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Influence of Nesting Materials on the Production of Clean Eggs

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Influence of Nesting Materials on the Production of Clean Eggs

E. M. FUNK, H. L. KEMPSTER AND M. Y. DENDY

INTRODUCTION

The great economic loss suffered annually by poultrymen in the United States as a result of the high percentage of dirty eggs produced is one of the major problems of the poultry industry. This loss is borne first by the producer who receives a reduced price for the eggs he sells, second by the processor and dealer who suffers higher losses on soiled eggs while in storage, and third by the hatcheryman who secures lower hatchability from soiled eggs. Consumers also lose because of lower quality in the eggs they buy.

Several methods of cleaning and treating soiled eggs have been devised which give results comparable in appearance, keeping qualities, and hatchability to clean eggs, but these methods are time-consuming and require the use of materials, equipment and labor. They result only in reducing to some extent the loss from soilage. Keeping the eggs clean still seems the most practical solution to the problem.

Studies at the Missouri Agricultural Experiment Station as reported by Funk (1937) showed that over 99 per cent of all eggs are clean when laid. Therefore if certain management practices can be employed which will permit the maintenance of eggs in their original state of cleanliness the soiled egg problem will be solved and one of the poultryman's major economic losses prevented.

This study deals with nesting material as it affects the production of clean eggs.

REVIEW OF LITERATURE

Van Wagenen (1930) reported a study which showed wood shavings to be superior to straw or no nesting material in the production of clean eggs.

Hadlington (1948) recommended as suitable nesting material grit or very coarse sand covered with a good layer of (1) rice hulls, (2) fine straw, or (3) wood shavings. He stated that recent studies in New South Wales indicated limestone grit may be more effective than any of the above listed materials in keeping eggs clean.

Funk (1937) found that hot, dry weather increased the percentage of clean eggs produced. Gathering eggs four times per day as compared

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to gathering only once reduced the proportion of dirty eggs by 50 per cent. He found that keeping the nests darkened was also effective in decreasing the percentage of dirty eggs, and keeping the birds in the laying house instead of giving them free range increased the percentage of clean eggs. Several nesting materials were found to be satisfactory for producing clean eggs. Shavings, oat hulls, sawdust, and excelsior were most effective in preventing dirty eggs.

Funk (1948) cited previous work by Jenkins, Hepburn, Swan and Sherwood in 1920 which showed that storage losses in all except clean eggs were too great for the industry to bear. This loss resulted regardless of the method of cleaning they employed. Since this study was made by Jenkins, Hepburn, Swan and Sherwood several methods of cleaning and treating soiled eggs have been devised which will result in soiled storage eggs keeping almost as well as clean eggs. However, there is added expense of cleaning and treating such eggs.

Funk and Forward (1949) found that some of these methods of cleaning and treating soiled eggs could be applied to hatching eggs with good results, but here again the cost of cleaning and treating reduces the producer's and hatcheryman's profits.

MATERIALS AND METHODS

Commercial Flock

Data were collected from a flock of 3,000 New Hampshire pullets mated to Delaware males from June, 1949 through December, 1949. All the eggs in this study were collected and classified by one person (M. Y. Dendy). Data were obtained for a total of 75 days during this period.

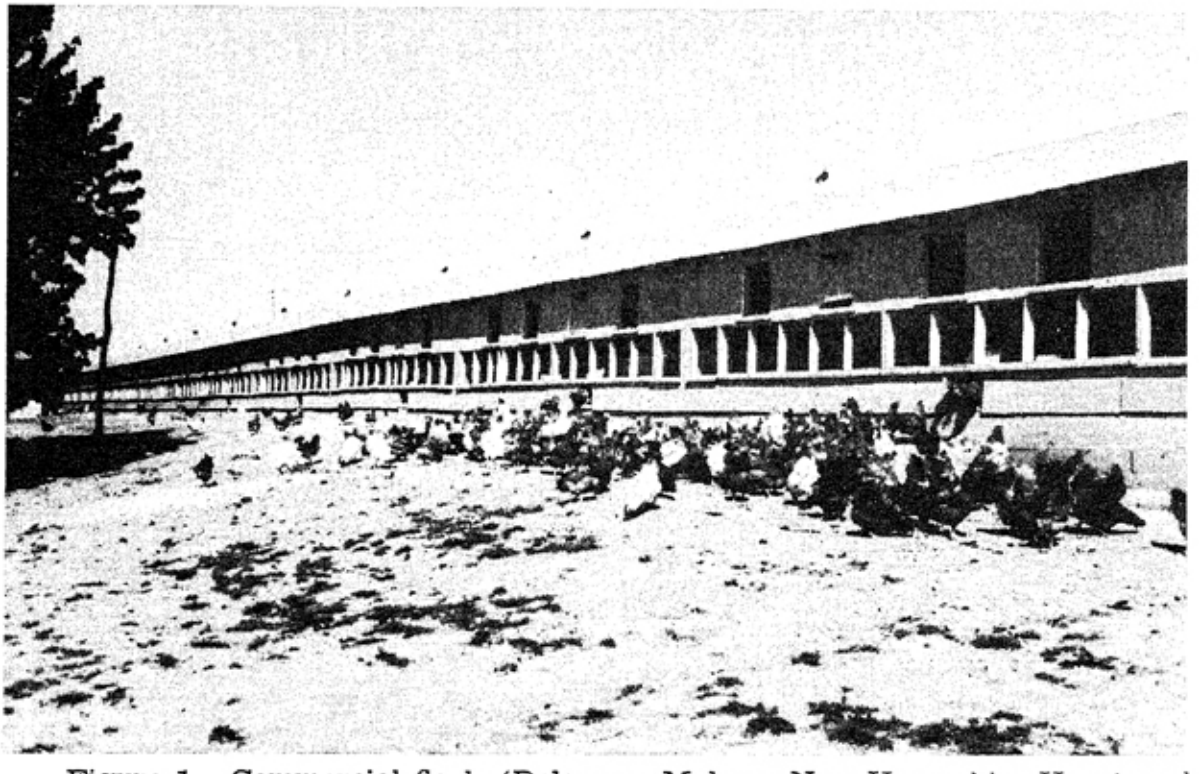

Figure 1. Commercial flock (Delaware Males x New Hampshire Hens) and laying house (24'x320') used in this investigation.

The pullets were housed in a 24x320-foot laying house (Fig. 1) with a 20x24-foot feed room on the east end. The rest of the house was divided into 10 pens, 30x24 feet. The birds were allowed free range until October 24, 1949 after which time they were confined to the laying house. Birds were able to go into any pen they chose.

The laying house floor was covered with built up straw litter and the house had wire-covered dropping pits. The nests were double-decked community type nests as described by Winner, Rickets, and Huff (1946). Each deck of nests was 2x5 feet, and there were two such double-decked nests per pen, giving a total of 40 square feet of nesting space per pen or 1 square foot per 7½ birds. This is less than the recommended 1 square foot per 5 or 6 birds.

Four nesting materials were studied: straw, sawdust, wood shavings, and a diatomaceous silica product hereinafter referred to by its commercial name, "Chick Bed." The nesting materials were randomized in the pens, but the nests in each particular pen were all filled with the same type of nesting material. Figure 2 shows hens in community nests in which shavings were used. Sawdust, shavings, and Chick Bed were used in the nest in only two pens each while straw was used in four pens.

The eggs were classified as either Clean, Dirty, Slightly Dirty or Stained, Checks and Cracks, or Floor Eggs. No egg was given more than one classification. Eggs classified under Dirty and Slightly Dirty or Stained were further classified as to the type of material causing the soilage, i. e., Soil (earth), Droppings, Egg Material, and Blood. (See Fig. 3.)

Eggs were collected at 10:00 a. m., 1:00 p. m. and 4:00 p. m. All eggs

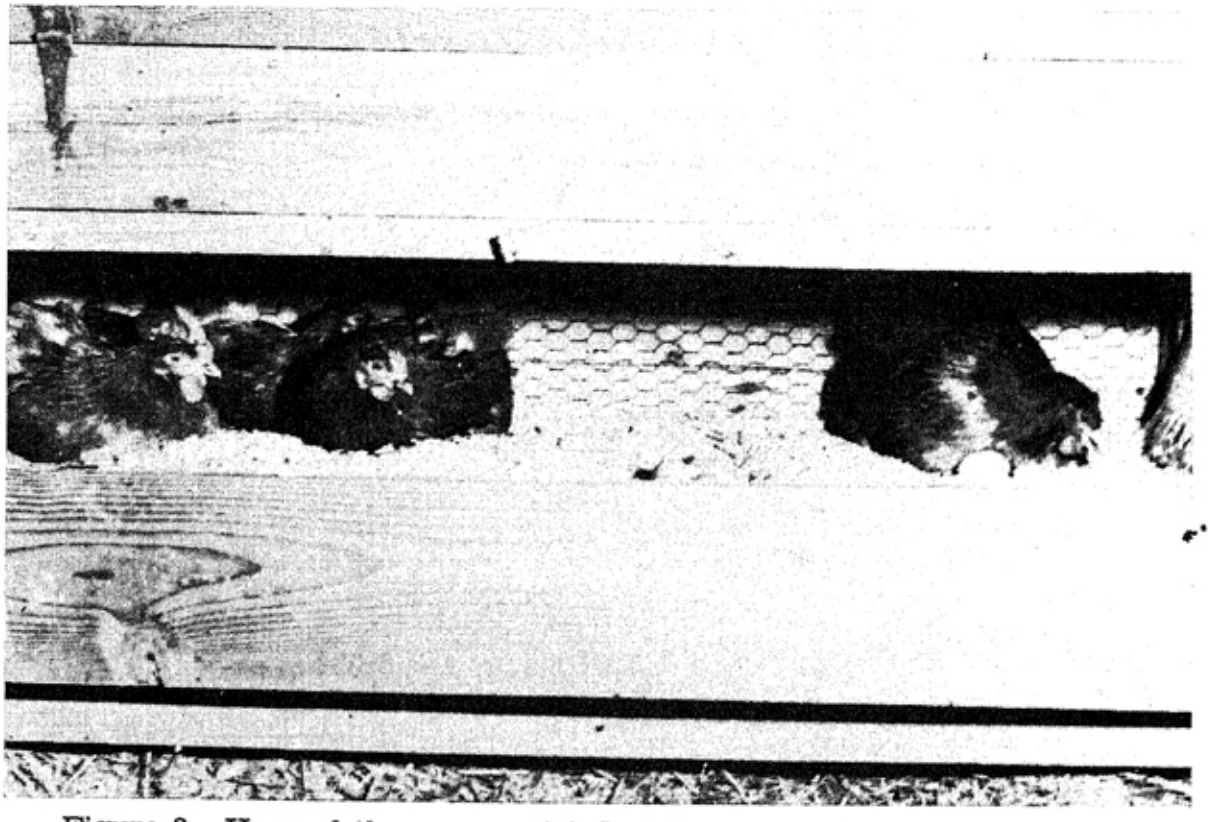

Figure 2. Hens of the commercial flock in community nests in which shavings were used.

were classified as they were taken from the nests. A total of 68,937 eggs was classified in this part of the study. Production for the period was below 50 per cent.

Trapnest Flock

Data were collected from a flock of 800 crossbred pullets from September, 1949 through April, 1950. These birds were the progeny from the Missouri phase of the Regional Poultry Breeding Project and included strain crosses, line crosses and breed crosses of five major breeds, Single Comb White Leghorns, New Hampshires, White Plymouth Rocks, Barred Plymouth Rocks and Single Comb Rhode Island Reds.

These birds were housed in a 24x104-foot laying house with an 8x24-foot feed room in the center and two 24x24-foot pens on each side. The laying house floor was covered with built up straw litter and the pens had wire-covered dropping pits. The nests were double-decked individual trap nests of the wire-front type. There were 48 nests per pen, or one nest per 4⅛ birds. The traps were run at least four times per day, and on severe cold days as much as 6 or 8 times. The regular personnel on the University poultry farm collected the eggs which were then placed in baskets and kept separate by pens until the end of the day when they were classified. Classification was in the same manner as for the commercial flock. The birds in this part of the study were confined to the laying house throughout the period of observation.

Four nesting materials were studied in this part of the study, Chick Bed, excelsior, shavings, and straw. All the nests in any one pen were filled with the same material.

A total of 99,355 eggs was classified in this part of the study. Production was at a high level and averaged well over 50 per cent for the greater part of the period. Data were collected for 220 days during this period.

Criteria for Classification of Eggs

All the eggs in the entire study were classified by M. Y. Dendy. The guide for the method of classification was an Order of Promulgation of Standards from the Office of the Secretary, United States Department of Agriculture, dated December 1, 1946. In this order the classes Clean, Dirty, Slightly Dirty or Stained, and Checks and Cracks were defined. After the study was well under way the classifying technique was checked by Mr. Robert J. Ashens, District Supervisor for the Production and Marketing Administration, United States Department of Agriculture, and approved. He did point out, however, that the grading was perhaps too strict on requirements for an egg to qualify as clean. In his opinion about 25 per cent of those graded as slightly dirty or stained; i. e., those having only very light specks of foreign matter on the shells would be graded as clean in commercial establishments. But in order to be consistent the grading was continued on a very strict basis throughout the entire period of observation.

Method of Analysis

The Analysis of Variance technique (Snedecor, 1946) was used to determine whether the differences that existed were statistically significant.

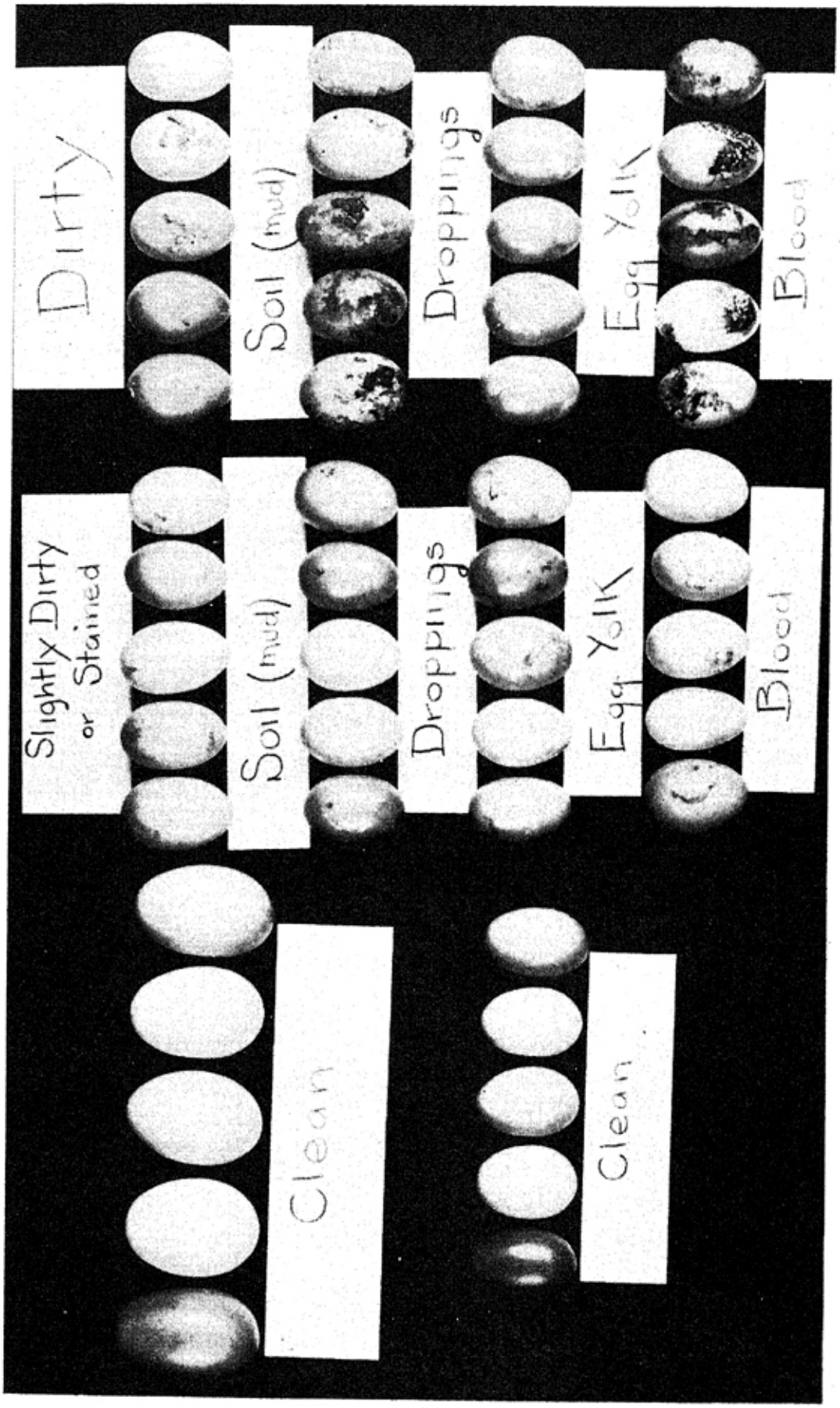

Figure 3. The classification of eggs used in this investigation

However, it was found necessary to use a modification of the usual method for computing the sums of squares for the several components of variance because of the data containing unequal or disproportionate subclass numbers. A method devised by Patterson (1946) was employed.

RESULTS AND DISCUSSIONS

Commercial Flock

Table 1 and Figures 4 and 5 present a summary of the data for the period of observation, showing total eggs laid in nests, total clean eggs, and the percentage of clean eggs by months and for each of the four materials tested. When studying these data it should be borne in mind that there were twice as many nests filled with straw as with any of the other materials.

The four materials fall into two groups in so far as their efficiency in producing clean eggs is concerned. Chick Bed and shavings are in the high group and sawdust and straw in the low group. In the high group it will be noted that shavings produced the higher percentage of clean eggs during the first three months of the study, but during the last four months the advantage shifted in favor of Chick Bed.

TABLE 1--SUMMARY OF DATA FOR PART ONE (COMMERCIAL FLOCK)

Month	Nesting Material			
	Chick Bed	Sawdust	Shavings	Straw
	Total Eggs Laid in Nests			
June	649	607	833	1809
July	1330	1229	1696	4139
August	527	394	545	1228
September	1753	1601	1907	5018
October	968	768	1065	3184
November	2018	1985	2302	5439
December	1716	1775	2139	4754
Total	8961	8359	10487	25571
	Total Clean Eggs			
June	405	309	536	1058
July	1029	900	1335	2841
August	418	305	452	904
September	1375	1163	1390	3304
October	736	525	780	2047
November	1464	1231	1637	3232
December	1199	1071	1243	2343
Total	6626	5504	7373	15729
	Per Cent Clean Eggs			
June	62.40	50.91	64.35	58.49
July	77.37	73.23	78.71	68.64
August	79.32	77.41	82.94	73.62
September	78.44	72.64	72.89	65.84
October	76.03	68.36	73.24	64.29
November	72.55	62.02	71.11	59.43
December	69.87	60.34	58.11	49.28
Average	73.94	65.84	70.30	61.51

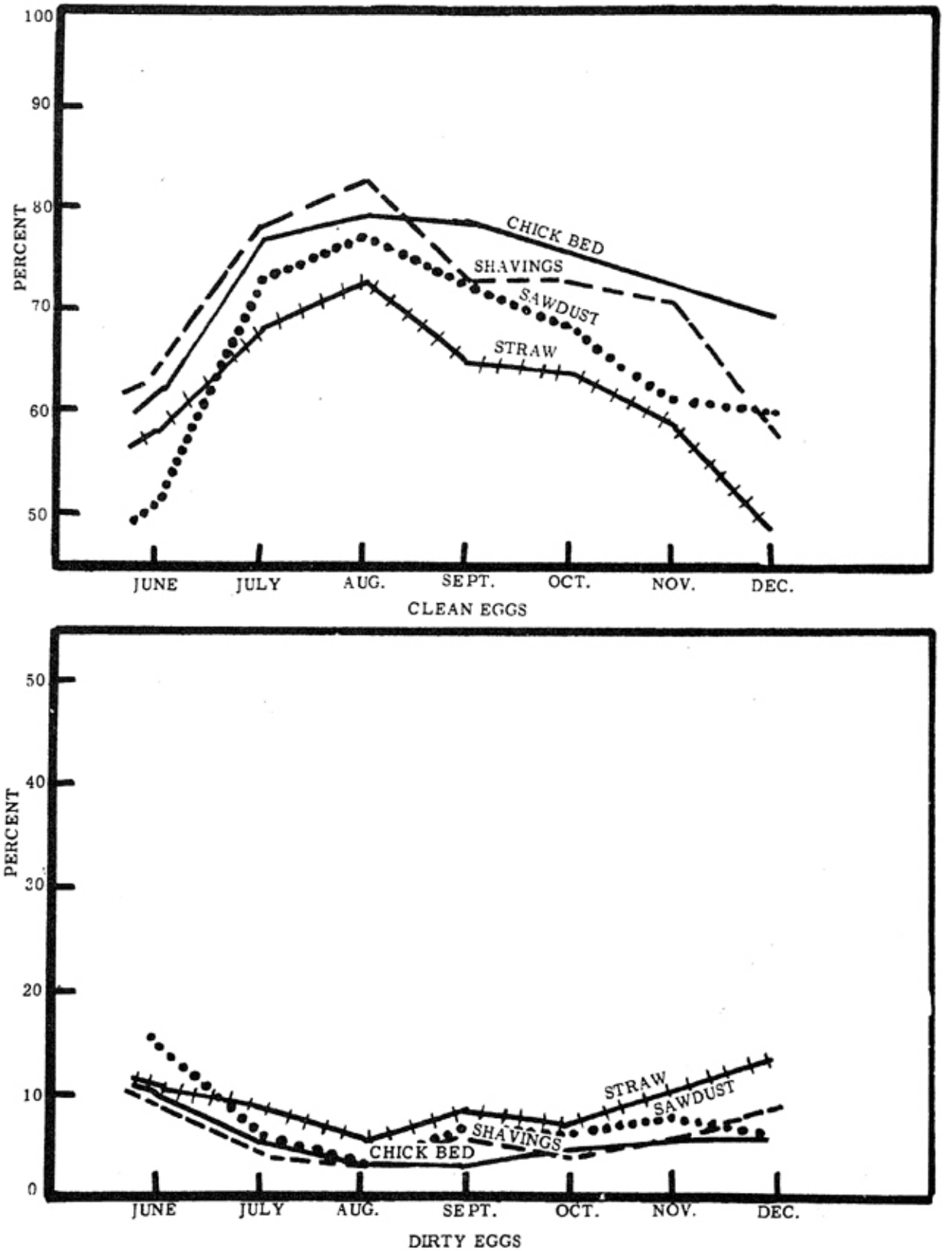

Figure 4. The percentage of clean and dirty eggs collected from nests in which different nesting materials were used. (Commercial flock.)

It is believed this was due to the higher humidity in the laying house as a result of decreased ventilation as temperatures declined in the fall and early winter, and to the fact that Chick Bed is capable of absorbing more

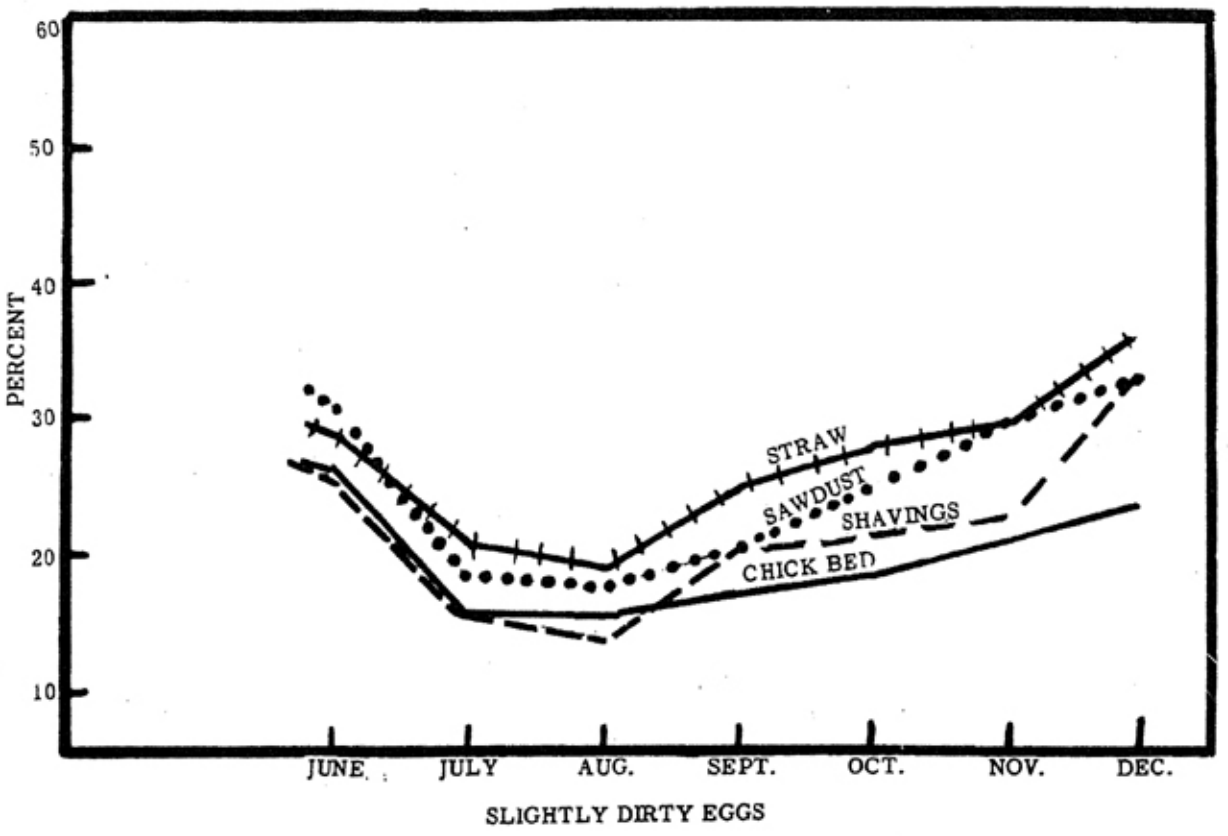

Figure 5. The percentage of slightly dirty eggs collected from nests in which different nesting materials were used. (Commercial flock.)

moisture than shavings. This feature was especially noticeable when eggs were broken in the nests. When this occurred it was necessary only to stir the egg material into the Chick Bed and in an hour or so the nest was dry again while with the other materials it was necessary to remove the egg material completely along with the contaminated nesting material or otherwise the nest remained in a wet, soiled condition for considerable time. It will be observed that in December the layers using Chick Bed nesting material produced 69.87 per cent clean eggs as compared to 58.11 per cent for shavings, an 11.76 per cent advantage for Chick Bed.

An examination of Table 2 which shows the dirty eggs by months, materials, and type of contaminating material shows that there was almost a 42 per cent increase for December over the preceding month in the proportion of dirty eggs from egg material in the nests where shavings were used while there was a slight but not significant decrease in the percentage of dirty eggs from egg material in the Chick Bed nests.

Table 3 presents similar data for slightly dirty or stained eggs. There was a 100 per cent increase during this same period for this type of soilage in the shavings nests and again a slight decrease in the Chick Bed nests. The explanation offered is that on December 7, 1949 about 900 additional birds were placed in the house. No mortality records were kept but it is estimated that losses to that date were not more than 250 or 300 birds out of the original 3,000 so that the house was still crowded and the additional birds greatly magnified any overcrowding effects. This resulted oftentimes in birds sitting on other birds in the same nest. It was very evident while

TABLE 2--KINDS OF CONTAMINATION ON DIRTY EGGS (COMMERCIAL FLOCK)

Month	Contamination				Contamination			
	Soil	Droppings	Egg	Blood	Soil	Droppings	Egg	Blood
	Chick Bed				Sawdust			
June	3	9	39	14	1	19	58	13
July	2	24	30	17	2	22	39	18
August	0	8	8	3	1	5	5	3
September	1	18	27	14	4	33	57	9
October	1	6	25	12	2	11	30	2
November	0	18	84	6	0	20	123	8
December	0	19	71	5	0	21	85	8
Total	7	102	284	71	10	131	397	61
% of Total	1.51	21.98	61.20	15.30	1.67	21.86	66.27	10.18
	Shavings				Straw			
June	0	13	27	35	1	42	121	44
July	4	22	27	21	30	86	181	61
August	0	0	10	5	0	27	31	15
September	3	29	63	16	29	170	180	45
October	1	18	27	4	13	91	108	19
November	0	24	98	6	0	127	421	19
December	0	36	139	9	0	133	491	20
Total	8	142	391	96	73	674	1533	223
% of Total	1.25	22.29	61.38	15.07	2.91	26.92	61.25	8.91

TABLE 3--KIND OF CONTAMINATION ON SLIGHTLY DIRTY OR STAINED EGGS (COMMERCIAL FLOCK)

Month	Contamination				Contamination			
	Soil	Droppings	Egg	Blood	Soil	Droppings	Egg	Blood
	Chick Bed				Sawdust			
June	20	59	54	41	26	91	36	37
July	28	92	50	44	26	134	35	30
August	10	43	12	16	11	39	11	8
September	33	174	37	62	27	209	38	52
October	3	120	23	34	20	130	19	21
November	0	250	113	74	8	406	86	85
December	0	270	88	52	7	400	88	86
Total	94	1008	377	323	125	1409	313	319
% of Total	5.21	55.93	20.92	17.92	5.77	65.05	14.45	14.72
	Shavings				Straw			
June	22	97	47	46	25	281	125	47
July	32	151	27	55	127	482	145	130
August	9	37	14	15	27	154	27	32
September	44	244	34	67	122	877	89	75
October	16	170	18	27	60	629	92	105
November	3	349	71	99	8	1101	288	206
December	1	481	142	77	0	1262	284	176
Total	127	1529	353	386	369	4786	1050	771
% of Total	5.30	63.84	14.73	16.11	5.28	68.60	15.05	11.05

collecting the eggs during the remainder of the period that the number of broken eggs in the nests greatly increased.

It may be noted from Tables 2 and 3 that this same type of soilage increased by three or four times for all types of nesting materials during November as compared to the preceding months. The explanation offered is that the birds were then in the highest peak of production achieved at any time during the study (about 45 per cent) and were even then crowding the nests and creating a great deal of breakage.

No such outstanding differences are noticed between the two materials in the low group. Sawdust did have a slight advantage over straw but not more than might be expected due to random fluctuation. Sawdust may have been a little more effective than straw in matting around the broken egg material and preventing its spread to other parts of the nest, but it did not compare favorably with Chick Bed or shavings in this respect.

If Tables 2 and 3 are combined it is noted that droppings was the most frequent cause of egg soilage with all nesting materials. This is expected because of the tendency of many birds to void droppings in the nest, and the fact that some birds always enter the nests with dirty feet.

Soil (earth) proved to be a minor cause of egg soilage, even when birds were on range. This may be due to birds walking through built up litter and their feet thus becoming at least partially cleaned and dried before reaching the nests.

Blood was the chief type of soilage on more than 10 per cent of all eggs classed as dirty or slightly dirty, and was the result in most cases of birds fighting in the nests.

Amount of Nesting Materials Used and the Length of Time Each Material Remained Serviceable.—It was felt that some comparison should be made between materials as to the amounts used and how long each material remained in serviceable condition in the nests. Therefore a record was kept of the length of time between changes for each type of nesting material. In order to establish a logical basis for this type of comparison it became necessary to adopt some arbitrary point at which the nesting material needed to be changed. For lack of a more accurate criteria we adopted 60 per cent as the "critical point." When the percentage of clean eggs produced by any nesting material fell to about 60 per cent the old nesting material was replaced with new.

Due to the limited time and labor available we were not able to keep accurate records of the amounts of materials used. Instead an average was taken of three or four refillings, or replacements, for each type of nesting material and the totals were calculated by this means:

$$\text{Average per refill (lbs.)} \times \text{number of nests} \times \text{number of times nests were filled} = \text{total amount (lbs.)}$$

Table 4 shows these data, and also the rank of the four materials as to length of service in the nests.

No attempt was made to rank the materials as to cost because of the difficulty in setting a value on such materials as sawdust and straw whose value may vary greatly from one locality to another.

TABLE 4--TOTAL NESTING MATERIAL USED, AVERAGE NUMBER OF DAYS EACH MATERIAL REMAINED SERVICEABLE, AND RANK OF THE FOUR MATERIALS (COMMERCIAL FLOCK)

Nesting Material	Times Nests Were Filled	Amount per Nest (lbs.)	No. of Nests	Total for Period (lbs.)	Av. No. Days Service-able	No. Refills in Excess of Highest Ranking Material	Rank According to Length of Service-ability
Chick Bed	8	30	4	960	23.4	-	1
Sawdust	12	45	4	2160	15.6	4	3
Shavings	10	20	4	800	18.7	2	2
Straw	13	12	4	1248	14.4	5	4

Some comparison can be made, however, as to the amount of time necessary to maintain the nests under these conditions. It was found that it took one man about 4 hours on the average to refill the nests in this house. The Chick Bed nests were filled 8 times during this period of 7 months, shavings 10 times, sawdust 12 times, and straw 13 times. This would represent for a house of this size and with all nests filled with the same material:

Chick Bed	4 days labor
shavings	5 days labor
sawdust	6 days labor
straw	6½ days labor

or, on a yearly basis approximately double the above figures. Therefore if the poultry enterprise is large scale in operation the difference in labor involved in maintenance of the nests may be an important factor in selecting nesting material.

Trapnest Flock

Table 5 and Figures 6 and 7 show a summary of the data for the second part of this study. It shows the total eggs laid in nests, total clean eggs and the per cent clean by months and for each of the four nesting materials tested. The reader is reminded that all birds were confined to the laying house for the entire period during which these data were collected.

Again it was found that the four materials fall into two distinct groups but with not quite so marked a difference between the two groups as in the first part of the study. Chick Bed and shavings were again in the high group, and excelsior and straw were in the low group. It will be noted that the percentage of clean eggs produced in this part of the study was considerably lower than for the first part. This may be explained in three ways.

First, the birds had to remain in the trap nests until they were released, and in some cases this period of time spent in the nests was two hours or more. Most birds if confined that long in a nest will void some droppings, and this along with any dirt or droppings brought into the nest on the birds' feet will tend to produce a higher percentage of dirty or slight-

ly dirty eggs than if nests are of the open type and birds are free to leave as soon as they finish laying. This is particularly true if the bird becomes restless and tries to find a way out of the nest.

Second, breed differences may have influenced the production of clean eggs. Some investigators maintain there are breed differences in the extent to which birds soil the nests. Funk (1937) stated that in trapnests the more phlegmatic breeds produced a higher percentage of clean eggs than did the more nervous breeds. Since a great many of the birds used in this part of the study were progeny from at least one Leghorn parent they possibly may have been of a more nervous disposition than the New Hampshires used in the first part of the study and therefore tended to soil the nests to a greater degree.

Third, time and labor were even more limited than in part one so that a lower critical point had to be adopted in setting up a criteria for changing nesting materials. It was decided if the percentage of clean eggs produced in any pen dropped below 50 per cent the nesting material for that pen would be changed the next day. This was not always possible, how-

TABLE 5--SUMMARY OF DATA FOR PART TWO (TRAPNEST FLOCK)

Month	Nesting Material			
	Chick Bed	Excelsior	Shavings	Straw
	Total Eggs Laid in Nests			
September	2062	1263	999	691
October	3150	3136	3065	2627
November	3655	3672	3745	3590
December	3443	3559	3792	3589
January	3278	3083	3401	3274
February	2870	2582	2983	2967
March	3456	2984	3621	3997
April	2465	2791	3412	2998
Total	24379	23070	25018	23733
	Total Clean Eggs			
September	1526	912	710	491
October	1966	1776	1858	1345
November	2231	1926	2183	1638
December	1884	1628	2241	1578
January	1764	1522	1894	1529
February	1675	1383	1737	1541
March	1930	1559	2081	2119
April	1536	1599	2072	1822
Total	14512	12305	14776	12063
	Per Cent Clean Eggs			
September	74.00	72.21	71.21	71.06
October	62.41	56.63	60.62	51.19
November	61.04	52.45	58.29	45.63
December	54.72	45.74	59.10	43.97
January	53.81	49.37	55.69	46.70
February	58.36	53.56	58.23	51.94
March	55.84	52.25	57.47	53.01
April	62.31	57.29	60.73	60.77
Average	59.53	53.33	59.06	50.83

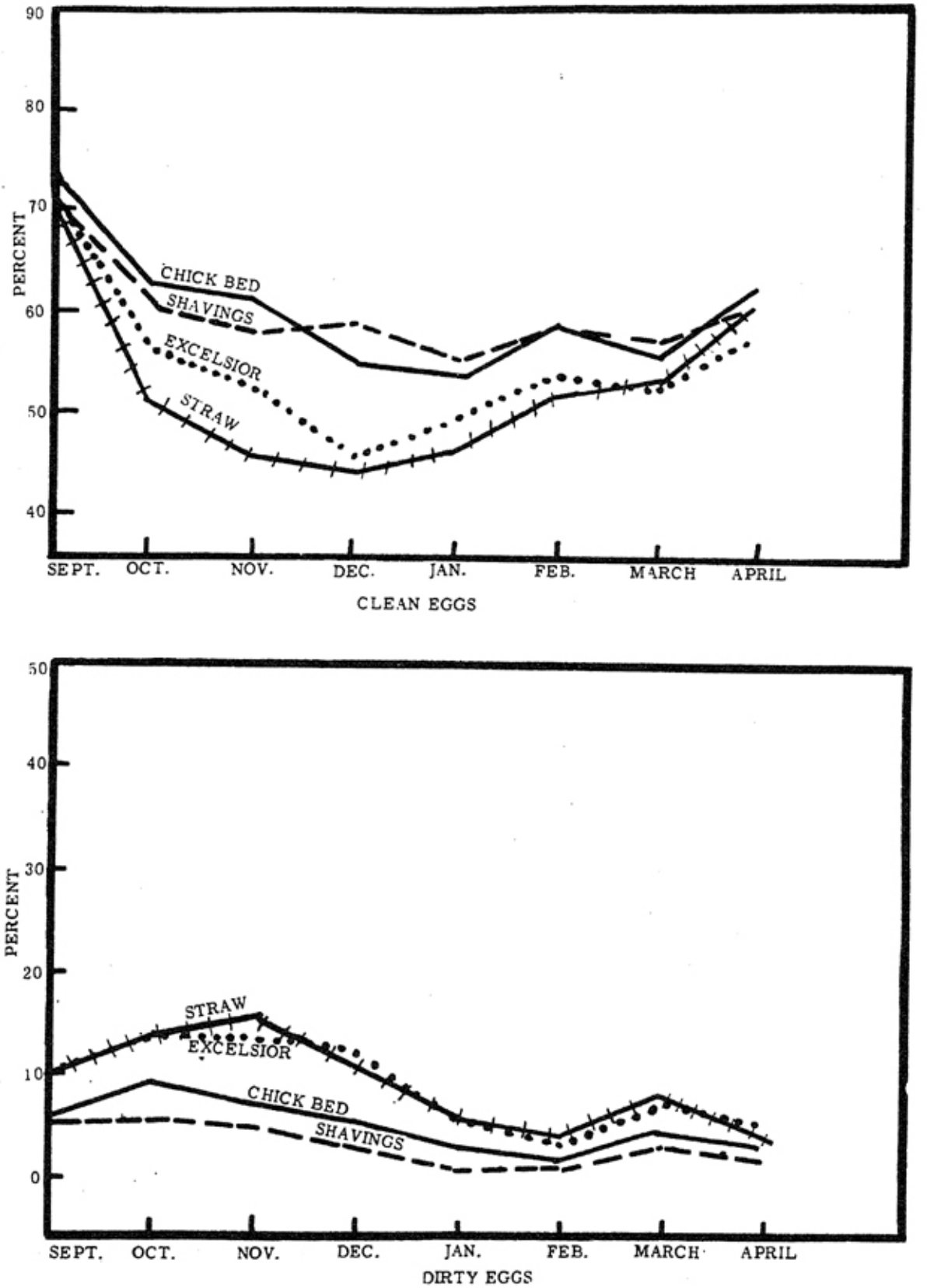

Figure 6. The percentage of clean and dirty eggs collected from nests in which different nesting materials were used. (Trapnest flock.)

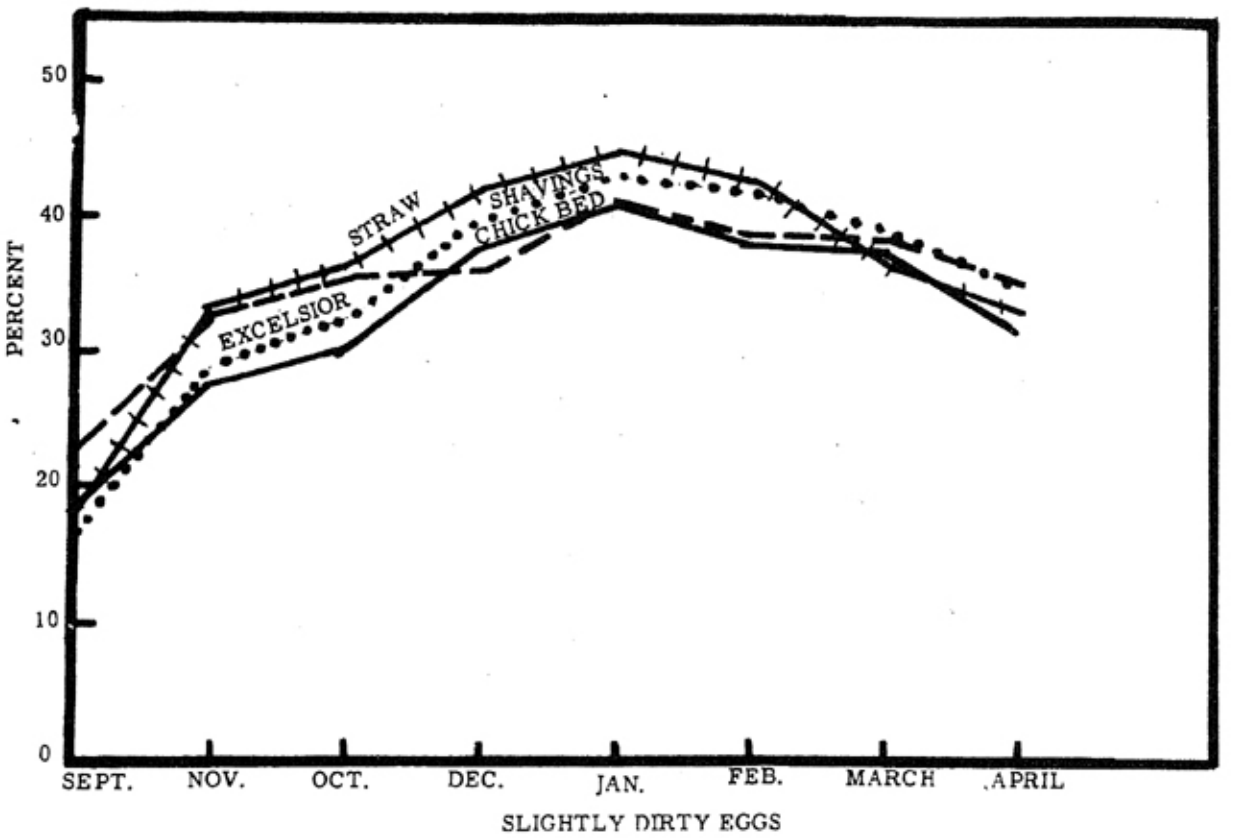

Figure 7. The percentage of slightly dirty eggs collected from nests in which different nesting materials were used. (Trapnest flock.)

TABLE 6--KIND OF CONTAMINATION ON DIRTY EGGS (TRAPNEST FLOCK)

Month	Contamination				Contamination			
	Soil	Droppings	Egg	Blood	Soil	Droppings	Eggs	Blood
	Chick Bed				Excelsior			
September	1	134	0	2	1	130	0	0
October	0	294	1	2	0	415	5	11
November	0	267	2	1	0	478	13	3
December	0	199	2	2	0	444	3	2
January	0	111	5	1	0	176	5	1
February	0	58	1	0	0	84	5	3
March	0	169	1	3	0	210	1	9
April	0	80	0	9	0	152	4	5
Total	1	1312	12	20	1	2089	36	34
% of Total	0.07	97.55	0.89	1.49	0.05	96.71	1.67	1.57
	Shavings				Straw			
September	0	52	2	2	0	67	1	2
October	2	177	1	3	0	349	11	5
November	0	191	3	1	0	537	27	5
December	0	121	4	0	0	418	8	2
January	0	56	0	2	0	206	3	0
February	0	51	0	3	0	124	2	0
March	0	119	0	6	0	321	9	0
April	0	83	0	2	0	128	4	1
Total	2	850	10	19	0	2150	65	15
% of Total	0.23	96.48	1.13	2.16	0.00	96.41	2.91	0.67

TABLE 7--KIND OF CONTAMINATION ON SLIGHTLY DIRTY OR STAINED EGGS (TRAPNEST FLOCK)

Month	Contamination				Contamination			
	Soil	Droppings	Egg	Blood	Soil	Droppings	Egg	Blood
	Chick Bed				Excelsior			
September	18	346	2	22	7	185	1	18
October	10	806	1	48	2	846	0	56
November	0	1089	0	20	0	1155	14	30
December	0	1288	1	10	0	1406	4	15
January	0	1321	9	14	0	1314	2	18
February	0	1100	0	7	0	1067	2	20
March	0	1284	0	13	0	1138	0	26
April	0	780	0	21	0	962	3	21
Total	28	8014	13	155	9	8073	26	204
% of Total	0.34	97.61	0.16	1.89	0.11	97.12	0.31	2.45
	Shavings				Straw			
September	11	195	0	17	2	108	0	14
October	15	941	4	36	3	831	9	36
November	1	1288	1	39	0	1270	15	43
December	0	1354	3	13	0	1481	16	21
January	0	1390	0	10	0	1458	2	15
February	0	1137	0	22	0	1262	1	11
March	0	1365	1	17	0	1473	0	20
April	0	1204	0	10	0	990	0	12
Total	27	8874	9	164	5	8873	43	172
% of Total	0.30	97.79	0.10	1.81	0.05	97.58	0.47	1.89

ever, and a few times two days would elapse before the change could be made. This is reflected in particular in the low percentage of clean eggs produced by straw, which had to be changed relatively often. This is apparent from an examination of Table 5.

There is the possibility of other unrecognized factors influencing this difference, but it is felt the three reasons offered above are the main causes of the differences in the percentage of clean eggs produced in the commercial flock as compared to the flock trapnested.

Table 6 shows a summary of Dirty Eggs, and Table 7 shows a summary of Slightly Dirty or Stained Eggs. It will be noted from these data that droppings was the cause of more than 95 per cent of the soilage for all types of nesting materials, for both classifications (Dirty, and Slightly Dirty or Stained).

The most noticeable feature of Table 6 is the low total of dirty eggs produced by shavings. Out of a total of 25,018 eggs produced only 881 were dirty. This did not, however, result in any advantage for shavings in the overall percentage of clean eggs produced. This difference apparently was absorbed in the Slightly Dirty or Stained classification.

Amount of Nesting Materials Used and the Length of Time Each Material Remained Serviceable.—The method of calculating the amounts used was the same as in part one. Table 8 shows the amounts used, length of

serviceability, and rank of the four materials as to durability.

Again Chick Bed and shavings ranked first and second respectively with excelsior third and straw fourth.

In the case of the trap nests it required the services of one man for an entire day to clean and refill the nests in this laying house. Therefore the amount of labor required to maintain the nests during this period (227 days) in a house of this size and with all nests filled with the same materia' would be as follows:

Chick Bed	7 days
excelsior	14 days
shavings	10 days
straw	21 days

TABLE 8--TOTAL NESTING MATERIAL USED, AVERAGE NUMBER OF DAYS EACH MATERIAL REMAINED SERVICEABLE, AND RANK OF THE FOUR MATERIALS (TRAPNEST FLOCK)

Nesting Material	Times Nests Were Filled	Amount per Nest (lbs.)	No. of Nests	Total for Period (lbs.)	Av. No. Days Service-able	No. Refills in Excess of Highest Ranking Material	Rank According to Service-ability
Chick Bed	7	3.67	48	1233.12	32.4	--	1
Excelsior	14	0.40	48	275.52	16.2	7	3
Shavings	10	0.73	48	350.40	22.7	3	2
Straw	21	0.83	48	836.64	10.8	14	4

CONCLUSIONS AND RECOMMENDATIONS

It can be concluded from the results of this study that one of the most important factors in the production of clean eggs is plenty of nesting space. In part one of the study it was found that a great increase in the percentage of dirty eggs occurred when the nesting facilities were crowded. The labor of maintaining the nests in satisfactory condition may be reduced by providing plenty of nesting space. The recommendation of one 10x12-inch nest per four or five birds appeared correct on the basis of results obtained in this study.

Chick Bed and shavings were the two outstanding nesting materials on the basis of the percentage of clean eggs produced, and on the basis of the length of time the materials remained serviceable in the nests. Chick Bed had a slight but definite advantage over shavings in the percentage of clean eggs produced, and in the amount of labor involved in maintaining the nests. The difference between these two materials in the percentage of clean eggs produced in this investigation was not statistically significant, but in a large scale poultry enterprise this small difference, if real, might be very important if the operator was trying to produce clean eggs to meet the demands of a quality market.

Tables 9 and 10 show an analysis of the result for parts one and two, respectively, of this study.

TABLE 9--ANALYSIS OF VARIANCE OF DATA FROM PART ONE (COMMERCIAL FLOCK)

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Ratios
Total	299	39,891.56	133.42	
Months	6	10,060.96	1,676.83	14.46*
Materials	3	6,455.92	2,151.97	18.55**
Interaction	18	2,087.70	115.98	1.48
Internal	272	21,286.26	78.26	

* Significant at the .05 point.
** Significant at the .01 point.

Materials Compared	Difference in Means
Chick Bed - sawdust	7.411 per cent **
Chick Bed - shavings	2.720 per cent
Chick Bed - straw	12.115 per cent **
sawdust - shavings	4.691 per cent *
sawdust - straw	4.704 per cent *
shavings - straw	9.395 per cent **

* Significant at the .05 point
** Significant at the .01 point

TABLE 10--ANALYSIS OF VARIANCE OF DATA FROM PART TWO (TRAPNEST FLOCK)

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Ratios
Total	879	119,280.18	135.70	
Months	7	7,672.25	1,096.03	4.927*
Materials	3	9,197.75	3,065.91	13.811**
Interaction	21	4,661.83	221.99	1.995**
Internal	848	97,748.35	115.27	

* Significant at the .05 point.
** Significant at the .01 point.

Materials Compared	Difference in Means
Chick Bed - excelsior	5.50 per cent **
Chick Bed - shavings	0.11 per cent
Chick Bed - straw	7.34 per cent **
excelsior - shavings	5.39 per cent **
excelsior - straw	1.84 per cent
shavings - straw	7.23 per cent **

* Significant at the .05 point
** Significant at the .01 point