THE FERTILITY OF MARSH SOILS.

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Marsh soils, from the fertility standpoint, may be divided into three classes: peat, muck and marsh border soils. By peat we mean a soil that is high in organic matter, usually 70 to 90%, but sometimes as low as 50%. The organic matter may be fairly well decomposed or it may be fibrous or brown in color. Muck soils are those having from 15 to 50% of organic matter; it is usually quite well decomposed and does not show vegetable tissue. The term "marsh border soils" is used to apply to those soils where the change from marsh to upland occurs. The organic matter varies from 5 to 15% and consists of black humus which is shallow in depth and underlaid by sand or clay according to the character of the surrounding upland.

Each of these classes of soils have marked characteristics in regard to weight and fertility. Peat soils are light and as a rule have a smaller total amount of plant food than the other classes. They are high in nitrogen and low in phosphorus and potash, which in general is true of the other two classes of marsh soils, with the exception that the nitrogen content decreases with the organic matter, making marsh border soils lower in nitrogen.

ACIDITY OF MARSH SOILS.

The general impression prevails that marsh soils are very acid. This, of course, is true of undrained marshes where the organic acids formed have no chance to leach away or are not neutralized by a limestone wash from the upland. However, it is also true that these marsh lands become less acid when drained and placed under cultivation, so much so, that in several cases studied recently only a trace of acidity could be found in soils that were very acid several years ago.
LIMING MARSH SOILS.

Lime is usually added to a soil to furnish a suitable medium for the development of those bacteria which live with legumes and add nitrogen to the soil. Marsh soils are high in nitrogen, and it is usually supposed that they do not need lime even though they are acid, because legume crops do not have to be grown to furnish nitrogen. Experiments in this state with air slaked lime have shown that it is beneficial on acid marshes in increasing crop yields. Peat marshes contain a large amount of nitrogen, but this nitrogen is not available to plants. It must be made available, principally through bacterial action. The proper decay of humus or organic matter, and proper nitrification i.e. making nitrogen available, are largely dependent on the presence of lime; and if lime is not added there will be an insufficient supply of available nitrogen for plant growth. Lime will, to a limited extent, liberate plant food, but its principal use is to furnish a suitable medium for those bacteria which make plant food available.

The amount of lime to apply will depend on the kind of marsh soil and the amount of acidity present. Raw peat lands which have just been drained and are quite acid will need relatively large applications of lime to neutralize the acidity present and assist in hastening the decay of organic matter. Four or five tons per acre are usually advisable on these soils. Muck soils or marsh border soils do not as a rule need as large an application of lime as they are not so acid. One to two tons per acre is usually sufficient for these classes. Marsh soils in southern or eastern Wisconsin where there is a limestone wash from the uplands do not in general need an application of lime. Before applying lime to your soils it is always advisable to make an acidity test to determine the degree of acidity. These tests are made free for any resident of the State by the Soils Department, College of Agriculture, Madison, Wis.

In the experiments carried on throughout the state two forms of lime have given good results: air slaked lime and wood ashes. Ashes contain potash also which is beneficial. Other forms of lime can be used but they do not appear to be as beneficial or as efficient in quickly neutralizing the acidity and hastening decay of organic matter.

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MANURE ON MARSH SOILS.

On marsh soils where there is a deficiency of only one or two elements and a comparatively large amount of nitrogen it does not seem wise to add manure which in itself contains a large amount of nitrogen. Marsh soils in central and northern Wisconsin in general need phosphorus and potash. The amount of phosphorus and potash in 10 tons of barnyard manure can be purchased in the form of rock phosphate and ashes for $5.00 while the manure is worth $15.00 to upland soil. The ashes also contain lime which is not found in manure. The commercial phosphorus ashes or potash should be purchased to supply this deficiency and the manure applied to upland soils where the organic matter and nitrogen are needed. However, there is one exception to this rule. On raw peat lands where horse manure has been applied the crop yield are usually larger than when the same amount of phosphorus and potash are applied in the form of commercial fertilizers. This increase in yield is partly due to the amount as well as availability of plant food added but is largely due to the addition of those bacteria which cause the decomposition of organic matter. Manure not only adds these bacteria in large numbers but also furnishes readily available plant food for them to live on and develop until such time when they can gain a foothold and do their work in the soil. It is advisable therefore to apply horse manure to marsh soils, but the application should be light and be put on with the idea of inoculating as much soil as possible. Three to four tons of manure per acre will be sufficient for this purpose. Loam soils rich in limestone where bacteria are present in large quantities may, possibly, also be used to inoculate newly drained, raw, peat lands with the necessary bacteria. Experiments along this line are being carried on at the present time and further data will be available soon. As stated previously, lime should be applied to furnish a suitable medium for those bacteria to develop.

POTASSIUM ON MARSH SOILS.

The analyses of marsh soils made up to the present time indicate that the potassium content varies from 200 to 1,820 pounds per acre for peat soils and from 4,200 to 8,300 for marsh soils
having more earthy matter. Upland clay soils contain from 16,600 to 50,000 pounds of potash per acre eight inches. These figures show that nearly all marsh soils comparatively speaking are low in potash, and need it to grow good crops. Field experiments throughout the state have also indicated very clearly that potash in some form is necessary to grow the best crops on these soils.

FIGURE 14.—THIS SOUTHERN WISCONSIN MARSH RESPONDED TO PHOSPHATE AND POTASH TREATMENT.

This soil is not acid, yet it requires both phosphate and potash fertilizers. No treatment produced 2 tons, and a mixture of acid phosphate and muriate of potash produced 14.5 tons of green corn per acre.—Courtesy Wisconsin Agricultural Experiment Station.

PHOSPHORUS ON MARSH SOILS.

Chemical analyses have shown that the phosphorus content of marsh soils is variable to a large degree. In some cases it does not exceed 200 pounds per acre eight inches, while in others it may be as high as 1,000 pounds or more per acre. This variability indicates the need of a chemical analysis before applying phosphorus to marsh soils in any large quantities. There is also a wide variation in the availability of phosphorus in different soils in the state. As a general rule acid soils are low in available phosphorus. Recent experiments have shown that most of the marsh soils in Wisconsin are benefited by an application of phosphorus.

Three forms of phosphorus are available, they are, acid phosphate, bone meal and rock phosphate. The last two are more available and give quicker results. However, rock phosphate is
cheaper and if applied properly will give better results for the money expended than the other two forms.

**RESULTS SECURED WITH FERTILIZERS ON MARSH SOILS.**

In Marinette county on peat underlaid by sand the yield of potatoes was 77 bushels per acre on the field not treated, 218 bushels where manure was applied, 168 bushels where 3,000 lbs. of ashes were applied and 196 bushels where 300 lbs. of acid phosphate and 2,000 lbs. of ashes were applied. In thise case the 15 tons of manure were worth $22.50 produced a slightly larger yield than ashes and phosphate valued at $7.00. The yield in all cases due to the application of fertilizers is very large, thus showing that fertilizers are necessary for these soils.

At Babcock, Wis., the following results were secured in 1915 on potatoes:

<table>
<thead>
<tr>
<th>Fertilizer Description</th>
<th>Yield (Bushels)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check Plot</td>
<td>110</td>
</tr>
<tr>
<td>Phosphorous (400 lbs. bone meal)</td>
<td>128</td>
</tr>
<tr>
<td>Potash (200 lbs. of Muriate of Potash)</td>
<td>128</td>
</tr>
<tr>
<td>Potash and Phosphorous</td>
<td>160</td>
</tr>
</tbody>
</table>

At Bancroft the following results were secured with potatoes in 1915:

<table>
<thead>
<tr>
<th>Fertilizer Description</th>
<th>Yield (Bushels)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No fertilizer</td>
<td>43</td>
</tr>
<tr>
<td>Acid Phos. (300 lbs.)</td>
<td>59</td>
</tr>
<tr>
<td>Potash (150 lbs. of Muriate)</td>
<td>91</td>
</tr>
<tr>
<td>Potash and Phosphorous</td>
<td>110</td>
</tr>
</tbody>
</table>

At Palmyra in 1911, an application of 15 tons of manure produced 10.5 tons of silage, while 500 lbs. of muriate of potash produced 13.5 tons per acre. The value of the manure was $22.50 while the potash cost $9.00 per acre. This data again shows that commercial fertilizers will supply these deficiencies as well as manure. This work at Palmyra was carried on under the direction of W. W. Weir of the Soils Department.

On march in Waukesha county an application of 150 lbs. of muriate of potash produced 15 tons of silage per acre while the field receiving no treatment only three tons per acre were harvested.

In central Wisconsin a 19 acre field of potatoes which was killed by frost on August 27th, 1915, yielded better than 150
bushels per acre where 300 pounds of acid phosphate and 150 pounds of muriate of potash was applied. A neighbor who did not believe in fertilizers did not secure a crop sufficiently large to pay for seed and labor.

Numerous other illustrations could be given where commercial fertilizers have benefited marsh soils, but these illustrations selected from different locations in the state show that marshes in all sections are benefited by proper treatment.

The fact that fertilizers must be purchased and used on marsh soils need not discourage the prospective buyer or the man who wishes to develop this type of soil, providing he can purchase the land at a reasonable price. He must bear in mind though that he has special problems to meet before he can secure his harvest. The money that must be expended for drainage and fertilizers is comparable to money spent on other types of soils for land clearing operations. Marsh soils, when properly drained, cultivated and fertilized will produce good crops. However, there is a period of development of from one to three years depending on the soil management, which must be gone through before the best crops can be secured.

CROPS ON MARSH SOILS.

Marsh soils which are newly drained and are peaty should be planted to such crops as buckwheat and flax, because:—1st, they have a short growing season and can be planted late in spring or early summer thus giving ditches or tile an opportunity to do their work thoroughly before the crop is planted; 2nd, these plants will grow on soils high in nitrogen without as much danger from lodging as grain crops; 3rd, their feeding roots are shallow, thus permitting them to grow on soils where the water table may be high during the first season; 4th, if planted thickly, they form a dense shade which prevents the growth of weeds and marsh grasses. It is generally supposed that a cultivated crop like potatoes or corn will grow well during the first year on newly drained marshes, however, experience has shown that this opinion is erroneous. The stand as well as growth of these crops is usually very uneven and the irregularities of the land and coarseness of the peat make cultivation almost impossible so that grasses and weeds grow in
abundance. During the second year if the land is well drained it can be planted to corn and potatoes. An application of fertilizers as previously indicated should be made after the field is plowed. Fall plowing is preferable to spring plowing. After the plowing the field should be disced thoroughly and deeply to place it in good physical condition. Compacting is also essential to prevent the surface from drying out. On soils where drainage is not very good the second crop should be timothy and alsike clover and used for pasture and hay. Fertilizer should also be applied for this crop. Among other crops that can be grown successfully are potatoes, corn for silage, onions, soybeans, alfalfa, cabbage, beets, and other truck crops.

**SYSTEMS OF FARMING.**

Two systems of farming may be followed on marsh soils. They are dairy or truck farming. Grain farming will not prove profitable due to the lack of phosphorus and potash and excess of nitrogen which causes lodging and improper filling of the head. Blight and rust are quite bad and lower the yields of grains on these soils. The practice of fattening cattle in the summer and selling in the fall gives some profit, but it will later give way to dairy farming, and the quicker this transition occurs the more profitable farming will be. It is gratifying to note that on marsh lands in central Wisconsin, farmers are building many silos showing that they are planning on winter feeding of stock. With dairy farming such cash crops as onions, potatoes and soybeans could be grown.

Truck farming can be followed in those localities which are near to market. Cabbage, beets, celery, etc., are being grown quite extensively in southern and eastern Wisconsin.

There undoubtedly have been many crop failures on marsh soils as well as many successful crops. The man who purchases land of this kind must bear in mind that additional money besides the purchase price is needed to develop his property. On most peat lands the purchaser must have from ten to twenty dollars additional per acre to pay for the usual every-day expenses, cost of drainage, fertilizers, etc., that is, enough to take care of him until his farm is in condition to produce good crops. There are in sections of Wisconsin at the present time, quite a number
of farmers, who, through lack of sufficient capital, are discouraged and are condemning marsh soils because they do not have the means to do those things which are essential to success on this type of soil. A large percentage of these people may have been deceived as to the quality of the soil, or were possibly under the impression that the land which they were purchasing was similar to other land which they knew but which was under a high state of cultivation, while the new land must first be developed. I believe it the duty of every one who wishes to aid in the development of marsh soils to state the facts as they are, that is, if a certain field needs special treatment, emphasize that fact, and do not let a man struggle along when, as the old saying goes, "a dollar expended in time will save nine." With proper coöperation among all people interested in the development of marsh soils, there is no doubt in my mind that with better drainage, proper cultivation and fertilization most of the marsh soils can be made as productive as any soil in the state.

DISCUSSION.

Mr. Wakeman. What can you afford to pay for wood ashes to fertilize marsh land?

Mr. Ullsperger. Five dollars a ton for unleached ashes. Leached ashes are almost worthless.

Mr. Dibble. When do you seed flax?

Mr. Ullsperger. About the middle of June at the rate of half a bushel to the acre.

Mr. Myers. I think that manure sweetens the soil and helps it more than commercial fertilizer. Horse manure is both cheaper and better than commercial fertilizer.

Mr. Ullsperger. If you have upland that needs your manure, the commercial potash is cheaper for your marsh.

Mr. Bracken. Is it not true that tile takes the place of fertilizer?

Mr. Ullsperger. Yes, by introducing air and decomposing the peat so as to make its ingredients available. It can not liberate potash, however, when there is so little in the peat. You can not get blood out of a turnip. Both tile and fertilizer are needed.
Mr. Thorne. Does not tiling make the roots go deeper so that the plant can get potash from the sub-soil?

Mr. Ullsperger. Bacteria and the weathering agents work very slowly in the sub-soil, so very little of the potash in the sub-soil is made available by drainage.

Mr. Myers. Burning makes a marsh soil better.

Mr. Ullsperger. It makes the potash more available, but it drives off the nitrogen. It is all right to burn on the surface, but I do not believe in burning any of the peat.

Upon motion the convention adjourned to 9:30 A. M.

The Wisconsin State Drainage Association holds its summer meeting in the field in Racine County September 4 and 5, 1916. Arrangements are being made by the people of Racine to visit several drainage districts by automobile. From there we go to Madison to see tractors and excavating machinery demonstrate on marsh lands. About September 1, each member will be notified of the exact hour and place of the Racine meeting.

The next annual meeting will be held at Madison in January or February, 1917, while the legislature is in session. A program will be sent to all members and to all others who apply.