Properties of soils.

beneficial effect may be brought about by adding lime, either in the form of burnt lime (after being water slaked) or as carbonate of lime (ground limestone). Fertilisers of an acid nature, such as superphosphate and gypsum, tend to bring the same beneficial change about, but nitrate of soda leaves a residue of soda in the soil which is harmful to the texture of the clay. Alkaline soils containing appreciable proportions of sodium carbonate (black alkali) are notoriously bad in texture if there is a fair amount of clay present, for the presence of this alkaline material prevents the flocculation or aggregation of the minute particles taking place.

Other means of improving the texture of clay soils is to plough them up early and expose them to the action of frost, or to the alternate heating and cooling, wetting and drying that the surface soil would thus undergo. Working such soils when wet is fatal for the clay material is thus puddled.

Testing for acidity and alkalinity in soils—Lay strips of blue and of red litmus paper on the bottom of a shallow vessel like a large watch glass, or a small clock glass, or a small bowl, and pour in a fair amount of the fine soil to well cover the papers. Thoroughly moisten the soil by pouring in some distilled water (or freshly boiled, clean rain water) carefully down the sides of the vessel, and leave for about a quarter of an hour. Then carefully remove the soil and note any permanent change in colour of the strips after allowing them to dry. Should the soil be of an acid nature the blue litmus will be turned red, but an alkaline soil will turn the red litmus blue. If the soil is neutral there will be very little change in the colour of either of the papers. When carrying out this test prevent contamination of the fingers and of the vessel as much as possible, and the experiment should be carried out where there are no acid or ammonia fumes.

It may be pointed out, however, that the litmus test is not a very satisfactory one, and great caution must be observed in connection with it. It does not always follow that because the soil solution will turn blue litmus more or less red in colour it will be an economical proposition to lime that land. Sourness or acidity arises from various causes and liming is not always desirable. Some crops thrive in a soil with a slight acidity, though many crops do best in a neutral soil, while a few will even flourish in a soil that is rather alkaline.

Sugar cane is a crop that does not seem to have a marked predilection either way, so farmers should ascertain first of all, by experimenting on a few plots, whether their particular soil does give increased yields by liming. Of course, liming has other reasons in its favour besides correction of acidity, which were pointed out in my previous lecture, and one beneficial effect was also pointed out in the last experiment.

I have only attempted, in the short time at my disposal, to illustrate a few of the properties of the soil that are useful for the farmer to know, but it is hoped that it has been sufficient to create interest in the subject and to enable him to understand better a few of the many problems that he has to deal with in the cultivation and treatment of the many types of soils he often meets with on his farm.

SOIL FERTILITY

(Paper By M. EDELMAN, C.D.A., Lecturer in Agriculture, Cedara.)

It is not intended to discuss soil fertility from every point of view in this paper, as Mr. Williams has already dealt with the properties of the soil, and Mr. Staples' paper on "How Plants Feed and Grow" has furnished us with a further supply of information relating to the soil. The main object of this lecture is to try and drive home first what soil fertility means to the crop, and second its significance to the farmer.

The fundamental principles underlying soil fertility are the same for sugar cane as for any other crop, and, of the many factors that control farming today, four are outstanding, and these go to decide the value of any farm; they are:—

1. Climatic Conditions.
2. Labour Supply.
3. Distance of Farm from Nearest Railway.
4. The Soil.

The climate is left to nature to decide; the labour supply remains more or less constant in respective areas; in most cases the distance from the nearest railway station cannot be altered but when the soil is considered it is left to the farmer to get the best out of it, or left to the native to get the worst out of it. Other things then being equal, the farmer is dependent on his soil for profitable yields. A fer-

tile soil is one in such a condition that it will stimulate the growth of plants to a maximum in regard to yield and quality in a given period.

We know that warmth, air, and water are required for successful plant production, but, how do these affect the fertility of the soil? Something more is necessary—condition. The soil must be in a fit state before proper use can be made of the warmth, air, and water.

The old system and the new.—When the soil is naturally rich, or where there are large stretches of land available for cultivation, improvement is an easy matter, fertility is regained by a system of resting, that is new land is cultivated, while the old land is allowed to lie idle until the fertility is restored by means of a fresh growth of vegetation which afterwards forms humus. But, how many farmers today can afford to rest their lands as a means of restoring the productive powers of same. As a country passes from an extensive to a closer or intensive system of farming as a result of more settlers on the land and the rise in land values, then the average agriculturist cannot afford to rest his land and wait, and it is the intensive system of farming which we are daily entering into, when it is left to us to maintain the fertility of the soil by:—

1. Correct Cropping.
2. The Use of the Correct Fertilisers.
3. Good Soil Management.

Soil fertility may be studied under three headings:—

1. Chemical.
2. Biological.
3. Physical.

These are all of the utmost importance, because the absence of the one factor is like a chain with a missing link—there is no connection. No matter how much plant food a soil contains, or how many millions of organisms are present, plant food and bacteria may be of little use unless the soil is in a good physical condition, or in "good heart." The condition of a soil may be compared with the constitution of a man or animal, and what does a weak constitution mean? It means a general weakness. What then is it that decides the physical state or condition of the soil, or the controlling factor of soil fertility?

1. Water. 2. Humus. 3. Tillage.

Humus or Organic Matter.—Humus or organic matter is the decayed animal or vegetable material. It is the chief source of nitrogen in the soil. As a result of nitrification, a process brought about by different groups of organisms, the organic matter is first changed into a nitrite compound, then into a nitrate compound, the form in which nitrogen is utilised by the plant. Organic matter makes a light sandy soil more retentive of moisture and fertilisers, owing to the binding effect it has on the soil particles, in other words it acts as a sponge. A good supply of humus makes clay soils more friable; it assists in creating a proper air supply which is often lacking in cold heavy clays; and in such a condition the soil can easily be worked into good tilth. In building up a worn out soil, in nine cases out of ten the first step taken towards improvement is the introduction of a large supply of humus. But, the trouble is, the supply of humus in the form of kraal manure or farmyard manure does not nearly equal the demand, therefore some other method of incorporating humus with the soil must be resorted to.

Lead pencil value of farm manure.—We may well include here a statement by an American Agriculturist:—"The sad thing about the whole problem of soil fertility as we see it, is that some company with a long sounding name has not been able to sell humus at a profit to the farmer. If soil humus, or vegetation partially developed into humus, could be procured in a form that it could be shipped, and sold to the farmers as phosphates and nitrogenous fertilisers have been, many fields that are now unprofitable for tillage purposes would be very desirable land."

Green manuring and soil fertility.—In the absence of kraal manure or farmyard manure, and as a means of supplying humus to the soil, green manuring i.e., the ploughing in of a crop when in a succulent state may be practised. Although this may seem to many a wasteful practice in so far as a good deal of material of feeding value to cattle is turned under, still without a correct supply of humus no soil can be termed in best condition.

Crops for green manuring. Crops used for the purpose may be divided into two groups:—

1. Legumes (nitrogen gatherers).
2. Non-legumes.

Whenever the opportunity presents itself, a crop in the legume group should be selected, as a legume, through the medium of its roots is capable of utilising atmospheric nitrogen and of fixing it in the soil in such a form as will prove useful to the succeeding crops. This is the main reason why the legume is often termed a soil improver.

The best of the legumes to use are:— Cowpeas for summer and early autumn; velvet bean for summer and early autumn; field pea for winter or spring; lupin for winter or spring (especially for sandy soils).

Under coastal conditions, the cowpea and velvet bean will be found very useful for green manuring. The velvet bean is a very rank grower, covers the ground well, and produces a very heavy growth of vine and leaf, exactly what is required for the soil.

Although the crops in the non-legume group are not capable of fixing nitrogen, many of them are exceptionally quick in growth, and of immense value when turned under; for example: buckwheat for early summer, rye for winter and spring, rape for winter and spring.

Stage of growth for turning under the crop.—The rate of decay of the green matter will depend on the stage of development. Generally the best time to plough in is after the flowering or when the crop is half grown, as the most rapid rate of decay is when the plants are at this stage, when also there is the development of a suitable supply of stem and leaf to create a large increase in humus when ploughed in. However, the farmer cannot always be guided by this, and can turn under the crop when there is sufficient growth to warrant the operation. The more rapidly a crop decomposes in the soil, the more quickly can it prove beneficial to the ensuing crops.

Tillage and fertility, plant food in the soil.—A soil is composed of water, bacteria, humus, and mineral matter, but what use are they unless they can be made to play their respective parts in the feeding of plants? Take for example the millions of organisms ever ready to help the plant, but which require the best conditions to work properly.

Tillage will help to obtain the best results from the beneficial bacteria; the lack of good tillage results in an insufficient air supply, the coldness in the soil. Then the injurious bacteria act and may cause a loss of nitrogen to take place.

"Tillage is manure"—an adage by Jethro Tull, a farmer of England in the very early days—may well be borne in mind today. Jethro Tull, arguing from his hoeing experiments, concluded that manures were unnecessary: for the soil if only stirred up enough and exposed to the air will provide all the plant requires.

What is the use of plant food in the soil if it is locked up? None whatsoever There is however, a key to the solution—tillage.

According to "Cedara Memoirs" Volume 3, a sandy sugar soil in addition to other elements contains:—

Nitrogen	.06 per cent
Potash	.04 per cent
Phosphoric Oxide ..	.01 per cent
Lime	.05 per cent

According to the analysis, one acre of soil nine inches deep weighing 2,500,000 lbs. per acre contains:

Nitrogen	1,500 lbs.
Potash	1,000 lbs.
Phosphoric Oxide	250 lbs.
Lime	1,250 lbs.

Assuming that a 25 ton sugar cane crop extracts from the soil nitrogen 85 lbs., potash 54 lbs., phosphoric oxide 37 lbs., and lime 44 lbs., then the soil, according to the analysis illustrated herein can supply seventeen crops with its nitrogen requirements, 18.5 crops with its potash requirements, 6.7 crops with its phosphoric oxide requirements, and 28.4 crops with its lime requirements.

Unfortunately, however, this only works well on paper, and not in practice, and this is where a farmer can go wrong, in assuming that a soil analysis will give all the information that is required about the soil.

Soil analysis.—By having a soil analysed the composition of a soil is only secured, and very often when a crop proves a failure when grown in a soil with a good composition, the analyst is generally blamed for the failure, but this is far from right; very often the blame should be borne by somebody else. Tillage is one of the deciding factors that make plant food available for plants. Although the soil may contain hundreds of pounds of plant food, all of it is never available for plant growth at the correct time, but the maximum amount can be made available by cultivation.

Active series of forces—There always exist two active series of forces, the one constructive and the other destructive. They act alike in the mineral, vegetable, and animal kingdom. We plough to convert an undisturbed soil into a fertile soil fit for plant growth.

Ploughing.—Ploughing is firstly practised in order to prevent the soil from forming into its natural state again, and in order to open up the first 6 to 12 inches to further breaking influences of air, water, carbonic acid, vegetable matter, and organisms. Ploughing will loosen the top layer of the soil; a hardpan near the surface is fatal to all cultivated plants, and destructive to soil fertility. The soil is the home of the roots of plants, and they must have plenty of air, warmth, moisture, and plant food. When the plant is at home, it prefers plenty of room for root movement, and the better this condition, the better will be the portion of the crop above ground. Air and water are introduced by ploughing, which has for another object the burying of vegetative growth, i.e., weeds and grass. This results in cleaning the soil and also introducing a supply of humus or organic matter. Again in districts with a low rainfall, or with a very unequally distributed rainfall, by ploughing the land deep, and following this with the harrows, a water blanket is formed over the subsoil to prevent evaporation.

How deep to plough.—The exact depth to plough will depend on the character of the soil. As a general rule, it is fatal to the crop following to turn up a large amount of unweathered subsoil. The better way to secure a deep soil, is to gradually deepen the ploughing each year until the desired depth is secured. Also by ploughing at different depths fresh plant food of the different layers of the soil, is made available year after year instead of the majority of it in one season.

When to plough, benefits of early ploughing.—New land should be ploughed in the autumn or the winter before the crop is to be planted. Early ploughing will assist the farmer in forming a fine seed bed early in the season, as atmospheric influences, such as wind, sun, frost and rain, which have a disintegrating effect on the ploughed surface, cause the soil to crumble down into a fine tilth. Early

ploughing assists in the eradication of weeds, as the roots and seeds of such are exposed to the sun, and sometimes frost, which have a killing effect on the former as well as on the latter. Many insects are also killed by the practice. Finally, early ploughing results in the thorough pulverisation of the soil. If the land is harrowed immediately after ploughing moisture is also conserved.

Cultivation.—The work of the harrows and cultivators is very much eased where the ploughing of the soil has been carried out intelligently. The chief object of cultivation is to obtain good tilth, a clean seed bed, and to conserve moisture. These are the favourable soil conditions for plant growth. Good tilth should, wherever possible be obtained before planting so that after cultivations can maintain that tilth.

The mulch.—During a spell of dry weather, it is advisable to practise shallow cultivation frequently. A thin layer of earth is thus removed from the underlying soil, and is arranged as a fine layer on the surface, when the continuous upward movement of the water through the soil into the air is checked just below the surface and the roots of the plants can then make full use of the moisture. Again, the capillary tubes are broken and the water kept in reserve just below the surface, and saved for the plants. The necessity for frequent cultivations during dry weather is to restore the mulch which is so easily broken. Lastly, finely divided soils will give the plant a good hold in the soil, a lumpy soil will not give the plant proper support nor will it conserve moisture.

Working a soil.—In working the different classes of soil, their distinctive characters should always be borne in mind, e. g., in the case of a light sandy soil, as it is naturally a loose type it should not be stirred too frequently. Cultivation may also be proceeded with during wet weather. Rolling will benefit this soil more than the other types. But in cultivating the other extreme, say a clay soil, the more cultivations it receives, the better, as owing to its compactness, unless it is well stirred, it may choke the plants. Clay soils should never be worked when in wet condition, as they "puddle;" in other words, hard lumps are formed which are sometimes unbreakable with the heaviest of implements. This should prove to show that all soils cannot be worked alike in order to make the best of their productive powers.

Thorough cultivation is a basic principle underlying agriculture today, whether for cotton, maize, tobacco, or sugar cane.

Conclusion.—Again I might mention that great soil combine "Humus and tillage," and as soon as this partnership is dissolved, the soil fertility chain is broken. Finally the fundamental secret of continued success in farming is the maintenance of soil fertility.

HOW PLANTS GROW AND FEED

(Paper By R. R. STAPLES, M.A. U.D.A., Cantab.)

Although plant growth is a phenomenon of the commonest occurrence, very few understand the way in which this really wonderful process is brought about.

Structure of the plant.—Before the subject can be readily understood, it is necessary to touch on the general structure of an ordinary plant. For the sake of convenience, we will divide the plant into three parts—root, stem and leaves. Each of these parts is beautifully constructed of minute individual parts called cells. The cells are so small that they are invisible to the naked eye, and can only be clearly seen with the aid of a microscope capable of magnifying them many hundreds of times. The shapes of these cells differ greatly to suit the purpose for which they are used. Some are spherical, some cubical, others tubular. The wood or fibres of plants are simply very minute tubes stuck closely together. The living cells contain that wonderful substance called protoplasm, (a slimy fluid, which alone is able to bring about the numerous chemical reactions collectively termed growth.

Composition.—Besides the protoplasm, a great multitude of other compounds are also found in an ordinary plant cell, but by means of numerous water culture experiments it has been conclusively proved that certain substances, and these only, are required to enable the plant to build up its tissues. It is impossible to tell you what these substances are without using scientific names, and the following is a complete list:—Water, nitrates, sulphates, phosphates, potash, lime, magnesia, iron, and carbon-dioxide. All of these, with the exception of carbon-