

**LIVESTOCK AND POULTRY MANURE NUTRIENT ASSESSMENT
AND DISTRIBUTION IN NORTH CAROLINA**

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North Carolina is one of the leading states in livestock and poultry production. In 1989, approximately 3.6 million animal units, as defined by USEPA, were grown in the state. Current trends in this industry are towards production consolidation and intensification. These efforts, while being sound from an economic and management perspective, often do not consider the full environmental impact that can ensue from the increased generation of animal manure. In the production of livestock and poultry, several by-products are generated. The two that are produced in the greatest quantities are manure and animal mortality. Both must be managed properly to optimize nutrient usage and protect surface and ground water quality.

The nutrient assessment project was initiated to:

- 1) assess current generation of manure by county,
- 2) determine the amount of nutrients from manure that could be recovered and made available to agronomic crops,
- 3) determine the quantity of nutrients required in each county,
- 4) determine the amount of nutrients purchased in each county as commercial fertilizer,
- 5) calculate the percent of agronomic crop nutrient needs that could be supplied by animal manure, and
- 6) determine the nutrient balance in each county after animal manure and purchased nutrients are considered.

In order to optimize usage of this information, the nutrient assessment data was geographically depicted to serve as a tool for:

- 1) determining where the livestock are located and identifying "clustering effects," i.e., high densities of livestock production around support facilities such as feed mills, hatcheries, processing plants, etc.;
- 2) evaluating the quantities of manure nutrients available for plant growth and how they may supplement the inorganic nutrient sources in a given area;
- 3) assessing the potential for nutrient impairment of water resources; and
- 4) providing a decision-making guide for future county or area-wide growth and development.

All animal by-products contain organics and nutrients. Manure organics can provide a fuel source, while the nutrients, if managed properly, can be used as a feed source or as a plant

fertilizer. "Best Management Practices" (BMPs) for manure used as a feed or fertilizer include manure collection, treatment, storage, and nutrient/feed analysis. Additional BMPs are required when manure is used as a fertilizer. These practices include proper timing, rate, and application uniformity in relation to the nutrient needs of the growing plants. In addition, soil conservation practices to reduce soil, manure, and nutrient movement off site are needed.

Manure Characterization

Data on manure, litter, wastewater, and sludge quantities and characteristics are necessary to assist in the planning, design, and operation of manure collection, storage, pretreatment, and utilization systems for livestock and poultry enterprises. The *North Carolina Agricultural Chemicals Manual* contains summaries of data from a wide base of published and unpublished information on livestock manure production and characterization. These summaries represent typical domestic food animal and poultry species as well as different farm manure management systems within species. Fresh manure values represent "as voided" feces and urine. Farm manure management systems include the following:

- 1) paved lot manure scraped within two days either directly into a manure spreader for field spreading or into a short-term storage structure;
- 2) unpaved feedlot manure scraped after each group of livestock;
- 3) annual accumulations of poultry manure with wood shavings or peanut hulls as a litter base;
- 4) liquid slurry accumulating for 6-12 months from manure, excess water usage, and storage surface rainfall surplus;
- 5) surface liquid from an anaerobic treatment lagoon; and
- 6) bottom sludge from an anaerobic treatment lagoon.

Actual values vary due to differences in animal diet, age, usage, productivity, management, and location. Whenever site-specific data are available or actual sample analyses can be performed, such information should be considered in lieu of the mean summarized values.

Animal production in North Carolina produced approximately 21 million tons of fresh manure in 1989. Figure 1 shows the total manure distribution by counties. An additional 47,000 tons of poultry mortality and 25,000 tons of swine mortality also had to be managed but is beyond the scope of this paper. Animal manures contained 158,000 tons of nitrogen (N), 108,000 tons phosphate (P_2O_5), 101,000 tons of potash (K_2O), plus significant quantities of secondary and micronutrients.

Collectable Manure

All animals are not raised in confinement where their manure can be easily collected for reuse. Cattle and sheep spend most of their time on pasture. Some hog enterprises consist of dirt or pasture lots. A small percentage of turkeys are still finished on open range. While these unconfined animals still contribute manure nutrients to the pasture system, these nutrients are not addressed in this assessment. About 52% of the total fresh livestock and poultry manure is considered collectable in North Carolina.

Nutrients Remaining After Storage and Treatment Losses

During the time between manure voiding by the animal and transport to the field for spreading, much of the nutrients can be lost through drying or dilution, surface runoff, volatilization, or microbial digestion. Since different manure management systems either conserve or sacrifice varying amounts of nutrients, an estimate must be made of the percentage of farms using specific systems. Applying these percentages to the manure characteristics appropriate to the specific method gives the remaining nutrients after storage and treatment losses. About 35% of the fresh manure nitrogen, 53% of the phosphate, and 39% of the potash from the total livestock and poultry enterprises in North Carolina are available for field spreading.

Land Application BMPs

Manure used as a fertilizer source must be applied at a rate that meets the nutrient requirements of the plant. In most instances, the application rate is based on the nitrogen (N) supplying content of the manure. Application rates should not exceed the plant nutrient requirements for N. Excess N can leach through the soil or run off the soil surface to contaminate ground and surface waters. In areas where phosphorus (P) cannot be retained on site or in areas with P-sensitive waters, land application should be limited to the P needs of the plant, as dictated by soil tests. Soil conservation practices such as grass waterways, field borders, conservation tillage, strip tillage, and contour farming are important BMPs to reduce soil, manure, and nutrient movement off site.

In addition to applying the proper rate of manure, optimum timing and application uniformity are important management criteria to assure water quality and plant use. When manure is applied to the land, some nutrients are immediately available, while others are more slowly released through decomposition. When plants are actively growing, they can use these nutrients. If the manure is applied too far in advance of the crops' needs, however, the nutrients will not be used and are subject to leaching or surface runoff. Uniform application is also important to assure that adequate nutrients are available to all plants.

Plant Available Nutrients

Estimates of nutrient availability coefficients for various manure management systems and application methods are summarized in the *North Carolina Agricultural Chemicals Manual*. The plant-available portion of the manure nitrogen (PAN) was determined by combining a percentage of the ammonia (ammonium) -nitrogen using the appropriate ammonia volatilization value based on the application method with one-half of the organic nitrogen assumed to be plant available during the same year of application. For this assessment, all manure, litter, slurry, and sludge were assumed to be surface broadcast followed by soil incorporation within 48 hours, while lagoon liquid was assumed to be irrigated without soil incorporation. About 20% of the fresh manure nitrogen (32,000 tons), 40% of the phosphate (43,000 tons), and 30% of the potash (30,000 tons) from the total livestock and poultry enterprises were actually available for plant usage in 1989.

Crop Nutrient Requirements

To determine the nutrient requirements of all agronomic crops and pastures (excluding legumes, horticultural, and silvicultural crops), the state nitrogen fertilization rate recommendations as found in the *North Carolina Agricultural Chemicals Manual* were used. Since considerable variability in P and K indexes occur across the state, an assumption of 50 pounds each of P_2O_5 and K_2O per acre were used for this assessment. When considering on a statewide basis the nutrient requirements of all non-legume agronomic crops and pastures and the plant-available nutrients from manure, about 15% of N, 55% of P_2O_5 , and 39% of K_2O needs can be met with animal manure. At the county level in 1989, no county had enough manure to exceed the nitrogen requirements of all non-legume agronomic crops and pastures (Figure 2), however, there was enough to provide 100% or more of the nutrient requirements in 13 counties for P_2O_5 (Figure 3) and 8 counties for K_2O .

County Nutrient Balances

Commercial fertilizer purchases were also considered in assessing county nutrient balances. While these data may reflect a bias because fertilizers purchased in one county may be used in another county, the data still warrant consideration. Based on this input, approximately 23, 19, and 25% of the counties had surplus quantities of N, P_2O_5 , and K_2O , respectively, using a non-legume agronomic crop and pasture base (Figures 4 and 5).

Usefulness of Animal Manure Nutrient Assessment

This assessment is being used by the North Carolina Cooperative Extension Service to focus and network educational efforts on

animal waste management where there is the greatest need. Agents in counties where quantities of manure can supply a significant portion of crop nutrient needs are being encouraged to include manure management into their plans of work and to share this information with their county commissioners and advisory boards. Agent training in animal waste management has been conducted to familiarize them with the nutrient assessment; the process of manure decomposition and its consequence on nutrient release; and nutrient management and how it affects water quality.

In addition, agents are being encouraged to use the animal distribution maps to initiate discussions with livestock and poultry integrators on the need to consider dispersing livestock operations to prevent excessive "clustering" of animal units. These clusters might be sources of water impairments if they exceed the crop nutrient needs of the area.

Meetings with people in the fertilizer industry are being conducted to discuss the potential impact of these findings on their sales and to explore opportunities for incorporating organic sources into existing fertilizer operations.

Nutrient assessments can also be used for layers in a geographic information system (GIS). Obviously, large volumes of data must be manipulated and computerization is a must.

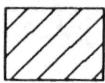
For more information on the use of livestock and poultry manure as fertilizer, contact the county Cooperative Extension Center and ask for Soil Fact Sheets, *Swine Manure as a Fertilizer Source*, AG-439-4, and *Poultry Manure as a Fertilizer Source*, AG-439-5.

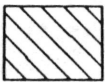
NORTH CAROLINA

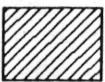
TOTAL MANURE

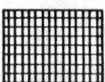
TONS/YR.

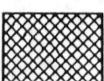
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 39652 to 76715

 76715 to 117429

 117429 to 185370

 185370 to 267005

 267005 to 1299668

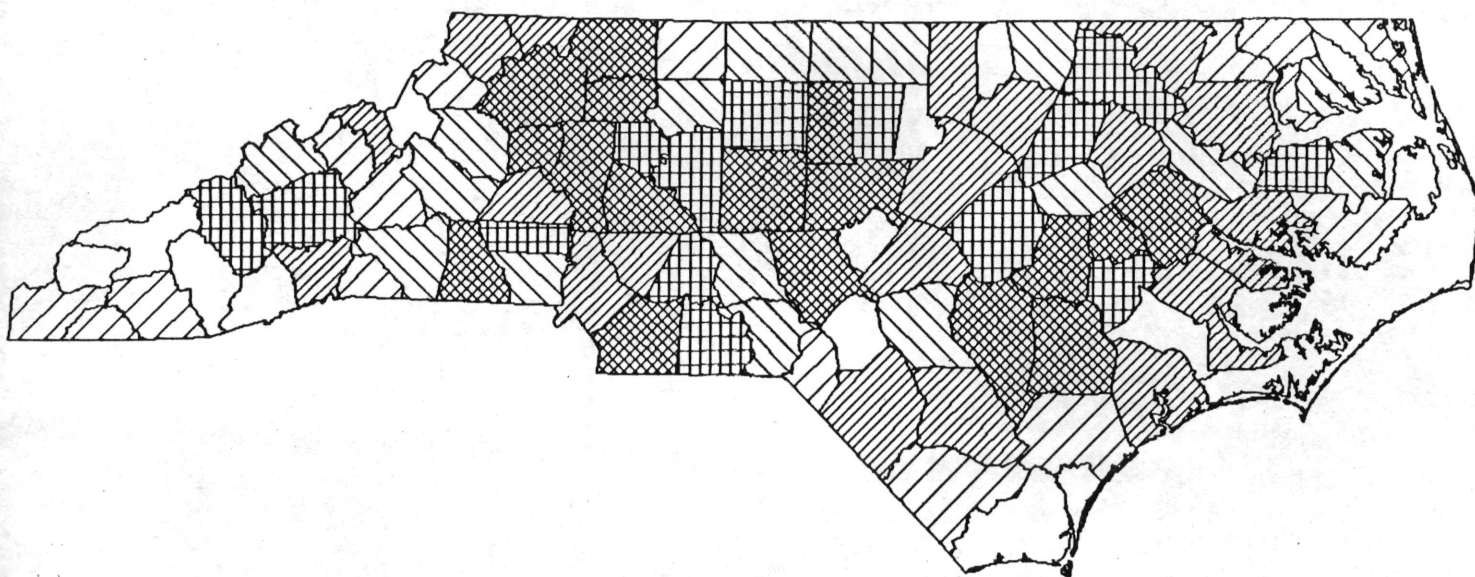


Figure 1

Nitrogen Available From Manure

For Field Crops and Pasture Land

% of Req.

0 to 20

20 to 40

40 to 60

60 to 75

75 to 100

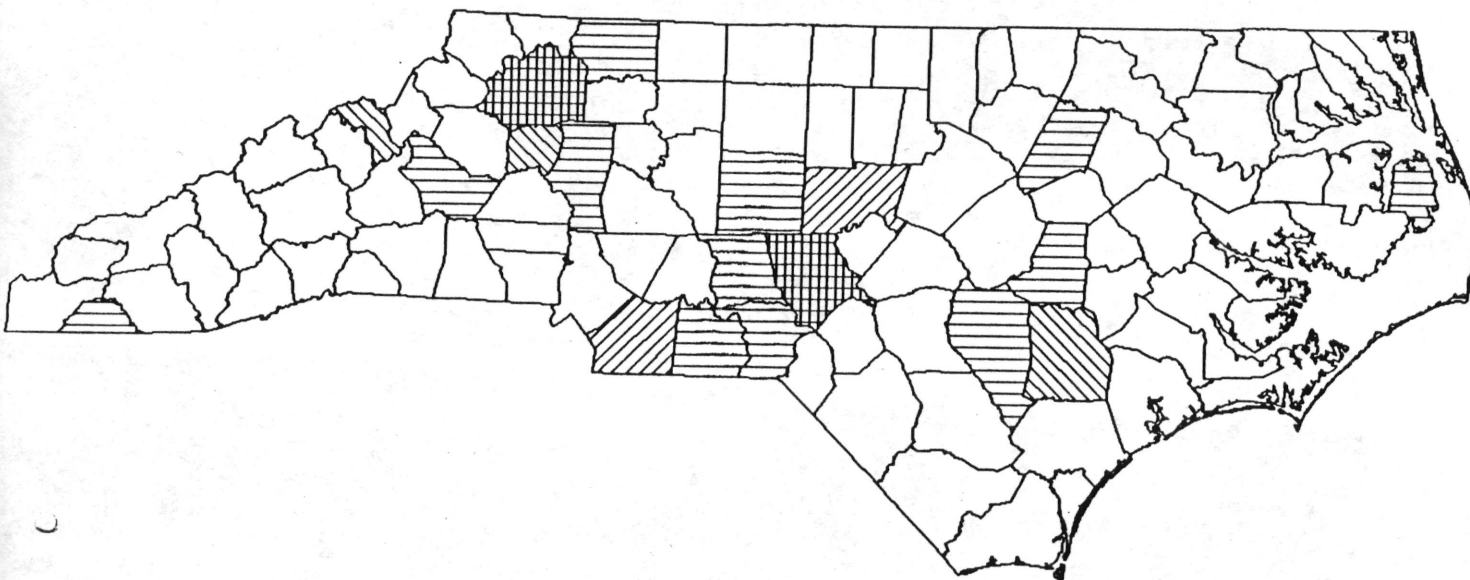


Figure 2

Phosphate Available from Manure

For Field Crops and Pasture Land

Percent of Requirement

0 to 25

25 to 50

50 to 75

75 to 100

100 to 350

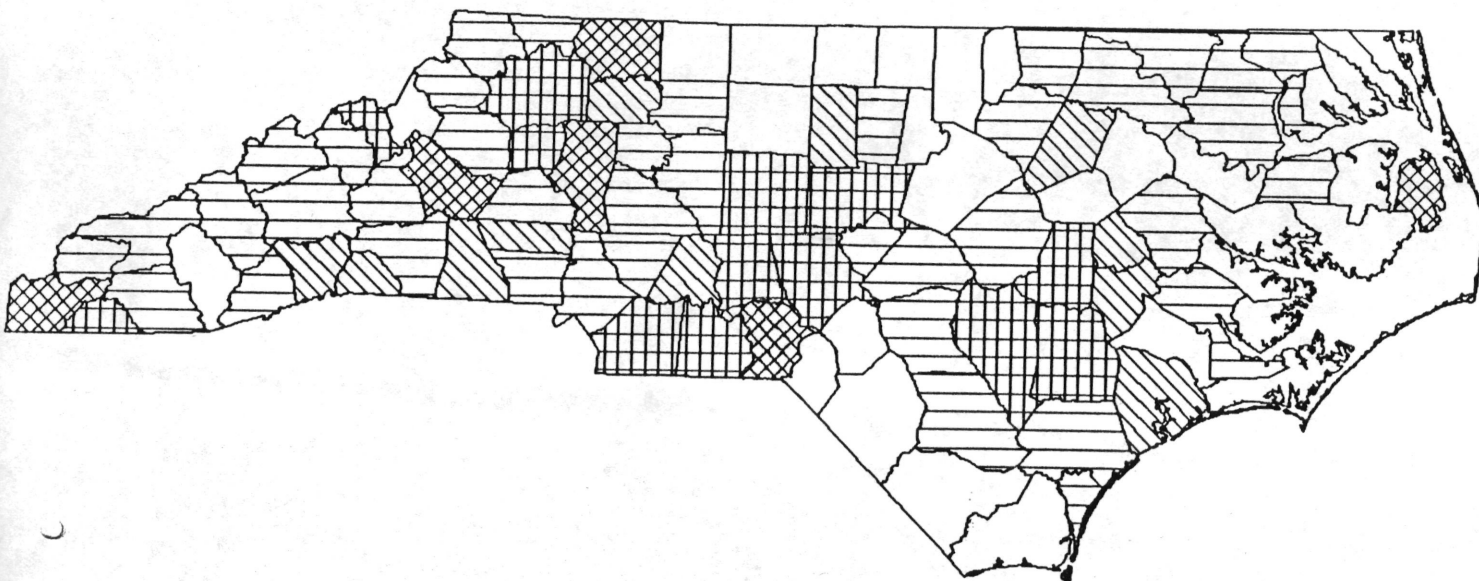


Figure 3

Nitrogen Required

After Manure and Commercial Fertilizer

Tons/Year

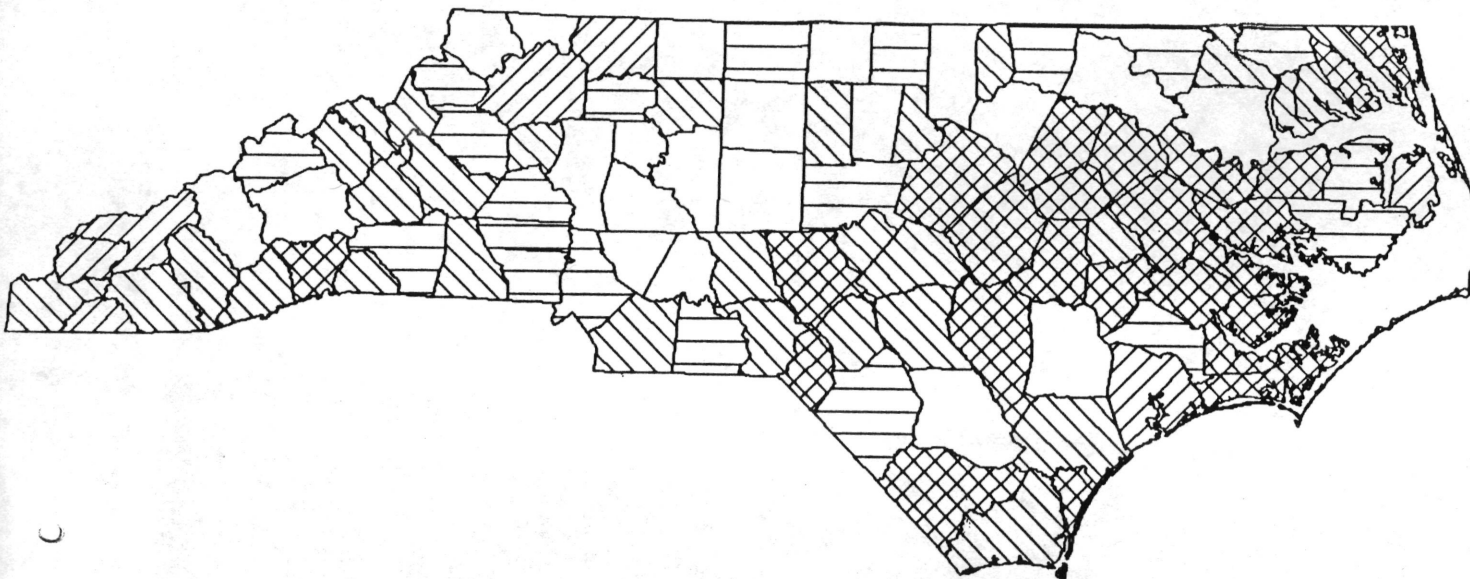
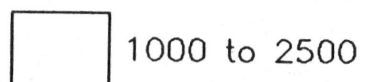
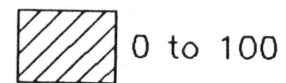
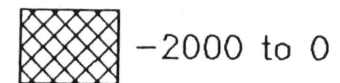
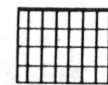


Figure 4

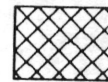
Phosphate Required

After Manure and Commercial Fertilizer

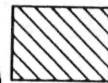
Tons/Year



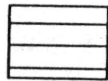
-2700 to 0



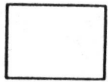
0 to 500



500 to 1000



1000 to 2000



2000 to 2600

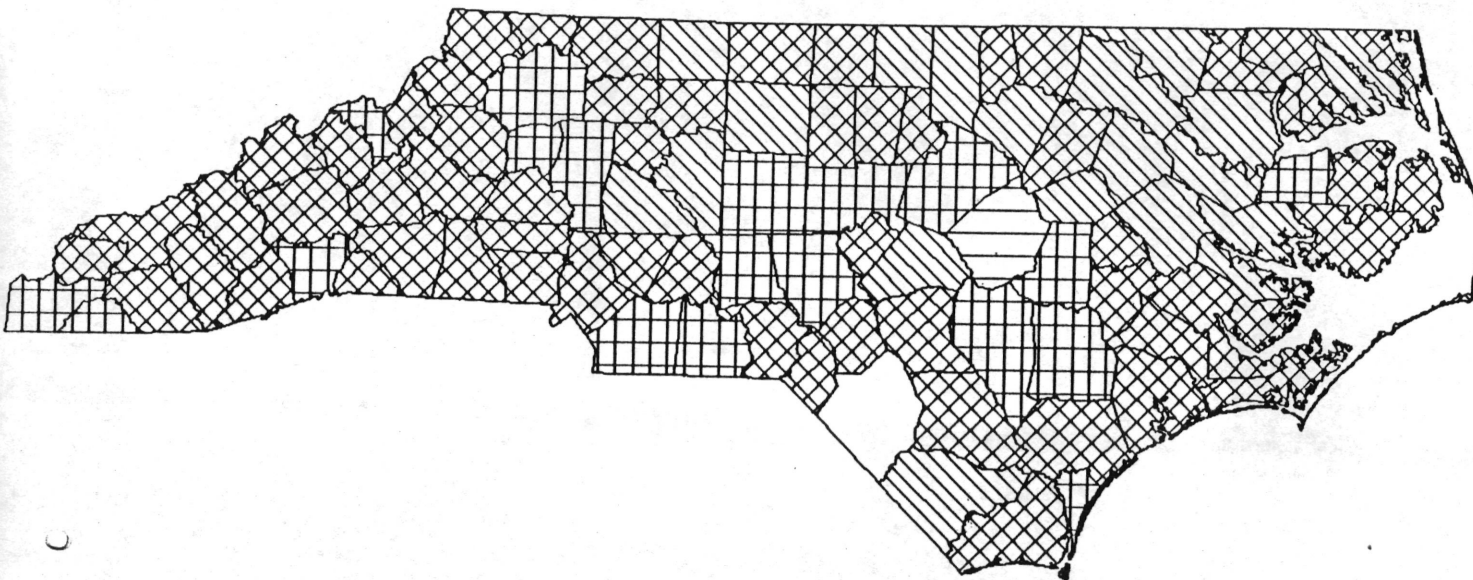


Figure 5

MANURE
NITROGEN BALANCE

COUNTY	CROP REQ.	N AVAIL.	N STILL REQ.	REQ. N
	FOR N (TONS/YR)	FROM MANU (TONS/YR)	AFTER COLL FROM MANU (TONS.YR)	SUPPLIED B COLL. MANU (PERCENT)
MOORE	906.23	839.85	66.38	92.68
WILKES	1887.83	1678.32	209.51	88.90
MITCHELL	384.40	242.96	141.44	63.20
ALEXANDER	1237.68	773.68	464.00	62.51
DUPLIN	4204.58	2578.61	1625.96	61.33
CHATHAM	2195.63	978.71	1216.92	44.58
UNION	4815.13	1991.38	2823.75	41.36
CLAY	241.30	96.05	145.25	39.81
RANDOLPH	3104.23	1053.47	2050.76	33.94
MONTGOMER	598.53	201.36	397.17	33.64
SAMPSON	4827.58	1438.52	3389.06	29.80
WAYNE	4062.78	1158.79	2903.99	28.52
DARE	64.50	17.93	46.57	27.80
ANSON	1739.18	463.38	1275.80	26.64
RICHMOND	757.63	194.60	563.03	25.69
SURRY	2209.58	549.65	1659.93	24.88
IREDELL	3994.68	953.51	3041.17	23.87
BURKE	691.25	146.87	544.38	21.25
NASH	2234.95	473.43	1761.52	21.18
LINCOLN	1548.88	298.91	1249.97	19.30
ALAMANCE	2321.10	442.98	1878.12	19.08
CHEROKEE	520.55	96.60	423.95	18.56
GREENE	2648.60	490.32	2158.28	18.51
CLEVELAND	2274.13	412.06	1862.07	18.12
LENOIR	3204.83	513.80	2691.03	16.03
ONslow	1279.80	198.32	1081.48	15.50
YADKIN	2495.60	381.76	2113.84	15.30
POLK	334.68	50.88	283.80	15.20
HENDERSON	1166.53	174.44	992.09	14.95
ORANGE	1761.63	251.46	1510.17	14.27
STANLY	3169.55	445.06	2724.49	14.04
MECKLENBUR	1049.05	142.13	906.92	13.55
CALDWELL	868.92	117.45	751.47	13.52
ROWAN	3044.66	403.55	2641.11	13.25
DAVIE	2053.55	271.41	1782.14	13.22
HAYWOOD	1679.73	218.69	1461.04	13.02
GASTON	1001.58	125.99	875.59	12.58
WASHINGTON	2624.83	325.72	2299.11	12.41

MANURE
NITROGEN BALANCE

COUNTY	CROP REQ. FOR N (TONS/YR)	N AVAIL. FROM MANU (TONS/YR)	N STILL REQ. AFTER COLL FROM MANU (TONS.YR)	REQ. N SUPPLIED B COLL. MANU (PERCENT)
ASHE	2104.55	242.96	1861.59	11.54
BUNCOMBE	2280.55	262.14	2018.41	11.49
WARREN	1338.95	153.05	1185.90	11.43
FRANKLIN	2365.00	267.84	2097.16	11.33
CATAWBA	1698.63	190.22	1508.41	11.20
ALLEGHANY	2198.55	242.96	1955.59	11.05
HARNETT	2211.68	242.96	1968.72	10.99
NORTHAMPTO	2128.35	229.96	1898.39	10.80
RUTHERFORD	1078.98	114.63	964.35	10.62
PITT	4362.73	460.28	3902.45	10.55
MCDOWELL	518.95	54.66	464.29	10.53
HALIFAX	3375.18	343.74	3031.44	10.18
DAVIDSON	2422.45	244.57	2177.88	10.10
BERTIE	2869.95	288.21	2581.74	10.04
CABARRUS	1992.18	199.08	1793.10	9.99
WATAUGA	1013.98	98.45	915.53	9.71
MACON	623.78	60.54	563.24	9.71
LEE	579.75	55.96	523.79	9.65
NEW HANOVE	188.03	18.11	169.92	9.63
FORSYTH	1117.38	105.69	1011.69	9.46
JOHNSTON	3685.38	340.67	3344.71	9.24
TRANSYLVANI	383.58	34.91	348.67	9.10
SWAIN	120.45	10.92	109.53	9.07
GRAHAM	121.30	10.92	110.38	9.00
WAKE	1663.95	148.84	1515.11	8.94
HERTFORD	1256.20	109.71	1146.49	8.73
CRAVEN	1821.83	151.93	1669.90	8.34
CHOWAN	985.50	81.31	904.19	8.25
GATES	1358.93	111.65	1247.28	8.22
GUILFORD	2841.90	233.33	2608.57	8.21
YANCEY	593.35	47.47	545.88	8.00
PENDER	1118.75	87.53	1031.22	7.82
CUMBERLAND	1761.10	136.74	1624.36	7.76
MADISON	1490.38	114.14	1376.24	7.66
BLADEN	2340.88	172.40	2168.48	7.36
EDGECOMBE	3225.75	225.83	2999.92	7.00
SCOTLAND	1260.98	87.86	1173.12	6.97
PERQUIMANS	1863.50	125.78	1737.72	6.75

MANURE
NITROGEN BALANCE

COUNTY	CROP REQ. FOR N (TONS/YR)	N AVAIL. FROM MANU (TONS/YR)	N STILL REQ. AFTER COLL FROM MANU (TONS.YR)	REQ. N SUPPLIED B COLL. MANU (PERCENT)
GRANVILLE	2573.80	172.20	2401.60	6.69
CURRITUCK	1031.48	68.26	963.22	6.62
CASWELL	1511.53	97.66	1413.87	6.46
ROCKINGHAM	1894.25	114.89	1779.36	6.07
JACKSON	373.55	22.61	350.94	6.05
BRUNSWICK	811.85	47.29	764.56	5.82
WILSON	2642.18	147.01	2495.17	5.56
MARTIN	2536.90	138.54	2398.36	5.46
PERSON	1989.83	106.93	1882.90	5.37
TYRRELL	2131.75	111.67	2020.08	5.24
STOKES	1531.58	79.62	1451.96	5.20
VANCE	722.55	37.07	685.48	5.13
DURHAM	604.65	28.60	576.05	4.73
HOKE	1257.38	48.28	1209.10	3.84
BEAUFORT	5004.10	191.89	4812.21	3.83
AVERY	399.10	15.14	383.96	3.79
CARTERET	975.00	35.47	939.53	3.64
PAMLICO	1014.68	34.56	980.12	3.41
JONES	1496.65	41.75	1454.90	2.79
ROBESON	7022.60	182.93	6839.67	2.60
COLUMBUS	3225.63	83.38	3142.25	2.58
CAMDEN	1380.35	25.65	1354.70	1.86
HYDE	3224.78	58.76	3166.02	1.82
PASQUOTANK	2149.08	36.08	2113.00	1.68

TOTAL 187170

NITROGEN BALANCE
 MANURE + COMMERCIAL FERTILIZER

COUNTY	COMMERCIAL PURCH. N (TONS/YR.)	(-) = SURPLUS
		N BALANCE AFTER MANURE AND COMM. FER (TONS/YR)
DUPLIN	3847.92	-2221.96
BEAUFORT	6777.21	-1965.00
LENOIR	4641.27	-1950.25
WAYNE	4810.07	-1906.08
SAMPSON	5115.72	-1726.67
NASH	2880.16	-1118.64
WASHINGTON	3378.43	-1079.32
CRAVEN	2321.21	-651.32
MARTIN	3030.18	-631.82
CARTERET	1548.95	-609.42
SCOTLAND	1745.62	-572.50
PASQUOTANK	2679.68	-566.68
EDGECOMBE	3530.59	-530.67
WILSON	2999.96	-504.80
MOORE	462.34	-395.97
NEW HANOVE	467.33	-297.41
JOHNSTON	3630.72	-286.01
WAKE	1614.93	-99.82
CURRITUCK	1062.81	-99.60
PITT	3940.60	-38.15
PAMLICO	1005.16	-25.04
HENDERSON	1015.46	-23.37
COLUMBUS	3165.49	-23.24
WILKES	183.71	25.80
DARE	9.12	37.45
CLAY	79.48	65.77
ONSLOW	999.65	81.83
SWAIN	22.25	87.28
GRAHAM	22.63	87.75
SURRY	1566.11	93.82
MITCHELL	25.96	115.48
MONTGOMER	275.98	121.18
POLK	158.65	125.15
ALAMANCE	1737.96	140.16
MCDOWELL	300.44	163.85
PENDER	866.59	164.63
FORSYTH	844.69	167.00

NITROGEN BALANCE
 MANURE + COMMERCIAL FERTILIZER

COUNTY	COMMERCIAL PURCH. N (TONS/YR.)	(-) = SURPLUS
		N BALANCE AFTER MANURE AND COMM. FER (TONS/YR)
ALEXANDER	292.02	171.98
GREENE	1946.40	211.88
RICHMOND	324.09	238.94
CHEROKEE	180.55	243.40
DURHAM	319.19	256.86
BRUNSWICK	502.95	261.61
HOKE	942.52	266.58
TRANSYLVANI	78.45	270.22
LEE	247.21	276.58
JACKSON	54.48	296.46
VANCE	384.61	300.87
CHOWAN	591.28	312.91
AVERY	62.32	321.64
MACON	237.56	325.68
CAMDEN	1017.42	337.28
CUMBERLAND	1264.37	359.99
HERTFORD	771.06	375.43
YANCEY	161.73	384.15
PERQUIMANS	1343.72	394.00
BURKE	146.02	398.36
HARNETT	1536.95	431.77
UNION	2380.05	443.69
CLEVELAND	1388.38	473.69
GASTON	366.38	509.21
MECKLENBUR	335.91	571.01
CALDWELL	165.80	585.67
LINCOLN	659.84	590.12
GATES	640.94	606.33
TYRRELL	1380.66	639.42
JONES	812.82	642.08
CHATHAM	554.78	662.14
NORTHAMPTO	1176.01	722.38
MADISON	610.84	765.39
RUTHERFORD	183.20	781.15
ANSON	467.99	807.81
WATAUGA	88.88	826.65
WARREN	342.63	843.27

NITROGEN BALANCE
 MANURE + COMMERCIAL FERTILIZER

(-) = SURPLUS
 N BALANCE

COUNTY	COMMERCIAL PURCH. N (TONS/YR.)	AFTER MANURE AND COMM. FER (TONS/YR)
HYDE	2302.64	863.38
CATAWBA	629.84	878.57
PERSON	957.84	925.06
ROCKINGHAM	836.11	943.25
YADKIN	1167.61	946.23
ROBESON	5844.54	995.13
HALIFAX	2008.01	1023.43
ORANGE	449.82	1060.35
GUILFORD	1529.15	1079.42
HAYWOOD	372.48	1088.56
CASWELL	271.21	1142.66
BLADEN	1020.94	1147.54
FRANKLIN	940.82	1156.34
DAVIE	610.20	1171.94
CABARRUS	528.90	1264.20
BUNCOMBE	727.39	1291.02
STOKES	93.16	1358.80
RANDOLPH	676.05	1374.71
BERTIE	1194.36	1387.38
STANLY	1308.51	1415.98
DAVIDSON	703.44	1474.44
IREDELL	1409.41	1631.76
ASHE	175.46	1686.13
ALLEGHANY	185.81	1769.78
ROWAN	764.24	1876.87
GRANVILLE	336.00	2065.60

123,797.6

*all values
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MANURE PHOSPHORUS BALANCE

COUNTY	CROP REQ. FOR P (TONS/YR)	P AVAIL. FROM MANUR (TONS/YR)	P STILL REQ. AFTER COLL. FROM MANU (TONS/YR)	REQ. P SUPPLIED BY COLL. MANU (PERCENT)
WILKES	639.28	2199.86	-1560.59	344.12
MOORE	366.08	1106.82	-740.75	302.35
DUPLIN	1672.53	4134.21	-2461.69	247.18
MITCHELL	127.10	299.11	-172.01	235.33
ALEXANDER	431.98	996.90	-564.92	230.77
CHATHAM	779.38	1271.54	-492.17	163.15
CLAY	77.75	124.59	-46.84	160.24
UNION	1993.53	3117.33	-1123.81	156.37
RANDOLPH	1167.58	1357.37	-189.79	116.26
MONTGOMERY	237.18	273.16	-35.99	115.17
SAMPSON	1997.78	2230.12	-232.34	111.63
ANSON	664.58	740.93	-76.35	111.49
WAYNE	1697.13	1714.38	-17.26	101.02
DARE	23.75	22.87	0.88	96.29
RICHMOND	302.48	283.46	19.02	93.71
IREDELL	1356.23	1200.42	155.80	88.51
SURRY	839.58	687.52	152.06	81.89
CHEROKEE	172.70	140.08	32.62	81.11
BURKE	229.25	185.17	44.08	80.77
NASH	1028.90	728.71	300.19	70.82
GREENE	1090.35	747.08	343.27	68.52
CLEVELAND	863.33	576.77	286.56	66.81
LINCOLN	553.33	361.91	191.42	65.41
LENOIR	1311.58	841.30	470.28	64.14
ALAMANCE	874.20	534.58	339.62	61.15
ONslow	508.35	309.82	198.53	60.95
STANLY	1239.35	680.18	559.17	54.88
POLK	118.73	61.71	57.02	51.98
HENDERSON	359.93	186.61	173.32	51.85
YADKIN	952.20	477.74	474.46	50.17
CALDWELL	298.53	144.89	153.64	48.53
HAYWOOD	551.08	259.00	292.08	47.00
DAVIE	713.35	325.36	387.99	45.61
WASHINGTON	1037.88	469.88	568.00	45.27
ORANGE	652.38	285.73	366.65	43.80
ASHE	693.35	299.11	394.24	43.14
ALLEGHANY	709.90	299.11	410.79	42.13
ROWAN	1105.31	465.60	639.71	42.12
MECKLENBURG	380.35	160.21	220.14	42.12
BUNCOMBE	727.45	291.71	435.74	40.10

MANURE PHOSPHORUS BALANCE

COUNTY	CROP REQ. FOR P (TONS/YR)	P AVAIL. FROM MANUR (TONS/YR)	P STILL REQ. AFTER COLL. FROM MANU (TONS/YR)	REQ. P SUPPLIED BY COLL. MANU (PERCENT)
GASTON	355.98	141.63	214.35	39.79
RUTHERFORD	379.48	148.79	230.69	39.21
WARREN	528.40	202.26	326.14	38.28
MCDOWELL	170.15	64.97	105.18	38.18
FRANKLIN	968.95	367.69	601.26	37.95
PITT	1897.33	711.55	1185.78	37.50
WATAUGA	336.23	122.80	213.43	36.52
TRANSYLVANIA	122.63	44.63	78.00	36.40
CATAWBA	624.38	224.30	400.08	35.92
BERTIE	1088.65	387.04	701.61	35.55
SWAIN	39.20	13.93	25.27	35.54
CABARRUS	742.48	262.10	480.38	35.30
GRAHAM	39.90	13.93	25.97	34.91
MACON	207.68	71.82	135.86	34.58
NEW HANOVER	71.18	23.98	47.20	33.69
NORTHAMPTON	937.20	314.88	622.32	33.60
HALIFAX	1468.23	477.51	990.72	32.52
DAVIDSON	909.90	292.61	617.29	32.16
JOHNSTON	1614.13	499.44	1114.69	30.94
CRAVEN	739.43	225.45	513.98	30.49
HARNETT	990.68	299.11	691.57	30.19
FORSYTH	424.63	127.95	296.68	30.13
LEE	249.90	74.65	175.25	29.87
PENDER	445.25	132.67	312.58	29.80
GATES	524.48	155.36	369.12	29.62
YANCEY	195.05	57.07	137.98	29.26
BLADEN	886.63	256.25	630.38	28.90
HERTFORD	504.15	144.36	359.79	28.63
MADISON	497.13	141.00	356.13	28.36
CHOWAN	431.50	115.88	315.62	26.86
CUMBERLAND	731.00	190.37	540.63	26.04
GUILFORD	1091.30	271.23	820.07	24.85
CURRITUCK	409.58	99.09	310.49	24.19
JACKSON	122.35	28.82	93.53	23.56
PERQUIMANS	741.25	174.28	566.97	23.51
SCOTLAND	558.33	128.79	429.54	23.07
EDGECOMBE	1403.25	320.78	1082.47	22.86
BRUNSWICK	325.95	68.61	257.34	21.05
GRANVILLE	1015.10	212.20	802.90	20.90
WAKE	891.65	185.08	706.57	20.76

MANURE PHOSPHORUS BALANCE

COUNTY	CROP REQ. FOR P (TONS/YR)	P AVAIL. FROM MANUR (TONS/YR)	P STILL REQ. AFTER COLL. FROM MANU (TONS/YR)	REQ. P SUPPLIED BY COLL. MANU (PERCENT)
TYRRELL	840.25	169.55	670.70	20.18
CASWELL	612.18	119.12	493.06	19.46
WILSON	1179.83	220.24	959.59	18.67
MARTIN	1031.55	192.48	839.07	18.66
ROCKINGHAM	786.00	138.99	647.01	17.68
PERSON	803.78	139.36	664.42	17.34
STOKES	613.78	101.26	512.52	16.50
DURHAM	243.30	36.57	206.73	15.03
AVERY	131.95	19.31	112.64	14.63
BEAUFORT	2048.25	288.45	1759.80	14.08
VANCE	338.10	46.90	291.20	13.87
HOKE	543.13	72.31	470.82	13.31
CARTERET	378.25	47.45	330.80	12.54
PAMLICO	423.48	48.38	375.10	11.42
JONES	594.15	61.72	532.43	10.39
COLUMBUS	1309.38	120.93	1188.45	9.24
ROBESON	2963.20	268.84	2694.36	9.07
YDE	1231.43	85.31	1146.12	6.93
CAMDEN	551.70	37.45	514.25	6.79
PASQUOTANK	895.43	50.82	844.61	5.68

73,779

PHOSPHORUS BALANCE
 MANURE & COMMERCIAL FERTILIZER

(-) = SURFACE
 P BALANCE

COUNTY	COMMERCIAL PURCH. P (TONS/YR)	AFTER MANURE AND COMM. FER (TONS/YR)
DUPLIN	164	-2625.69
UNION	639.76	-1763.57
WILKES	71.16	-1631.75
MOORE	10.16	-750.91
SAMPSON	429.04	-661.38
ALEXANDER	25.18	-590.10
CHATHAM	68.8	-560.97
RANDOLPH	171.8	-361.59
IREDELL	467.52	-311.72
WAYNE	252.84	-270.10
WAKE	928.84	-222.27
ANSON	141.56	-217.91
MITCHELL	9.78	-181.79
WASHINGTON	621.34	-53.34
CLAY	6.48	-53.32
MONTGOMERY	4.08	-40.07
HENDERSON	196.38	-23.07
CHEROKEE	53.08	-20.46
NEW HANOVER	48.96	-1.76
DARE	0	0.88
BURKE	41.02	3.06
RICHMOND	4.26	14.76
SWAIN	6.48	18.79
GRAHAM	5	20.97
JACKSON	69.5	24.03
STANLY	534.92	24.25
POLK	17.46	39.55
BUNCOMBE	395.3	40.44
ALAMANCE	293.2	46.42
HAYWOOD	237.86	54.22
TRANSYLVANIA	21.42	56.58
AVERY	52.94	59.70
SURRY	78.12	73.94
LINCOLN	113.42	78.00
MCDOWELL	14.52	90.66
YANCEY	33.9	104.08
MACON	28.94	106.92
CASTON	104.66	109.69

PHOSPHORUS BALANCE
 MANURE & COMMERCIAL FERTILIZER

COUNTY	(-) = SURFACE P BALANCE	
	COMMERCIAL PURCH. P (TONS/YR)	AFTER MANURE AND COMM. FER (TONS/YR)
CLEVELAND	158.5	128.06
ONslow	52.6	145.93
CALDWELL	7.38	146.26
MECKLENBURG	68.54	151.60
CHOWAN	161.1	154.52
LEE	4.36	170.89
WATAUGA	33.68	179.75
CRAVEN	321.6	192.38
DURHAM	11.82	194.91
PAMLICO	168.66	206.44
PERQUIMANS	357.3	209.67
RUTHERFORD	8.96	221.73
CARTERET	101.6	229.20
ASHE	159.6	234.64
HERTFORD	121.64	238.15
WAKE	231.02	239.80
BRUNSWICK	17.5	239.84
ALLEGHANY	165.06	245.73
NASH	54.36	245.83
FORSYTH	29.74	266.94
VANCE	18.04	273.16
PENDER	32.54	280.04
CURRITUCK	19.38	291.11
MADISON	61.2	294.93
GATES	73.9	295.22
WARREN	13.8	312.34
SCOTLAND	108.78	320.76
DAVIE	63.88	324.11
GREENE	11.24	332.03
ROCKINGHAM	313	334.01
TYRRELL	325.96	344.74
CATAWBA	44.18	355.90
ORANGE	5.58	361.07
LENOIR	104.4	365.88
JONES	129.1	403.33
YADKIN	61.66	412.80
HYDE	725.38	420.74
CABARRUS	41.94	438.44

PHOSPHORUS BALANCE
 MANURE & COMMERCIAL FERTILIZER

(-) = SURFACE
 P BALANCE

COUNTY	COMMERCIAL PURCH. P (TONS/YR)	AFTER MANURE AND COMM. FER (TONS/YR)
CUMBERLAND	71.98	468.65
BLADEN	154	476.38
CASWELL	0.46	492.60
STOKES	12.32	500.20
CAMDEN	6.82	507.43
HALIFAX	452.82	537.90
NORTHAMPTON	77.76	544.56
FRANKLIN	48.8	552.46
GUILFORD	261.56	558.51
ROWAN	68.74	570.97
DAVIDSON	15.04	602.25
PERSON	50.64	613.78
BERTIE	78.86	622.75
HARNETT	26.86	664.71
PASQUOTANK	130.2	714.41
MARTIN	121.24	717.83
WILSON	239.24	720.35
GRANVILLE	5.98	796.92
PITT	272.36	913.42
BEAUFORT	843.18	916.62
EDGECOMBE	123.02	959.45
COLUMBUS	226.48	961.97
JOHNSTON	111.16	1003.53
ROBESON	155.16	2539.20

14,315

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MANURE POTASSIUM BALANCE

COUNTY	CROP REQ. FOR K (TONS/YR)	K AVAIL. FROM MANURE (TONS/YR)	K STILL REQ. AFTER COLL FROM MANU (TONS/YR)	REQ. K SUPPLIED BY COLL. MANU (PERCENT)
MITCHELL	127.10	247.22	-120.12	194.51
WILKES	639.28	1209.43	-570.16	189.19
ALAMANCE	274.20	448.19	-173.99	163.45
MOORE	366.08	594.67	-228.59	162.44
ALEXANDER	431.98	606.18	-174.20	140.33
CLAY	77.75	92.84	-15.09	119.41
DUPLIN	1672.53	1983.96	-311.44	118.62
CHATHAM	779.38	793.51	-14.13	101.81
DARE	23.75	20.69	3.06	87.12
RANDOLPH	1167.58	860.63	306.95	73.71
UNION	1993.53	1433.06	560.47	71.89
MONTGOMER	237.18	167.13	70.05	70.47
IREDELL	1356.23	890.79	465.44	65.68
SAMPSON	1997.78	1288.74	709.04	64.51
SURRY	839.58	494.50	345.08	58.90
HENDERSON	359.93	202.01	157.92	56.13
BURKE	229.25	124.22	105.03	54.19
ANSON	664.58	357.11	307.47	53.74
WAYNE	1697.13	876.60	820.53	51.65
LINCOLN	553.33	280.23	273.10	50.64
CHEROKEE	172.70	84.60	88.10	48.99
RICHMOND	302.48	145.79	156.69	48.20
POLK	118.73	56.05	62.68	47.21
HAYWOOD	551.08	254.85	296.23	46.25
CLEVELAND	863.33	387.04	476.29	44.83
GREENE	1090.35	478.98	611.37	43.93
ORANGE	652.38	284.66	367.72	43.63
MECKLENBUR	380.35	163.09	217.26	42.88
BUNCOMBE	727.45	304.42	423.03	41.85
DAVIE	713.35	290.74	422.61	40.76
GASTON	355.98	143.19	212.79	40.22
ROWAN	1105.31	442.33	662.98	40.02
YADKIN	952.20	366.22	585.98	38.46
CALDWELL	298.53	112.04	186.49	37.53
ONSLOW	508.35	183.93	324.42	36.18
ASHE	693.35	247.22	446.13	35.66
MCDOWELL	170.15	59.81	110.34	35.15
ALLEGHANY	709.90	247.22	462.68	34.82
NASH	1028.90	349.54	679.36	33.97
MACON	207.68	70.27	137.41	33.84

MANURE POTASSIUM BALANCE

COUNTY	CROP REQ. FOR K (TONS/YR)	K AVAIL. FROM MANURE (TONS/YR)	K STILL REQ. AFTER COLL FROM MANU (TONS/YR)	REQ. K SUPPLIED BY COLL. MANU (PERCENT)
CATAWBA	624.38	209.57	414.81	33.56
TRANSYLVANI	122.63	40.44	82.19	32.98
RUTHERFORD	379.48	124.17	255.31	32.72
SWAIN	39.20	12.40	26.80	31.63
STANLY	1239.35	385.70	853.65	31.12
GRAHAM	39.90	12.40	27.50	31.08
LENOIR	1311.58	404.24	907.34	30.82
WATAUGA	336.23	102.76	233.47	30.56
DAVIDSON	909.90	266.62	643.28	29.30
WASHINGTON	1037.88	301.83	736.05	29.08
FORSYTH	424.63	122.71	301.92	28.90
CABARRUS	742.48	213.74	528.74	28.79
WARREN	528.40	149.68	378.72	28.33
YANCEY	195.05	55.06	139.99	28.23
NEW HANOVE	71.18	20.03	51.15	28.14
MADISON	497.13	133.16	363.97	26.79
FRANKLIN	968.95	243.74	725.21	25.16
HARNETT	990.68	247.22	743.46	24.95
GUILFORD	1091.30	266.24	825.06	24.40
HALIFAX	1468.23	337.05	1131.18	22.96
JACKSON	122.35	26.11	96.24	21.34
PITT	1897.33	401.50	1495.83	21.16
CRAVEN	739.43	156.24	583.19	21.13
JOHNSTON	1614.13	339.49	1274.64	21.03
NORTHAMPTO	937.20	190.91	746.29	20.37
BERTIE	1088.65	220.72	867.93	20.27
LEE	249.90	50.62	199.28	20.26
GRANVILLE	1015.10	193.35	821.75	19.05
GATES	524.48	99.09	425.39	18.89
WAKE	891.65	168.08	723.57	18.85
PENDER	445.25	83.74	361.51	18.81
BLADEN	886.63	163.36	723.27	18.42
CASWELL	612.18	112.39	499.79	18.36
CHOWAN	431.50	78.70	352.80	18.24
CUMBERLAND	731.00	130.95	600.05	17.91
CURRITUCK	409.58	72.06	337.52	17.59
HERTFORD	504.15	84.55	419.60	16.77
ROCKINGHAM	786.00	131.72	654.28	16.76
SCOTLAND	558.33	90.40	467.93	16.19
BRUNSWICK	325.95	49.27	276.68	15.12

MANURE POTASSIUM BALANCE

COUNTY	CROP REQ. FOR K (TONS/YR)	K AVAIL. FROM MANURE (TONS/YR)	K STILL REQ. AFTER COLL FROM MANU (TONS/YR)	REQ. K SUPPLIED BY COLL. MANU (PERCENT)
STOKES	613.78	91.90	521.88	14.97
PERSON	803.78	120.10	683.68	14.94
PERQUIMANS	741.25	109.42	631.83	14.76
EDGECOMBE	1403.25	194.24	1209.01	13.84
TYRRELL	840.25	113.96	726.29	13.56
AVERY	131.95	17.72	114.23	13.43
DURHAM	243.30	32.51	210.79	13.36
VANCE	338.10	41.35	296.75	12.23
MARTIN	1031.55	122.30	909.25	11.86
WILSON	1179.83	127.22	1052.61	10.78
CARTERET	378.25	38.15	340.10	10.09
BEAUFORT	2048.25	196.78	1851.47	9.61
HOKE	543.13	46.11	497.02	8.49
PAMLICO	423.48	35.83	387.65	8.46
JONES	594.15	41.24	552.91	6.94
COLUMBUS	1309.38	88.21	1221.17	6.74
ROBESON	2963.08	192.02	2771.06	6.48
HYDE	1231.43	60.60	1170.83	4.92
CAMDEN	551.70	26.47	525.23	4.80
PASQUOTANK	895.43	38.64	856.79	4.32

73172.9

POTASSIUM BALANCE
 MANURE & COMMERCIAL FERTILIZER

(-) = SURPLUS
 K BALANCE

COUNTY	COMMERCIAL PURCH. K (TONS/YR)	AFTER MANURE AND COMM. FER (TONS/YR)
DUPLIN	1083.2	-1394.64
ALAMANCE	901.7	-1075.69
SAMPSON	1411.04	-702.00
MOORE	448.64	-677.24
WAYNE	1487.48	-666.96
WILKES	20.52	-590.68
WASHINGTON	1296.02	-559.97
HALIFAX	1675.48	-544.31
CARTERET	815.14	-475.04
SCOTLAND	782.94	-315.02
BERTIE	1109.96	-242.03
UNION	789.6	-229.13
HERTFORD	639.04	-219.44
ALEXANDER	31.3	-205.50
JOHNSTON	1471.16	-196.53
HENDERSON	336.04	-178.13
GATES	575.2	-149.82
PITT	1643.96	-148.14
MITCHELL	0	-120.12
CHATHAM	64.48	-78.62
NEW HANOVE	75.92	-24.77
JONES	577.54	-24.63
BEAUFORT	1871.86	-20.39
CLAY	1.38	-16.47
LENOIR	912.34	-5.00
DARE	1.2	1.86
IREDELL	463.26	2.17
PERQUIMANS	622.8	9.03
ONSLOW	303.64	20.78
SWAIN	4.84	21.96
CHEROKEE	63.44	24.66
GRAHAM	0.82	26.68
CRAVEN	549.34	33.84
CHOWAN	307.98	44.82
POLK	7.04	55.64
MONTGOMER	9.06	60.99
LINCOLN	206	67.10
JACKSON	22.12	74.12

POTASSIUM BALANCE
 MANURE & COMMERCIAL FERTILIZER

COUNTY	(-) = SURPLUS K BALANCE	
	COMMERCIAL PURCH. K (TONS/YR)	AFTER MANURE AND COMM. FER (TONS/YR)
TRANSYLVANI	6.28	75.91
BURKE	12.62	92.41
RICHMOND	55.32	101.37
MCDOWELL	6.7	103.64
AVERY	3.9	110.33
YANCEY	8.5	131.49
MACON	5.4	132.01
RANDOLPH	174.7	132.25
GASTON	72.74	140.05
ANSON	163.7	143.77
LEE	40.96	158.32
GREENE	446.46	164.91
CALDWELL	6.26	180.23
WILSON	863.4	189.21
CUMBERLAND	410.18	189.87
SURRY	144.02	201.06
MECKLENBUR	15.96	201.30
PAMLICO	186.04	201.61
DURHAM	6.2	204.59
ROCKINGHAM	444.62	209.66
NASH	464.74	214.62
HAYWOOD	74.08	222.15
HYDE	943.08	227.75
WATAUGA	5.66	227.81
PENDER	128.94	232.57
MARTIN	662.32	246.93
RUTHERFORD	5.4	249.91
BRUNSWICK	22	254.68
FORSYTH	39.38	262.54
BLADEN	449.5	273.77
VANCE	15.86	280.89
EDGECOMBE	920.42	288.59
TYRRELL	436.2	290.09
WAKE	419.58	303.99
MADISON	56.92	307.05
CLEVELAND	157.5	318.79
CURRITUCK	1.2	336.32
CATAWBA	63.6	351.21

POTASSIUM BALANCE
 MANURE & COMMERCIAL FERTILIZER

COUNTY	(-) = SURPLUS K BALANCE	
	COMMERCIAL PURCH. K (TONS/YR)	AFTER MANURE AND COMM. FER (TONS/YR)
ORANGE	16.24	351.48
PERSON	324.76	358.92
WARREN	4.76	373.96
DAVIE	36.88	385.73
HARNETT	354.68	388.78
BUNCOMBE	28.92	394.11
HOKE	102.74	394.28
COLUMBUS	801.3	419.87
ASHE	23.06	423.07
ALLEGHANY	33.02	429.66
CASWELL	8.3	491.49
STOKES	15.14	506.74
STANLY	344.08	509.57
CABARRUS	11.22	517.52
CAMDEN	6	519.23
GUILFORD	269.7	555.36
YADKIN	21.66	564.32
NORTHAMPTO	148.68	597.61
DAVIDSON	25.08	618.20
ROWAN	32.82	630.16
FRANKLIN	61.18	664.03
PASQUOTANK	136.6	720.19
GRANVILLE	8.92	812.83
ROBESON	644.7	2126.36

33,996