TECHNICAL BULLETIN NO. 71 JANUARY 1967

Pineapple Hay as a Litter Material for Broilers

ERNEST ROSS

HAWAII AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF HAWAII

CONTENTS

ACKNOWLEDGEMENT

This study was conducted in cooperation with the Hawaii Fryer Council.

THE AUTHOR

Dr. Ernest Ross is Poultry Scientist at the Hawaii Agricultural Experiment Station and Professor of Poultry Science, College of Tropical Agriculture, University of Hawaii.

Pineapple Hay as a Litter Material for Broilers

ERNEST ROSS

INTRODUCTION

The popularity of wood shavings for broiler litter may be attributed largely to their low cost, general availability, and desirable moisture absorptive qualities. Recently, because of various economic factors, wood shavings in Hawaii have been in short supply. Since present trends indicate that this shortage will continue, an extensive project was initiated to investigate new potential sources of litter materials as well as to study procedures for extending the existing supply of wood shavings. Such factors as litter depth, reuse of litter for several broods, and possible fumigation of reused litter are being studied.

LITERATURE REVIEW

Andrews and McPherson (1963) investigated the use of oak shavings, ground flax stalks, clay, oat straw, and rice hulls. Trail (1963) reported on studies with coffee husks, feathers, chopped dried grass, and hessian. Studies have also been carried out using peanut shells, corn cobs, cottonseed hulls, as well as other materials. While some of these materials have proven to be satisfactory, none are readily available at a reasonable cost in the principal broiler-producing area of Hawaii.

Cane bagasse is an abundant by-product of the sugar industry which, when properly processed, has proven satisfactory as a broiler litter. However, Hudson (1947) reported seven cases of an *Aspergillus fumigatus* infection in the eyes of baby chicks reared on bagasse litter. More recently, Ross (1965) reported an acute case of respiratory aspergillosis in a broiler flock reared on fresh, untreated bagasse. Degree of infection, mortality, and morbidity rates were very high. It would appear that the use of fresh bagasse should be avoided until some means can be found for minimizing or eliminating the danger from *Aspergillus fumigatus* infection. At the present

time no commercial facilities are available in Hawaii for drying and baling bagasse.

Another potential litter material available locally is pineapple hay prepared from cut and dried pineapple plants. Since the cost of pineapple hay could be an important deterrent to its use as a litter material, consideration was also given to extending its use both by decreasing litter depth and by reusing the litter. Most broiler growers in Hawaii normally use litter to a depth of 4 inches. By reducing the depth of pineapple hay to 2 inches the litter cost per unit could be cut in half. Reducing the depth of wood shavings would also reduce litter costs in addition to extending the available supply.

Further savings in litter material could be effected by reusing the litter for succeeding broods. The concept of built-up litter was developed extensively in a series of publications by Kennard and Chamberlin (1947, 1948*a*, 1948*b*, 1949, and 1951). The results of these studies clearly indicated the effectiveness of old built-up litter as a sanitary procedure, especially with respect to control of coccidiosis. Kennard and Chamberlin reported a higher rate of growth and in most cases lower mortality on old built-up litter compared to fresh or new built-up litter.

In spite of these results, most broiler growers in Hawaii, as well as many on the Mainland, utilize the single-use system of litter management. One of the major reasons for this is the fear of perpetuating disease organisms from one brood to the next. A possible means for minimizing this danger would be to fumigate the poultry litter between broods.

Very little work has been published on fumigation of poultry litter. Edgar and King (1955) conducted some preliminary studies in which they tested the efficacy of various concentrations of methyl bromide against *Aspergillus fumigatus* spores, *Ascaridia galli* eggs, and *Eimeria tenella* oocysts. While they presented evidence that these infective materials were killed by methyl bromide when used at the rate of 1 pound per 100 square feet of floor space, they did not test the methyl bromide fumigation under field conditions. In 1962, Klepser *et al.* fumigated poultry litter under field conditions at the rate of ½ and 1 pound of methyl bromide per 100 square feet of floor space. They reported no significant mortality among chicks placed on the fumigated litter within a few hours following termination of the fumigation period. Their preliminary report, however, did not contain data on the subsequent performance of these chicks.

Reported herein are results of broiler trials conducted to study pineapple hay as a litter material, the reuse of pineapple hay litter, and fumigation of this reused litter material.

MATERIALS AND METHODS

Four trials were conducted in a broiler house measuring 28 by 100 feet, divided into 24 pens of approximately 100 square feet each. The experimental pens line each side of the house and open on a central service aisle.

The sides of the broiler house are of 1-inch hexagonal wire and are provided with 6-foot movable curtains which extend up from a solid 30-inch concrete block wall. The ends of the house are solid except for access doors. The floors are concrete with drains to facilitate cleaning. All partitions are movable and are made of stretched hexagonal wire on wooden frames.

Brooding was done with 250-watt infrared brooders, at the rate of one brooder per pen. The infrared bulbs were set at 24 inches from the litter initially and were raised gradually during the first 3 weeks. No heat was used after 3 weeks except for an occasional night during cold or rainy weather.

One hundred and one to 104 one-day-old chicks were started per pen. They were placed on cardboard laid on top of the litter within a 4-foot diameter aluminum or cardboard draft guard 18 inches high. At this time, two 1-gallon chick waterers and one chick box-top feeder were used per pen. After 3 days the draft guards were expanded and the cardboard floor removed. Two tube feeders and one automatic water cup were then provided per pen.

All chicks used were straight-run crossbred broiler chicks obtained from randomly selected commercial hatcheries. The chicks received regular commercial broiler feed supplied by several commercial feed mills. However, in any one trial all chicks were from the same hatchery and all received the same commercial feed. A broiler starter feed was fed for the first 5 to 6 weeks, followed by a broiler finisher feed. The net weight of all feed was recorded by pen, and feed consumption and group body weights were recorded at 3, 6, and 9 weeks of age. Trial 4, however, was terminated at 8 weeks of age. Feed conversion was calculated as the ratio of grams of feed consumed per gram of gain in body weight. The growth and feed conversion data were analyzed by means of the analysis of variance (Snedecor, 1956) and tests of significance by means of a multiple range test (Duncan, 1955).

Approximately 2 weeks lapsed between the termination of one trial and the start of the next trial. During this time the house was cleaned in preparation for the next brood. The standard sanitation program included the removal of litter, feeders, waterers, and infrared brooders. The feeders and waterers were washed and the brooder hovers wiped clean. Before the clean litter was installed all interior surfaces including side screens, roof, and rafters were steam cleaned.

The wood shavings were obtained from a local lumber yard and the pineapple hay was purchased from a commercial pineapple company which processed the product primarily for use as a dairy feed. Pineapple hay consists of the upper part of the pineapple plant which is chopped, and then dried in a rotary triple pass dehydrator. The moisture content was approximately 6 to 7 percent and the particle length ranged from 1 to 4 inches. The pineapple hay used in the first 3 trials was obtained fresh from the mill shortly prior to use. In the fourth trial, however, the pineapple hay used was about 15 months old at the start of the trial.

Litter Depth

The standard litter depth commonly used in broiler houses in Hawaii is approximately 4 inches of litter. If less litter material could be used a substantial savings in litter material could result. Therefore, in the first 3 trials, two litter depths of 2 and 4 inches were evaluated.

The litter material for the first trial was weighed as it was distributed to a depth of 2 or 4 inches. At this time, it was found that approximately 180 pounds of wood shavings and 200 pounds of pineapple hay provided litter to a depth of 4 inches per 100-square-foot pen. Thereafter, the litter was weighed into the pens as required, 90 and 100 pounds of wood shavings and pineapple hay, respectively, being used for the 2-inch treatments, and 180 and 200 pounds, respectively, for the 4-inch treatments.

In the first trial, 9 pens contained 4 inches of wood shavings, 9 pens contained 4 inches of pineapple hay, and 2 pens each contained 2 inches of the same litter materials. In the second trial there were 3 pens of each litter material at 4 inches and 2 of each 2-inch treatment. In the third trial there were 3 pens of each litter at both the 2- and 4-inch depth. Four pens each of wood shavings and pineapple hay were used at the 4-inch depth in trial 4. Table 1 shows the experimental plan for the 4 trials.

TABLE 1. Experimental plan showing number of replications per treatment

			PINEAPPLE HAY			
LITTER DEPTH	WOOD SHAVINGS (FRESH)	PINEAPPLE HAY (FRESH)	Reused (2×)	Reused (2×) + 1st Fumigation	Reused (3×)	Reused (3×) + 2nd Fumigation
Trial 1:						
4 inches	9[1]	9				
2 inches	2	2				
Trial 2:						
4 inches	3	3	3	3		
2 inches	2	2				
Trial 3:						
4 inches	3	3			3	3
2 inches	3	3				
Trial 4:						
4 inches	4	4				

[1]Each replicate pen contained 101 to 104 straight-run broiler chicks.

Reused Litter

When litter was to be reused, the surface of the litter was raked, and caked or wet litter as well as feathers were removed. The remaining litter

was then piled in the center of the pen and covered with an 8-mil polyethylene tarpaulin to protect the litter while the building was washed and steam cleaned. After steam cleaning, the litter was leveled out again and topped with approximately 1 inch of fresh litter material. The same procedure was followed whenever litter was to be reused.

In trial 2, triplicate pens of chicks on reused wood shavings and pineapple hay litter (used with one previous brood from trial 1) were compared with chicks reared on fresh wood and pineapple hay litter. In trial 3 the reused litters had previously been used for two broods each. Thus, in this trial the chicks represented the third brood to be reared on the same litter.

Fumigation of Reused Litter

The litter to be fumigated was covered with polyethylene in the same manner as described for the reused litter treatments, care being taken to tape the edges securely to the concrete floor. Fumigation was carried out using one 1-pound can of methyl bromide per pen, delivered to the top center of the pile through a tygon tube inserted through a slit in the polyethylene sheeting. The slit in the sheeting was sealed with tape immediately after removal of the delivery tube and the pile was kept covered for 48 hours. After fumigation was completed the plastic covers were removed and the piles of litter allowed to air for 24 hours. They were then leveled out and handled like the reused litter pens.

Triplicate pens of chicks on fumigated-reused pineapple hay litter in trial 2 were compared with chicks reared on untreated reused litter. In trial 3 the fumigated-reused litter was the same litter used in trial 2; therefore, it was being used for the third brood of chicks and had been fumigated two times. The fumigation rate in both trials was 1 pound per pen which was the same rate used by Edgar and King (1955) and Klepser *et al.* (1962).

RESULTS AND DISCUSSION

Fresh Pineapple Hay Versus Wood Shavings

Body Weight

No statistically significant differences in average 9-week body weights were found either for male or female chicks on either type of litter or at either 2- or 4-inch litter depth (table 2). These data indicate that growth of the birds on pineapple hay litter was comparable to that of the control birds on wood shavings litter.

Feed Conversion

No consistent trend was noted in efficiency of feed utilization. In the first trial, for some anomalous reason, the feed conversion of the birds raised on wood shavings litter was significantly poorer than that of the birds raised on pineapple hay litter ($P = <0.01$). However, no significant differences in feed conversion values were obtained in subsequent trials.

TABLE 2. Effect of wood shavings and pineapple hay litter on mean 9-week body weight, feed conversion, and mortality of broiler chicks

ITEM	TRIAL							
	1		2		3		4[1]	
	Wood	Pine-apple	Wood	Pine-apple	Wood	Pine-apple	Wood	Pine-apple
4-inch litter								
Male body wt., lb.	4.19	4.18	4.49	4.44	4.47	4.30	3 58	3.68
Female body wt., lb.	3.20	3.22	3.43	3.46	3.51	3.47	2.77	2.87
Feed/gain	2.52**	2.28	2.23	2.21	2.25	2 26	2 21	2.16
Mortality, %	2.67	2.03	1.30	2 98	1.65	1.96	2.21	3.40
2-inch litter								
Male body wt., lb.	4.36	4.12	4.53	4 47	4.38	4.39		
Female body wt., lb.	3.33	3.12	3.57	3.45	3.43	3.42		
Feed/gain	2.50**	2.25	2.23	2.26	2.28	2.30		
Mortality, %	2.90	3.36	1.45	1.47	3.20	2.24		

[1]Duration of trial 4 was 8 weeks. All other trials were of 9 weeks duration.
**In trial 1 the feed conversion of the groups on wood shavings litter was significantly poorer than for the groups reared on pineapple hay litter, p 0.01.

Mortality

Chick mortality was generally low in all trials. No significant differences in mortality were apparent between groups reared on wood shavings or pineapple hay litter, or at the different litter depths.

Market Quality

On the basis of limited market data there was no apparent difference in market grade or eviscerated yield due to treatment. Some small breast blisters were observed in birds reared on the 2-inch litter treatments.

The most dramatic difference observed between treatments was the highly superior "finish" observed in birds reared on pineapple hay litter in the first 3 trials as compared to those reared on wood shavings litter. This difference was so pronounced that it drew unsolicited comments from all processors. Workers in the picking line of one processing plant were readily able to segregate the treatment groups solely on the basis of the birds' "finish." The effect on "finish" was apparent in both the 2-inch and 4-inch pineapple hay litter treatments. In the fourth trial, however, the "finish" of birds reared on the pineapple hay litter was not judged to be superior to that of the control group. In fact, one processor rated the "finish" of the pineapple hay group well below that of the wood shavings group. Since the pineapple hay used in this trial had been stored in burlap bags for at least 15 months prior to use it would appear that the factor or factors that enhanced the "finish" of the birds was lost during the storage period.

Litter Condition

Litter condition of both the wood shavings and pineapple hay litters was generally good in trials 1, 2, and 4. However, some caking of the litter

did occur towards the end of the trials. In the first 2 trials this caking was only moderate and occurred mostly in the pineapple hay pens. For some unexplained reason caking would occur at random in one or two pineapple hay pens and not in the other replicates. Very poor litter condition occurred in the third trial probably due to wet weather. Both the wood shavings and pineapple hay litters were affected in this trial although the litter in the pineapple hay pens was somewhat more caked than the litter in the wood shavings pens. In spite of the very poor litter condition in this trial, mortality was not appreciably affected and excellent growth and feed conversion were obtained.

Litter Cost

The cost of the pineapple hay used in these studies was $44.00 per ton at the pineapple-processing plant. Assuming that the delivery cost would be approximately the same as for wood shavings the additional cost for pineapple hay litter material would be $44.00 per ton. At the rate of 200 pounds of pineapple hay litter per pen of 100 square feet (4-inch treatment), the litter cost per pen was $4.40 or approximately 4.4¢ per bird. The cost for the 2-inch treatment (100 pounds of pineapple hay per pen) was just half of that of the 4-inch treatment, or 2.2¢ per bird. While this represents an increase in cost of production it may have to be accepted if wood shavings become unavailable. However, the improved carcass quality or "finish" noted above may help to offset the higher cost of the pineapple hay litter. A premium of 1¢ per pound for the superior carcass quality would almost pay for the additional cost of 4 inches of litter and would more than pay for the cost of only 2 inches of pineapple hay litter.

Fumigated Versus Nonfumigated Reused Pineapple Hay Litter

Body Weight

Table 3 summarizes the 9-week data obtained in this study. The average body weights of the chicks reared on fresh and reused pineapple hay litter in trials 2 and 3 were not significantly different.

Feed Conversion

The efficiency of feed utilization of the birds reared on the reused litter (table 3) was consistently poorer than the feed efficiency of the control birds on fresh litter. However, this difference in feed conversion was not significant statistically.

Mortality

The overall mortality rates for both trials was slightly higher for birds reared on the reused litter as may be seen in the last two columns of table 3.

TABLE 3. Effect of fresh and reused pineapple hay litter on mean 9-week body weight, feed conversion, and mortality of broiler chicks

ITEM	TRIAL 2		TRIAL 3		AVERAGE BOTH TRIALS	
	Fresh 1st brood	Reused 2nd brood	Fresh 1st brood	Reused 2nd brood	Fresh	Reused
Male body wt., lb.	4.44	4.41	4.30	4.39	4.37	4.40
Female body wt., lb.	3.46	3.44	3.47	3.41	3.46	3.43
Feed/gain	2.21	2.26	2.26	2.29	2.24	2.28
Mortality, %	2.58	0.65	1.96	3.69	2.10	2.26

While the mortality rate was the highest among the birds on reused pineapple hay litter in trial 3, it was also the lowest for this treatment in trial 2. None of the observed differences were statistically significant.

Market Quality

There was no apparent effect on market quality attributable to the reused litter although the improvement in "finish" previously noted when birds were reared on pineapple hay litter was also observed when birds were reared on reused pineapple hay litter in both trials. It would appear, therefore, that the factor in pineapple hay responsible for the superior market quality is stable for at least 6 months, the age of the litter at the start of trial 3.

From the data presented it would appear that no serious adverse effects were noted when pineapple hay litter was used for 2 or 3 broods.

Litter Cost

As noted earlier, the cost of the pineapple hay used in these studies was calculated to be approximately 4.4¢ per bird when used at a depth of 4 inches. When the pineapple hay litter was reused, 50 pounds of fresh pineapple hay was added per pen making the total cost of pineapple hay per square foot (per bird) 5.5¢. Since this cost could now be charged to 2 birds the per bird cost was reduced to 2.75¢. In the third trial an additional 50 pounds of pineapple hay was added bringing the cost per square foot of litter to 6.6¢, chargeable to 3 birds. Thus the average litter cost per bird in each of the 3 trials would be 2.2¢ compared to the 4.4¢ cost for a single use.

Fumigated Versus Nonfumigated Reused Pineapple Hay Litter

Methyl bromide fumigation of pineapple hay litter was without significant effect on body weight, feed conversion, or mortality of broiler chicks reared to 9 weeks of age. Table 4 summarizes the pertinent data for the

TABLE 4. Effect of methyl bromide fumigation of reused pineapple hay litter on mean 9-week body weight, feed conversion, and mortality of broiler chicks

ITEM	TRIAL 2		TRIAL 3		AVERAGE BOTH TRIALS	
	Reused—2nd brood		Reused—3rd brood			
	Fumigated	Non-fumigated	Fumigated	Non-fumigated	Fumigated	Non-fumigated
Male body wt., lb.	4.41	4.41	4.47	4.39	4.44	4.40
Female body wt., lb.	3.49	3.44	3.42	3.41	3.46	3.43
Feed/gain	2.24	2.26	2.29	2.29	2.27	2.28
Mortality, %	1.62	0.65	1.97	3.69	1.80	2.17

2 trials. While there was some slight advantage in body weight and feed conversion for birds reared on the fumigated litter in both trials, these differences were neither consistent nor statistically significant. Mortality was lower among the birds reared on the nonfumigated litter in one trial and higher in the other trial.

Fumigation of pineapple hay litter also appeared to be without effect on litter condition or market quality. The superior "finish" of birds reared on pineapple hay, previously noted, was also observed among birds reared on the fumigated litter.

The cost of litter fumigation was estimated at about 1¢ per square foot on the basis of the cost of the methyl bromide and the cost of the plastic tarpaulin assuming that the plastic could be used for four fumigations. The cost estimate does not include labor, since the labor costs based on the small experimental units could not be realistically applied to a commercial operation. Further, the hazardous nature of methyl bromide suggests the desirability or advisability of having litter fumigation done by commercial fumigation specialists.

SUMMARY AND CONCLUSIONS

The performance of broiler chicks reared on fresh pineapple hay litter was not significantly different from that of chicks reared on fresh wood shavings litter. Carcasses of chicks reared on fresh pineapple hay litter had a superior "finish" as compared to the carcasses of chicks reared on wood shavings litter. However, the factor or factors in pineapple hay responsible for this phenomenon appeared to be lost or inactivated after 15 months storage of the hay. If a premium could be obtained for the superior "finish" of birds reared on pineapple hay litter, it could largely offset the cost of the pineapple hay (4.4¢ per bird).

Except for a slightly greater incidence of breast blisters, the performance of chicks on 2 inches of litter in 100-square-foot pens was as good as that of chicks reared on 4 inches of wood shavings or pineapple hay litter.

Performance of chicks on pineapple hay litter reused for 2 or 3 broods was as satisfactory as for chicks reared on fresh pineapple hay litter. Thus, barring any serious disease conditions, the practice of reusing the pineapple hay litter could result in further litter economies.

Fumigation of reused pineapple hay litter did not result in any appreciable improvement in any of the economic factors studied. In view of this general lack of response, the dangerous nature of methyl bromide and the additional cost involved, fumigation of reused pineapple hay litter is not recommended. It is possible that under certain conditions fumigation of litter may be both desirable and feasible, but further work needs to be done with this technique before specific recommendations can be made.

REFERENCES

ANDREWS, L. D., and B. N. MCPHERSON.
1963. COMPARISON OF DIFFERENT TYPES OF MATERIALS FOR BROILER LITTER. Poultry Sci. 42: 249–254.

DUNCAN, D. B.
1955. MULTIPLE RANGE AND MULTIPLE F TESTS. Biometrics 11: 1–42.

EDGAR, S. A., and D. F. KING.
1955. THE EFFECTIVENESS OF METHYL BROMIDE IN STERILIZING POULTRY LITTER. Poultry Sci. 34: 595–597.

HUDSON, C. B.
1947. *Aspergillus fumigatus* INFECTION IN THE EYES OF BABY CHICKS. Poultry Sci. 26: 192–193.

KENNARD, D. C., and V. D. CHAMBERLIN.
1947. NEW FINDINGS IN POULTRY FEEDING AND MANAGEMENT. Ohio Farm and Home Res. Bull. 32(248): 193–199.

_____ and _____
1948*a*. BUILT-UP LITTER TO DATE. Ohio Farm and Home Res. Bull. 33(253): 130–135.

_____ and _____
1948*b*. BUILT-UP FLOOR LITTER A SOURCE OF DIETARY FACTORS ESSENTIAL FOR THE GROWTH OF CHICKENS. Poultry Sci. 27: 240–243.

_____ and _____
1949. GROWTH AND MORTALITY OF CHICKS AS AFFECTED BY THE FLOOR LITTER. Ann. New York Acad. Sci. 52(art. 4): 583–588.

_____ and _____
1951. GROWTH AND MORTALITY OF CHICKENS AS AFFECTED BY THE FLOOR LITTER. Poultry Sci. 30: 47–54.

KLEPSER, G. E., J. E. KINMAN, and W. O. MILLER.
1962. FUMIGATION OF CHICKEN LITTER WITH METHYL BROMIDE. Information bulletin of The Dow Chemical Co., Midland, Michigan.

ROSS, E.
1965. AN ASPERGILLOSIS OUTBREAK IN A BROILER FLOCK ON BAGASSE LITTER. Hawaii Farm Sci. 14(3): 5–6.

SNEDECOR, G. W.
1956. *Statistical Methods, 5th Edition.* Iowa State College Press, Ames, Iowa.

TRAIL, J. C. M.
1963. EFFECT OF DIFFERENT KINDS OF LITTER ON GROWTH AND FEED EFFICIENCY IN CHICK REARING. Poultry Sci. 42: 169–172.

UNIVERSITY OF HAWAII
COLLEGE OF TROPICAL AGRICULTURE
HAWAII AGRICULTURAL EXPERIMENT STATION
HONOLULU, HAWAII

THOMAS H. HAMILTON
President of the University

C. PEAIRS WILSON
Dean of the College and
Director of the Experiment Station

G. DONALD SHERMAN
Associate Director of the Experiment Station