

FERTILITY OF SOILS OF HANCOCK COUNTY, INDIANA.

BY

R. H. CARR, H. S. COPELAND AND E. GENTZLER,

PURDUE UNIVERSITY.

There are at least six factors which are recognized as essential in crop production and all are thought to be of about equal importance; these are *light, moisture, temperature, seed, place for seed to grow, and sufficient food for its use*. Of these the one most easily controlled is the last mentioned or food for its use. There are at least ten food elements necessary to grow crops and of these sufficient carbon, hydrogen, oxygen and sulphur seem to be supplied naturally while iron is needed in small amounts from soils usually containing an abundant supply. The other five food elements nitrogen, phosphorus, calcium, magnesium and potassium are usually present in the soil in more limited quantities and are removed by cropping in a rotation to corn, wheat, oats and clover to the extent of about 75 lbs. of phosphorus, 160 lbs. of calcium, 318 lbs. of potassium, 65 lbs. of magnesium per rotation, and at least 150 lbs. of nitrogen for every 100 bu. of corn and its stalks.

The supply of potassium in the soil is usually 20,000 lbs. (per acre 6 $\frac{2}{3}$ m's) or more in all but the unusual soils. The amounts of calcium and magnesium vary from 8,000 to 10,000 lbs. per acre whereas the amount of phosphorus is much more limited varying from 1,000 to 3,000 lbs. per acre and is usually the limiting factor in the production of crops. Nitrogen also is a very important element in crop production and is present in soils to the extent of 1,000 to 5,000 lbs. per acre. It too is often a limiting factor and one of the most expensive to replace unless returned through the aid of legume crops instead of commercial fertilizers. Thus it will be evident that only the system of farming which returns as much to the soil as the crops remove can be considered good farming and anything less must be termed "mining". A chemical invoice of part of the plant food in Hancock County, Indiana, has just been made, and is reported here.

Plan of Procedure.

One hundred representative soils were collected in the usual way in August, 1918, by Mr. Copeland and after being air dried were ground and analyses were made for total nitrogen, total phosphorus, volatile matter, amount of calcium or magnesium present as carbonate, acidity to litmus, and solubility of soil in dilute nitric acid. The carbon dioxide determination was made by treating 20 grams of soil with 10 per cent hydrochloric acid in such a manner that the volume of gas evolved could be determined. The data obtained from the above is contained in the tables which follow.

Discussion and Summary.

The data is so arranged as to put in one group all soils containing approximately the same organic content. This has been found desirable because

it seems to classify a soil more accurately than any other single factor investigated. It will be noted from all tables that the nitrogen, phosphorus, acid soluble matter and crop yield increase as the per cent of organic matter increases.

The plant food soluble in dilute acid (n/5) is 1.98 per cent for soils in table 1 having a volatile content of 2 to 3% whereas that for table 7 containing 10% or over averages 7.83% soluble in this acid, besides the latter shows a high corn yield compared with that shown in tables 1 and 2.

It will be noted that nearly all soils produced some carbon dioxide gas (4 to 6 c. c.) when treated with hydrochloric acid including those slightly acid to litmus. This indicates that a small evolution of gas when treated with acid does not prove the soil is not acid as is often noted in the literature.

It will be noted also from tables 1, 2 and 3 containing low organic matter that the soils most acid to litmus belong in these three groups and embrace about 70 per cent of the total. In comparing the nitrogen content of the different groups of soils noted in tables 1 to 7 with that of counties previously reported in the Proceedings it is found that the *clay soils* with a volatile content of 0 to 4% contain the following amounts of nitrogen in lbs. per acre for the different counties. Elkhart County 2,049, Allen County 3,667, Hancock County 2,779, and Cass County 1,743.

Where the *clay loams* predominate with a volatile content of 4 to 6% Elkhart County contained 2,553 lbs. of nitrogen per acre, Allen County 3,985 lbs., Hancock County 3,372 and Cass County 2,700.

The *loam soils* with a volatile content varying from 6 to 10% were higher still—Elkhart County soils contained 4,213 lbs. per acre, Allen County 5,305, Hancock 5,259, and Cass County 4,411. The above figures were obtained from the analyses of over 400 samples of soils representing all townships in each of the counties.

RELATION OF PLANT FOOD CONTENT TO CORN YIELD

*Relation of volatile matter,
acid sol. matter, nitrogen, and phosphorus to crop yield*

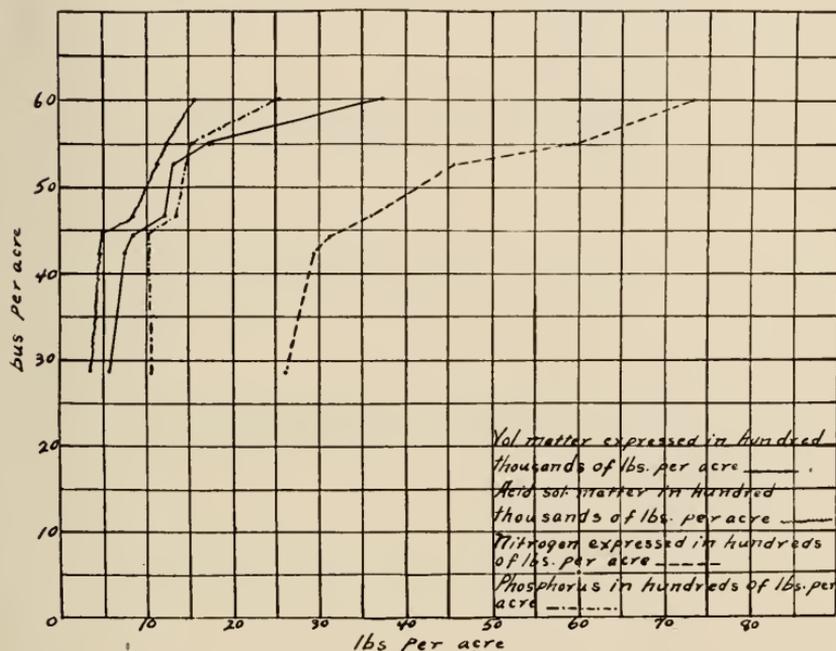


TABLE 1
Volatile matter 2-3%.

5 B.....WA*	45	2.21	2081.	837.	1.41	1.01	10.5
IV.....Y*	15	2.58	2595	975.	2.26	0.70	4.5
5 Br.....Y*	15	2.97	3115	1542.	2.48	0.45	..
12 Br. Sur.....Y*	50?	2.95	2742.	917.	1.77	0.25	4.5
Average.....	28.7	2.68	2634.	1068.	1.98	0.602	6.5

A = Acid.

X = Neutral or Slightly Acid.

Y = Basic.

TABLE 2.
Volatile Matter 3-4%

Soil Sample	Bu. Corn Per A	Per Cent Volatile Matter	Lbs. (N) Per A. 6 $\frac{2}{3}$ In.	Lbs. (2) Per P. 6 $\frac{2}{3}$ In.	Per Cent N $\frac{5}{5}$ HNO $\frac{3}{3}$ Sol. Matter	C. C. of N $\frac{5}{5}$ HNO $\frac{3}{3}$ Neut. by 1 gram soil	C. C. of CO $\frac{2}{2}$ from 20 gram soil	
4 J	X	50	3 80	2635	936	2 63	0 60	7 0
1 BC	Y	20	3 43	2375	870	3 64	0 20	8 0
8 BC	X	50	3 53	3625	1580	6 85	1 61	4 0
6 G	A	60	3 98	4280	1310	3 70	1 11	10 0
8 G	A	50	3 53	4046	1136	2 40	0 75	
4 Br.	Y	60	3 82	3547	1009	1 48	0 15	5 0
10 Br.	X	25	3 49	3815	1198	2 38	0 70	4 0
11 Br.	Y	25	3 75	2614	1136	2 27	0 30	4 0
12 Br Sub.	Y		3 55	2749	964	2 01	0 35	4 5
8 S.C.	A	20	3 79	2260	825	2 00	0 65	
4 V	Y	35	2 71	2509	1007	2 24	0 60	4 5
5 V	Y	30	3 53	3589	804	2 64	0 60	4 0
10 V	A	40	3 55	2915	779	1 95	0 60	6 0
8 Bu.	Y	65	3 99	2899	1111	1 36	1 21	7 0
10 Bu.	Y	40	3 94	2742	1012	1 58	1 01	4 5
2 BR.	Y		3 40	2748	1050	1 70	0 20	7 0
7 BR.	Y	75	3 16	2538	700	1 98	0 40	12 0
8 BR.	X	30	3 64	2066	549	1 86	0 40	9 0
2 C	X	35	3 92	2660	1100	2 46	0 35	6 0
11 C	Y	50	3 98	2517	1167	1 64	0 45	7 0
Average	42 2	3 67	2924	1018	2 40	5 97	6 3	

A = Acid
X = Neutral or slightly acid
Y = basic.

TABLE 3

Volatile matter 4-5%.

Soil Sample	Bu. Corn Per A.	Per Cent Volatile Matter	Lbs. (N) Per A. 6 $\frac{1}{2}$ In.	Lbs. (2) Per P. 6 $\frac{1}{2}$ In.	Per Cent N/5 HNO ₃ Sol. Matter	C. C. of N/5 HNO ₃ Neut. by 1 gram soil	C. C. of CO ₂ from 20 gram soil
5 J.....X	45	4.32	3898.	719.	2.53	0.35	5.0
8 J.....A	30	4.01	3056.	1153.	1.84	0.30	4.5
11 J.....A	40	4.95	2770.	747.	2.09	0.30	4.5
3 G.....Y	65	4.98	5375.	1406.	2.55	0.70	5.5
9 G.....Y	50	4.52	2239.	918.	1.93	0.50	...
10 G.....Y	50	4.17	3119.	970.	2.37	0.81	...
11 G.....Y	40	4.21	2620.	834.	2.74	0.81	8.5
6 Br.....Y	25	4.07	3895.	1133.	2.34	0.30	7.1
2 SC.....A	40	4.13	3872.	1092.	4.89	0.50	4.0
3 Bu.....A	50	4.38	2859.	979.	2.10	0.91	7.2
6 Bu.....Y	55	4.29	2690.	826.	1.86	1.21	6.5
7 Bu.....X	50	4.69	3266.	1193.	2.92	1.61	5.0
9 Bu.....Y	40	4.27	2262.	1003.	1.97	1.11	5.5
4 BA.....Y	50	4.73	2629.	1239.	2.04	0.40	6.5
10 BA.....Y	55	4.01	2489.	1046.	1.83	0.25	8.5
7 C.....A	50	4.43	2973.	1103.	8.24	0.15	6.5
9 C.....A	50	4.16	3085.	852.	3.20	0.30	5.5
4 C.....Y	40	4.87	2866.	963.	3.04	0.55	6.5
1 C.....Y	40	4.78	2057.	1128.	2.26	0.40	8.0
Average.....	44.4	4.17	3106.	1016.	3.31	0.608	6.16

A = Acid.

X = Neutral or slightly acid

Y = Basic.

TABLE 4.
Volatile matter 5-6%

Soil Sample		Bu. Corn Per A.	Per Cent Volatile Matter	Lbs. (N) Per A. 6 $\frac{2}{3}$ In.	Lbs. (2) Per P. 6 $\frac{2}{3}$ In.	Per Cent N/ $\frac{1}{2}$ HNO $_3$ Sol. Matter	C. C. of N/ $\frac{1}{2}$ HNO $_3$ Neut. by 1 gram soil	C. C. of CO $_2$ from 20 gram soil
8 C	X	50	5.43	3140	1282	5.46	0.86	7.0
1 BR.	X	40	5.66	3869	1271	3.0	0.60	11.0
5 BR.	X	45	5.68	3926	1502	3.56	1.01	6.5
3 V	X	45	5.46	3482	1211	3.83	1.11	5.0
7 V	X	50	5.19	4785	1849	3.97	1.16	5.5
8 V	X	20	5.45	4864	1735	4.51	1.51	4.5
11 V	X	65	5.57	4483	1404	4.64	1.31	16.0
1 SC	X	50	5.60	5305	1400	3.01	0.75	16.0
5 SC	Y	50	5.15	2578	1284	2.89	0.91	6
3 BC	Y	40	5.08	3077	959	3.80	0.40	7.5
1 J	X	50	5.05	3339	1020	3.28	0.96	6.0
6 J	X	40	5.35	30	881	2.92	0.70	9.0
7 J	Y	50	5.04	3599	1254	3.21	0.60	5.0
9 J	Y	50	5.29	4949	1870	2.96	0.65	5.0
7 Br. Sub.	X	..	5.80	1182	1512	11.26	4.29	111.5
13 Br. Sub	X	..	5.67	2860	1313	4.24	1.82	..
5 C	A	50	5.78	3592	1211	3.90	0.50	6.0
Average		46.8	5.53	3637	1356	4.14	1.13	14.22

A = Acid.
X = Neutral or slightly acid.
Y = Basic.

TABLE 5
Volatile matter 6-8%

Soil Sample	Bu. Corn Per A.	Per Cent Volatile Matter	Lbs. (N) Per A. 6 $\frac{2}{3}$ In.	Lbs. (2) Per P. 6 $\frac{2}{3}$ In.	Per Cent N/s HNO ₃ Soi. Matter	C. C. of N/s HNO ₃ Neut. by 1 gram soil	C. C. of CO ₂ from 20 gram soil
7 BR, sur.....X	..	7.35	4431.	1472.	7.48	0.31	8.0
3 SC.....X	25	6.20	4014.	1475.	5.29	1.82	6.0
1 G.....A	65	6.0	5276.	2016.	1.44	1.61	7.0
2 G.....A	50	7.25	6929.	1305.	3.71	1.31	...
4 BC.....X	60	6.47	4198.	1352.	6.34	1.36	7.0
5 BC.....X	60	7.76	4816.	1332.	6.75	1.41	6.5
6 BC.....Y	60	7.80	4816.	1313.	6.59	1.16	...
7 BC.....A	50	6.95	2113.	886.	2.58	0.05	5.0
2 Bur.....X	60	6.69	4601.	1607.	3.30	1.51	4.0
6 V.....X	60	6.50	6005.	1397.	3.88	1.21	4.0
9 V.....X	50	6.32	5369.	1610.	3.86	1.31	7.5
3 BR.....Y	60	7.89	5489.	1922.	3.67	1.01	8.0
6 BR, sur.....X	75	6.03	3091.	1499.	13.56	7.27	1.64
6 BR, sub.....X	..	6.16	3289.	1878.	13.69	5.30	1.91
9 BR.....X	50	6.68	4342.	1257.	3.17	0.709	5.5
3 J.....X	40	7.44	5411.	1370.	5.84	1.26	8.0
6 C.....X	50	6.88	4052.	1292.	4.06	1.06	6.5
3 C.....X	50	6.23	4391.	1479.	3.93	1.21	6.5
Average.....	52.8	6.76	4591	1470.	4.39	1.80	27.8

A = Acid.
X = Neutral or slightly acid.
Y = Basic.

TABLE 6
Volatile Matter 8-10%.

Soil Sample	Bu. Corn Per A.	Per Cent Volatile Matter	Lbs. (N) Per A. 6 $\frac{3}{4}$ In.	Lbs. (2) Per P. 6 $\frac{3}{4}$ In.	Per Cent N/ ₅ HNO ₃ Sol. Matter	C. C. of N/ ₅ HNO ₃ Neut. by 1 gram soil	C. C. of CO ₂ from 20 gram soil
10 J.....Y	50	8.17	4844.	1500.	6.11	2.42	6.0
11 BR.....X	55	8.49	5507.	1531.	4.57	1.31	7.5
5 G.....A	65	9.60	7626.	1680.	8.10	3.23	12.0
10 C.....X	50	9.36	6235.	1832 16	5.16	1.41	6.5
2 BC.....X	30	9.64	5558.	1230.	9.25	2.67	13.0
2 Br.....Y	75	8.25	6472.	1746.	4.49	1.46	8.0
14 Br.....Y	55	8.09	6167.	1444.	4.04	1.21	...
7 SC.....X	60	8.74	5011.	1061.	7.47	2.62	6.0
Average.....	55	8.79	5928.	1510.	6.15	2.04	8.40
Volatile Matter 10 C ₆ and Over.							
4 Bur.....X	..	10.89	5114.	1619.	1.87	2.72	5.0
4 G. sur.....A	..	40.92	8631.	3783.	15.20	7.22	31.0
7 G.....A	80	34.50	8460.	4798.	12.93	5.20	5.0
2 J.....X	Woods Pasture	11.76	8803.	1766.	6.06	1.36	7.0
12 C.....X	50	12.10	7888.	2021.	8.31	2.02	9.0
8 Br.....X	Woodland	10.75	6278.	1535.	4.83	1.21	5.5
2 V.....X	50	10.13	6139.	2093.	5.59	1.92	5.5
Average.....	60	18.72	7342.	2516.	7.83		

A = Acid.
X = Neutral or slightly acid.
Y = Basic.