CHICKEN MANURE -- its Production, Composition, and Use as a Fertilizer

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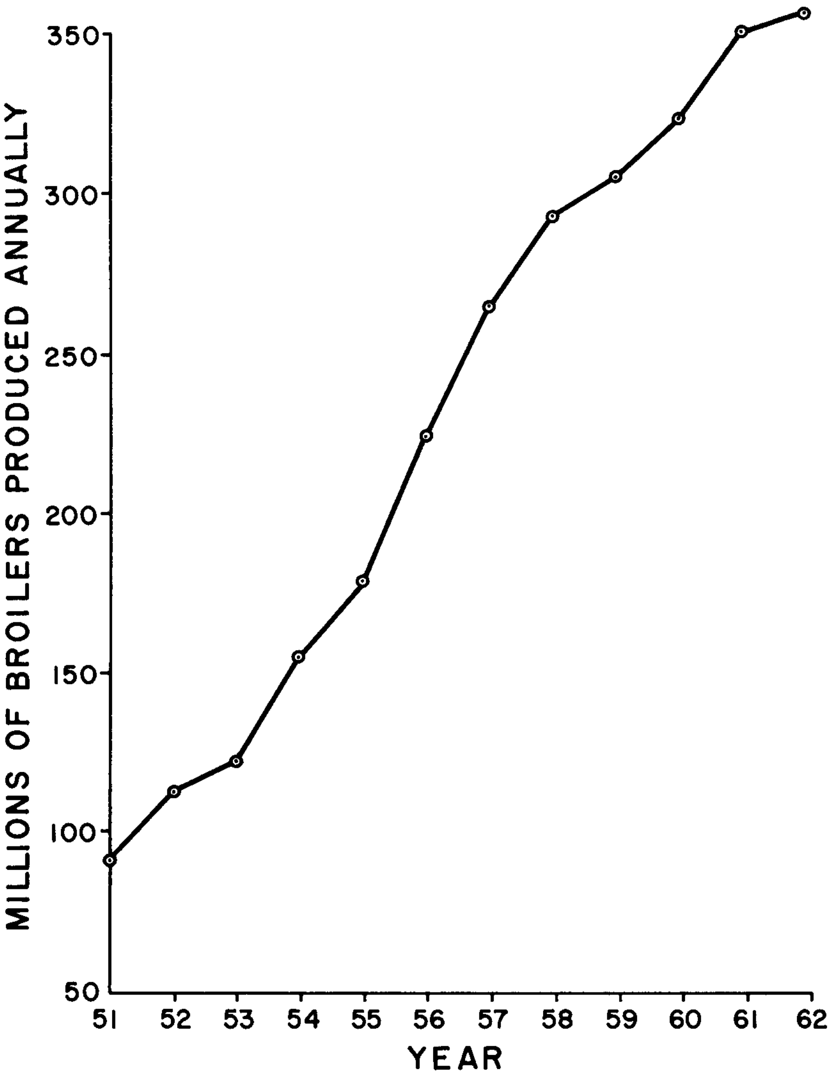

Figure 1. Commercial broiler production in Georgia.

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H. F. Perkins, M. B. Parker and M. L. Walker[1]

Introduction

Georgia has been the foremost state in broiler production for the last 12 consecutive years (1). Since 1951 annual broiler production has increased steadily from 88.7 million birds to 353.6 million in 1962 (Figure 1). In addition, more than 12 million laying hens were grown in Georgia during 1962 (1).

Vast quantities of manure are produced each year from this giant poultry industry. The value of this by-product in soil improvement and in crop production is well known. However, many factors which should influence the use of poultry manure in crop production are not well known. Some of these factors are: 1) manure production per bird, 2) fertilizer value of manure, 3) effects of manure on soil acidity and fertility, and 4) residual effects.

This publication presents data obtained in recent investigations dealing with utilization of chicken manure in crop production. Chicken manure — as referred to in this publication and also in general for Georgia — consists of accumulated droppings and litter, moisture, feathers, wasted feed and usually some soil material. All nutrient values are reported on a elemental basis.[2]

Factors Which Influence Manure Production

Birds and Feeds

Manure production is influenced by many factors. These include the type of chicken, age and breed of chicken, concentration of birds, feed conversion, kind and amount of feed, type and amount of litter, moisture content of litter, type of floor, and even climatic conditions during accumulation. Losses of organic matter and nitrogen (N) during accumulation also affect the amount that will be produced in a given period of time. Floor litter manure in England (5) lost over 40 per cent

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[2]To convert P (phosphorus) and K (potassium) to P_2O_5 and K_2O, multiply by 2.29 and 1.20, respectively.

of its organic matter and 50 per cent of its N during 48 weeks of accumulation. In Connecticut (3) three bushels of fresh manure from dropping pits lost 55 per cent organic matter and 77 per cent N when stored for 20 weeks in a laying house.

Data regarding the accumulation of floor litter manure over a long period of time is limited. A report from England (5) indicates that 1 ton of chopped straw per 200 hens would yield about 5 to 6 tons of floor litter manure (moisture included) in a year. The use of this information in estimating the amount of manure produced by hens in Georgia is questionable because of the different management practices and climatic conditions in the two areas.

The amount of floor litter manure removed from each of eight broiler houses in Georgia is shown in Table 1. The average amount from eight houses was 2.12 tons (24 per cent moisture) per 1000 birds in a 10-week period. In each of these houses, management practices were comparable, and manure was removed from the house and weighed during September. In all houses except one, manure production per 1000 birds was quite similar. The high value for this particular house was due to a considerable amount of soil being removed with the manure. Earlier research (4) showed that in soil-floored houses soil material may constitute up to 25 per cent of the total amount of floor litter manure.

Table 1. Accumulation of Manure Mixed with Litter in 10 Weeks from Broilers in Georgia.

House No.	Birds per house	Manure removed from house	Moisture	Manure/1000 birds: Fresh wt.	Manure/1000 birds: Dry wt.
	Number	Pounds	Per cent	Pounds	Pounds
1	13,500	54,490	26.7	4,036	2,958
2	13,500	59,317	24.5	4,394	3,317
3	16,000	67,925	21.8	4,245	3,320
4[a]	16,000	85,830	20.8	5,364	4,248
5	4,200	15,845	30.4	3,773	2,626
6	4,200	17,440	25.1	4,152	3,110
7	4,200	17,420	25.6	4,148	3,086
8	16,000	61,290	19.8	3,831	3,072
Mean			24.3	4,243	3,217

[a]Considerable soil removed with manure when house was cleaned.

Management Practices

Management practices, undoubtedly, influence the amount as well as the composition of chicken manure. These practices vary widely even within a county or community. Some indication of this variation in management practices can be seen from data in Table 2. Almost all of the houses sampled had soil floors. Only nine out of 113 houses had other types. Sawdust and shavings were used almost equally as litter in broiler houses, but shavings was the predominant litter in hen houses. One-half of the broiler houses was cleaned after each 10-week growing period. When more than one group of broilers was grown on the initial litter, the grower usually removed the loose feathers from the house and added a small amount of dry litter.

Only one group of birds used the initial litter in all hen houses sampled. Houses were cleaned and fresh litter was added before a new group of birds was placed in the house. In hen houses the approximate length of the time that the initial litter and accumulated droppings remained in the house depended upon the productivity of the layers.

Table 2. Management Practices Used in Poultry Houses in Georgia Where Samples Were Collected for Chemical Analyses (4).

	Number of houses: Broiler	Number of houses: Hen
Type of floor		
Soil	78	26
Wood	3	1
Concrete	1	4
Type of litter		
Sawdust	36	6
Shavings	35	18
Sawdust and shavings	9	5
Other	2	2
Age of litter (weeks)[a]		
0 - 10	41	0
11 - 20	23	0
21 - 40	13	12
41 - 60	4	18
More than 60	1	1
Total number of houses	82	31

[a]Length of time since first group of birds was placed on litter.

Composition of Manures

Influence of Feed

Huge amounts of feed are required annually for poultry production. In Georgia more than one million tons of feed per year are required for broilers alone. These feeds are the source of plant nutrients found in the manure. N (nitrogen), P (phosphorus), and K (potassium) are the major nutrients. Feeds, and consequently, manure, also contain small amounts of calcium, magnesium, sulfur, boron, copper, iron, manganese, molybdenum, zinc, and possibly other plant nutrients.

Only a small portion of each nutrient contained in the feed is digested by the chicken. New Jersey workers (7) found that only 19 per cent of the N, 12 per cent of the P, and 5 per cent of the K contained in feeds were utilized by a 4-pound white Leghorn hen during a 2-year period, starting from the day she hatched.

Investigators in Pennsylvania (6) reported that a laying hen will digest about 54 per cent of the dry matter contained in feeds with the remaining 46 per cent being voided in the manure. This compares with 81 per cent of the N, 88 per cent of the P, and 95 per cent of the K being voided in the manure (7). Therefore, the fresh droppings without litter are richer in plant nutrients than the feed from which they came.

Broilers and Hens

Samples from 82 broiler houses and 31 hen houses were collected and analyzed for moisture, N, P, and K. These samples were collected in 1955 in seven Northeast Georgia counties where large numbers of commercial chickens are grown. In each instance the sample was taken after the poultry had been removed to simulate farmer practices in removal of manure. Average composition of broiler manure, by counties, is shown in Table 3. Broiler manure as it came from the house averaged 25.0 per cent moisture, 1.7 per cent total N, 0.81 per cent total P, and 1.25 per cent total K. Average values for each county were not greatly different from the mean value for all counties. The small differences in nutrient composition among counties are not due to a moisture variable alone since similar differences in composition can be found even after the manure has been dried (Table 3).

Hen manure, as it came from the house, averaged 36.9 per cent moisture, 1.3 per cent total N, 1.20 per cent total P, and 1.14 per cent total K (Table 3). For some unknown reason the moisture content of samples from Union County was higher than from the other two counties. Variations in composition among counties existed whether compared on a fresh or dry basis.

Table 3. Average Total N, P, and K Content of Broiler and Hen Manures by Counties in Georgia.

County	Samples	Moisture	Moist weight basis			Dry weight basis		
			N	P	K	N	P	K
	No.		per cent					
		Broiler						
Dawson	14	22.1	1.8	0.97	1.33	2.3	1.23	1.66
Habersham	14	22.5	1.5	0.79	1.16	1.9	1.01	1.49
Jackson	17	19.4	1.7	0.79	1.33	2.1	0.97	1.66
Lumpkin	16	26.8	1.6	0.84	1.33	2.2	1.14	1.83
Union	6	34.4	1.6	0.66	1.08	2.4	1.01	1.66
White	15	30.6	1.9	0.79	1.25	2.7	1.14	1.83
Mean (82 samples)		25.0	1.7	0.81	1.25	2.3	1.08	1.69
		Hen						
Lumpkin	4	29.4	1.6	1.23	1.41	2.3	1.76	1.99
Towns	8	30.2	1.6	1.19	1.16	2.3	1.72	1.66
Union	19	44.5	1.1	1.19	1.08	2.0	2.16	1.91
Mean (31 samples)		36.9	1.3	1.20	1.14	2.0	1.88	1.85

Generally, hen manure contained a higher percentage of moisture than broiler manure. This may have been influenced by climatic conditions at the time of sampling. Most of the hen manure samples were collected in the spring when manures would ordinarily contain more moisture than in summer. Most of the broiler manure samples were collected in the summer.

Broiler manure contained more N, considerably less P, and about the same amount of K as hen manure. The high N content of broiler manure was probably due to a high protein diet and also to less loss of nitrogen in volatile forms during the shorter periods of accumulation.

Chicken manure as found on the farms has a wide range in composition. Any one constituent alone may vary by a factor of three or four. Data in Table 4 illustrate the range in composition of broiler and hen manure analyzed in this study. From the lowest to highest values for broiler manure, moisture varied 420 per cent, N varied 270 per cent, P varied 300 per cent, and K varied 160 per cent. Variation in the composition of hen manures was comparable to that of the broiler manure.

The average availability of P and K in broiler and hen manure samples is shown in Table 5. Rock phosphate used as a mineral source for chickens may account for part of the unavailable P in manure. Also, P may be contained in the organic matter which may not be available until decomposition takes place.

Soil material which often becomes mixed with floor litter manure may contain 1 per cent or more of total K, yet only a small fraction of this is readily available to plants. Granite grit used in chicken production may contain 5 per cent or more K, little of which is in an available form.

Table 4. Range in Composition of Broiler and Hen Manures in Georgia.

Type of manure	Samples	Range in fresh material			
		Moisture	N	P	K
	No.	per cent			
Broiler	82	11.1-57.3	0.7-2.6	0.31-1.23	0.66-1.74
Hen	31	15.4-64.4	0.6-2.4	0.70-1.89	0.75-2.16

Table 5. Average Availability of the Total P and K in Broiler and Hen Manures in Georgia (4).

Type of manure	Samples	P[a]	K[b]
	No.	per cent	
Broiler	31	94.1	85.7
Hen	31	88.4	88.3

[a]Citrate soluble
[b]Water soluble

Influence of Poultry Manure on Crop Production

Field tests were conducted at Blairsville, Athens, and Tifton to evaluate the response of different crops to poultry manure. Except where indicated, the following general procedure was used: Test areas were plowed and manure was broadcast and disked into the soil immediately after application for annual crops. Manure treatments for established sods were applied to the surface without disturbing the sod. Some chemical properties of manure used in the investigations are given in Table 6.

Table 6. Moisture Content and Total N, P and K Content of Poultry Manure Used in Investigations.

Crop	Year	Kind of manure	Moisture	Dry weight basis N	P	K
			per cent			
		Blairsville				
Corn	1955	Hen	42	1.2	1.52	1.29
Corn	1957	Broiler	31	2.9	1.01	1.68
Grass-Clover	1955	Broiler	41	2.7	1.12	2.00
Cabbage	1957	Broiler	34	2.9	1.39	2.26
		Athens				
Cotton	1956	Broiler	28	2.2	0.66	1.91
Cotton	1957	Broiler	41	1.9	0.75	1.49
Cotton	1958	Broiler	32	1.9	0.48	1.66
Oats	1956	Broiler	21	1.9	0.66	1.83
Oats	1957	Broiler	28	1.5	0.48	1.49
Corn	1955	Broiler	24	1.9	0.48	1.74
Corn	1959	Broiler	23	1.8	0.48	1.49
Coastal bermuda-grass	1957	Broiler	41	1.9	0.75	1.49
Coastal bermuda-grass	1958	Broiler	32	1.9	0.48	1.66
Coastal bermuda-grass	1959	Broiler	23	1.8	0.48	1.49
Coastal bermuda-grass	1960	Broiler	33	1.6	0.40	1.25
		Tifton				
Corn	1958	Broiler	10	2.1	0.88	1.49

Soil tests were made for each area and adequate lime was applied where needed to obtain desired soil pH values. Soil test values for each experimental area are reported in Table 7. Commercial P and K were placed in the row at planting for row crops, broadcast and disked into the soil for oats, and left on the surface for sod crops. A part of the commercial N, as ammonium nitrate, was applied in the same manner as P and K and the remainder used as sidedress or topdress applications.

Table 7. Soil Type and Soil Test Values of Samples from Experimental Areas Used in Investigations.

Crop	Year	Soil type	pH	P	K
		Blairsville			
Corn	1955	Congaree fsl	5.3	low	low
Corn	1957	Chewacla sil	5.9	low	low
Grass-Clover	1955	Alluvial-undifferentiated	7.4	medium	low
Cabbage	1957	Hiwassee 1	5.7	low	medium
		Athens			
Cotton	1956	Cecil sl	5.4	low	medium
Oats	1956	Cecil cl	5.7	low	low
Corn	1955	Cecil sl	5.5	high	medium
Corn	1959	Cecil sl	6.7	medium	low
Coastal bermudagrass	1957	Cecil sl	6.2	low	low
		Tifton			
Corn	1958	Tifton ls	5.4	high	low

Corn

An investigation was established in the Mountain area at Blairsville in 1955 to evaluate the effect of hen manure, with and without commercial fertilizer, on corn production. An increase of approximately 100 bushels of corn per acre as compared to the control was obtained in 1955 for the treatment of 100-44-84 pounds of N-P-K, respectively, with 5 tons of manure per acre (Table 8). Apparently, this rate of fertilizer was not needed since the treatment consisting of the same rate of commercial fertilizer and 2.5 tons of manure resulted

Table 8. Yield Response of Corn Grown on Congaree Fine Sandy Loam to Hen Manure and Commercial Fertilizer, Blairsville.

Treatment per acre: Manure	N	P	K	Yield per acre: 1955	1956[a]
tons		pounds		bushels	
0	0	0	0	32	27
0	50	22	42	77	74
0	100	44	84	99	94
2.5	0	0	0	48	26
2.5	50	22	42	90	80
2.5	100	44	84	131	121
5.0	0	0	0	74	32
5.0	50	22	42	103	67
5.0	100	44	84	133	109
10.0	0	0	0	114	52
LSD @ 0.05				18	18

[a]No manure applied in 1956

Footnote: Hybrid - Dixie 33 @ 15,000/A
Pounds of nutrients (total analysis) per ton of manure - N - 14, P - 18, and K - 15.

in 98 bushels more corn than the control. The low fertilizer treatment (50 N, 22 P, and 42 K) produced about the same yield as 5 tons of manure which contained 70, 90, and 75 pounds of N, P, and K, respectively. Five tons of manure with the low fertilizer treatment gave approximately the same yield as the high fertilizer treatment.

In the second year (Table 8), commercial fertilizer treatments produced yields about equal to those of the previous year. Manure treatments, as residual, were not as effective as the year in which they were applied. As residual only, the 10-ton rate produced a significant increase in yield over the control. This lack of response at the lower rates of manure was not unusual since the N content of the manure was relatively low (0.7 per cent) and this element appeared to be the limiting nutrient in corn production.

Data presented in Table 9 indicate a marked yield response of corn to broiler manure applications of 4 and 8 tons per acre without the addition of commercial N at Blairsville. The 12-ton rate of manure did not result in a significant increase in yield above the 8-ton rate. A significant response was obtained for 4 tons of manure with or without commercial N. Commercial fertilizer had no significant effect on yields when applied with 4 tons of manure or more. Yields were increased by P applications only where manure was not applied. No response was obtained to commercial K.

Table 9. Effect of Commercial Fertilizer and Broiler Manure on Yield of Corn Grown on Chewacla Silt Loam, Blairsville, 1957.

Fertilizer per acre			Manure (tons per acre)			
N	P	K	0	4	8	12
pounds			bushels per acre			
0	0	0	50	112	164	174
0	44	84	35	122	174	194
100	44	84	120	165	193	196
100	0	84	83	159	177	185
100	44	0	108	161	184	190

LSD @ 0.05 - for fertilizer treatments within one manure rate - 21
- for manure rate within one fertilizer treatment - 31

Footnote: Hybrid - Dixie 33 @ 16,000/A
Pounds of nutrients (total analysis) per ton of manure - N - 40, P - 14, and K - 23.

In nutrient comparison, 4 tons of manure containing 160-56-92 in N-P-K, respectively, produced slightly less corn than the fertilizer treatment of 100-44-84.

In an effort to evaluate broiler manure for corn production in the Coastal Plain area, an investigation was initiated in Tifton in 1958. Significant increases in corn yields resulted from fertilizer and manure treatments in 1958 (Table 10). Yield of corn following the addition of

Table 10. Effect of Broiler Manure and Commercial Fertilizer on Corn Grown on Tifton Loamy Sand, Tifton.

Treatment per acre[a]				Yields per acre	
Manure	N	P	K	1958	1959
tons	pounds			bu.	
0	0	0	0	17	19
0	120	44	84	68	68
4	0	0	0	45	30
4	120	44	84	67	70
8	0	0	0	52	40
8	120	44	84	70	49
12	0	0	0	62	37
12	120	44	84	69	63
LSD @ 0.05				18	18

[a]Manure applied in 1958 only, but N, P, and K applied annually.

Footnote: Hybrid - Dixie 18
Pounds of nutrients (total analysis) per ton of manure - N - 38, P - -16, and K - 26.

12 tons of broiler manure gave results which were comparable to those receiving the commercial fertilizer treatment of 120 N, 44 P, and 84 K. Manure had no effect on yield where commercial fertilizer was added. Four and 8 tons of manure were significantly less effective than commercial fertilizer in promoting yield increases of corn.

Residual effects of manure appeared evident in 1959. The 4-, 8-, and 12-ton per acre rates of manure resulted in yield increases of 11, 21, and 18 bushels of corn per acre, respectively, as compared with no treatment. Residual effects of manure were considerably less than the effects of an annual application of commercial fertilizer. Over the two-year period, 12 tons of manure containing 456-192-312 pounds of N-P-K, respectively, produced 63 bushels more than the control. By comparison, 240-88-168 as commercial fertilizer, gave 96 bushels more than the control.

Data in Table 11 show that, in the Piedmont area at Athens, yields of corn were increased considerably by manure and by complete fertilizer over the treatment receiving only commercial N. Two and one-half, 5 and 10 tons of manure produced comparable yields of approximately 70 bushels per acre. Commercial fertilizer had no effect on yields when used with manure.

Manure treatments were applied as a mulch between the rows two days after planting corn. This method of application reduced stands of corn from 10,305 plants per acre with 2.5 tons to 9,389 plants with 5 tons, and to 6,412 plants with 10 tons per acre. The smaller number of plants was associated with lower yields. Reduction in yield from the heavier rates of manure may have been even greater except for the negative relationship between ears per plant and stalks per acre. Ear weights were heavier in the plots receiving manure.

Table 11. Influence of Broiler Manure with and without Added Commercial Fertilizer on Corn Production on Cecil Sandy Loam, Athens, 1955.

Treatment per acre				Plants	Ears per	Ear	Yield
Manure	N	P	K	per acre	plant	wt.	per acre
tons	pounds			number	number	pounds	bushels
0	70	0	0	10,763	0.85	0.31	42
2.5	0	0	0	10,305	1.14	0.41	70
5	0	0	0	9,389	1.27	0.41	69
10	0	0	0	6,412	1.55	0.42	64
0	90	26	47	10,076	1.05	0.29	54
2.5	20	26	47	10,076	1.23	0.38	70
5	20	26	47	7,328	1.62	0.37	68
10	20	26	47	6,412	1.61	0.39	60
LSD @ 0.05				871	0.18	0.07	11

Footnote: Hybrid - N. C. 27
Pounds of nutrients (total analysis) per ton of manure - N - 28, P - 7, and K - 26.

Data in Table 12 show the results from an investigation established at Athens in 1959 to determine the initial and residual effects of commercial fertilizer and rates of broiler manure on corn yields. Corn production in the initial year was limited by drought during the tasseling stage of growth. All treatments receiving manure or commercial fertilizer produced similar yields which were significantly greater than the control.

The residual effect of all rates of manure in 1960 resulted in higher corn yields than those obtained from the control (Table 12). Yields were directly related to the amount of manure applied the previous year. The commercial fertilizer treatment did not result in a significant effect on yields. Rainfall in 1960 and 1961 appeared to be adequate during the growing season. Residual effects of the 4-ton rate had almost disappeared by 1961, but the heavier rates still had a pronounced effect on yields. However, this residual effect was less than in 1960. In 1962, the fourth year after application, residual effects of manure did not result in significant yield increases. Low yields in 1962 were attributed partially to adverse weather conditions.

Residual effects from Blairsville and Tifton are somewhat different from those reported from Athens. In the biennial experiment at Blairsville (Table 8) more than 75 per cent of the total increase in yield from 10 tons of manure was obtained the initial year. Tifton data (Table 10) show that 71 per cent of the total increase in yield from 12 tons of manure was obtained the year in which it was applied. In comparison, only 17 per cent of the total increase in yield from 12 tons of manure was obtained the initial year at Athens. Drought limited corn production at Athens during the initial year and this, apparently, was not the case during the initial year at Blairsville and Tifton. Greater utilization of nutrients from manure during the initial year would be expected when soil moisture conditions were favorable.

Table 12. Initial and Residual Effects of Broiler Manure and Commercial Fertilizer on Corn Grown on Cecil Sandy Loam, Athens.

Treatment per acre[a]	Yield per acre				
	1959	1960	1961	1962	Total
	bushels				
None	26	20	25	8	79
4 tons manure	58	42	31	13	144
8 tons manure	51	57	49	20	177
12 tons manure	48	80	57	20	205
16 tons manure	51	90	63	20	223
104 - 32 - 60 lb. (N-P-K)	55	29	29	8	121
LSD @ 0.05	16	13	11	N.S.	......

[a]Applied in 1959 only.

Footnote: Hybrid - Dixie 82 @ 12,000/A.
Pounds of nutrients (total analysis) per ton of manure - N - 28, P - 17, and K - 23.

Oats

A marked increase in grain yields of Arlington oats was obtained following applications of broiler manure at rates of 2.5, 5 and 10 tons per acre to a low fertility Cecil clay loam at Athens (Table 13). The manure was broadcast and disked into the soil two weeks before seeding the oats. In 1956-57, the 10-ton per acre rate of manure resulted in a significant reduction in yield as compared with the 5-ton rate. The 10-ton rate of manure caused severe lodging and late maturity; therefore, this treatment was omitted in 1957-58. A significant residual effect of the 10-ton rate was observed in the succeeding crop.

The 5 tons of manure in 1956 resulted in higher yields than other treatments. The second application of 5 tons of manure resulted in less yield than was obtained with the second application of 2.5 tons

Table 13. Effect of Broiler Manure and Commercial Fertilizer on Yield of Oats Grown on Low Fertility Cecil Clay Loam, Athens.

Annual Treatment	Yield per acre	
	1956-57	1957-58
per acre	bushels	
None	2.5	5.3
2.5 tons manure	41.1	64.8
5 tons manure	67.2	51.9
10 tons manure[a]	55.4	16.9
60 - 20 - 26 lb. (N-P-K)	31.9	32.1
LSD @ 0.05	6.7	3.8

[a]Applied in 1956 only.

Footnote: Pounds of nutrients (total analysis) per ton of manure
1956-57 - N - 30, P - 10, and K - 29.
1957-58 - N - 22, P - 7, and K - 21.

of manure. Severe lodging occurred with the higher rate and apparently was responsible for the lower yield. All annual rates of manure resulted in the production of more grain than the commercial fertilizer treatment.

Cotton

Data presented in Table 14 indicate that annual applications of 2.5 tons of broiler manure per acre to Cecil sandy loam more than doubled cotton yields as compared to untreated plots over a three-year period. Manure at 5 and 10 tons per acre did not result in yields significantly different from those obtained with 2.5 tons of manure.

All rates of manure used in 1956-58 had a residual effect on cotton yields in 1959 (Table 14). Yields following three annual applications of 5 and 10 tons of broiler manure per acre were comparable and significantly higher than those obtained from the 2.5 ton per acre treatment.

Table 14. Effect of Broiler Manure on Yields of Cotton Grown on Eroded Cecil Sandy Loam, Athens.

Manure annual application 1956-58	Average Seed cotton 1956-58	Seed cotton 1959[a]
tons/A	pounds per acre	
None	413	327
2.5	970	884
5.0	1,187	1,217
10.0	1,171	1,288
LSD @ 0.05		367

[a]Residual effect of previous applications of manure
Footnote: Pounds of nutrients (total analysis) per ton of manure
1956 - N - 32, P - 10, and K - 27.
1957 - N - 22, P - 9, and K - 18.
1958 - N - 26, P - 7, and K - 23.

Forage Crops

Broiler manure and commercial fertilizer treatments were applied in 1955 to an established sod consisting of Herds' grass, tall fescue, orchard grass, and white clover grown in the Mountain area at Blairsville (Table 15). Ten tons of manure produced about the same yield as the commercial fertilizer treatment of 100 N, 44 P, and 84 K at the first clipping, but the manure was much more effective in forage production for the remainder of the season.

In 1955, 2.5 tons of manure which contained 82, 35, and 62 pounds of N, P, and K, respectively, produced virtually the same yield as commercial N-P-K at per acre rates of 100-44-84. Forage was more evenly distributed with the manure treatment. The highest total yield appeared to result from the treatment of 5 tons of manure plus

Table 15. Effect of Commercial Fertilizer and Broiler Manure on Air-Dry Forage Yield of a Grass-clover Mixture Grown on Alluvial Undifferentiated Soil, Blairsville.

Treatments per acre[a]		1955				1956
		1st clip.	2nd clip.	3rd clip.		
N - P - K	Manure	May 25	July 22	Sept. 11	Total	Total
pounds	tons	pounds per acre				
0 - 0 - 0	0	668	668	756	2,112	2,313
100 - 44 - 84	0	2,887	666	751	4,304	3,890
0 - 0 - 0	2.5	1,912	1,238	1,194	4,344	3,001
100 - 44 - 84	2.5	3,812	1,003	817	5,632	4,063
0 - 0 - 0	5.0	1,831	957	1,116	3,904	3,414
100 - 44 - 84	5.0	4,006	1,417	1,344	6,767	4.493
0 - 0 - 0	10.0	2,834	1,585	1,538	5,957	2,969
LSD @ 0.05		659	367	389	1,085	831

[a]Fertilizer applied annually and manure in 1955 only.

Footnote: Pounds of nutrients (total analysis) per ton of manure - N - 33, P - 14, and K - 25.

commercial fertilizer at the first clipping, but total yield from this treatment was not significantly different than those obtained from 10 tons of manure. Yield of forage from the latter treatment may have been higher if injury to the grass had not occurred following surface application of the treatment.

Only a small residual effect from the manure was noted in the 1956 yields (Table 15). The 5-ton rate resulted in a significant yield increase as compared to the no manure treatment. Apparently, most of the nutrients contained in the manure were utilized by the plants or lost by other means prior to the 1956 growing season. Stand damage which occurred in 1955 may be responsible for the low yields in the plots receiving the 10 tons of manure.

Data in Table 16 show the relationship between N applied as commercial N or manure N and percentage clover in a Herd's grass, tall fescue, orchard grass-white clover mixture. The percentage clover at each clipping was inversely related to the amount of N applied from either source. Ten tons of manure or 2.5 or 5 tons of manure plus 100 pounds of commercial N virtually eliminated clover from the area. Generally, the percentage of clover was greater at the second clipping on July 22 than at either of the other two clipping dates (May 25 and September 11).

An investigation was initiated at Athens in 1957 to evaluate surface applications of broiler manure for production of Coastal bermudagrass. Data in Table 17 indicate a significant response from all rates of manure, during the 4-year period of the experiment, except the 2.5-ton rate in 1959. Five tons of manure applied annually resulted in higher yields than were obtained with the 2.5-ton rate. In general, commercial N, P, and K at 192, 42, and 80 pounds per acre resulted in an average of more than 1 ton of forage per acre than other treatments. Adverse weather conditions over the 4-year period resulted in low forage yields for all treatments.

Observations made at the first harvest of Coastal bermudagrass in 1957 and 1958 indicated that plots which had received broiler manure treatment were seriously infested with spring weeds. Weed counts and percentage coverage by weeds were made on April 7, 1959, after manure

Table 16. Percentage Clover in a Grass-clover Mixture for Each Clipping as Affected by Treatments at Blairsville, 1955.

Fertilizer application per acre			Tons of broiler manure per acre			
N	P	K	0 Clover	2.5 Clover	5 Clover	10 Clover
	pounds			per cent		
			First Clipping			
0	0	0	9	11	3	0
50	22	42	3	2	2	—
100	44	84	1	0	0	—
0	44	84	16	2	4	—
			Second Clipping			
0	0	0	53	52	29	3
50	22	42	18	15	15	—
100	44	84	4	5	2	—
0	44	84	59	30	27	—
			Third Clipping			
0	0	0	32	28	29	6
50	22	42	11	16	12	—
100	44	84	9	3	1	—
0	44	84	39	17	21	—

Table 17. Effect of Broiler Manure on Yield of Coastal Bermudagrass Grown on Cecil Sandy Loam, Athens.

Annual treatment per acre				Dry forage per acre			
N	P	K	Manure	1957	1958	1959	1960
lb	lb.	lb.	tons		tons		
0	0	0	0	0.52	0.17	0.82	0.57
0	0	0	2.5	1.53	0.56	1.24	1.72
0	0	0	5.0	2.17	1.21	2.36	3.36
96	21	40	0	2.43	1.81	2.44	2.13
192	42	80	0	3.82	2.83	4.37	3.97
LSD @ 0.05				0.49	0.36	0.58	0.69

Footnote: Pounds of nutrients (total analysis) per ton of manure,
1957 - N - 22, P - 9, and K - 18.
1958 - N - 26, P - 7, and K - 23.
1959 - N - 28, P - 7, and K - 23.
1960 - N - 22, P - 5, and K - 16.

and commercial fertilizer had been applied March 11. Results obtained are shown in Table 18. Manure treatment markedly increased the number and percentage area in the plots covered by weeds in comparison to treatment with commercial fertilizer. The increased weed growth on the manured plots was apparently due to better germination and survial since the same species occurred generally over the entire area. Cooper, Maxwell, and Owens (2) found that weed seed fed in a capsule to White Leghorn hens were destroyed in the digestive tract. Weeds were not a problem after the first harvest regardless of treatment.

Table 18. Influence of Broiler Manure and Mineral Fertilizer on Weed Infestation in an Established Stand of Coastal Bermudagrass Grown on Cecil Sandy Loam, Athens, 1959.

Treatment per acre[a]				Weeds	Weed
N	P	K	Manure	per sq. ft.[b]	Coverage
	pounds		tons	number	per cent
0	0	0	0	10	5
192	42	80	0	25[c]	5
96	21	40	0	22[c]	5
0	0	0	2.5	44	83
0	0	0	5.0	43	94

[a]Initiated in 1957, treatments applied annually.
[b]April 7.
[c]At time of count only ⅓ of N treatment had been applied.

Cabbage

Broiler manure and commercial fertilizer treatments on a Hiwassee loam at Blairsville in 1957 resulted in significant increase in cabbage yields (Table 19). Results from a one-year study indicate that yields from treatments of 8 and 12 tons of manure per acre were comparable and both were significantly higher than the 4-ton per acre manure rate.

Table 19. Effect of Broiler Manure and Commercial Fertilizer on the Yield of Cabbage Grown on Hiwassee Loam, Blairsville, 1957.

Fertilizer per acre			Manure (tons per acre)			
N	P	K	0	4	8	12
	pounds			tons/A		
0	0	0	1.62	7.83	11.07	11.66
40	18	33	6.73	11.05	11.74	12.79
80	36	66	10.54	12.45	11.76	12.66
120	54	99	10.10	11.02	12.26	13.02

LSD @ 0.05: 1.46 for rates of fertilizer at same level of manure.
1.52 for rates of manure at same level of fertilizer.

Footnote: Pounds of nutrients (total analysis) per ton of manure, N - 38, P - 18, and K - 30.

No response was obtained with commercial fertilizer above the rate of 80-36-66 pounds of N, P, and K, but manure increased yields at all rates of commercial fertilizer. The data indicate that yields from 4 tons of manure per acre were about the same as those obtained from the low rate of fertilizer. Eight tons of manure, 4 tons of manure plus 40-18-33, and 80-36-66 resulted in yields that were similar. All of these three treatments appeared to be desirable rates of application.

Influence of Broiler Manure on Soil Properties

Soil pH Values

The initial effect of broiler manure applications disked into the soil on pH values of an acid Cecil sandy loam may be seen in Figure 2. Manure applications of 2.5, 5, and 10 tons per acre temporarily increased soil pH values and each increment increased pH values over the preceding increment. Maximum pH change for the spring-applied manure occurred within two weeks after application. Values for pH determined 30 days after application were generally less than those determined 15 days after application. All values were similar after 90 days.

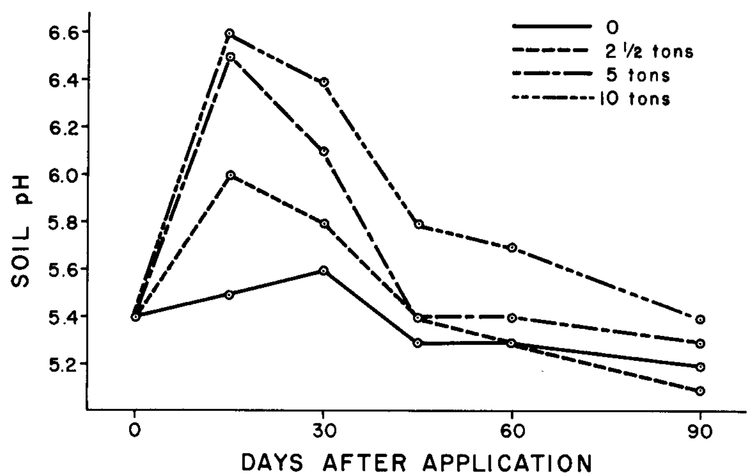

Figure 2. Influence of spring applied (March 30) broiler manure on soil pH values of Cecil sandy loam on which cotton was grown, Athens, 1955.

In another experiment on a Cecil soil, manure was applied in the fall (September) and disked in at rates of 2.5, 5, and 10 tons per acre. At this location the highest pH value for each rate occurred

within two weeks after treatment. Values for pH did not begin to decline materially until 90 days after application. Not until after 180 days were all pH values comparable. This temporary increase in pH may be accounted for by the ammonia liberated by the decomposing manure. As microbial activity converted the ammonia to nitrates, the effect disappeared.

Similar studies were conducted at the Mountain Experiment Station on two bottom land and two terrace soils. Manure applications did not significantly affect soil pH values under these conditions.

Data in Figure 3 illustrate the long term effect of a heavy rate of manure on soil pH values of a Cecil sandy loam. Manure plowed down at a rate of 16 tons per acre resulted in a significant reduction in soil pH values 42 months after application.

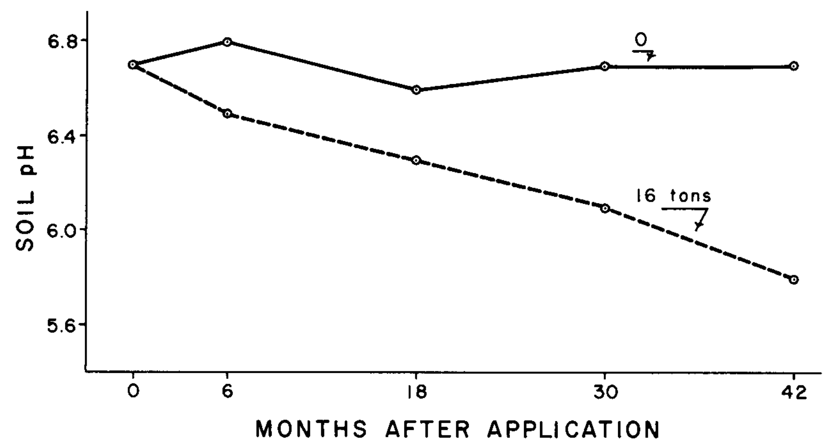

Figure 3. Soil pH values as influenced by single application of 16 tons of broiler manure per acre for corn grown on Cecil sandy loam, Athens, 1959.

Soil Phosphorus and Potassium

Residual effects of broiler manure plowed down at rates of 8 and 16 tons per acre on available P and K were detected during a 42-month period after application on a Cecil sandy loam at Athens (Table 20). Soil P and K values which were initially low were increased markedly following manure applications. After 42 months the P and K values had decreased from the maximum, but soil receiving 16 tons of manure per acre still contained a high level of each of these nutrients as determined by soil tests.

Data presented in Figure 4 illustrates a residual build up of available P and K in a Cecil sandy loam soil following annual applications of manure for corn production. Similar data were obtained at Blairsville on a State loam following two annual applications of manure to a grass-clover sod.

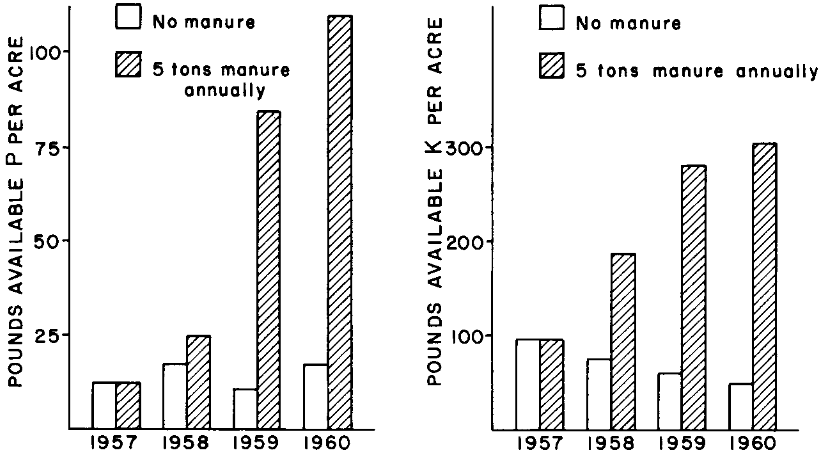

Figure 4. Soil phosphorus and potassium values as influenced by annual applications of broiler manure to Cecil sandy loam on which Coastal Bermudagrass was grown, Athens.

Table 20. Soil Phosphorus and Potassium Values as Influenced by a Single Application of Different Rates of Broiler Manure for Corn Grown on Cecil Sandy Loam, Athens, 1959.

Month after manure applications	Broiler manure - tons/Acre					
	0		8		16	
	P	K	P	K	P	K
	pounds/A					
0	22	88	22	68	22	68
6	30	102	60	224	190	424
18	25	120	75	188	150	352
30	16	70	85	205	135	287
42	11	79	65	130	95	219

Footnote: Pounds of nutrients (total analysis) per ton of manure - N - 28, P - 7, and K - 23.

Soil fertility level evaluation
P - 0-20 (low), 21-40 (medium), and 41+ (high)
K - 0-100 (low), 101-200 (medium), and 201+ (high)

Summary

Recent investigations at several Georgia agricultural experiment stations indicate that broiler and hen manures are valuable sources of readily available plant nutrients.

The manures vary widely in composition as a result of type of bird, kind of feed consumed, climatic conditions, management of the poultry house, and system of handling the manure upon removal from the house. Broiler manure, as taken from the house, contained an average of 25.0 per cent moisture, 1.7 per cent N, 0.81 per cent P, and 1.25 per cent K. Hen manure averaged 39.9 per cent moisture, 1.3 per cent N, 1.20 per cent P and 1.14 per cent K. Of the total P and K in the manures, about 90 per cent were in available forms.

Accumulated floor litter from 1,000 broilers in 10 weeks averaged about 2.12 tons, containing 25 per cent moisture.

Significant yield responses were obtained for all crops investigated following the use of manures at rates from 2.5 to 16 tons per acre. Investigations were conducted: 1) on corn, a grass-legume mixture, and cabbage at the Georgia Mountain Experiment Station, Blairsville; 2) on cotton, oats, corn, and Coastal bermudagrass at the College Station, Athens, and 3) on corn at the Coastal Plain Station, Tifton.

The percentage clover in a grass-clover sod was reduced by manure and commercial N.

Significant residual effects of chicken manure on yields of corn, oats, cotton, and a grass-legume mixture were obtained.

Spring weed infestation was increased markedly following broiler manure applications to Coastal bermudagrass.

Broiler manure applications to soils at Athens resulted in a temporary increase in soil pH values, but did not significantly influence pH of soils at Blairsville. Broiler manure at a rate of 16 tons per acre progressively reduced soil pH values at Athens during a 42-month period.

Annual applications of broiler manure markedly increased available P and K in soils at Athens and Blairsville.

Literature Cited

1. Annual Poultry Summary. April 26, 1963. Georgia Crop Reporting Service, Misc. Publication.
2. Cooper, J. B., T. L. Maxwell, Jr., and A. D. Owens. 1960. A study of the passage of weed seeds through the digestive tract of the chicken. Poultry Sci. 39: 161-163.
3. Papanos, S., and B. A. Brown. 1950. Poultry Manure; Its Nature, Care and Use. Connecticut (Storrs) Agr. Exp. Sta. Bul. 272.
4. Parker, M. B., H. F. Perkins and H. L. Fuller. 1959. Nitrogen, phosphorus, and potassium content of poultry manure and some factors influencing its composition. Poultry Sci. 38: 1154-1158.
5. Tinsley, J., and T. Z. Nowakowski. 1959. The composition and manurial value of poultry excreta, straw-dropping composts and deep litter. III. Experimental studies on deep litter. J. Sci. Food Agric. 10: 224-232.
6. White, J. W., F. K. Holben and A. C. Richer. 1944. Production, Composition, and Value of Poultry Manure. Pennsylvania Agr. Exp. Sta. Bul. 469.
7. Yushok, W., and F. E. Bear. 1943. Poultry manure; Its Preservation, Deodorization, and Disinfection. New Jersey Agr. Exp. Sta. Bul. 707.