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# The use of COMPOST (Built-up) LITTER in CHICKEN HOUSES

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# CONTENTS

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## INTRODUCTION

Built-up litter came into use during World War II as a means of saving labor and litter (Hayes, 1944). Instead of removing the litter, when it became dirty, a little clean litter was spread on top of the old and sometimes stirred into it to reduce caking and facilitate drying. As the litter became deeper (built-up), during the late fall and winter, the floors became dryer. The deep litter served as insulation, making floors warmer and resulting in less condensation of moisture on the litter.

Ohio Experiment Station investigators reported that the use of built-up (used) poultry house litter saves labor and litter costs and reduces mortality (Kennard and Chamberlin, 1947, a, b) and provides nutrient material essential for growth of chickens and hatchability of eggs (Kennard and Chamberlin, 1948, a, and Kennard, Bethke and Chamberlin 1948, a; 1949).

## WHAT IS COMPOST (BUILT-UP) LITTER?

Compost litter as used in this report, is litter that has been "built-up" to a depth of six or more inches by the addition of a small amount of new litter to the old as needed and which has been in use six months or longer (Kennard and Chamberlin, 1950; 1951, b; and Kennard, 1954 a). Compost is more descriptive than "built-up" because the latter might mean deep litter only. Compost means that it has been used long enough to contain sufficient microorganisms and moisture from the droppings to produce heating and sanitation (decomposition) effects.

In the Station's experiments at Wooster three floor litter procedures were used. 1. **Fresh litter** removed and renewed each two weeks. 2. **New built-up litter** started anew for each brood with additions of fresh litter as needed. No litter was removed until the end of the

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brooder period (10 to 12 weeks) when all litter was completely removed and renewed before starting the next brood of chicks. 3. **Compost (old built-up) litter** which was the continued use of the same litter for consecutive broods of chicks. The same litter was successfully used in some of the experiments during seven years for 30 consecutive broods of chicks.

## OBJECTIVES

Since the Ohio Agricultural Experiment Station poultry research workers' (Kennard and Chamberlin 1950 a, and Kennard 1954 a) recommended re-use of chicken house litter, especially for brooding chicks, is contrary to the generally accepted standards of sanitation, it has been desirable to obtain more data on the subject. One objective of this report is to summarize the work of Kennard and associates as well as that of others at the Ohio station and elsewhere who have studied compost litter from the standpoint of sanitation, nutritional properties and management. Another objective is to provide information on the value of compost litter in present day chicken production with the use of drugs for preventing coccidiosis, vitamin $B_{12}$ for growth and hatchability, and antibiotics for health.

## SANITARY VALUE OF COMPOST LITTER FOR STARTING AND GROWING CHICKENS

### IMMUNITY AGAINST COCCIDIOSIS

Until a few years ago, coccidiosis caused heavy mortality among growing chickens. The recommended practice for control of the disease was frequent change of litter (Beach and Sanborn, 1936), at least once a week after the chicks were two weeks old. The purpose was two-fold, to keep the number of coccidia oocyst low in the litter and to prevent them from becoming infective (sporulating) by maintaining dry litter.

Kennard and Chamberlin (1947) observed that adding fresh litter to the old at frequent intervals and stirring, rather than frequent replacement by clean litter resulted in dryer floors and less mortality from coccidiosis, during the brooding period.

Kennard and Chamberlin (1947 a) reported that growing four broods of chicks on the same built-up (compost) litter resulted in low mortality and very low losses from coccidiosis. This was followed by growth of additional broods on the same litter and with similar results (Kennard and Chamberlin 1948 b; 1949 a, b, c; 1950 a; 1951, and Kennard 1949 a) (Tables 1 and 2). A total of 20 consecutive broods were successfully grown on the same litter in almost continuous use for five years. They believed that lower losses from coccidiosis on compost litter may have been due to the drier condition of the litter which would retard sporulation of coccidia (Boughton, 1939) or the heating effect of and ammonia production by compost litter which would reduce the virulence of or kill the coccidia.

**TABLE 1.—Influence of kind of litter and ration on growth and mortality of broilers.**

**(Kennard and Chamberlin 1948, b; 1949, a; 1951, 1950, a)**

| Exp. | Average weight per bird | | | Feed per pound live weight | | | Mortality | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fresh | New built-up | Com-post | Fresh | New built-up | Com-post | Fresh | New built-up | Com-post |
| | Lb. | Lb. | Lb. | Lb. | Lb. | Lb. | Pct. | Pct. | Pct. |
| | Basal all-plant ration with 28 percent soybean oil meal | | | | | | | | |
| 1 | 2.15 | | 2.22 | 4.03 | | 3.78 | 8 | | 6 |
| 2 | 2.19 | 2.38 | 2.49 | 3.96 | 4.06 | 3.95 | 5 | 7 | 2 |
| 3 | 2.55 | 2.61 | 2.74 | 4.12 | 4.22 | 4.01 | 9 | 8 | 7 |
| 4 | | 2.38 | 2.49 | | 4.06 | 3.95 | | 7 | 2 |
| 5 | | 2.62 | 2.71 | | 4.14 | 3.98 | | 7 | 8 |
| 6 | | 2.19 | 2.28 | | 3.84 | 3.95 | | 4 | 4 |
| 7 | | 2.70 | 2.95 | | 4.05 | 4.00 | | 2 | 1 |
| 8 | | 3.07 | 3.02 | | 4.19 | 4.05 | | 16 | 5 |
| Av. | 2.30 | 2 26 | 2 67 | 4.04 | 4.08 | 3.78 | 7 | 7 | 4 |
| | Basal ration with 7 percent meat scraps and 5 percent dried whey | | | | | | | | |
| 1 | 1.87 | 2.03 | 2.20 | 4.24 | 4.33 | 3.36 | 14 | 21 | 6 |
| 2 | 1.45 | 1.73 | 2.34 | 7.59 | 4 15 | 3.80 | 18 | 19 | 5 |
| 3 | 1.59 | 1.87 | 2.47 | 5.90 | 4.70 | 4.21 | 37 | 15 | 11 |
| 4 | | 1.73 | 2.34 | | 4.15 | 3.80 | | 19 | 5 |
| 5 | | 1.87 | 2.49 | | 4.44 | 4.15 | | 15 | 10 |
| 6 | | 1.97 | 2.31 | | 3.98 | 3.82 | | 14 | 4 |
| 7 | | 2.09 | 2.70 | | 4.68 | 4.29 | | 44 | 4 |
| 8 | | 2.21 | 2.94 | | 4.89 | 4.13 | | 38 | 7 |
| Av. | 1.64 | 1.94 | 2.47 | 5.91 | 4.41 | 3.94 | 23 | 23 | 6 |

*200 White Leghorn X Rhode Island Red straight run crossbred chicks used in each pen in trials 1-6 and 200 New Hampshire broiler strain chicks in trials 7-8.

Jeffrey (1949) reported that in 1946 they began to omit cleaning some of the brooder houses and by 1949 practically all of their chickens were brooded on used (dirty) litter. Some strains, including the college flock of White Plymouth Rocks appeared to become acclimated to long used (dirty) litter to such an extent that mortality was low when brooded upon it.

Kennard, Moore and Chamberlin (1954, a) reported a nearly double mortality when broiler chicks were brooded on new built-up litter than when brooded on compost litter (Table 2). The mortality among 13 broods, involving 6945 chicks, was 10.8 percent when brooded on new built-up litter and 5.7 percent when brooded on compost litter.

**TABLE 2.—Influence of new built-up and compost litter on growth and mortality of broilers.**

**(Kennard, Moore and Chamberlin 1954, a)**

| | Average weight per bird | | Feed per pound live weight | | Mortality | |
|---|---|---|---|---|---|---|
| | Kind of Litter | | | | | |
| | New built-up | Compost | New built-up | Compost | New built-up | Compost |
| | Lb. | Lb. | Lb. | Lb. | Pct. | Pct. |
| 1* | | 2.28 | | 3.76 | | 13 |
| 2† | 3.27 | 3.57 | 6.14 | 4.91 | 38 | 12 |
| 3‡ | 2.89 | 3.12 | 5.66 | 5.34 | 12 | 6 |
| 4* | 2.12 | 2.26 | 4.57 | 4.33 | 7 | 8 |
| 5‡ | 3.65 | 3.82 | 4.75 | 4.89 | 33 | 4 |
| 6‡ | 2.04 | 2.22 | 4.35 | 3.36 | 15 | 6 |
| 7‡ | 2.83 | 3.01 | 4.51 | 4.50 | 8 | 2 |
| 8‡ | 2.55 | 2.74 | 4.08 | 3.98 | 9 | 8 |
| 9‡ | 2.19 | 2.28 | 3.89 | 3.95 | 4 | 4 |
| 10§ | 3.70 | 2.95 | 4.05 | 4.00 | 2 | 1 |
| 11§ | 3.07 | 3.02 | 4.19 | 4.05 | 15 | 5 |
| 12§ | 3.03 | 2.83 | 4.01 | 4.14 | 33 | 7 |
| 13§ | 2.85 | 3.16 | 3.73 | 3.89 | 14 | 5 |
| Total | 2.77 | 2.92 | 4.50 | 4.28 | 10.8 | 5.7 |

*Rhode Island Red pullets.
†Rhode Island Red cockerels.
‡Leghorn—Rhode Island Red crossbreds.
§New Hampshires.

Koutz (1948) reported that compost litter did not kill or prevent sporulation of coccidia. However, day-old chicks brooded on compost litter developed satisfactory immunity to coccidiosis while those brooded on wire did not. This was demonstrated by challenging both groups with heavy doses of sporulated oocysts. The resulting mortality was 0.6 percent among those brooded on compost litter and 27 percent when brooded on wire.

Koutz (1952, a) (1953) (1955) obtained better growth and lower mortality when chicks were brooded on compost rather than new litter (Table 3). Coccidiosis was the principal cause of mortality of chicks brooded on new litter. Chicks brooded on hen compost litter did as well as those on broiler compost litter. This observation is in agreement with the findings of Kennard and Chamberlin (1947 a). The coccidia in the chicks on wire may have been carried on dust particles from adjoining pens, by the feed or by the attendant.

Moore et al. (1952) (1953) conducted four trials in which antibiotics and/or coccidiostats were fed to chickens brooded on new and compost litter (Table 4). Mortality was less on compost litter than on frequently changed litter. The antibiotics, penicillin and aureomycin, stimulated the growth of birds on compost litter. Feeding a coccidiostat to birds brooded on compost litter reduced mortality, stimulated growth, and improved feed conversion. The coccidiostat, nitrosal, stimulated more growth than the other treatments. The combination of penicillin and nitrosal gave better results than when either was used alone.

Smith (1953), Dressen, et al. (1954) and Kinder and Kempster (1954) have confirmed the earlier work of Kennard, Koutz, Moore, et al. that chicks may be brooded on compost litter with no greater mortality, if as great, as when brooded on frequently changed litter.

Van Ness (1953) attributed the decline in coccidiosis losses in recent years, during the brooding of broilers, to the use of built-up, deep litter and the use of a coccidiostat such as nitrofurazone, nitrophenide, arsanilic acid and sulfaquinoxaline, in the feed continuously at preventive levels. The combination permits the chicks to pick up coccidia from the litter and develop immunity and the drug protects them against losses during this period.

Horton-Smith and Long (1954) reported that the heating effect and ammonia production in built-up litter reduced the number of coccidia oocysts in it but did not destroy them. Two of 20 chickens raised on wire until 6 weeks of age and then placed on built-up litter died with coccidiosis. After 4 weeks on the litter the remaining 18

**TABLE 3.—Influence of kind of litter on growth and mortality of broilers and the presence of worms and coccidia. (Koutz 1952, a; 1953, 1955)**

| Observation | Compost hen litter. Average of 2 pens.† Used 9 to 24 months | | | | Compost broiler litter. Average of 3 pens. Used 11-14 times | | | | New changed litter. Average of 3 pens | | | | Wire floor. Control, 1 pen | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Experiment | | | | Experiment | | | | Experiment | | | | Experiment | | | |
| | 1 | 2 | 3 | Av. | 1 | 2 | 3 | Av. | 1 | 2 | 3 | Av. | 1 | 2 | 3 | Av. |
| Average weight at 12 weeks (lbs.) | 2.5 | 3.0 | 2.5 | 2.7 | 2.8 | 3.0 | 2.3 | 2.7 | 2.7 | 3.0 | 2.5 | 2.7 | 2.9 | 3.4 | 2.8 | 3.0 |
| Mortality (%) | 3.4 | 1.7 | 21.7 | 8.9 | 2.2 | 4.4 | 20.2 | 8.9 | 10.0 | 6.7 | 24.4 | 13.7 | 6.7 | 0.0 | 3.3 | 3.3 |
| Average number worms* per chicken | 47 | 68 | 29 | 48 | 14 | 16 | 0.3 | 10.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Average number worm* eggs per gram of litter | 94 | 133 | 100 | 109 | 137 | 92 | 87 | 105 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Average number scavenger mites and ova per gram of litter | 1523 | 5718 | 5275 | 4172 | 5385 | 5964 | 6599 | 5983 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Coccidia present in litter and birds | yes | yes | yes | | yes | yes | yes | | yes | yes | yes | | yes | yes | yes | |

*Ascaridia lineata, Heterakis gallinae and Capillaria retusa.

†Used 30 day-old New Hampshire broiler chicks per pen in each experiment.

**TABLE 4.—Influence of kind of litter and antibiotic and coccidiostat feed supplementation on growth and mortality of broilers.**

**(Moore et al. 1952, 1953)**

| | | Mortality (%) | | | | | Average weight (lbs.) at 12 weeks | | | | | Pounds feed per pound of gain | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Litter** | **Feed supplement†**   **Trial*** | **1** | **2** | **3** | **4** | **Av.** | **1** | **2** | **3** | **4** | **Av.** | **1** | **2** | **3** | **4** | **Av.** |
| New | Changed biweekly (control) | 4 | 27 | 14 | | 15 | 3.09 | 2.45 | 2.73 | | 2.82 | 4.05 | 5.00 | 3.27 | | 4.11 |
| Old | 21 or more broods (control) | 3 | 12 | 5 | | 7 | 3.37 | 2.65 | 2.90 | | 2.92 | 3.91 | 4.22 | 3.59 | | 3.91 |
| Old + | Penicillin | 2 | 9 | 4 | | 5 | 3.44 | 3.17 | 3.24 | | 3.28 | 3.87 | 4.05 | 3.23 | | 3.72 |
| Old + | Aureomycin | 3 | 9 | 2 | | 5 | 3.51 | 3.00 | 3.26 | | 3.26 | 3.84 | 4.09 | 3.47 | | 3.80 |
| Old + | Bacitracin | 6 | 8 | 2 | | 5 | 3.23 | 2.91 | 3.04 | | 3.06 | 4.09 | 4.21 | 3.38 | | 3.89 |
| Old + | Nitrosal | 4 | 3 | 3 | | 3 | 3.71 | 3.45 | 3.28 | | 3.48 | 3.63 | 3.91 | 3.38 | | 3.64 |
| Old + | Megasul | 5 | 7 | 1 | | 4 | 3.17 | 2.52 | 2.88 | | 2.86 | 4.07 | 4.69 | 3.56 | | 4.11 |
| Old + | Sulfaquinoxaline | 5 | 6 | 1 | | 4 | 3.29 | 2.48 | 2.89 | | 2.89 | 4.05 | 4.62 | 3.55 | | 4.07 |
| Old + | Nitrofurazone | | | 5 | 4 | | | | 3.04 | 3.06 | | | | 3.36 | 4.00 | |
| Old + | Nitrofurazone + sodium arsenilate | 2 | 8 | | | | 3.43 | 2.84 | | | | 3.87 | 4.35 | | | |
| Old + | Penicillin + nitrosal | 2 | 6 | 0.5 | 12 | | 3.72 | 3.72 | 3.35 | 3.47 | | 3.56 | 3.85 | 3.56 | 3 63 | |
| Old + | Penicillin + sulfaquinoxaline | | | | 3 | | | | | 3.35 | | | | | 3.76 | |
| Old + | Penicillin + nitrofurazone | | | | 4 | | | | | 3.30 | | | | | 4.02 | |
| New + | Penicillin + nitrosal | | | | 10 | | | | | 3.32 | | | | | 4.19 | |
| New + | Penicillin + aureomycin | | | | 17 | | | | | 3.30 | | | | | 4.07 | |
| Old + | Aureomycin + nitrosal | | | | 4 | | | | | 3.57 | | | | | 3.56 | |

*200 straight run New Hampshire chicks per pen in Trial 1 and 200 White Plymouth Rocks in Trials 2, 3 and 4.

†The basal diet was a 22 percent protein, high energy ration.

birds were challenged with massive doses of sporulated coccidia, with no losses. Twelve of 20 birds which had been kept on wire died following the challenge. The test demonstrated that chicks brooded on litter from 6 to 10 weeks of age developed immunity to later coccidial infection.

Berg et al. (1956) reported good growth and low mortality of broilers brooded on compost litter. The addition of a coccidiostat (furazolidone, nitrofurazone, or sulfaquinoxaline) stimulated early growth over that of the basal ration containing procaine penicillin (3 ppm.). By the time the broilers were 11 weeks old, there was little difference in weights of birds receiving a coccidiostat or without one. Birds started in batteries and placed on compost litter at 4 weeks of age ranged in mortality from 1.04 to 8.32 percent, while those on the litter as day-old chicks ranged in mortality from 0 to 4.16 percent. The chickens started on compost litter in the beginning (day-old) developed immunity to coccidiosis.

Winter, Adams and Naber (1956) reported as good growth, and no greater mortality, among broilers brooded on compost litter as on new built-up litter (Table 5). It is noteworthy that the compost litter was a mixture of hen house compost litter and broiler house litter which had been used for 32 previous broods. Feeding a high level antibiotic (100 grams of aureomycin per ton) improved the rate of growth slightly when broilers were brooded on both types of litter.

**TABLE 5.—Influence of the kind of litter and an antibiotic feed supplement on the growth and mortality of chicks.**
**(Winter, Adams and Naber, 1956)**

| Trial | Litter | Supplement | Av. wt. | Feed per lb. gain | Mortality Percent |
|---|---|---|---|---|---|
| | New | None | 2.44 | ---- | 5.2 |
| 1* | New | Antibiotic | 2.71 | ---- | 4.0 |
| 8 weeks | Old† | None | 2.47 | ---- | 5.2 |
| | Old | Antibiotic | 2.54 | ---- | 4.0 |
| | New | None | 3.13 | 2.93 | 1.7 |
| 2 | New | Antibiotic | 3.23 | 2.85 | 1.7 |
| 10 weeks | Old† | None | 3.20 | 2.95 | 0.0 |
| | Old | Antibiotic | 3.29 | 2.89 | 2.5 |

*125 straight run White Plymouth Rocks per pen in trial 1 and mixed broiler strains in trial 2. Fed the Ohio 22 percent protein broiler ration (Ohio Ext. Bul. 343. 1954).

†The old litter was a mixture of fresh broiler and hen compost litter and old broiler house litter which had been used for 32 previous broods in trial 1 and 33 in trial 2

## CONTROL OF LOSSES DUE TO PARASITES

Ackert and Wisseman (1944) reported that growing chickens receiving a good ration could tolerate an average of 17.9 ascarids per bird before any damage would be apparent.

Cottier (1948) reported that broilers raised on clean litter were slightly heavier at 10 weeks of age and harbored fewer parasites than when raised on litter that had been used previously one or more times.

Riedel (1951) reported light parasite infection in 12 successive broods of broilers raised on concrete and dirt floors, with removal of litter between broods. He believed that the infection was introduced by flies, the caretaker, or by other means. Riedel believed that worm infection would cause little or no damage in broilers before marketing because of the time required for viable ova to embryonate and the worms to develop to maturity.

Todd and Hansen (1951) infected 566 New Hampshire chicks with 50 embryonated ascarid ova per chick and observed the health and growth of the birds during the following three weeks. This was regarded as the most critical period for damage following infection. The presence of the worms did not appear to interfere with weight gains or increase mortality. In fact the 126 birds that did not become parasitized weighed less (214 gram average) than 186 birds which harbored 1 to 5 worms each and averaged 226 grams at time of autopsy.

Koutz (1952, a) (1953) (1955) reported that compost litter harbored parasite ova, while new built-up litter did not. Broilers brooded on both types of litter harbored parasites but the number was much greater in chicks raised on compost litter. However, the average weight of broilers was about the same (Table 3) at 12 weeks whether raised on compost or new, built-up litter. The pens were idle 2 weeks between Experiments 1 and 2, and 10 weeks between Experiments 2 and 3. The lower parasite infection in Experiment 3 may have been due to this factor. Moore et al. (1954) also experienced difficulty in infecting broilers with worms from infected litter after it had remained idle for several weeks.

Moore, Chamberlin and Carter (1954) reported that brooding chicks on compost litter did not result in bad parasite infestation (Table 6), reduction in growth rate or poorer feed conversion. Pens of chickens with an average worm population as high as 60 per bird, lived as well and made as good gains as those with fewer worms. Allowing compost litter to remain idle during the summer or between broods, greatly reduced parasite infestation in the following brood. Koutz (1953) had observed similar difficulty in securing parasite infestation after the litter had remained idle for a time (Table 3, exp. 3).

**TABLE 6.—Influence of kind of litter on growth, mortality, feed conversion and worm infection of broilers (Moore, Chamberlin and Carter, 1954 and unpublished data)**

| Litter | Average weight at end of trial | | | | | Mortality (Percent) | | | | | Pounds feed per pound gain | | | | | Average number worms per bird | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Trial | | | | | Trial | | | | | Trial | | | | | Trial | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4* | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Compost | 2.9 | 3.0 | 2.5 | 2.0 | 2.8 | 10 | 10 | 14 | 39 | 11 | 3.3 | 3.3 | 3.0 | 3.1 | 3.3 | 20 | 4 | 60 | .03 | 0 |
| Compost and exposure | 3.0 | 2.7 | 2.5 | 1.8 | 2.8 | 13 | 10 | 10 | 56 | 6 | 3.3 | 3.2 | 3.0 | 4.5 | 3.2 | .3 | .1 | .5 | .30 | 0 |
| Wire | 2.9 | 2.5 | 2.5 | 1.9 | 3.1 | 20 | 8 | 8 | 52 | 11 | 3.4 | 4.0 | 2.7 | 4.5 | 3.2 | 5 | 0 | .2 | 0 | 0 |
| Wire and exposure | 2.7 | 2.6 | 1.7 | 1.5 | 2.8 | 22 | 16 | 76 | 70 | 11 | 3.5 | 3.5 | 2.9 | 3.3 | 3.3 | 1.5 | 20 | 158 | 20 | 8 |
| Compost and exposure | 3.0 | 3.1 | 2.6 | 2.1 | 3.0 | 6 | 11 | 13 | 37 | 8 | 3.2 | 3.2 | 2.8 | 3.2 | 3.1 | 9 | 2 | 14 | .06 | .02 |
| Compost | 2.8 | 3.1 | 2.6 | 2.2 | 2.7 | 7 | 11 | 12 | 14 | 14 | 3.3 | 3.1 | 2.9 | 3.5 | 3.1 | .2 | 4 | 2 | .30 | 0 |
| New | 2.7 | 3.0 | 2.6 | 2.0 | 2.5 | 10 | 9 | 6 | 20 | 7 | 3.4 | 3.3 | 2.9 | 3.1 | 3.5 | 49 | .2 | ? | .09 | 0 |
| New | 2.9 | 3.0 | 2.7 | 1.9 | 2.9 | 11 | 8 | 3 | 29 | 11 | 3.3 | 3.1 | 2.8 | 3.2 | 3.1 | .2 | .03 | .3 | 0 | .01 |
| Compost and exposure | 2.8 | 3.0 | 2.7 | 2.0 | 2.8 | 14 | 5 | 4 | 37 | 13 | 3.3 | 3.1 | 2.8 | 3.5 | 3.2 | 24 | 9 | ? | 1.4 | 0 |
| Compost and exposure | 2.9 | 3.1 | 2.7 | 2.1 | 2.9 | 8 | 9 | 4 | 33 | 5 | 3.3 | 3.2 | 2.8 | 3.4 | 3.2 | 27 | 11 | 47 | 1.6 | .06 |

*High mortality in Trial 4 due to respiratory disease outbreak. Exposure by dosing each bird with 200 embryonated ascarid eggs in trials 1 and 2.

Trial 1 = 29th brood, November 12, 1953—January 28, 1954. (77 days)
Trial 2 = 30th brood, February 11, 1954—April 28, 1954. (75 days)
Trial 3 = 31st brood, May 13, 1954—July 22, 1954. (70 days)
Trial 4 = 32nd brood, September 21, 1954—December 1, 1954. (70 days)
Trial 5 = 33rd brood, January 11, 1955—March 29, 1955. (77 days)

Horton-Smith and Long (1954) reported that compost litter, especially when piled, may reach a temperature high enough to destroy parasite eggs. Sufficient ammonia may also be produced in heaped compost litter to destroy worm eggs, especially if they are not embryonated.

### DESTRUCTION OF SALMONELLA BACTERIA

Botts et al. (1952) reported that Salmonella pullorum and Salmonella gallinarum disappeared more rapidly from old built-up corn cob litter than from new cob litter (Table 7). No pullorum bacteria were found in compost litter 15 days after infection and no fowl typhoid bacteria after 20 days. Emmel (1956) reported similar results. Salmonella pullorum died in moist, heating compost litter in 7-8 days but survived 46-49 days in dry compost litter.

## FOR PULLET LAYERS

Kennard and Chamberlin (1949) reared pullets on different kinds of litter and observed their health and egg production after housing. They observed no undesirable after effects from brooding or housing the pullets on old, built-up litter (Tables 8 and 9). Dressen et al. (1954) and Kinder (1957) have also reported favorable results with pullet layers housed on compost litter.

**TABLE 7.—Influence of kind of litter on destruction of Salmonella Pullorum and Fowl Typhoid (Salmonella gallinarum) Bacteria**

**(Botts et al. 1952)**

| Days after infection of litter | Bacteria per gram of litter | | | |
|---|---|---|---|---|
| | Salmonella pullorum | | Salmonella gallinarum | |
| | New cob litter | Compost litter | New cob litter | Compost litter |
| 2 | 34,000 | 21,000 | 4,000,000 | 360,000 |
| 8 | 157,000 | 18,400 | -------- | ------ |
| 10 | ------ | ------ | 3,500,000 | 50,000 |
| 12 | 790,000 | 10,500 | -------- | ------ |
| 15 | 86,000 | ------ | -------- | ------ |
| 16 | ------ | ------ | 2,000,000 | 30,000 |
| 20 | ------ | ------ | 40,000 | ------ |
| 25 | 31,000 | ------ | -------- | ------ |
| 26 | ------ | ------ | 16,000 | ------ |
| 63 | ------ | ------ | 800 | ------ |
| 67 | 1,000 | ------ | -------- | ------ |
| 70 | ------ | ------ | -------- | ------ |

TABLE 8.—Influence of use of built-up litter for finishing pullets and egg production.

(Kennard and Chamberlin, 1949)

| Ration | Kind of litter | Pullets 1st 14 weeks | | | Pullets 4-10 months | | | |
|---|---|---|---|---|---|---|---|---|
| | | Average weight | Feed per lb. gain | Mortality Percent | % egg production | Feed per dozen | Average body weight | Mortality Percent |
| | | Lbs. | Lbs. | | | Lbs. | Lbs. | |
| Complete | New, changed | 2.68 | 4.32 | 7 | 63 | 5.23 | 4.92 | 12 |
| | New unchanged | 2.83 | 4.51 | 8 | 63 | 5.59 | 5.22 | 15 |
| | Old, built-up | 3.01 | 4.50 | 2 | 58 | 5.90 | 5.26 | 15 |
| Incomplete | Old, built-up | 2.86 | 4.12 | 5 | 65 | 5.44 | 5.18 | 12 |
| | Old, built-up with grain | 2.82 | 4 31 | 6 | 64 | 5 57 | 5.30 | 16 |

TABLE 9.—Influence of kind of litter used for brooding on later egg production and mortality.

(Kennard and Chamberlin, 1949)

| Trial | Kind of litter on which brooded | Results after housing | |
|---|---|---|---|
| | | Eggs per bird | Mortality Percent |
| 1 | New litter | 121 | 26 |
| | Old hen litter | 133 | 9 |
| 2 | New litter | 143 | 21 |
| | Old hen litter | 172 | 9 |

# NUTRITIONAL VALUE OF COMPOST LITTER

## EARLY STUDIES

Lamoreaux and Schumacker (1940) reported that riboflavin is synthesized in the droppings from chickens. Bird and Marvel (1943) stated that chicken droppings contained a factor essential for hatchability. Rubin, Bird and Rothchild (1946) reported that chicken droppings contained a growth factor and that it was present in greater concentration in the droppings from hens than from young chickens. Scott (1947) reported that hens fed an all vegetable diet and kept on floor litter produced hatchable eggs but not when they were kept on wire. McGinnis, Stevens and Groves (1947) confirmed the earlier work that hen droppings contain a growth factor. Incubating the droppings at 30° C. for 72 hours increased the concentration of the factor.

Kennard and Chamberlin (1948, a) and Kennard, Bethke and Chamberlin (1948, a) showed that compost litter contained a factor or factors essential for growth and hatchability.

## RIBOFLAVIN IN COMPOST LITTER

Kennard (1949, a) reported that compost litter contains riboflavin but does not supply enough to produce maximum hatchability (Table 10). When breeders are kept on it.

**TABLE 10.—Influence of kind of litter and riboflavin supplement on hatchability.**
**(Kennard 1949, a)**

| Ration supplement | Percent hatchability of fertile eggs from breeders on | |
|---|---|---|
| | New litter | Compost litter |
| Basal (control) | 14 | 73 |
| Basal + 0.9 mg. riboflavin per lb. of feed | 41 | 83 |

## VITAMIN $B_{12}$ (APF FACTOR)

### GROWTH

That compost litter was potent in nutrition factors, especially in vitamin $B_{12}$ was demonstrated by Kennard and Chamberlin (1948 a, b) (1949 a, b) (1950) (1951 a) in eight experiments with 37 groups each of 200 broilers or a total of 7,400 birds.

The rate of growth, feed efficiency, and mortality were directly correlated with the length of time the litter had been in use (Table 1). The beneficial effects were not fully realized until after the litter had been in continuous use six months or longer.

The broilers which received the meat scraps-dried whey ration on new built-up litter (a common practice of many broiler growers) did considerably better than those on fresh litter. The best results however were obtained from the broilers on compost litter—18 percent better growth with 7 percent less feed and 3 percent less mortality.

It was when the birds received the all-plant ration deficient in vitamin $B_{12}$ and riboflavin, that the greater nutrition properties of compost litter than new built-up litter was most evident. In eight experiments with 3,200 broilers the birds on compost litter made 27 percent better growth with 11 percent less feed and 17 percent less mortality.

Halbrook, Winter and Sutton (1950, a, b, c, d) showed that poultry house compost litter is a good source of vitamin $B_{12}$ (Table 11), an essential factor for growth and hatchability. It is similar to the animal protein factor (APF) found in animal protein feedstuffs, which had earlier been regarded as essential in the ration for growth and hatchability. Vitamin $B_{12}$ is synthesized by microorganisms found in the litter.

**TABLE 11.—Influence of the kind of litter and holding conditions on its vitamin $B_{12}$ content**

**(Halbrook et al. 1950, a, b, c, d)**

| Litter and Treatment | Millimicrograms of vitamin $B_{12}$ per gram of litter |
|---|---|
| Fresh litter. No storage | 90 |
| Fresh litter. Held 1 week at 4° C. | 50 |
| Fresh litter. Held 1 week at 37° C. | 250 |
| Fresh litter. Held 1 week at 30° C. | 510 |
| New cob litter, before use | 1 |
| New cob litter, used 8 weeks | 110 |
| Compost litter, used one year | 261 |

Halbrook, Winter and Sutton (1950, d) reported that the addition of unautoclaved and autoclaved old poultry litter, which had been in use for a year, to a low vitamin $B_{12}$ chick ration stimulated growth (Table 12). The use of litter, autoclaved at 15 pounds pressure for 15 minutes, stimulated growth over that of unautoclaved litter, possibly as a result of making more nutrients available or by destroying possible toxic substances.

Couch and Reed (1950) reported that litter contains vitamin $B_{12}$ and an antibiotic.

**TABLE 12.—Influence of litter on chick growth. (Halbrook, et al. 1950, d)**

| Kind and amount of litter fed | Average weight at six weeks grams | Feed required per gram of gain grams |
|---|---|---|
| None | 345 | 3.78 |
| 2.5 percent New cob litter | 250 | 5.16 |
| 5.0 percent New cob litter | 265 | 4.85 |
| 1 percent Old litter | 419 | 3.04 |
| 2.5 percent Old litter | 390 | 3.29 |
| 5.0 Percent Old litter | 412 | 3.34 |
| 5.0 Percent Old litter, autoclaved | 493 | 2.55 |

In five experiments with a total of 23 groups each of 180 to 250 broilers (total 4,500) Kennard and Chamberlin (1951 a, b) found the growth of broilers on compost litter was accelerated by $B_{12}$-aureomycin or terramycin (Table 13). The all-plant rations deficient in vitamin $B_{12}$ yielded a comparable rate of growth when supplemented by either $B_{12}$-aureomycin or terramycin, which provided little or no vitamin $B_{12}$. This indicated that the broilers obtained ample vitamin $B_{12}$ from the compost litter.

The broilers on compost litter which received the corn-soy (99 percent ground corn, soybean oil meal, bonemeal and oyster shell) ration supplemented by an antibiotic (Experiments 4 and 5, Table 13) made a rate of growth comparable to that of the broilers that received the more comprehensive high energy broiler ration which included meat scraps, fish meal and dried whey. This was further evidence that the compost litter provided other essential dietary factors for growth of chickens besides vitamin $B_{12}$.

Champagne (1952) and Champagne et al. (1952) reported that chicks reared on old built-up litter weighed 0.3 pound more per bird at 8 weeks than those reared on new litter. Compos and Cruz (1953) stated that brooding chicks on compost litter increased the rate of growth and improved feed efficiency.

Moore, Chamberlin and Carter (1953) reported that chick growth was better when birds were brooded on old rather than new litter and that feeding a coccidiostat or antibiotic improved results on old litter (Table 4).

**TABLE 13.—Influence of ration on growth of chickens on compost built-up litter.**

**(Kennard and Chamberlin, 1951, a and 1951, b)**

| Experiment | Rations* | Average weight | Feed per pound | Mortality |
|---|---|---|---|---|
| | | Lb. | Lb. | Pct. |
| 1a | All-plant | 2.94 | 4.13 | 7 |
| | All-plant $B_{12}$ Aureomycin | 3.40 | 3.95 | 7 |
| | Animal protein | 3.02 | 4.05 | 5 |
| 2a | All-plant | 2.88 | 3.87 | 3 |
| | All-plant $B_{12}$ Aureomycin | 3.05 | 3.87 | 6 |
| | Animal protein | 2.83 | 4.14 | 7 |
| | Animal protein $B_{12}$ Aureomycin | 3.25 | 3.86 | 1 |
| | 22 percent broiler | 3.24 | 3.58 | 1 |
| 3a | All-plant | 3.04 | 3.98 | 7 |
| | All-plant $B_{12}$ Aureomycin | 3.45 | 3.48 | 4 |
| | Animal protein | 3.16 | 3.80 | 5 |
| | Animal protein $B_{12}$ Aureomycin | 3.52 | 3.85 | 2 |
| | 22 percent broiler $B_{12}$ Aureomycin | 3.79 | 3.85 | 3 |
| 4a | All-plant $B_{12}$ Aureomycin | 2.85 | 4.18 | 2 |
| | Corn-soy $B_{12}$ Aureomycin | 2.88 | 3.78 | 5 |
| | Corn-soy Terramycin | 3.17 | 3.69 | 4 |
| | Animal protein $B_{12}$ Aureomycin | 2.91 | 4.22 | 2 |
| | Broiler 22 percent Terramycin | 3.26 | 3.63 | 0.5 |
| 5b | Corn-soy | 3.66 | 3.47 | 4 |
| | Corn-soy Terramycin | 4.01 | 3.30 | 6 |
| | Corn-soy 22 percent, Terramycin | 4.10 | 3.42 | 7 |
| | Corn-soy 22 percent, Aureomycin | 4.11 | 3.30 | 3 |
| | Broiler 22 percent, Terramycin | 4.13 | 3.49 | 9 |

a—180 to 250 New Hampshires (straight run) in each group.

b—180 New Hampshire cockerels in each group.

*—All-plant: Low energy 20 percent protein.

—Animal Protein: (Meat scraps 5 percent, dried whey 3 percent) low energy 20 percent protein.

—22 percent Broiler:—(Meat scraps 5 percent, fish meal 3 percent, dried whey 3 percent) high energy.

—Corn-soy: 20 percent protein (yellow corn 59 percent, soybean oil meal 36 percent, bone meal 3 percent).

—Corn-soy: 22 percent (yellow corn 53 percent, soybean oil meal 42 percent, bone meal 3 percent).

—All rations included bone meal, oyster shell, salt-manganese mixture, vitamin A and D feeding oil and dried fermentation solubles.

Kennard, Moore and Chamberlin (1954, a) reviewed the earlier work on compost litter. They reported that compost litter supplied adequate vitamin $B_{12}$ for the production of hatchable eggs and for growth of broilers.

Kinder and Kempster (1954) reported no better growth but a little better feed efficiency when broilers were fed a complete ration and brooded on compost litter rather than on new litter. Better growth was obtained on old litter, if the birds were fed a $B_{12}$ deficient ration. Olliveri (1954) reported better growth on old litter than on new litter. Winter et al. (1956) obtained slightly better growth on compost litter than on new litter in spite of the fact that a supposedly complete ration was fed (Table 5).

## HATCHABILITY

Eight years of research work with a total of 34 groups (1500) trapnested breeders and approximately 80,000 pedigree-hatched eggs were conducted by Kennard, Bethke and Chamberlin (1948 a) (1949) to determine the minimum requiremnts of meat, milk or fish products and vitamin supplements necessary in the ration to produce eggs of good hatchability when the breeders are confined indoors (Table 14).

To obtain eggs of good hatchability from breeders on fresh litter it was necessary to supplement the all-plant ration with 2.5 percent dried whey or a riboflavin supplement, and four percent meat scraps or two percent fish meal, whereas the breeders on compost litter produced eggs of good hatchability when fed an all-plant ration composed of 99 percent ground corn, soybean oil meal, bonemeal, oyster shell, and iodized salt-manganese mixture (Table 14).

Schlamb and Winter (1948) reported that the hatchability of eggs from chickens on an incomplete (all plant protein) and complete (animal protein) ration increased, the longer chickens were kept on the same litter. The data are summarized in Table 15.

Sunde et al. (1951) reported that hatchability increased with the length of time litter was used, when the birds were fed an all vegetable protein ration. Feeding a vitamin $B_{12}$ supplement increased hatchability when the birds were on deep litter but an antibiotic supplement did not.

Dressen et al. (1954) reported better hatchability of eggs from hens on old than on new litter.

**TABLE 14.—Summarized results of four rations when the breeders were on fresh and compost litter**

**(Kennard, Bethke and Chamberlin, 1948, a; 1949 and Kennard 1949, a)**

| Basal rations plus: * | Experiment No. | Number eggs set | Percent fertile eggs hatched — Floor litter: Fresh | Percent fertile eggs hatched — Floor litter: Compost |
|---|---|---|---|---|
| No supplement | 4 | 4,503 | 33 | 78 |
| | 5 | 3,161 | 33 | 58 |
| | 6 | 4,471 | 17 | 77 |
| Total and average | | 12,135 | 28 | 71 |
| Riboflavin supplements† | 4 | 3,744 | 56 | 77 |
| | 5 | 3,431 | 68 | 84 |
| | 6 | 3,442 | 44 | 80 |
| | 7 | 7,133 | 36 | 84 |
| | 8 | 2,808 | 48 | 88 |
| | 8§ | 2,393 | 51 | 83 |
| Total and averages | | 22,951 | 50 | 83 |
| Riboflavin supplements† | 4 | 4,621 | 68 | 81 |
| Meat scraps, 2 percent | 5 | 3,572 | 77 | 83 |
| | 6 | 4,990 | 66 | 78 |
| | 7 | 2,727 | 62 | 85 |
| Total and averages | | 15,910 | 68 | 82 |
| Riboflavin supplements† | 4 | 4,670 | 79 | 80 |
| Vitamin $B_{12}$ supplements‡ | 7 | 5,676 | 80 | 82 |
| | 8 | 5,388 | 83 | 83 |
| | 8§ | 2,834 | 81 | 84 |
| Total and averages | | 18,568 | 81 | 82 |

*All-plant basal ration composed of ground corn and oats, wheat middlings, wheat bran, alfalfa meal, soybean oil meal, bonemeal, oyster shell, iodized salt-manganese mix and vitamin D supplement.

†Dried whey, synthetic riboflavin, or dried fermentation solubles (BY-500).

‡Meat scraps, 4 percent; vitamin $B_{12}$ (Merck), or $B_{12}$-aureomycin (Lederle).

§Corn-soy ration—ground corn 67, soybean oil meal 27, bonemeal 3, oyster shell 1.5, iodized salt-manganese mix .05, riboflavin and vitamin D supplements.

TABLE 15.—Influence of age of litter on production of a factor essential for hatchability.

(Schlamb and Winter, 1948)

| Time litter was used | Hatchability (%) on | |
|---|---|---|
| | Complete ration | Incomplete ration |
| 9–12 weeks | 65 | 35 |
| 21–24 weeks | 77 | 69 |
| 31–43 weeks | 79 | -- |

## UNKNOWN GROWTH FACTORS

Halbrook et al. (1950, d) reported that autoclaving litter resulted in greater growth promoting value (Table 12).

Jacobs et al. (1954) and Elam et al. (1954) reported that poultry litter contains an unknown growth factor.

Winter, Adams and Naber (1957) obtained better growth on compost litter than on new litter (Table 5) in spite of the fact that both lots were fed a supposedly complete ration. Apparently compost litter contains one or more as yet undetermined essential growth factors.

## PROTEIN—SPARING EFFECT

Kennard and Chamberlin (1949, a) reported that chicks fed an incomplete (all plant protein) ration and brooded on old, built-up litter made nearly as good growth as when fed a complete (animal protein) ration (Table 1). When the pullets were continued on the two types of rations and the different types of litter, during the first few months of egg production, the birds on old, built-up litter and fed the incomplete ration did as well as those on the complete ration (Table 8). Even reducing the protein content of the ration to 13 percent by feeding grain did not reduce egg production on old built-up litter. Apparently the birds obtained protein as well as growth and hatchability factors from the old, built-up litter.

## ECONOMIC VALUE OF COMPOST LITTER

### SAVING OF LABOR

It requires less time and far less litter to scatter a little new litter on top of the old and stir it to prevent caking than to remove all the litter and replace it with new litter every few weeks. Hayes (1944), the

Minnesota Poultry Extension Service (1950), Aubol (1951), Compos et al. (1953), Kinder and Kempster (1954), French and Ledger (1954) and others have advocated the use of built-up litter as a means of saving labor and reducing litter costs.

Aubol (1951) recommended the use of built-up litter in laying houses. He listed the advantages as saving in labor, warmer and drier floors, and supplies nutrients for growth and hatchability. The disadvantages were ammonia odor, flies (unless limed), and possible collection of disease germs.

Kennard and Chamberlin (1947, a, b; 1948, b; 1950 a; 1951 b) and Kennard (1954, a) recommended the scattering of a little clean litter on top of the old and/or stirring as needed to prevent caking, as a substitute for frequent replacement of litter, for both chicks and layers. Moore et al. (1953) have estimated that the saving in time per 1000 broilers by using compost litter instead of new litter amounts to about 7 hours (Table 16).

## SAVING OF LITTER

Kennard and Chamberlin (1947, a, b) recommended the scattering of a little clean litter over the old and/or stirring as frequently as necessary to keep the litter dry and from caking, instead of frequent replacement of litter. Removal of litter every 2 weeks for a period of

**TABLE 16.—Economy of using compost litter.**
**(Moore et al. 1953)**

| Observation | Costs | | | |
|---|---|---|---|---|
| | New litter | | Compost litter | |
| | Time | Cost | Time | Cost |
| Labor required per 1000 broilers | minutes | | minutes | |
| Cleaning | 600 | $12.00 | 163 | $3.26 |
| Adding fresh litter | 50 | 1.00 | 30 | .60 |
| Stirring | 67 | 1.34 | 70 | 1.40 |
| Litter used per 1000 broilers | pounds | | pounds | |
| | 1400 | $10.50 | 525 | $3.94 |
| Total | | $24.84 | | $9.20 |

28 weeks for 50 layers required 14 bales of shavings while only 2 were required for the built-up litter pen. Moore et al. (1953) reported that the use of new litter required per 1000 broilers per brood, amounted to 1400 pounds and only 525 pounds when brooded on compost litter (Table 16).

## WARMER HOUSE

Use of compost litter keeps the house warmer because of the insulating effect on the floor and also because of its heating effect due to microbial action. Koutz (1953) took daily temperatures of compost litter from February to May while brooding chicks on it. At the start of the test, the litter temperature was 54° F. and in 3 days it increased to 72° F. The litter temperature changed very little from day to day. During the hot days of spring it increased to 86° F. In the early morning the building temperature might be low but the litter temperature remained fairly constant. Occasionally there would be "hot spots" in the litter where the temperature would rise—one place had a record of 114° F.

Horton-Smith and Long (1954) measured the temperature in straw litter 2 years old in a laying house, which had been stirred from time to time to prevent caking and to provide equal distribution of droppings. The litter was 6 inches deep and on a cement floor. The house was populated with layers at the rate of 3.9 square feet per bird. Temperature recordings were as follows:

| Location | Lowest temperature Feb.-Mar. | Highest temperature June |
|---|---|---|
| Surface of litter | 42.5°F. | 75 °F. |
| 2 inches below surface | 45.0°F. | 72.5°F. |
| 4 inches below surface | 51.0°F. | 72.0°F. |
| 6 inches below surface | 46.0°F. | 74.0°F. |

Quigley (1954) suggested keeping the litter dry.

Emmel (1956) reported that the heating effect of moist built-up litter keeps it 5 to 8 degrees warmer below the surface than on top.

Kennard and Chamberlin (unpublished data) found that compost litter had a tendency to keep the floor cooler in hot weather and warmer in cold weather, as shown by the following temperatures:

| Date | Outside Maximum | 12" above floor at 4:00 p.m. | Litter at 4:00 p.m. | | |
|---|---|---|---|---|---|
| | | | Top | Middle | Bottom |
| March 16 | 34 | 50 | 64 | 71 | 71 |
| May 15 | 74 | 68 | 71 | 71 | 68 |
| June 26 | 90 | 78 | 77 | 76 | 74 |
| July 31 | 85 | 76 | 86 | 82 | 82 |
| August 28 | 87 | 76 | 76 | 75 | 73 |

## PRESERVATION OF FERTILIZER VALUE

Poultry litter increases in fertilizing value with the length of time that it is used, because of the increasing percentage of poultry droppings that becomes mixed with it. Bentley et al. (1952) reported that after one year's use broiler compost litter reached its maximum nitrogen content. It then contained four to five times more nitrogen than cow manure. Likewise it contained ten times more phosphorus and four times more potash. These three fertilizer ingredients alone had a commercial fertilizer value of $20 to $25 per ton of compost litter.

## RETENTION OF NITROGEN (AMMONIA)

Yushok and Bear (1943) recommended the addition of hydrated or quick lime to poultry droppings to reduce the loss of nitrogen as ammonia and to reduce objectionable odors.

Gustafson and Weaver (1944) and Turk and Weidemann (1945) recommended scattering 2 pounds of superphosphate per 100 birds daily over the dropping boards or in the dropping pits to reduce the loss of nitrogen.

Yushok and Bear (1948) rated superphosphate, quicklime, and gypsum in the order given for efficiency in retaining nitrogen in poultry droppings, when used at a level of 200 pounds per ton. Bentley et al. (1951) and Winter and Cotterill (1953) (Table 17) showed that scattering superphosphate over poultry litter and/or the droppings is better than hydrated lime for retention of nitrogen for preventing the escape of ammonia.

**TABLE 17.—Effect of mineral additions to poultry house litters for retaining nitrogen.**

**(Winter and Cotterill, 1953)**

| Litter and pit treatment | Ammonia in air above pits (Mg. per 1000 liters) | | Nitrogen content of litter |
|---|---|---|---|
| | Good ventilation | Poor ventilation | Percent |
| None control | 2.3 | 28.0 | 3.72 |
| Hydrated lime | 3.8 | 21.8 | 3.30 |
| Superphosphate | 2.4 | 7.3 | 4.95 |
| Pulverized limestone | -- | ---- | 3.30 |
| Gypsum | --- | ---- | 4.27 |

## MAINTENANCE OF SUITABLE CONDITION

Litter needs to be kept reasonably dry to prevent caking and thereby provide more surface for absorption of moisture for evaporation.

Bearse et al. (1946) reported that the condition of the litter in laying houses was improved by adding hydrated or quick lime to the litter (1 pound per 3.3 square feet of floor space). The lime appeared to coat the litter particles and reduced caking.

Kennard and Chamberlin (1947, a, b) reported that scattering 10 to 15 pounds of hydrated lime over 100 square feet of floor space, adding a little additional new litter, and stirring every 2 to 4 weeks, avoided the necessity for frequent changes of litter in brooding and laying pens. The litter remained in better condition and the pens were freer from odors.

Kennard and Chamberlin (1948, a, b, c, d, 1950; 1951) stated that the addition of hydrated lime (10 to 15 pounds per 100 square feet of floor space every 2 to 4 weeks) reduced the rate of growth slightly (Table 18). They suggested that the lime might interfere with the chemical and biological changes that normally take place in built-up litter. Mortality was less where lime was used. While the addition of lime improved the texture of litter, as reported by Bearse et al. (1946) it reduced the moisture content only slightly, from 40 percent when no lime was used to 38 percent when hydrated lime was used and to 34 percent when pulverized quicklime was used.

**TABLE 18.—Influence of lime addition to litter on growth and mortality of broilers.**

**(Kennard and Chamberlin 1948, a, b, c, d; 1950; 1951)**

| Trial | Kind of litter | Average weight at 12 weeks | Pounds feed per pound gain | Mortality Percent |
|---|---|---|---|---|
| | | Lb. | | |
| 1 | New litter, 1st brood, hydrated lime | 2.35 | | 2 |
| | New litter, 1st brood, unlimed | 2.37 | | 4 |
| | New litter, 2nd brood, limed | 2.57 | | 3 |
| | New litter, 2nd brood, unlimed | 2.66 | | 8 |
| 2 | New litter, limed | 2.03 | 3.88 | 8 |
| | New litter, unlimed | 2.05 | 4.68 | 20 |
| | Old litter, 4th brood, limed | 2.14 | 3.78 | 6 |
| | Old litter, 4th brood, unlimed | 2.13 | 3.85 | 8 |

Halbrook, Winter and Sutton (1950, c) reported that new cob litter had a pH of 6.3. It increased to 7.0 when used for 8 weeks and to 8.0 when used for one year. Adding lime to the litter at the rate of 10 to 15 pounds per 100 square feet increased the pH to 8.5-9 and reduced the count of all classes of bacteria, yeasts, and molds. This results in a retardation of synthesis of vitamin $B_{12}$.

Kennard, Chamberlin and Bentley (1951) reported that mineral additions to litter were most beneficial in keeping it from caking during the early stages of its use. After it had been used for one or two broods, the addition of mineral was less necessary for preventing caking. There was little difference in the effectiveness of hydrated lime, superphosphate, finely ground limestone and gypsum in preventing caking when used at a level of 25 pounds per 100 square feet of floor space.

## SUMMARY

The use of compost floor litter for chickens has been subjected to the studies of many research workers. In view of the fundamental and extensively applied research results obtained and its wide use by poultrymen, compost litter can be considered safe and economical for chickens of all ages.

Compost litter is sanitary in that its use results in lower mortality of broilers if brooded on it rather than on frequently changed litter from one day of age (Table 2).

Compost litter permits broilers to immunize themselves to coccidiosis by intake of coccidia oocysts from the litter before they reach the most susceptible age for the disease (Tables 3 and 4).

The feeding of a coccidiostat to chicks brooded on compost litter affords additional protection against losses due to coccidiosis (Table 4).

Parasite infection is present among broilers brooded on compost litter but is not harmful as measured by growth rate, feed utilization and mortality (Tables 3 and 6).

Compost litter destroys Salmonella bacteria quicker than new litter (Table 7).

Compost litter supplies riboflavin (Table 10), vitamin $B_{12}$ (Table 11) and lessens the need for protein (Table 8).

Compost litter supplies one or more unknown growth factors (Table 5).

The use of compost litter reduces labor and litter costs (Table 16). Once compost litter becomes established no additional litter needs to be added. Instead some of the litter will need to be removed occasionally

to keep it within convenient bounds. However never less than four to six inches of the litter should be left on the floor for continued use.

The addition of superphosphate to compost litter is a desirable means of reducing objectionable odors, reducing the loss of nitrogen as ammonia and maintaining a higher nitrogen content (fertilizer value) of the litter (Table 17).

As a fertilizer, broiler compost litter was found by Bentley et al. (1952) to contain four to five times more nitrogen than cow manure. Likewise it contained ten times more phosphorus and four times more potash. These three fertilizer ingredients alone had a commercial fertilizer value of $20 to $25 per ton of compost litter.

Compost litter keeps poultry houses warmer and the floors dryer than when the litter is changed frequently. However, adequate ventilation should be provided where compost litter is used.

## CONCLUSION

The use of compost litter in chicken houses for starting, growing, laying and breeding stock is an economical practice.

The use of a coccidiostat in the ration for young chickens and the known vitamin and protein requirements in chicken rations are recommended, even though they are kept on compost litter.

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