the four lots were distributed uniformly into three lots according to body weight at 20 weeks of age. The three lots were continued on the same growing ration until the laying trials started at 24 weeks. At the beginning of the laying trials Lots 1, 2, and 3 were laying at the rate of 65.8, 66.2, and 65.9 percent, respectively. This suggests that the pullets were distributed uniformly according to sexual maturity.

The pullets in both trials were fed the laying mashes listed in Table 3. A basal mash was mixed at a feed mill for uniformity. To this was added a pre-mix of ground grains at the Station farm together with the meat scrap in mashes 1 and 2 and the additional quantities of soybean oil meal required in mashes 2 and 3. An effort was made to obtain the same lot of soybean oil meal from the mill as was used in the basal mash. Because of wartime conditions this was not always possible, and for approximately 8 weeks before August 1, 1943, soybean oil meal had to be used that was found to be of poor quality when tested by the method of Caskey and Knapp *(4)*.

In addition to a continuous supply of mash, each pen was supplied with a hopper of whole oats. Scratch grain (equal parts of cracked corn and wheat) was fed in the litter each

TABLE 3—*Ingredients and Analysis of Laying Mashes*

Mash formula no.	1	2	3
	(percent)	*(percent)*	*(percent)*
Ingredients			
Cereal basal*	50.0	47.0	42.0
Bran	11.4	11.4	11.4
Alfalfa meal	7.5	7.5	7.5
Meat scrap	10.0	5.0	..
Soybean oil meal	13.0	20.0	28.0
Dried whey	2.5	2.5	2.5
Riboflavin concentrate	2.5	2.5	2.5
Limestone	1.0	1.0	1.0
Bone meal	1.0	2.0	4.0
Salt	1.0	1.0	1.0
Manganese sulphate	0.0125	0.0125	0.0125
D-activated animal sterol	0.1	0.1	0.1
TOTAL	100.0125	100.0125	100.0125
Calculated analysis			
Protein—(percent)	20.10	20.09	20.33
Calcium—(percent)	1.70	1.59	1.78
Phosphorous—(percent)	0.96	0.93	1.04
Vitamin A—units per lb.	6599	6480	6408
Vitamin D—units per lb.	900	900	900
Riboflavin—units per lb.	2487	2437	2349

*—Cereal basal contained the following percentages of ground grains: corn 50, wheat 20, barley 20, oats 10.

evening. About 6 months after start of the November trial it was observed that the pullets in this trial were consuming considerably more grain than mash and that the pullets in the March trial were rapidly approaching the same grain/mash ratio, even though the oats were not always of high quality. Consequently, on May 24 the oats were restricted to the three March lots. At first this was done by feeding as much whole oats as they consumed of scratch the previous day. On July 5 this plan was changed to that of opening the oat hoppers two hours each morning until December 4, when the restriction was discontinued. The feed was not restricted to the November pullets at any time.

The pens were lighted in the November trial from the beginning through April to provide a 14-hour day. To maintain egg production during the summer months, all-night lights were used in the March trial starting June 20. On December 19, the lights in these pens were changed to come on at 10 p. m.

The laying trials were each conducted for 52 weeks. Egg production was calculated on a hen-day basis by 4-week periods. The birds were weighed and the feed recorded on an 8-week basis, making 6½ instead of 13 periods as in the case of the egg records. The March pullets were continued beyond the 52-week period to obtain eggs for the hatching trials. Allowance was made for the feed consumed by the cockerels used in both trials.

Results and Discussion—In Table 4 are shown the average feed consumed per bird per 8-week period, the feed consumed per dozen eggs, and the average yearly egg production for the November and March trials.

TABLE 4—*Average Feed Consumption per Period and per Dozen Eggs, and Average Yearly Egg Production for November and March Laying trials*

Ration and lot no.	Protein concentrate in mash	Av. feed consumption per period		Av. feed consumption per doz. eggs		Av. yearly egg production	
	Trials	Nov.	Mar.	Nov.	Mar.	Nov.	Mar.
		(pounds)		*(pounds)*		*(percent)*	
1	Meat scrap 10 Soybean meal 13	16.6	14.5	8.7	9.2	48.7	41.4
2	Meat scrap 5 Soybean meal 20	15.4	15.3	7.5	10.2	49.5	41.4
3	Soybean meal 28	15.9	15.1	8.6	10.8	47.1	38.8
	Least significant difference					3.6	4.1

There is no definite trend in the feed consumed when the three different rations are compared within each trial. In the November trial Lot 1 consumed the most feed, while in the March trial Lot 2 consumed the most feed. Likewise, the average feed consumed per dozen eggs does not vary uniformly in both trials. In the March trial the feed consumed per dozen eggs increased slightly from Lots 1 to 3, but since the November lots did not increase in the same manner, variations cannot be explained by the differences in the rations.

The yearly average egg production for the first two lots varied slightly in the November trial but was identical in the other trials. In both trials the egg production for Lot 3 was lowest as compared with the other lots. The average egg production, however, for the hens fed the different rations in the same trial when analyzed statistically showed no significant difference for the 13 28-day periods. In other words the difference between the egg production for Lot 3 in both trials and that for the other lots in the same trial is not large enough to be considered a real difference. This suggests that for egg production, one ration was as good as another in these trials. Environmental influences other than rations apparently lowered the egg production in the March trials as compared with the November trials.

The percentage egg production by periods is given in Table 5. In the November trials the lowest egg production occurred during July and August (periods 9 and 10). Those on Ration 2 recovered more rapidly and laid at a higher rate until the end of the trial. The pullets in the March trials started off at a high rate, but they also slumped during July and August (periods 4 and 5), from which they recovered slightly during

TABLE 5—*Percentage of Egg Production by Four-week Periods for November and March Trials*

Period	November trials*			March trials†		
Lot no.	1	2	3	1	2	3
	(percent)	*(percent)*	*(percent)*	*(percent)*	*(percent)*	*(percent)*
1	28.8	24.2	24.6	71.7	72.5	74.5
2	79.2	74.2	77.8	67.8	68.9	60.0
3	75.8	76.5	76.7	60.4	54.4	49.8
4	76.3	73.9	74.7	44.0	38.8	36.9
5	71.5	66.2	71.4	35.7	43.9	37.6
6	59.0	67.6	65.3	41.7	40.9	40.9
7	56.0	58.1	47.2	48.8	45.9	53.5
8	52.6	40.2	38.1	39.9	47.6	38.8
9	24.5	24.5	26.1	32.5	42.3	25.3
10	19.4	27.0	22.2	31.1	25.2	16.9
11	20.3	40.7	26.6	17.8	10.5	11.0
12	31.1	44.3	39.0	15.3	14.3	15.5
13	26.0	26.5	23.3	31.6	33.5	44.0
Average	48.7	49.5	47.1	41.4	41.4	38.8

*—Started November 18, 1942, and completed November 16, 1943.
†—Started March 15, 1943, and completed March 12, 1944.

the two following periods. The low production coincides with the onset of high summer temperatures. Whether the poor-quality soybean oil meal fed before August also had any effect on egg production cannot be determined from these trials.

The all-night lights used on the March pullets throughout this period maintained egg production at a higher level than had previously been found possible without lights. It has been the experience at this Station that fall-hatched pullets do not maintain their production throughout the summer months and consequently have a lower yearly production than spring-hatched pullets. These lots molted in December and January and showed symptoms of colds, from which they were recovering when the trials were concluded.

Table 6 shows that the average initial body weight was the same for all six lots of pullets. The average final body weight is surprisingly uniform for all lots except for the November pullets on Lot 3. In all lots there was a slight gain in body weight. This agrees with Bird *(1)* and with Carver, Brant, and Evans *(3)* that rations containing little or no animal protein are capable of maintaining body weight. Recently Heuser and Norris *(7)* found that when soybean oil meal was the sole source of supplementary protein, the pullets generally declined in weight. After substitution of the crushed wheat for the wheat bran and middlings, all of the pens gained in weight. In other words, when the rations contained bran and middlings, body weight was maintained better in the groups receiving some animal protein. These results suggest that, since wheat is more digestible than wheat byproducts, it maintains body weight more readily. It does not follow, however, that all wheat byproducts should be eliminated from poultry rations.

The total mortality shown in Table 6 is variable; hence mortality cannot be attributed to the source of protein supplement.

In Table 7 the average feed consumed per bird for the total period is broken down to show the average amount of mash,

TABLE 6—*Average Initial and Final Body Weight, Average Gain, and Total Mortality for November and March Laying Trials*

Ration and lot no.	Protein concentrate in mash	Average initial body weight		Average final body weight		Average gain		Total mortality	
	Trials	Nov.	Mar.	Nov.	Mar.	Nov.	Mar.	Nov.	Mar.
		(pounds)		*(pounds)*		*(pounds)*		*(percent)*	
1	Meat scrap 10 Soybean meal 13	5.1	5.1	5.9	5.9	.8	.8	20.4	15.9
2	Meat scrap 5 Soybean meal 20	5.1	5.1	5.7	5.7	.6	.6	19.0	28.4
3	Soybean meal 28	5.2	5.2	6.4	5.6	1.2	.4	39.6	14.8

scratch, and oats consumed. The November lots consumed more grain (scratch and oats) than mash in all cases. This is shown by the ratio of grain to mash. The pullets on Ration 1 and 3 consumed over twice as much grain as mash, while those on Ration 2 consumed about 1½ times as much grain as mash. This lower ratio probably explains the slightly higher egg production for those on Ration 2. The pullets in the March trial were restricted as previously explained, so that the ratio of grain to mash as shown in Table 7 is approximately equal and is the same for all lots in the trial.

The average protein consumed in the total ration has been calculated for the different lots and given in Table 7. The pullets in the November trial in all lots consumed less protein than those in the March trial because of the higher grain ratio. Lot 2 in the November trial consumed more protein, since they ate more mash than the others and laid at a higher rate. Results from other experiments at this Station show that less than 14 percent of protein in the ration is likely to decrease egg production. Even though the November lots consumed less protein than the March lots, they laid at a higher rate. Seasonal or other environmental influences apparently had a greater influence on egg production in these trials than the amount of protein consumed.

It is interesting to note that the egg production of Lot 3 in the November trial was not significantly lower than that of Lot 1, even though Lot 3 was fed no animal protein concentrate. Apparently animal protein is not necessary with heavy grain consumption to maintain egg production and likewise to maintain body weight.

Hatchability—The hatching data from the lots on the different rations are compared in Table 8. Five settings spread out over the normal hatching season were made from each of the three lots. The total number of eggs set for Lots 1, 2, and

TABLE 7—*Average Feed Consumed per Bird, Ratio of Grain to Mash, and Average Protein in Ration for November and March Laying Trials*

Ration and lot no.	Trials	Average feed consumed per bird				Ratio of grain to mash	Average protein in ration
		Mash	Scratch	Oats	Total		
		(pounds)	*(pounds)*	*(pounds)*	*(pounds)*	*(pounds)*	*(percent)*
1	Nov.	35.7	38.8	35.8	110.3	2.1 : 1	13.9
	Mar.	42.8	28.0	25.3	96.1	1.2 : 1	15.0
2	Nov.	38.4	32.5	30.6	101.5	1.6 : 1	14.4
	Mar.	39.8	29.9	28.5	98.2	1.2 : 1	14.7
3	Nov.	32.7	37.5	35.8	106.0	2.2 : 1	13.7
	Mar.	43.5	27.1	25.7	96.3	1.2 : 1	15.0

3 was 781, 759, and 889, respectively. The cockerels were rotated between the pens at regular intervals. Hatching data are available only from the March trial, the first hatch being in March 1944.

When the total percentage of salable chicks is considered in Table 8, there is a tendency for the percentages to decrease as the soybean oil meal increased in the ration. The cull chicks included a few weak and crippled but consisted largely of unhealed chicks in all hatches. On the last hatch from Ration 3 the percentage of salable chicks dropped to 57.3, the culls being nearly all unhealed chicks. On the following or twenty-third day, nearly all these chicks had healed and were put in the salable class. If the last hatch from Ration 3 is omitted, the total percentage of salable chicks is 88.3, which is comparable with that obtained from Ration 1.

The increase in the percentage of unhealed chicks in the last hatch of Ration 3 can hardly be explained by any differences in the rations. The soybean oil meal used during the hatching trials appeared to be of good quality, and as far as the authors are aware, the mashes were mixed the same throughout the entire hatching period. It was observed after these trials were concluded that the percentage of unhealed chicks was decreased when the temperature of the hatcher was slightly increased. This, together with the fact that there is considerable variation in the percentages of unhealed chicks within each group, suggests that the large increase in the last hatch from Ration 3 can be explained by improper incubation conditions.

TABLE 8—*Comparison of Hatchability and Salable Chicks from March Trials*

Ration and lot no.	Date hatched	Fertile eggs	Hatchability of fertile eggs	Cull chicks	Salable chicks	
		(number)	*(percent)*	*(number)*	*(number)*	*(percent)*
1	Mar. 21	131	70.2	5	87	94.6
	Mar. 30	124	76.6	8	87	91.6
	April 17	156	62.2	18	79	81.4
	May 1	150	84.7	18	109	85.8
	May 15	159	84.9	12	123	91.1
Total		720	75.8	61	485	88.8
2	Mar. 21	88	79.5	7	63	90.0
	Mar. 30	153	73.9	7	106	93.8
	April 17	143	71.3	25	77	75.5
	May 1	155	69.0	19	88	82.2
	May 15	161	74.5	22	98	81.7
Total		700	73.1	80	432	84.4
3	Mar. 21	143	83.2	5	114	95.8
	Mar. 30	210	71.4	23	127	84.7
	April 17	152	71.7	19	90	82.6
	May 1	152	83.5	12	115	90.5
	May 15	159	73.6	50	67	57.3
Total		816	76.2	109	513	82.5

These data suggest that equally good results can be expected from a breeding mash containing soybean oil meal as the principal source of protein as from one containing equal parts of soybean oil meal and meat scrap. When the soybean oil meal is properly supplemented with vitamins and minerals, it apparently is as efficient as meat scrap for satisfactory hatchability. These conclusions are not entirely in agreement with those of Wilgus and Zander *(9)*. These workers found that while soybean oil meal alone is satisfactory for good egg production, some animal protein is necessary for satisfactory hatchability. On the other hand, Heuser and Norris *(7)* recently found no difference in hatchability between all-mash rations supplying all of the supplementary protein from soybean oil meal and rations supplying part from soybean oil meal and part from meat scrap. The differences in the results obtained by these workers is difficult to explain except on the basis of variability in feeds. The discrepancies do suggest that, for marginal safety, some animal protein should be included in the breeding mash for satisfactory hatchability.

Summary of Laying and Hatching Trials—Two series of laying trials were conducted in which three mashes in each series were used containing 10, 5, and 0 percent of meat scrap, the difference in protein being made up by soybean oil meal. The mash containing no meat scrap was as satisfactory for egg production as the mashes containing either 5 or 10 percent of meat scrap. Likewise, body weight was maintained, and the hatchability was as good on the all-soybean-oil-meal mash as compared with the mashes containing meat scrap. In the last hatch the lowest percentage of salable chicks was obtained from the mash containing no meat scrap. A probable explanation for this is discussed.

General Summary and Conclusions

The results show that for egg production a mash in which soybean oil meal is the sole source of supplementary protein will give satisfactory results when properly balanced with vitamins and minerals. Because of variability in soybean oil meal and in other feed ingredients as well, some animal protein should be included in the starting and hatching rations. While these trials do not show conclusively how much animal-protein supplement is necessary, they do suggest that for starting and growing mashes and for hatching rations the minimum level is around 2½ percent. For rapid growth such as in broiler production, the animal protein should be supplied in part by fish meal.

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