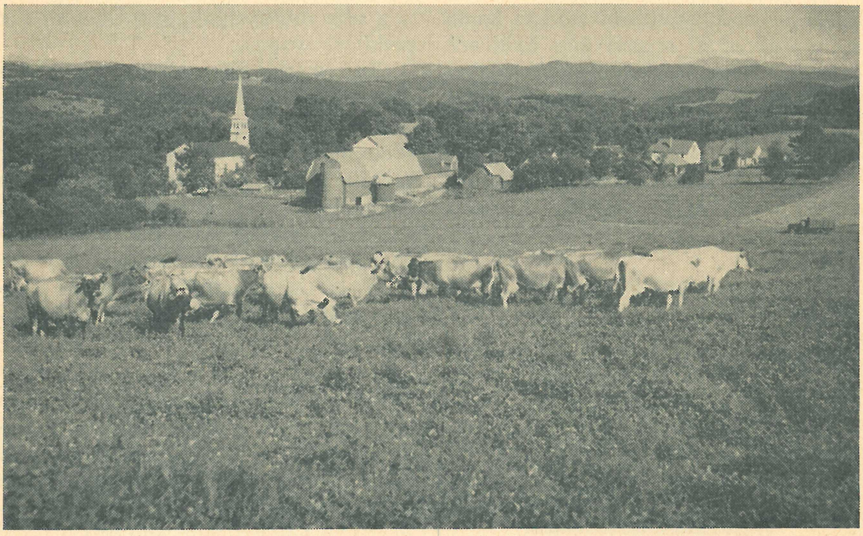

Fig. 1. Dairying on hilly land in Vermont. (Photo by A. Devaney, Inc., N. Y.)

The Net Worth of Soils in the Northeast

By C. L. W. Swanson

Soils Department, Connecticut Agricultural Experiment Station, New Haven, Connecticut

WHEN the Pilgrims landed at Plymouth Rock, they couldn't have stepped onto a more infertile soil. It is fortunate they came for religious freedom rather than farming, or they would have been extremely disappointed and disillusioned. Perhaps one reason they had such tough sledding the first year can be attributed to the sandy Carver soils of that area. These soils are about the exact opposite of the fertile prairies in the Midwest. It is true that the Indians put a fish in every hill of corn, which we now know furnished enough plant nutrients to grow a 50-bushel corn crop.

Northeastern soils may be the poorest naturally but they are among the most responsive soils we have anywhere. If they are managed properly, which includes the use of fertilizers, they are very productive. The way they are made up and how they are managed, in addition to climate, account for much of this.

I'd like to explain a few basic facts about our soils to show what I mean. In other words, I am going to take them apart and attempt to show why they act like they do.

First, we have to understand that soils are more than "skin" deep. Soils are a three dimensional system. They have a top, sides, and bottom. We can express this by what we call a soil profile. If we dig a pit, we observe that the soil to a two- to three-foot depth has three layers which we may call the A, B, C layers or horizons. The composition of these soil layers determines the kind of soils we have. For example, if the soil has about equal amounts of sand, silt, and clay, it has a loam texture.

Environment Makes Different Soils

The environment under which a soil was formed has a great deal to do with the kind of soil it is and its fertility. The soils of the Northeast have developed in a cool, humid climate under forest. Decomposition of the forest litter produced organic acids which subsequently were washed into the soil profile by rains. Soil-forming processes are reflected in the appearance of the soil to a depth of 24 to 30 inches. The major great soil groups occurring in the Northeast are Podzols, Gray-Brown Podzolic, and Brown Podzolic. These great soil group names are used for naming broad regional patterns of soils having similar characteristics. Thus is given a regional picture of the kinds of soils produced by climate and vegetation as reflected in the soils by degrees of leaching, by parent rocks from which they were formed, by kinds of relief on which they were developed, and the stages of maturity of the soils.

Podzols are named for the ash-like, nearly white leached layer that lies just under the thick accumulation of organic debris. This makes a striking profile in its natural state. Well-drained Podzols have formed where forests of spruce, fir, and northern hardwoods predominate in the northern area and at the higher elevations in the southern part. Virgin Podzols are characterized by this one- to four-inch nearly white mineral horizon just beneath the forest litter. This is underlain abruptly by a reddish brown, rusty colored subsoil horizon. The texture of all layers of horizons is about the same throughout the profile.

In the southern part, the leaching process is not quite so strong because the litter from the white pine-oak forest is thinner and less acid. As a result, the well-drained soils do not have a leached light gray or white surface mineral horizon, and the rusty colored subsoil horizon is absent or developed only to a slight degree. These soils are called Brown Podzolic and are closely related to Podzols. They are characteristically yellowish brown in the upper part. Texturally, the Brown Podzolic soils are similar to the Podzols. When these soils are cleared and plowed, the upper horizons are mixed and the soils are hard to tell apart.

Still farther south and to the west, accumulation of materials in the B or subsoil layer takes place. More clay occurs in this horizon than in the other great soil groups, having a finer texture and more pronounced structure. This layer is also a darker color, commonly being dark yellowish-brown. These soils are called Gray-Brown Podzolic.

The great soil groups depict regional characteristics. Broadly they are related to length of growing season, temperature and rainfall, and consequently to agricultural production practices. Leaching, combined with their inherent infertility, has been strong enough in all of the soils to make it necessary to use fertilizers for economic crop production.

Locally, differences in soil development overshadow these broad regional differences. Local factors extremely important from the standpoint of management and production on the individual farm are degree of drainage, extent of fertilizer residue, and kind of parent material from which the soil was derived.

Comparison with Other Areas

Soils in the Northeastern States differ greatly from those found in some other parts of the United States. If they are compared with those from the Midwest, several striking differences are noted.

For example, the Tama silt loam, a prairie soil developed from loess, occurs principally in Iowa. This soil is developed under a somewhat warmer climate than is general for the Northeast, having less rainfall and being under grass instead of trees. The numerous grass roots bring up plant nutrients from the subsoil. When the plants decay, the plant nutrients are added to the soil surface. The Tama has a deep topsoil (12-18 inches) in comparison to the thin topsoil (2-4 inches) of Podzols and Brown Podzolic soils. Prairie soils have no distinct horizons like the Podzol light gray layer but grade from the A horizon into a lighter colored, more sticky and plastic layer. Below that is a deep, pale yellow, mixed limy till. This is the way the soils appear over a large part of the undulating uplands of the Corn Belt.

The soils in the Northeastern States differ from those in the Midwest not only morphologically but also in their native fertility and responsiveness to fertilizers. In forested areas when the soils are in their natural state, the pH in the profile ranges from as low as 3.5 to as high as 6.0. On the other hand, the prairie soils are only slightly to medium acid (pH 5.6-6.5) and in many of the soils in this area the lower horizons are neutral or calcareous. Except for special crops like tobacco and potatoes, liming must be practiced for maximum production of crops in the Northeastern States. Liming not only corrects the acidity but furnishes calcium as a plant nutrient and immobilizes iron and aluminum compounds which make phosphates unavailable in acid soils. Liming in the Midwest is done mainly to assure stands of legumes, like clover or alfalfa. Lime has the same beneficial effects in the Northeast but to a greater degree.

Contrasts in carbon content are also marked. In forested areas, the top 4-6 inches of soil contain large amounts of partly decomposed plant remains, and are therefore high in organic matter. The Gloucester soil in Connecticut, a Brown Podzolic soil, contains about 51,000 pounds per acre of carbon in this layer.[1] At about a similar depth, the Carrington soil in Iowa, another prairie soil, averages 48,000 pounds.[2] As depth increases, the differences are more marked. At the 12- to 15-inch depth this soil averages 28,600 pounds per acre while the Gloucester at the 7- to 15-inch depth has 11,000 pounds. At the next depth, 15 to 24 inches, the Carrington has more than twice (8,400 lbs. more) as much carbon as the Gloucester soil.

Although the soils in the Northeastern States are naturally infertile, they are highly responsive to fertilization. Because of this, and for other reasons, they are especially suitable for the growing of intensive crops like tobacco, potatoes and vegetables. As much as 200 pounds of nitrogen, 120 pounds of phosphoric acid, and 200 pounds of potash per acre are applied annually to shade-grown tobacco in the Connecticut Valley.

The predominantly sandy texture of the soils means that they warm up early in the spring and that they can be worked soon after rains. Their predominantly loose structure allows for good aeration and rapid oxidation of organic materials which are conducive to making nutrients quickly available to plants. However, this looseness makes it necessary to add supplemental nitrogen to replace that leached from the soil.

The unusual ability of these soils to tie up phosphates applied as fertilizers has resulted in many of them becoming higher in phosphates than they were before cropping, especially where heavily fertilized crops like tobacco, potatoes and vegetables have been grown.

Plant-food Content of Soils

Comparison of the natural fertility status of soils in the Northeast with that of soils in other areas in the United States shows the Northeastern soils to be very low naturally in nitrogen. The sandy nature of the soils and the relatively high precipitation are conducive

[1] Lunt, H. A. The forest soils of Connecticut. Conn. Agr. Exper. Sta. Bul. 523. 1948.

[2] Pearson, R. W. and Simonson, R. W. Organic phosphorus in seven Iowa soil profiles: Distribution and amounts as compared to organic carbon and nitrogen. Soil Sci. Soc. Amer. Proc. 5:162-167. 1940.

Fig. 2. Soil mapping by A. Ritchie, Jr. of the Connecticut Agricultural Experiment Station in a tobacco-producing area in the Connecticut Valley. Broadleaf tobacco in foreground and shade-grown tobacco in background.

to leaching of nitrogen. This is in contrast to the Midwest with high soil nitrogen, high silt and clay soils, and moderate rainfall. Also, leaching under grasses is retarded by their numerous and fine root systems in contrast with that which occurs with the relatively coarser and fewer roots of trees.

Little, if any, phosphorus is removed from soils by leaching action. Removal from the soil is principally by harvesting of crops or by soil erosion. Also, some soils are inherently poor in phosphorus. The Northeastern soils are quite high in native phosphorus in comparison with most areas in the

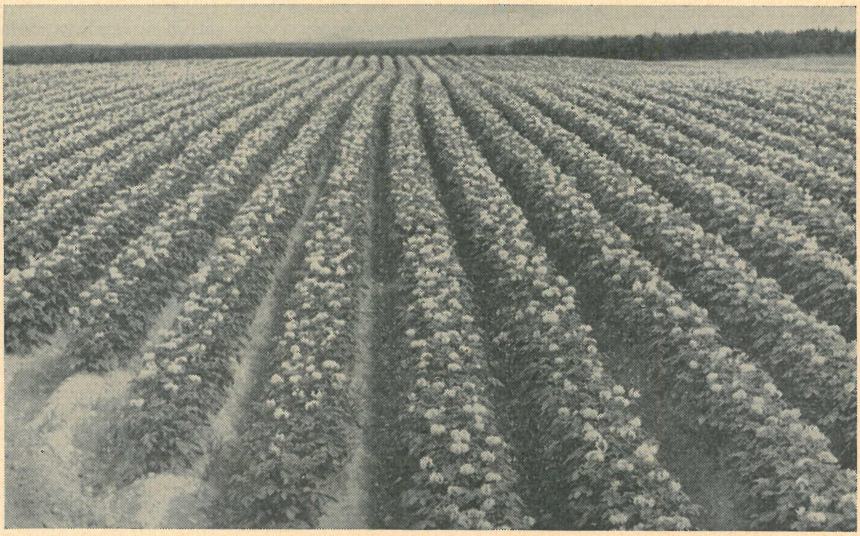

Fig. 3. Potatoes in bloom in Aroostook County, Maine. (Photo courtesy Maine Agricultural Experiment Station.)

Southeast and Southern United States.

The amount of potash occurring in soils naturally depends largely on the amount contained in the rocks from which the soils are derived. In a general way, this compares with areas having soils produced from rocks weathered rather recently, as in glaciated and mountainous areas or in the drier parts of the United States. Since the Northeast, except for the southern tip was covered by glaciers, the soils are relatively young. Consequently, the soil potash content is generally rather high.

Soil Removal by Erosion

Loss of soil from erosion is not the problem in the Northeast that it is in some other parts of the United States. Generally, here the topsoil consists of the thin A horizon incorporated by plowing with the upper part of the B horizon. So, we really are farming "made" soils, at least "made" soils in comparison with those in the Midwest. Midwestern soils have "built-in" fertility; in the Northeast, the fertility is "built into" the soils. We have two different kinds of management for these different kinds of soil.

The productivity of the Northeastern soils has been greatly improved mainly by large applications of commercial fertilizers and manures used in a generally intensive agriculture. On cultivated soils especially, we should be concerned about the fertility we are losing because of erosion. Little natural fertility is lost from virgin soils by soil removal because these soils never were fertile.

Erosion affects the physical nature of soils in the Northeast more than their chemical status. Removal of the already low amounts of fine materials (silt and clay) means that less fertility-holding material is left. Fertilizers will then leach more quickly, as well as wash down the slope.

Agricultural Worth of Northeastern Soils

One may ask "What are the agricultural potentials of the Northeastern States?" These States occupy 5.6 per cent of the land area of the United States and produce 10 per cent of the farm income (Table I). The West Northcentral States (Minn., Iowa, Mo., N. Dak., S. Dak., Neb., Kans.) occupy 3 times more area but produce only 2½ times more total farm income. The Pacific Coast States (Wash., Ore., Cal.) are twice as large as the Northeastern States but produce the same amount of agricultural income. Yet the Northeastern States have a population density about 8 times greater than either of these areas.

If the agricultural incomes of Iowa and Connecticut are compared, in 1949 the income per acre for land in farms for Connecticut was $95.31 and for Iowa $47.73. For Wisconsin, a more diversified State, the amount was

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TABLE I.—LAND USE, FARM INCOME, AND POPULATION DENSITY FOR SELECTED REGIONS IN THE UNITED STATES*

Region	Land area of U.S. 1950	Cropland harvested 1944	Plowable pasture 1944	Forest land 1944	Farm income 1948	Population per square mile 1940
	%	%	%	%	%	
Northeastern	5.6	5.3	4.0	10.0	9.9	211.4
East Northcentral	8.2	17.3	19.8	7.6	19.1	108.7
West Northcentral	17.2	37.6	21.1	7.4	26.3	26.5
Mountain	28.8	6.6	4.0	20.0	6.9	4.8
Pacific Coast	10.8	4.3	6.8	15.9	10.2	30.4

* Source: U. S. Bureau of the Census. Statistical Abstract of the U. S.: 1950 (71st Ed.) Washington, D. C. 1950.

increases of 10.2 tons of cane and 1,926 pounds of sugar from 60 pounds of nitrogen, 40 pounds of P_2O_5, and 60 pounds of K_2O. Five locations on Mhoon silty clay loam planted to stubble cane gave an average increase of 8.1 tons of cane for 60 pounds of nitrogen alone. The average increase from the complete application carrying 60 pounds of nitrogen, 40 pounds of P_2O_5, and 60 pounds of K_2O was 10.8 tons of cane and 2,100 pounds of sugar per acre.

TABLE V.—RESPONSE TO FERTILIZERS FROM STUBBLE CANE ON ALLUVIAL SOILS, 1945-1951

Pounds per acre plant nutrients N[1]–P_2O_5–K_2O	Average of 6 locations on Baldwin silt loam[2]		Average of 5 locations on Commerce very fine sandy loam[3]		Average of 5 locations on Mhoon silty clay loam[4]	
	Tons/A cane	Lbs./A sugar	Tons/A cane	Lbs./A sugar	Tons/A cane	Lbs./A sugar
0–0–0	19.30	3,206	15.41	2,646	14.73	2,596
60–0–0	24.39	4,028	23.92	4,134	22.84	4,086
60–0–60	26.96	4,436	25.06	4,398	23.94	4,377
60–40–60	26.78	4,352	25.60	4,572	25.52	4,696

[1] Nitrogen from ammonium nitrate; P_2O_5 from 20% superphosphate; K_2O from 60% muriate of potash.
[2] At one location 80-40-60 gave the highest yield.
[3] At three locations 80-40-60 gave the highest yield.
[4] At one location 80-0-60 gave the highest yield and at another 80-40-60 gave the highest yield.

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(*From page* 10)

$32.93; for South Carolina, it was $17.96 (1950 census).

The native infertility of the soils of the Northeast, plus the intensive nature of its agriculture, is reflected in the fertilizer consumption for the area. Although only 5 per cent of the cropland and 4 per cent of the plowable pasture (Table I) in the United States are in these States, 12 per cent of the total amount of fertilizers used in this country were applied to these soils (Table II). This represented 9 per cent of the N, 12.5 per cent of the P_2O_5, and 14 per cent of the K_2O used in the United States.

TABLE II.—ESTIMATED CONSUMPTION OF N, P_2O_5, AND K_2O FOR FISCAL YEAR 1949-50 FOR SELECTED REGIONS IN THE UNITED STATES*

Region	N		P_2O_5		K_2O			
	Total tons	U.S. total	Total tons	U.S. total	Total tons	U.S. total	Grand total	U.S. total
		%		%		%		%
Northeastern	88,400	8.9	245,900	12.5	155,700	14.1	490,000	12.1
W. Northcentral	71,500	7.2	227,600	11.6	64,200	5.8	363,300	9.0
Continental U.S.	987,900	....	1,960,900	....	1,106,500	....	4,055,300	....

* Source: Production and Marketing Administration, USDA. The Fertilizer Situation for 1951-1952. Washington, D. C. 1952.

The West Northcentral region, by contrast, had 38 per cent of the cropland and 21 per cent of the plowable pasture but applied to its soils only 9 per cent of the fertilizers used in the United States. Of this, 7 per cent was N, 12 per cent P_2O_5, and 6 per cent K_2O of the total amounts of these respective fertilizers.

Another interesting fact on the productive capacity of Northeastern soils is brought out by the 1950 census data. When the states are ranked in order of average gross income per acre from farming, the first five and the tenth are in the Northeast. The top states are New Jersey leading with $161 per acre, then Delaware, Connecticut, Massachusetts, and Rhode Island fifth with $84. California and Iowa are next, being tied with $58 per acre. Pennsylvania ranks tenth at $51.

Potential of Northeastern Soils

Since the productive capacity of Northeastern soils is so high, one wonders if instead of spending from $50 to $2,000 per acre[3] on preparing land for irrigation, as is being done in the Far West, it might not be wiser to spend from $25 to $200 for clearing and improving land in the Northeast. Once the land is cleared, there are no further costs for items like irrigation water, for rainfall is usually adequate. Supplemental irrigation, of course, increases yields in some years. With our population increasing at the rate of 4 persons[4] every minute, and with the Northeast in the most densely populated area in the United States, some thought might be given to this possibility as one means of increasing our food supply. Nearness to market is another reason for using our Northeastern soils to their maximum capacity.

It is estimated that from 10 to 20 per cent more of the land in the Northeast could be put into agricultural production. In fact, during the early years of our country, more land was producing crops than now. The acreage which could be cleared and improved would vary with the kind of soils present in the area in question. Modern power equipment now makes it possible to clear fields of stones and boulders never before possible. Many areas can now be drained and put into production as the result of improved land drainage techniques and improved knowledge of the management of the soils after they have been drained. Trees have always been cut and they present no problem.

Soil Mapping Information Needed

Just any kind of land should not be put into production. Some soils are too stony or rocky, some are too sandy and droughty, some would be impractical to drain because of the tightness and impervious nature of their subsoils, some would be too steep and should be kept in trees for controlling erosion. Even in excluding all these soils having inhibiting factors for economical crop production, many soils which are comparable to those now producing crops are now in trees or idle land. Modern soil survey techniques bring out desirable relationships of soils for crop production. Also, information from soil surveys show what soils are adapted to the production of given kinds of crops.

Clearing and draining of land for use in increasing the production of crops cannot be construed as soil conservation measures. They are, in a sense, an exploitation of our soil resources. But this exploitation can be a well-managed one so that every soil will be used to its utmost in producing crops and at the same time be improved in its fertility and productivity. Erosion will be at a minimum. Fertilizers, pesticides, crop rotation, and other management practices will be employed for improved yields. The productivity of our soils will be increased and their fertility maintained or increased.

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[3] Bureau of Reclamation, U. S. Dept. Interior. Reclamation Project Data. 1951.

[4] Production and Marketing Administration, USDA. The 5th Plate. Washington, D. C. 1951.