The FORESTRY CHRONICLE

Vol. XVI

JUNE, 1940

No. 2

LAND CLASSIFICATION

By P. C. STOBBE, B.S.A., M.Sc.

*Agriculturist in charge of soil surveys in New Brunswick for
the Federal Department of Agriculture*

The Maritime Provinces and parts of Quebec, Ontario and the Eastern States are in the zone of acid and leached soils known as pod sols. Soils are influenced by climate, vegetation, geological origin of their parent material, topography, drainage, texture and by the treatments which they have received from man. The principles underlying these influences are explained as the basis of land classification and the more important groups of soils in New Brunswick are discussed.

MANY people have the opinion that the soil is an inert body and consider it as mere dirt. Actually, the soil is a dynamic body in which changes are going on continually. It has taken thousands of years for the soil which we are working with today, to develop, and numerous factors have controlled and guided this process of development. These factors act as a valuable guide in making soil and land classifications.

CLIMATIC ZONES

The climate is the most important of these factors and due to its influences the Canadian soils may be divided into a number of large zones. The Maritime Provinces, most of Quebec, part of Ontario and the Northern part of the New England States are in the Podsol zone, or zone of leached and degraded soils. In this zone the climatic factors favour the development of acid soils and coniferous trees are the dominant vegetation.

To the south and west of the acid pod sols are the Brown Earth or Brown Forest Soils. In this zone temperatures are less severe, precipitation is somewhat less, leaching is less and the grey layer, typical of the podsol is absent. Deciduous trees are the dominant vegetation.

In Western Canada, where precipitation is more limited, occur the zones of Black and Brown grassland soils. In the northern sections of the western provinces podsolized soils are found under forest vegetation.

PODSOL SOILS

While it is quite obvious that all soils of any one zone are not alike, all soils of the same zone have certain characteristics in common. The striking common characteristic of the soils of the podsol zone is the presence of a grey leached layer, varying in thickness from a trace to 10 inches and more, immediately below the surface soil.

Under eastern climatic conditions plant growth is quite rapid and organic matter tends to accumulate on the surface of the soil because the micro-organisms, which are responsible for the decomposition of organic remains, cannot function efficiently during the long cold periods. The organic matter, which

is partially decomposed during the summer, is not broken down completely into carbon dioxide and water as under some conditions in warmer climates, but yields a number of organic acids as end products. These acids give the soil its sour reaction, and as they are washed into the soil by rain water, they dissolve first the easily soluble bases such as calcium, magnesium, potassium and sodium and remove them from the soil. As this reaction goes on, the surface soil becomes more and more acid and finally the sesqui-oxides such as iron and aluminum are removed, leaving a grey layer high in silica. This grey layer is very deficient in nutrient elements and the extent of its development largely determines the fertility of the soil. The leached sesqui-oxides precipitate and accumulate below the white layer, forming a reddish-brown horizon. A typical profile of an eastern podsol soil has the following characteristic colour scheme; a black surface layer underlain by a white and red layer respectively.

FOREST TYPES

The kind of organic matter and its chemical composition influence this development. Coniferous foliage is more resistant to decomposition and yields more acid products than does deciduous foliage. Coniferous tree cover as a rule produces a thick podsolized grey layer. Deciduous foliage decomposes more readily and forms a black mull. Its end products of decomposition are less acid, as a result of which the grey leached layer is comparatively thin.

GEOLOGICAL FORMATION

The geological formation and mineral content of the soil also influence variations within climatic zones. The nature of the loose surface drift, the kind of mineral fragments in the drift, their chemical composition, their ease of weathering and the mode of deposition of the drift all have an important bearing on the development and fertility of the soil. If the mineral fragments of the soil, such as limestone, yield basic end products on weathering, then soil leaching is restricted. The free lime which is washed into the soil neutralizes the acids formed from the organic matter and thus counteracts their deteriorating effect on the soil. If the products of weathering of the mineral fragments are acid, then the ordinary leaching of the soil will be accelerated and the fertility of the soil on such a formation is very poor.

DRAINAGE

Drainage is a very important factor in local districts where climatic conditions and geological formations are uniform. It affects the temperature, moisture relation, aeration and the biological life of the soil.

Good drainage provides favourable physical conditions for plant growth. Aeration is essential for the life and activity of most of the beneficial micro-organisms of the soil. In ill-drained soils poor aeration and cold temperature restrict the activity of the aerobic micro-organisms and in many cases prevent the release of elements necessary for plant growth. Decomposition of plant remains is restricted and poorly decomposed organic matter accumulates on the surface resulting in the formation of acids, leaching and degradation.

In well-drained soils conditions are more favourable for the chemical weathering of the mineral fragments. Lack of air and oxygen in poorly

drained soils bring about chemical reduction and hydration of the soil complexes, in many cases forming poisonous substances which restrict plant growth. These chemical changes are often associated with dispersion and puddling of the soil and thus enhance the bad physical condition already existing.

HARDPANS

Drainage conditions are often aggravated by soil hardpans. There are many different types of hardpan and only some of these, that are important in the Eastern Provinces, will be mentioned here.

The "Iron hardpan" or "Ortstein" is usually found immediately below the grey podsol layer and is formed by the cementing of the subsoil with the iron and aluminum that have leached from the upper layer. This hardpan is as a rule red in colour, hard as a rock, and greatly restricts the penetration of plant roots. It is usually found in dry, coarse-textured soils.

The "Humus hardpan" or "Bog-iron hardpan" in which humus and iron, which have leached down to the subsoil, form the cementing material, is another common type. It is darker in colour than the "Ortstein" and its effect on plant growth is somewhat similar. It not only hinders the penetration of roots but also restricts the penetration of ground water. During prolonged dry seasons plants suffer more from drought than on well drained soils because the soil moisture is confined below the hardpan and cannot be reached by the roots.

The "Clay hardpan" is very common and causes a great deal of trouble. It is partially due to the downward leaching and precipitation of soil colloids and partially to the original deposition of clay and is usually associated with variations in texture of the soil profile. Like the other hardpans it is very compact and restricts root penetration and water movement.

TEXTURE

Soil texture or degree of fineness of the soil such as clay, silt, sand, etc., greatly affects soil development and soil fertility. The lighter sandy or gravelly soils leach more readily than heavier soils and require a large percentage of organic matter to maintain their fertility. Acidity and other defects can, however, be much more readily corrected on sandy soils than on the heavier clay soils. The physical condition of the acid clay soils is usually very poor and they tend to become clogged and thus poorly drained and aerated.

INDICATIONS OF SOIL FERTILITY

Good indications of soil fertility may be obtained by examining the soil to a depth of approximately three feet. Features of the soil profile indicating the fertility of the soil under New Brunswick conditions may be summarized as follows.

The thickness of the grey layer is a measure of the intensity of leaching and is closely associated with soil fertility. The greater the depth of the leached layer, the poorer is the soil. If the depth exceeds plough depth then the fertility of the soil is very low and the soil approaches the line of sub-marginal agricultural land.

The intensity of leaching depends greatly on the mineral composition of the drift material and the parent rock. If a slight fizz can be obtained by

dropping dilute acid on the rock fragments that are scattered through the soil, the soil in all probability is not very acid and should make fairly good agricultural land. Maps on geology and surface geology will give any one familiar with the soil forming processes, a rough idea what soils may be expected in a given district.

Furthermore, the kind of organic matter that is found on the surface of the soil is connected with the degree of soil degradation and soil fertility. If a layer of poorly decomposed coniferous foliage covers the ground, the soil is likely to be leached and poor. On the other hand, if a fairly well decomposed black mull is found the soil is probably in a fairly good state of fertility. In other words, hardwood ridges, on which the maple, beech and yellow birch association thrive, will most likely make fairly good agricultural land, provided that other physical factors are favourable. The white birch alone is usually found on badly leached soils and poor agricultural land.

Good drainage is a very important factor in regard to soil fertility and under New Brunswick conditions poor drainage probably places more land in the marginal or submarginal class of agricultural land than any one of the other factors that have been discussed. Ill-drained soils with a tree cover of stunted black spruce and its characteristic undergrowth are entirely unsatisfactory for agricultural purposes. Some of the medium, ill-drained soils will make fairly good agricultural land provided they are under-drained. If not drained, their value for agricultural purposes is not very great and only certain crops can be grown successfully. The signs of ill-drainage can be observed in the soil profile even in a dry year as the subsoil has a variegated or mottled appearance and rusty streaks occur along root channels. Some of the best stands of pulp and timber in this province grow on this type of land.

Very light, sandy and gravelly soils are often unsuitable for agricultural purposes because they are too dry, severely leached and have not sufficient colloidal material, both organic and inorganic, to retain fertilizers that may be added to them. Jack pine is usually the dominant vegetation on such poor sandy soils in New Brunswick.

In examining the soil attention should be paid to the presence of hardpans. If the hardpan is found close to the surface the value of the soil is greatly decreased. A depth of 24 to 30 inches of soil over the hardpan is considered to be sufficient for the production of the ordinary farm crops.

Besides these factors, there are some strictly physical conditions that will determine the fertility and suitability of the land, and anyone familiar with agriculture can recognize them. The degree of roughness of topography and the amount of stones and boulders on the land often make an otherwise fertile soil undesirable for agricultural purposes and such land should be left under forest.

EFFECT OF MAN

It is not the purpose of this paper to discuss the management of the different soils after they have been brought under cultivation. However, it should be emphasized that the soils which have been formed under entirely different conditions and vary in their natural fertility require different treatments. Each soil must be treated according to its needs and what is right

for one soil type may or may not be right for another. By proper management a poor soil may be improved and again, by wrong farming methods a good soil may be depleted, so that it will not produce a satisfactory crop. Success or failure, therefore, depend not only on the soil that is handed out to a settler but also on the settler himself.

BURNING

Many of the agricultural soils in New Brunswick are in great need of organic matter. This is contrary to what one would expect under our climatic conditions and is due to several causes.

Many settlers follow the practice of burning their land as thoroughly as possible, while clearing. When the burning is intensive enough to burn the leaf mat, the soil is robbed of one of its main constituents and it will take many years of very intensive farming to return to the soil what has been lost during a few hours of burning. On cultivation of such burned land the soil up to plough depth consists largely of the original grey leached layer which is very deficient in nutritive elements and low in organic matter. Fairly good crops can be obtained for a year or two after breaking, but in subsequent years the crops are very poor. The best results are obtained if the leaf mould is mixed up with the grey layer. It is therefore advisable to burn the slash and stumps at a time when the leaf mould is wet and will not burn so easily.

A similar situation arises from forest fires. In many cases after brush fires have swept through the country, it takes a long time for tree growth to reappear, particularly on well-drained slopes. Here the soil not only has lost the layer of organic matter from the surface, which usually forms the seed bed for tree seeds, but due to the intensive heat that is developed by severe burning, the soil is partially sterilized. Most of the soil micro-organisms which are responsible for converting some of the elements of the soil into a form more available for plant growth, have been destroyed and it often takes a long time to build up the biological life of the soil until a stage is reached where plant growth can again resume. Thus, the total loss from forest fires consists not only of the loss of timber and pulp but must also include damage done to the soil. The damage to the soil is in some cases a temporary condition, while in other cases it is permanent, at least as far as this generation is concerned.

It should be pointed out that on ill-drained soils, burning seldom is severe enough to cause great damage to the soil. In many cases burning of ill-drained land which has considerable moss on its surface, will improve conditions because the large amount of moss and poorly decomposed organic matter interferes with the tilth and physical condition of the soil. Such ill-drained soils, however, are usually badly leached and generally unfit for agriculture.

EFFECT OF FARMING

With prolonged cultivation organic matter will rapidly decrease unless some provision is made for its maintenance. The lack of organic matter lowers the general fertility of the soil and favours soil erosion, especially on steep, long slopes. Soil erosion is very severe in some cases and thousands of tons of soil containing large amounts of plant food are being removed annually. The sodding down and reforestation of the steeper slopes and the introduction of

proper crop rotations and soil management practices will go a long way towards restricting erosion.

The use of lime is essential for successful crop production on very acid soils. The lime not only raises crop yields but also makes provisions for the incorporation of organic matter by the ploughing down of clover. The lime policy adopted by the New Brunswick Department of Agriculture is highly commendable and further educational work among farmers is advisable.

With prolonged cropping the nutritive elements in the soil become depleted and unless provisions are made for their maintenance crop yields decrease rapidly and weeds become a serious problem. It is generally recognized that nitrogen, phosphorus and potassium are needed for satisfactory crop yields and are applied in fertilizer form. Magnesium also often becomes deficient and it can be added to the soil either in the form of dolomitic limestone or as the sulphate with the ordinary fertilizer mixture.

SOIL SURVEY IN NEW BRUNSWICK

The soil survey in New Brunswick was started in 1938 by the Experimental Farm Service, Dominion Department of Agriculture, in cooperation with the New Brunswick Department of Agriculture and the University of New Brunswick.

The purpose of the soil survey is to classify and map soils according to their inherent chemical and physical characteristics, to relate those as far as possible to the agricultural adaptations and possibilities, and to determine the main problems associated with the different soil types. The information obtained by the soil survey should be of value to the practical farmer and should greatly aid the extension man and the research worker.

The survey in New Brunswick has up to the present time mainly been confined to agricultural areas. Large sections of wooded land included in the surveyed areas were examined in less detail than the cleared land because it is a time-consuming operation to delineate soil boundaries in dense woods. The main purpose in examining the wooded areas was to establish if any extensive areas suitable for land settlement purposes were present.

During the two years of soil survey operations in New Brunswick four main groups of soils were encountered. These may be listed as follows:

1. The soils on the Pre-Carboniferous schists and shales which are dominant to the north and west of a line running from Harvey to Bathurst.
2. The soils on the Upper-Carboniferous or Pennsylvanian formation which occupy most of the land to the south and east of this line.
3. The red soils on the Lower-Carboniferous or Mississippian formation, the largest area of which is found in the vicinity of Sussex. Smaller scattered areas occur at Plaster Rock, Harvey, Kingsclear, and elsewhere.
4. The water-deposited soils along river valleys, streams and sea shores.

Very likely several other groups occur, such as the granitic soils north of McAdam and the clay soils in the eastern section of the Province. These, however, have not been studied to any extent so far.

Each group consists of a number of soil series and soil types which differ from each other in respect to drainage, texture, topography and other less important soil characteristics. In all groups the well-drained soils are best suited

for agricultural purposes and many of the ill-drained soils are marginal agricultural land but will produce good stands of spruce.

The natural fertility of the soils on the Pre-Carboniferous formation is higher than that of the other groups. The well-drained soils of this group have under natural conditions a tree cover consisting chiefly of the maple, yellow birch and beech association. They are comparatively slightly leached and are not excessively acid, although the use of lime will give favourable results with hay and grain crops. Under extensive cultivation organic matter tends to deplete rapidly, unless provisions are made for its maintenance, and the soil is subject to severe erosion. Magnesium deficiencies occur occasionally if this element has not been added to the soil from time to time.

The natural fertility of the soil on the Pennsylvanian formation is quite low. The natural vegetation of the well-drained soils of this group consist of a mixed coniferous-deciduous tree cover. A large percentage of the soils of this group is ill-drained and has a dominantly coniferous tree cover. The soils are extensively leached, very acid and are underlain by a boulder clay hardpan at depths varying from 20 to 36 inches. The application of lime is one of the essential prerequisites for successful farming. On extensively cultivated land the organic matter content of the soil is often very low and magnesium deficiencies occur frequently.

The natural fertility of the soils on the Mississippian formation approaches that of the soils on the Pre-Carboniferous formation. The soils of these two groups, however, differ very much in appearance as the former have a characteristic bright red subsoil. The soils on the Mississippian formation are often very stony and their topography is quite rugged.

The water-worked soils in the river valleys differ considerably in their natural fertility. The interval soils on the bottom land are some of the most fertile soils in the province but due to their periodic flooding their use is restricted to certain crops. Coarse gravelly soils on knolls and slopes are not very fertile; they are very acid, badly leached and often too dry. Sandy soils on the gently rising slopes of the valleys are well suited for farming purposes but care must be taken to maintain their organic matter content and lime has to be added for successful hay and grain growing.