FARMING KNOW-HOW
Guidelines to Better Family Farming

Soil Productivity and Fertilizers

COOPERATIVE EXTENSION SERVICE
Michigan State University
EXTENSION BULLETIN E-1137 SF-10 NOVEMBER 1977

Duane S. Girbach, County Extension Director, Livingston County

Soil samples are frequently submitted for testing in an effort to determine what crops can be grown. Soil testing is important and provides information about fertility levels but does not indicate the condition of drainage or soil structure. Productivity of a soil depends on a number of items besides fertility levels. Improving soil fertility or organic matter content of a soil will not improve crop yields if drainage or soil structure are limiting factors.

While this publication deals with management practices that will improve fertility levels, a farmer needs to be aware of other soil conditions that limit productivity.

Organic Versus Inorganic Fertilizers

Because organic matter has many desirable effects on soil, some people reason that adding organic matter to soils might improve the nutritional quality of the crop itself. It has also been suggested that inorganic fertilizers may even have undesirable effects on the nutritional quality of crops.

Plants convert inorganic compounds to organic compounds. When organic materials are incorporated into the soil, micro-organisms break down the organic matter into inorganic forms. Regardless of how nutrients are applied to the soil and whether of organic or inorganic origin, they enter the plant in the same chemical form. The benefit of adding organic materials such as animal waste, compost, crop residues and sewage sludge — besides supplying plant nutrients — is that they improve the physical property of the soil.

Application of organic matter to soils is a beneficial practice even though it will not solve all plant nutrition problems. From a practical standpoint, high yields of quality food and feed crops often require both organic and inorganic fertilizers.

Animal Manure

Animal waste is valued for its plant nutrient content and as a source of organic matter. Table 1 gives nutrient values for common animal manures.

It is generally assumed that 50 percent of the nitrogen and phosphorus and nearly all of the potassium are available to plants during the year of application. The balance becomes available for the most part during the next two years.

To get the maximum value out of animal waste:

1. Use manure on crops that utilize all nutrients. Applying manure on fields previously harvested as corn silage or on fields from which you plan to harvest silage makes more sense than applying it on an alfalfa crop which doesn't require nitrogen.
2. Use sufficient bedding in the barn to absorb liquid waste.
3. Protect manure from runoff and leaching.
4. Incorporate manure into the soil as soon as practical.
5. Do not apply to frozen soil.

Manure is a valuable resource on livestock farms. It can provide an important portion of plant nutrients on well-managed farms. It may be possible for you to secure manure from a fairgrounds, auction yard, race

Table 1. Average Amounts of Nitrogen, Phosphorus, Potassium and Value of Manure.

Type of Manure	*Kind and Amount in Pounds per Ton* N	P_2O_5	K_2O	*Value*[1]
Chicken	30	18	9	$10.50
Beef	14	8	13	5.70
Dairy	11	5	11	4.30
Hog	10	6	9	4.10
Horse	14	5	14	5.20
Sheep	28	9	24	9.80

[1] *Calculated assuming present retail costs per pound are: N = 20¢, K_2O = 10¢ and P_2O_5 = 20¢.*

track or riding stable or other source that does not have sufficient land for waste disposal. However, hauling manure from locations off the farm may not be economically practical.

Sewage Wastewaters and Sludges

Municipal waste can provide nutrients and organic matter as well as a source of irrigation water for crops depending on your location. Be wary of undesirable chemicals that can be toxic if present in excessive amounts. Table 2 gives the nutrient content of material from over 50 Michigan municipalities.

The Michigan Department of Natural Resources (DNR) regulates the use of these materials on land. Farmers having the opportunity to use wastewater and/or sludges should contact the DNR for guidance. The Soil Conservation Service and Cooperative Extension Service can be helpful in advising growers under specific conditions.

Increased use of municipal waste on soil for crop production and environmental improvement appears practical.

Green Manure and Cover Crops

Green manure crops are grown and plowed down to improve the soil and its fertility. Cover crops, while grown primarily to reduce or prevent soil erosion, may also contribute to soil improvement.

A number of legumes, grasses and small grains can be used depending on your crop rotation. Legumes are excellent green manure crops. They may fix up to 100 pounds of nitrogen per acre during the year if effective strains of the proper root nodule bacteria are present in the soil or if they are added to the seed as an inoculant.

Below are the amounts of nitrogen that different legumes provide, depending on the stand. As a general rule, the more topgrowth plowed down, the more nitrogen is added to the soil.

Sweet clover, good stand ..... 100 lbs./acre
Alfalfa, 60-100% stand ..... 80-100 lbs./acre
Alfalfa, 30-60% stand ..... 40-60 lbs./acre
Red and other clovers ..... 40-60 lbs./acre
Soybeans ..... 0-40 lbs./acre

In the past, farmers depended largely on legumes as a source of nitrogen to supplement animal manure and soil nitrogen. Recently they have turned more to synthetic nitrogen to meet crop needs. Probable future energy problems suggest that renewed emphasis needs to be placed on green manure and cover crops.

Crop Rotation

The most desirable crop rotation depends on a number of factors, but certainly the topography of the land is important. Your local Soil Conservation District is eager to assist you in selecting a rotation suited to your farm on a field-by-field basis to reduce or prevent erosion.

Table 2. Range of N, P and K Concentrations Found in Sewage Wastewater Effluents and Sludges.

Nutrient	Wastewater Effluents		Sludges	
	Concentration (ppm)[1]	Pounds Per Acre Inch[2]	Concentration (Percent)	Pounds Per Dry Ton[3]
Nitrogen	11-75	2.5-17	0.1-3.2	2.0-64
Phosphorus	0.1-8.1	0.02-1.8	0.1-3.3	2.0-66
as P_2O_5	0.23-18.6	0.05-4.1	0.23-7.6	4.6-152
Potassium	4.0-27	0.9-6.1	0.05-0.9	1.0-18
as K_2O	4.8-32	1.1-7.3	0.06-1.1	1.2-22

[1] *ppm = parts per million; 10,000 ppm = 1%*
[2] *1 acre inch of water equals about 27,000 gallons and would cover 1 acre to a depth of 1 inch*
[3] *Sludges can vary from less than 1% solids to greater than 40% solids*

Numerous experiments have demonstrated the value of crop rotation. Corn has been grown continuously since 1876 at the University of Illinois alongside a three-year rotation of corn, oats and meadow without fertilization. The 79th consecutive corn crop yielded 36 bushels per acre. Corn on the plots that had been in a corn-oats-meadow rotation with no fertilizer produced 63 bushels per acre. However, when fertilized with nitrogen, phosphorus and potassium, yields were increased to 102 and 101 bushels per acre respectively in one year. Thus, differences in soil productivity in 79 years of different crop rotations were eliminated by one application of commercial fertilizer.

In the Illinois experiment, corn plots of the corn-oats-meadow rotation treated since 1904 with manure, lime and rock phosphate yielded 100 bushels an acre without added fertilizer. Thus, to maintain productivity, farmers can select their rotation from many possibilities.

The following rotations are examples utilizing cover and green manure crops.

1. Corn — with rye cover crop
   Oats — seeded to clover or alfalfa
   Hay or pasture
2. Corn — with rye cover crop
   Soybeans
   Oats — seeded to clover or alfalfa
   Hay or pasture
3. Corn — with rye cover crop
   Oats
   Wheat — seeded to clover
   Hay or pasture

Soil fertility can be increased by using animal manure, sewage wastewaters and sludges, green manure and cover crops and by suitable crop rotation. All of these things improve soil fertility, but farmers must remember that drainage and soil structure also contribute to the overall productivity of soil so they must not be overlooked in any soil improvement program.

Cooperative Extension Service Programs are open to all without regard to race, color, or national origin. Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8, and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Gordon E. Guyer, Director, Cooperative Extension Service, Michigan State University, E. Lansing, MI 48824.
Michigan State University Printing *1P-10M-11:77-UP, Price 5 cents, Single Copy Free to Michigan Residents.*