tween soils rich in humus and those poor in humus. A soil which by long cultivation has lost half its total humus, will show a loss of 10 to 25 per cent. of its water-holding power. Humus is also an important factor, especially in sandy soils, in assisting the capillary rise of subsoil water to the roots of plants. The part which humus plays in supplying water to crops is sufficient in itself for placing a high value upon the humus in soils.

Coming now more particularly to the chemical side of the question, it is important to note that humus as found in the soil always contains nitrogen, and that in its decay, acids are formed which combine with lime, potash and phosphoric acid, forming humates.

Practically all the nitrogen in soils is derived from the organic matter of natural vegetation or barnyard manure, and this, as has been stated, forms the humus; consequently, the amount of humus in a soil is an indication of the amount of nitrogen. Humus, as ordinarily obtained, contains from 3 to 10 per cent. of nitrogen, the amount depending upon the nature of the substance from which it was formed, its age, etc. Many good soils contain from 3 to 5 per cent. of humus, of which about one-tenth is nitrogen. Since, therefore, nitrogen is one of the most prominent constituents of humus, it can easily be seen that a loss in humus also results in a loss of nitrogen.

It is now well understood that the decomposition of organic matter is the result of the action of minute organisms. Cultivation opens up the soil and improves the conditions under which these organisms work, and thus hastens decomposition. As a result of these changes, generally known as "nitrification," humus is broken down, carbonic acid and various other acids are formed, and the nitrogen is converted into nitrates. These nitrates are soluble, and are caught by the water percolating down through the soil and carried away in the drainage water. Nitrification is one of the most important natural provisions for rendering the inert fertility of the soil available to plants, and a certain amount of it is necessary to plant growth, but it can easily be seen that under injudicious management or cultivation of the soil it may work a positive injury by causing unnecessary waste of the nitrogen; or, in case of rich soils, it may supply the growing crop with too much nitrogen, and thus produce a rank growth of straw and leaves. Moreover, it is also plain that unless organic matter is being continually added to a soil under cultivation, the amount of humus with all its beneficial effects and the amount of nitrogen must be gradually reduced.

Summer cultivation of all kinds greatly hastens nitrification. Consequently, bare summer-fallowing will be very beneficial to the succeeding crop, by increasing the amount of available nitrogen, but frequently, if not always, more nitrogen is brought into a soluble form than is necessary for the crop, and whatever the crop is unable to utilize is lost by leaching; thus the available nitrogen is increased, while the total nitrogen is greatly decreased. Experiments have demonstrated that for every pound of nitrogen absorbed by a crop following the summer-fallow, five pounds were lost in the drainage. Summer-fallowing is, therefore, only temporarily beneficial at the expense of the total humus and nitrogen of the soil. On the other hand, while summer cultivation of root and corn crops hastens decomposition in the same way as summer-fallowing, the plant food rendered soluble is absorbed by the growing plant. It may also be noted that nitrification commences in the spring, as soon as the soil becomes warm enough, and that it is naturally most rapid near the surface, where there is plenty of air; consequently, with late spring plowing the available nitrogen is plowed down and inert organic nitrogen is brought to the surface.

Another point regarding the value of humus not generally understood, is that besides being a great reservoir of nitrogen, humus is an indirect means of supplying the plants with other fertilizing constituents. The mineral portion of soils is composed of more or less finely-divided rock particles, insoluble in water. These must be brought into a soluble condition before they can serve as food for plants. In the decay of organic matter, carbon dioxide is liberated and aids materially in the decomposition of these insoluble substances. Various acids, known collectively as humic acids, are also formed, and these aid in this decomposition and combine with the lime, potash, phosphoric acid, iron, etc., and form the humates. The mineral matter combined with humus is rich in potash and phosphoric acid, two compounds which are of great agricultural value. In the case of rich prairie soils, over 1,500 pounds of phosphoric acid and 1,000 pounds of potash per acre to the depth of one foot have been found to be in combination with humus, while in soils poor in humus and worn by cropping, there may not be more than 100 pounds per acre. It is stated that the amount of phosphoric acid usually found associated with humus varies from 0.1 to 0.5 per cent. of the total amount in the soil, indicating in many cases the amount of this constituent available to plants.

It is not necessary to point out that loss of humus is always followed by a marked decline in productiveness. Every cultivator of the soil is familiar with that fact; nor is it necessary to discuss the various methods that may be followed to increase the humus content of the soil. Remember that land without a crop is subject to leaching, and that any crop, whatever it may be, grown to plow down will convert some of the inorganic constituents of the soil into organic combination and will form humus. Of course, no other crops will give so good results as the legumes, and just here let me state that it has been demonstrated that clover, roots and tops, three months old, will have gathered from the soil and atmosphere as much nitrogen as there will be in two good crops of wheat. During the growth of the clover, potash and phosphoric acid will be brought up from the subsoil by the deep roots, and on the decay of the plant be left in the surface of the soil. Further, in the decay of the clover, the physical condition of the soil will be improved, and the humic acid formed will aid in breaking up insoluble rock particles and combine with the constituents essential for the growth of crops. Nearly all our soils contain a large store of mineral plant food, which, in most cases, can be brought into an available condition by the combined use of humus and cultivation. In the absence or scarcity of the proper soil elements—like lime, potash, etc.—humus-forming material may produce sour lands, and lime particularly, and possibly phosphoric acid may be needed where humus is abundant, but in good soils, well stocked with lime, there is very little danger of this result.

In the above, some of the effects of humus on soils have been very briefly outlined. More might have been mentioned, but sufficient has been said to show clearly that humus is a very important constituent of the soil. It increases the water-holding capacity of a soil, it renders clays more open and friable, and sands more compact, it supplies nitrogen, and it aids materially in rendering available the mineral constituents of the soil. If it does improve soils in all or in any of the ways above indicated, it is safe to conclude that, as a rule, soils will be benefited by those systems of culture which will conserve or increase their humus content.

Some Modern Ideas in Crop Rotation.

To the Editor "The Farmer's Advocate":

In response to the editorial in the Feb. 15th issue of "The Farmer's Advocate," asking for ideas and experience in regard to crop rotation, I accept the invitation, hoping that by so doing I may help draw out a discussion upon a very important subject.

Nature exacts her own penalties. Man cannot transgress her laws with impunity. That this is true in regard to our treatment of the soils, as well as pertaining to our physical being, is indisputably proven by thousands of acres of impoverished farm lands all over our own and other agricultural countries. Man learns by experience, and it is the unpleasant and unprofitable realization of our initial statement which, of recent years, has been directing a rapidly-increasing current of attention to the question of the rotation of farm crops. With the so-thought inexhaustible fertility of a virgin soil, the early agriculturists had not the immediate need to study this question, but now, for many years, we have been face to face with the giant problem of how to maintain and increase the productiveness of our farms.

The subject is such a complex one that we must approach it from every side. That a rotation is necessary for long-continued success, needs little proof. Before deciding upon any particular system, however, we must consider the main points involved, such as its adaptability to the line of farming we wish to follow, its effect upon the fertility of our soil; the facilities it affords for the control, and, as far as possible, the eradication of noxious weeds and insect pests; and the economy of time and labor, as well as distributing the work over the entire year. These and others, as well as many minor points, are all involved.

Science teaches us the composition and needs of crops. It teaches us that cereal crops feed heavily upon the more important elements of plant food, especially nitrogen, without supplying anything appreciable in return; that leguminous crops, principally clovers, are the best and cheapest means of increasing the supply of nitrogen and humus in the soil; and that the cultivation of the fodder crops unlocks inert plant food, and renders it available. In these three established facts we have something to guide us in arranging our rotation so as to maintain and increase soil fertility. Of the three, we would give to clover the premier position. Not only does it supply valuable plant food, but by its large root system and the addition of humus, it greatly improves the mechanical condition of the soil. In our own experience, we have yet to find the crop that does not do well after clover, expecially if a good aftermath be plowed down. For this reason, we prefer as short a rotation as is consistent with the other objects to be attained, in order that all the land may be seeded to clover as often as possible.

For our own conditions, we prefer a three-year rotation, which is the one we are trying to follow. We are engaged in mixed farming, with live-stock products and apples as our chief sources of revenue. Beginning with a clover sod, the first year will be corn, roots and peas; second year, oats, barley and emmer following the corn and roots, and wheat on the pea ground, all being seeded to clover and timothy; third year, clover. While this is the system we would like to follow, we are sometimes obliged by circumstances to make departures from it. For some years the pea crop has necessarily been ruled out, and then we have had to sow the part of the sod, formerly given to peas, to barley or oats, to be followed by wheat, which is not what we like, as two cereal crops follow each other. However, since we apply the manure as much as possible to the crops following sod, if we are careful to give a liberal dressing to the part intended for wheat the following year, then this may not be a serious weakness, as we do not grow wheat to any great extent. In our locality it is too uncertain a crop to be very profitable. We might also overcome the difficulty by taking a part of the clover sod for wheat, seeding to clover and leaving down for two years instead of one, to keep it in the rotation. The past year we tried peas again on a small scale, with splendid results, but whether the weevil has gone to stay remains for succeeding years to tell.

Another difficulty in the way of working a systematic rotation upon our own farm is the variableness of the soil, which is from a sandy loam to a black clay, and former swamp soils, making certain portions of the farm particularly adapted to certain crops. To partly overcome this, and the fact that only part of the farm is fenced for pasturing, we are thinking of putting four fields under a four-year rotation of corn, barley and oats, and clover and timothy pastured for two years, these being the crops best suited to the soil.

To my mind, the advantages of the three-year rotation, as outlined, are: That all the land is in clover every third year, which greatly increases the amount of humus and nitrogen in the soil, and is then followed by a hoed crop, which renders available for the succeeding crops of cereal grain an abundant supply of the surface-soil plant food. These crops, especially barley, are shallow-rooted, and have a short season of growth. It also gives splendid opportunity to control weeds, because of the frequency of the hoed crop, and there is practically no chance for wireworms or white grubs becoming destructive, as the sod is broken when only one year old.

One objection which may be taken in these days of scarcity of labor is the large amount of plowing; but against this we have the fact that all the sod can be plowed any time between haying and winter—whenever most convenient. If the soil were not too heavy no plowing would be necessary after the corn and root crops, or, if done, it should be shallow, so as to keep the available plant food near the surface. A two or three furrow plow would do it quickly. A large part of the manure can also be hauled on during the winter, which also helps to balance up the time and labor of plowing.

Some, no doubt, under different conditions, prefer a different and longer rotation. If engaged in beef or dairy farming exclusively, leaving the sod down longer would give more hay and pasture. It is a matter which requires much thought before it can be satisfactorily arranged, and each man must consider his own peculiar conditions, and then choose accordingly. All, however, are dependent upon the same laws and workings of nature, which have been set in operation for the purpose of assisting man in supplying the needs of himself and his fellow men.

Lincoln Co., Ont. H. W. H.

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Haldimand Co., Ont.

I received the prizes for "The Farmer's Advocate" all right; they are good. "The Farmer's Advocate" is looked for in our house every week. Wishing your paper a successful year.
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