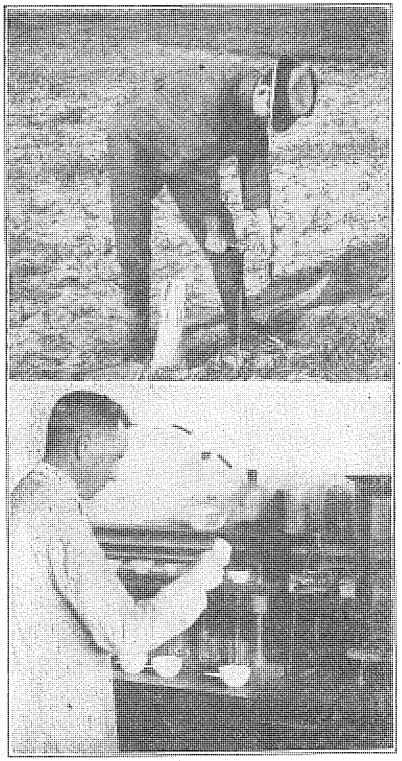
Circular 64 October, 1916

University of Wisconsin
College of Agriculture
Agricultural Extension Service

Have You Had Your Soil Analyzed?

A. R. WHITSON and W. J. GEIB

How to feed the soil economically so as to make it grow the largest crops and bring in the largest returns is becoming a matter of more and more importance to Wisconsin farmers.



MAKING THE SOIL TEST

By finding and remedying the cause of soil troubles the soil surveyor helps the farmer improve and increase his crop yields without impoverishing his land.

Much of the soil of the state is rich, often too rich, in one element, while lacking in one or two others.

Three million acres of marsh land are too rich in nitrogen but need the addition of phosphorus and potassium. Perhaps two-thirds of the state is covered with soil of varying degrees of acidity, which must be corrected before best crops can be grown. Three million acres of clay soils, five million acres of sandy soil, and several million acres of land needing draining, each offer a different problem in soil management.

Just how to handle their soils so as to improve them, is a problem in which many farmers are interested. On a great many farms certain fields do not produce yields which they should or some crops do not grow as well as others. We need to take stock of our soils in order to learn the causes of these conditions and to find ways of remedying them.

Many think that a chemical analysis of the soil will solve these problems. Numerous samples of soil are sent to the Wisconsin Experiment Station each year with the request that they be analyzed, a course of treatment outlined that will bring back the soil fertility, and advice given as to crops best adapted to the land. Chemical analysis of such samples will quite often indicate the condition of the soil, but in most cases an examination of the field itself is necessary.

WHY SOIL TESTS ARE IMPORTANT

Soils vary greatly in texture, chemical composition, and fertility.

But few fields are producing maximum crops.

Many soils lack one or more of the important plant food elements.

Different soils require different treatments.

The use of the wrong fertilizer will result in loss.

Crops poorly adapted to soil conditions are often grown.

Many Wisconsin soils are acid.

Some guide is necessary for permanent soil improvement.

Important conditions affecting the fertility of the land are seen when the field itself is examined which do not show from an inspection of a small sample of the soil. Moreover, the fertility of each field depends on the management of the whole farm. The rotation of the crops, the use of the different fields for pasture, and the manner in which the manure is preserved and distributed are all matters which determine the fertility of the fields, and which cannot be determined from the soil itself.

Recognizing the difficulty in drawing the proper conclusions from chemical analysis alone, the Experiment Station formerly refused to analyze chemically samples taken from a field which it was impossible to examine.

The legislature of 1913 passed a law establishing the State Soils Laboratory[1] as a part of the department of soils

[1] The work of the State Soils Laboratory is closely related to the Soil Survey, which is being made of the entire state under a coöperative agreement by the Wisconsin Geological and Natural History Survey, The Wisconsin Experiment Station, and the United State Department of Agriculture. It is the purpose of this Soil Survey to study and classify the soil, and prepare maps showing the location and distribution of all the different types of soil. Soil surveys are taken up by counties. In the new line of work described by this circular, soil surveys are utilized wherever possible. The work, however, is of a much more detailed character than any previously undertaken and as the soil problems on individual farms are carefully investigated, this service might well be called a Farm Soil Survey.

in the Wisconsin Experiment Station and providing that upon proper application any farmer or land owner in the state is entitled to the services of the State Soils Laboratory. This service includes making careful examination of the soil on the farm in question, the collecting of all information available as to the methods of farming which have been followed, and the lines of treatment which have been given the various fields. Samples of soil are collected for chemical analysis and sent to the Soils Laboratory at Madison.

By examining the soil and field conditions on individual farms.

By analyzing, chemically, the soils sent from fields to the laboratories and

By applying the results obtained at the Agricultural Experiment Station

The State Soils Laboratory strives to be of service to every farming community in the state.

When the chemical work has been completed, reports are prepared for each farm outlining methods for the permanent improvement of the soil.

This service is available to any farmer or group of farmers in the state, and to any resident or non-resident land owner. The service, through the consent and application of the owners is also available for prospective settlers, who before purchasing a tract of land, desire to have it examined. In such cases the man wishing to buy the land should request the owner to make application for a soils examination.

Before the most intelligent effort can be made in building up a soil, the variations and peculiarities of that soil must be known.

Farmers should have an inventory taken of their soil resources so that the best methods of fertilization, crop rotation, and cultivation, may be determined.

The work of the State Soils Laboratory is carried on by members of the Experiment Station staff, the field examinations being made by men who are in charge of the soil research and extension work in the different parts of the state. This arrangement makes sure that the examinations of the farms will be made

by men who have had a number of years experience in studying the soil problems of their respective parts of the state.

HOW TO APPLY FOR SOIL EXAMINATIONS

Application for soil examination and analyses should be made to the Agricultural Experiment Station, Madison, Wisconsin, upon forms found in the back of this circular. As soon as received, these applications are referred directly to the representative who will make the examination. It is generally advisable to delay the field examination until several applications have been received from the same part of the state so as to economize as far as possible in time and traveling expenses.

THIS SERVICE WILL AID

In improving the soil.

In building up "worn out" or "run down" land.

In reclaiming marsh land.

In handling and cropping raw or virgin land.

In selecting land from which to make a farm.

Reports on the work covering each farm examined are issued as soon as possible after the farm has been visited, but it should be borne in mind that the making of a complete chemical analysis of a soil is a time-consuming process and requires great care and accuracy of work.

Where field examinations are made and samples collected during one summer all reports will be issued so that recommendations made may be followed in the farm plans for the next season. When samples are collected in the spring such reports will usually be issued during the same field season. It is important that all interested in this work should send in their application as early as possible.

FARMERS UNITE TO REDUCE COST

Special attention is directed to the fact that where five or more farmers in a community unite in applying for soil examination and analysis, the cost to each is smaller than where a single farm is examined, and it is also possible for the Laboratory to render a greater service. After soil analyses have been made and reports prepared for a group of this kind, the College of Agriculture will, upon request, send a representative into the community for the purpose of holding a special meeting to discuss the various reports and to answer any other questions which may arise. These meetings are open, and all people of the community are invited to attend.

To maintain and increase the fertility of the soil is one of the greatest and most important problems with which the farmer has to deal.

Without an intimate knowledge of the soil on his own farm, no farmer can hope to reach the highest degree of efficiency in crop production.

CHARGES MADE FOR SOIL EXAMINATIONS AND ANALYSES

The charges which are made for the soil examinations and analyses are prescribed by law, and for the present are as follows:

Where the farm or tract of land examined includes 160 acres or less and where a field examination is made and one sample of soil is taken for chemical analysis, the charge is $5. When it is desired to have more than one sample analyzed the charge is $5 for the first sample and $3 for each additional sample. Where a field examination only is made and no chemical analyses are desired the charges are the same, except on large tracts of land.

When five or more farmers unite in applying for this service the charge to each farmer for the field examination on 160 acres or less and the analysis of one sample of soil is $3. When any member of a group wishes more than one sample analyzed the charge is $3 for the first and $2 for each additional sample.

Where field examinations are desired over rather large tracts, such as on unimproved land in upper Wisconsin and where few or no chemical analyses are called for, rates will be quoted upon application.

Charges for the services of the State Soils Laboratory are payable after the field examination has been made, and before the chemical analyses of the samples are begun.

Experience has shown that the fee charged covers about one-third of the actual cost, the remaining two-thirds being paid by the state from a special fund of $2,000 a year.

The Laboratory does not claim to be able to offer a solution for all soil problems and in common with all of the experiment stations is constantly studying questions which it has not yet been able to solve, but in the great majority of cases the reason for lack of fertility of a field or farm can be determined by such examinations.

SOME RESULTS OF FIELD EXAMINATIONS AND SOIL TESTS

After the fields have been examined, chemical analyses made, and the recommendations given, many farmers in different parts of the state have purchased and applied lime, phosphate fertilizers, and other materials.

A group of farmers near Grand Rapids purchased 3 car loads of lime, a group near Plainfield bought 2 car loads, and farmers near Hancock secured 7 car loads. At Hancock one farmer took 5 car loads. Practically all of this lime was used to correct the soil acidity so that clover and alfalfa could be grown to improve the sandy soil.

The owner of 887 acres of marsh land in Portage county purchased 443 tons of wood ashes and over 400 tons of rock phosphate after his land had been examined and his soil tested. The ashes cost $1.50 a ton f. o. b. and the freight was $1.40 a ton. The wood ashes contained about 67 pounds of potash per ton. By using wood ashes this farmer bought his potash at a cost of a little over 4 cents a pound.

One farmer who applied potash after his marsh soil had been tested secured a yield of 224 bushels of potatoes to the acre from the treated land and about 64 bushels where he did not add the potash. Another field in Taylor county produced 90 bushels of potatoes on untreated soil and 160 bushels on the treated. The soil was silt loam.

Another farmer who followed the suggestions offered by the Farm Soil Survey, grew about three tons of alsike clover and timothy to the acre on marsh soil ordinarily producing about a half a ton.

Near Roberts, a group of farmers united to have their soil analyzed. So well were they pleased with the results

that on the following year another group of farmers asked to have their soil examined.

Near Shiocton, an average of 30 per cent increase in all crops treated is reported following the use of a considerable amount of special fertilizers which were recommended.

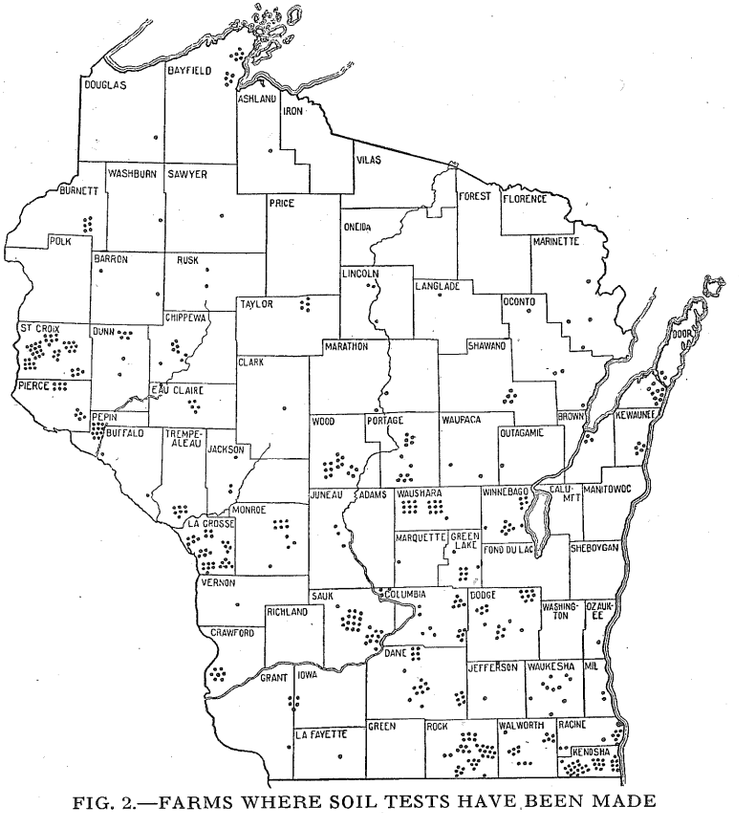


FIG. 2.—FARMS WHERE SOIL TESTS HAVE BEEN MADE

Since the inauguration of this work to July 1, 1916, 499 farms were examined by the representatives of the Farm Soil Survey for the purpose of assisting the farmer in permanent improvement of the soil. Up to September 25, 1916, the total number of applications received for this service numbered 585. Each dot represents a farm.

At Stevens Point following treatment outlined by the soils department, clover has been successfully grown on land on which it had previously been a failure.

Specific instances of this kind could be multiplied many times, but the facts show that farmers who have had their

fields examined and their soil analyzed are actually following out the recommendations made by the College of Agriculture for the permanent improvement of their soil and are receiving increased yields in return.

AVERAGE SOIL ANALYSES

Table I shows the average amounts of the important plant food elements in the surface eight inches of an acre on nine of the most important and extensive types of soil in

TABLE I.—THE AVERAGE ANALYSES OF SOME OF THE MOST IMPORTANT TYPES OF SOILS IN WISCONSIN†

Type of soil	Total phosphorus	Total potassium	Total nitrogen	Total calcium carbonate	Total organic matter	Acidity
Miami silt loam from southeastern Wisconsin...	1,120	42,600	2,800	2,020	54,800	Not acid to slightly acid
Knox silt loam from southwestern Wisconsin..	900	35,800	2,400	1,740	49,800	Not acid to slightly acid
Carrington silt loam from black prairies.....	1,680	39,200	5,040	.....	125,400	Acid
Colby silt loam from north central Wisconsin..	1,360	30,200	3,420	.....	69,400	Acid to very acid
Kennan silt loam from northern Wisconsin.....	1,120	33,800	2,800	.....	62,800	Acid
Superior clay loam (red clay) from northern Wis.	1,040	49,000	2,960	13,440	54,200	Not acid to slightly acid
Plainfield sand from sandstone areas.....	520	23,200	1,240	.....	3,020	Acid
Clyde silt loam from southeastern Wisconsin...	2,500	39,600	1,162	36,100	21,740	Not acid
Peat from southeastern Wisconsin*.....	707	840	10,962	.....	278,040	Slightly acid to not acid

† Figures indicate pounds per acre to depth of eight inches.
*Peat from central and northern Wisconsin is acid to very acid.

Wisconsin. It will be observed from this table that there is a wide variation in the amount of the various plant foods present in different kinds of soil. While this shows only the total amount present and does not indicate what proportion is available to plants, it does indicate if there is a marked deficiency or an abundant supply. This information is used in connection with that which is obtained in making a careful field examination, and is supplemented by work of the Experiment Station on different kinds of soil. With this

fund of information on hand efficient plans can be readily worked out which will greatly assist in permanently improving any soil in the state.

TAKING SAMPLES AND MAKING FIELD EXAMINATIONS

Soil examinations in the field are made by the use of a soil auger, with which borings may be taken to a depth of about three feet. A sample of soil for chemical analysis is collected by taking borings in from 10 to 20 different places in a field or over a tract of land where the soil is uniform. The material from the surface eight inches only is analyzed chemically, the subsoil being examined chiefly for its physical characteristics. Where two or more distinct types of soil occur on a farm, it is often desirable to have a separate analysis made of a sample from each kind of soil which covers a large enough proportion of the farm to make it important.

In addition to taking a sample of soil from a single field, or from a larger part of a farm, it may be desirable to make a field examination of the entire farm. This is done by going over the farm and taking borings at a sufficient number of places to determine fully the character of the soil and its variations. From the information thus collected, along with the history of the methods of farming followed, valuable suggestions can be made for the improvement of the soil over the entire farm.

Field examinations only are sometimes made where general information concerning the character of the soil on a tract of land is desired, and where the parties interested wish a report without the delay necessitated by the making of a chemical analysis. Such a report can usually be prepared without delay as soon as the field examination has been completed.

SOIL ACIDITY SHOWN BY TEST

Acidity of the soil has a very important effect on the growth of legumes, expecially clover and alfalfa, which are best suited to Wisconsin conditions. These legumes are of the utmost importance in maintaining soil fertility, because they have the power of gathering nitrogen from the atmosphere. This nitrogen if purchased in the form of commer-

cial fertilizers costs from 15 to 20 cents a pound under ordinary conditions, and a good field of alfalfa will gather from the atmosphere from 100 to 150 pounds each year. A determination of the acidity of the soil and the use of such an amount of lime as will correct it is therefore essential.

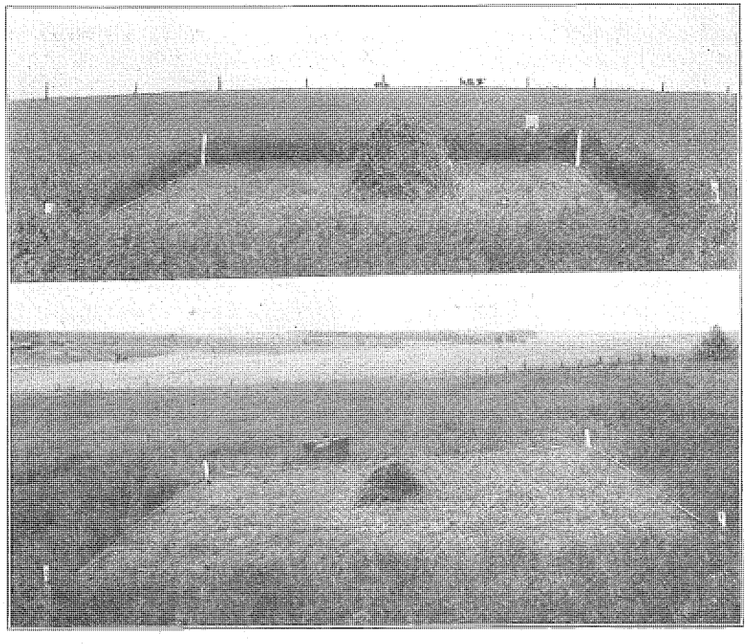


FIG. 3.—ALFALFA WILL NOT THRIVE ON ACID SOILS

The soil in the field shown in the lower view is acid. Note the thin, uneven, short stand of alfalfa. The yield on this field was light, unsatisfactory and it was not profitable.

The soil in the field shown in the upper view is not acid. Note the dense, uniform stand of alfalfa. The yield on this field was more than double that grown on the acid soil in the field shown above.

This is one of the tests always made in the examination of the farm.

The new Truog method for determining soil acidity, which is now in use, not only detects the acidity itself, but it also determines the approximate amount of lime which it will be necessary to add to correct the acidity in the soil.

MANY FARMS NEED PHOSPHORUS

The element phosphorus is one of the most important for plant growth, but occurs always in the soil in extremely small amounts. Moreover, in the mature plant it is fixed in the seed or grain and so is most apt to be sold from the farm. It is true that a considerable amount of this element

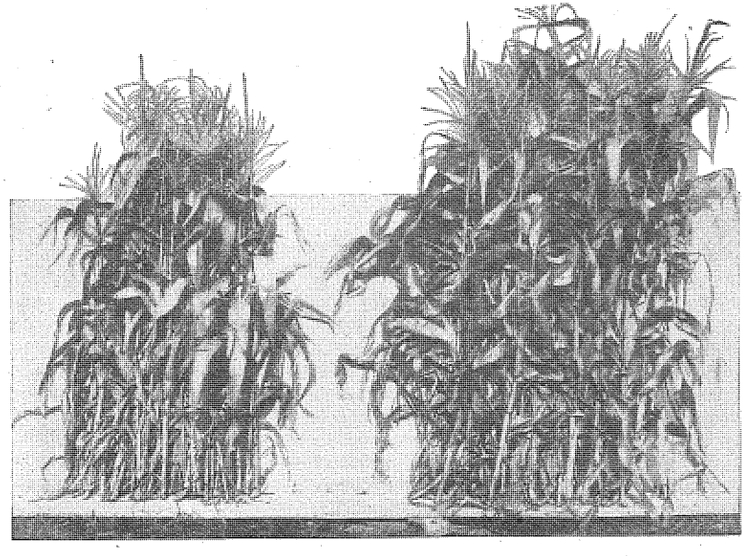


FIG. 4.—MOST ACID SOILS RESPOND TO PHOSPHATE FERTILIZERS

On this acid prairie soil, the addition of phosphate produced a larger yield of corn, and ears of better quality. Corn from phosphate plot on right.

is returned to Wisconsin farms in the concentrates fed to dairy cattle, but bran is the only feed containing any large amount of this and the quantity of bran fed is constantly decreasing. It is probably true that on more than half of the farms of the state a proper use of some form of phosphorus fertilizer would be profitable.

Several forms of phosphorus fertilizers are in use, each of which has its proper place, some being best adapted to one type of soil and others to other types.

POTASSIUM LOW IN CERTAIN SOILS

Potassium, commonly called potash, is one of the elements essential to plant growth. The largest amount of potassium is stored in the coarser parts of plants such as in the straw or corn stalks, so that a considerable proportion of this element taken from the soil by crops is again returned to the land in the manure.

FIG. 5.—POTASH SUPPLIED THE NEED OF THIS MARSH IN WAUKESHA COUNTY

This non-acid marsh produced corn nine feet high where 150 pounds of muriate of potash were applied per acre, while that on the untreated portion, shown in the foreground, was too poor to be worth harvesting.

Most of the soils of the state contain a sufficient supply of potassium. Many of the sand types show a deficiency in this element as do also some marsh soils. Marshes made up largely of peat are very markedly deficient in potassium.

On heavier soils the chief question relating to potassium is regarding its availability which depends largely upon the character and amount of organic matter present.

Wood ashes form a valuable source of potassium, and when dry and unleached contain from 3 to 5 per cent of this element. An application of one-half ton per acre

would be equivalent to 100 pounds of high grade sulphate or muriate.

NITROGEN AND ORGANIC MATTER

The supply of nitrogen and organic matter in Wisconsin soils is extremely variable. Practically all of the light colored upland soils of the state are somewhat deficient while all of the sand soils are markedly lacking in this respect. The black prairie soils are well supplied with organic

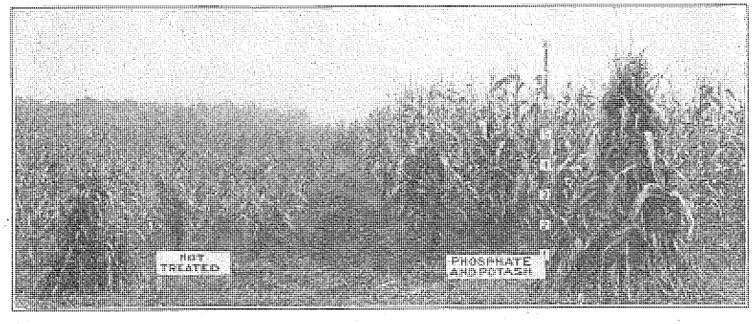


FIG. 6.—THIS SOUTHERN WISCONSIN MARSH RESPONDED TO PHOSPHATE AND POTASH TREATMENT

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. Some marshes are deficient only in potassium while others are deficient also in phosphorus.

matter but in old cultivated fields it is often in an inert resistant form so that the nitrogen is not always readily available to growing crops. Freshly decaying vegetable matter in the form of green manuring crops will greatly improve this condition. Marsh soils are abundantly supplied with organic matter. Where the marshes consist of peat the organic matter content usually varies from 50 to over 90 per cent of the total weight of the soil.

MARSH SOILS

The management of radical types of soil, such as marsh, very sandy soil, and heavy clay, each requires consideration of its individual characteristics. It is usually supposed that marsh soils when fully drained will prove extremely fertile.

This idea probably arose from the comparison of their dark color with the black prairie soils which have proved to be highly fertile. As a matter of fact, however, marsh soils have but very little resemblance to these black prairie soils; the latter have only 8 to 15 per cent organic matter, the balance being made up of earthy matter derived from rocks,

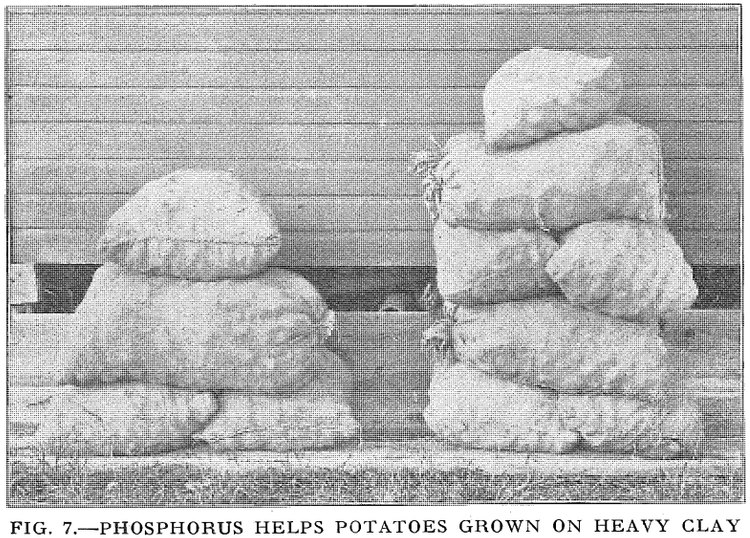


FIG. 7.—PHOSPHORUS HELPS POTATOES GROWN ON HEAVY CLAY

Comparative yields of potatoes resulting from an experiment at Ashland with manure alone as compared to manure supplemented with rock phosphate on heavy clay soils. Soil tests and experiments indicate that many of the heavy soils will be benefited by the application of some form of phosphorus.

while peat soils which make up most of the marsh land contain from 50 to 95 per cent of organic matter and therefore have but little earthy matter. While a good supply of organic matter is important it does not furnish the essential elements potassium and phosphorus in proper amounts and peat soils are therefore extremely low in these elements. As a result it is frequently found that while two or three crops may be produced on some marsh soils after drainage, the peat marshes prove extremely infertile after that unless this deficiency is remedied by the application of the proper fertilizers. Some marsh soils are deficient only in potassium, others in both potassium and phosphorus, and in still others the acidity of the soil must be taken into consideration as well.

SANDY SOILS

The State of Wisconsin includes a large amount of very sandy soil which can be farmed with profit only when unusual care is given in its management. The treatment required to develop a considerable degree of fertility in such soils includes the proper tillage, the use of crops best adapted to it, and frequently the use of some particular fertilizers.

HEAVY CLAY SOILS

Careful management is of especial importance in the handling of clay soils. As a single plowing when too wet may injure them for several years, it is necessary to plow only when in the proper moisture condition. With few exceptions the heaviest soils of the state are deficient in organic matter and some of them, especially the red clays, are also somewhat deficient in phosphorus. While the supply of potassium is abundant, only a very small proportion of it is available because of the lack of a sufficient supply of decaying organic matter.

Published and distributed under Act of Congress, May 8, 1914, by the Agricultural Extension Service, College of Agriculture of the University of Wisconsin, the United States Department of Agriculture, coöperating.

I hereby apply for a field examination and soil analysis of my farm.

Name and address..

Location of land, distance and direction from station...........................

....

If known, give: Town.................... Range.................... Sec. and ¼ sec..................... No. of acres..

Character of soil (whether sand, clay, or marsh)..

Remarks:...

Name and address..

Location of land, distance and direction from station...........................

....

If known, give: Town.................... Range.................... Sec. and ¼ sec..................... No. of acres....................

Character of soil (whether sand, clay, or marsh)..

Remarks:...

Name and address..

Location of land, distance and direction from station...........................

....

If known, give: Town.................... Range.................... Sec. and ¼ sec..................... No. of acres....................

Character of soil (whether sand, clay, or marsh)................. ....

Remarks:...

Name and address..

Location of land, distance and direction from station...........................

....

If known, give: Town.................... Range.................... Sec. and ¼ sec..................... No. of acres....................

Character of soil (whether sand, clay, or marsh)................. ....

Remarks:...

Name and address..

Location of land, distance and direction from station...........................

....

If known, give: Town.................... Range.................... Sec. and ¼ sec........................ No. of acres....................

Character of soil (whether sand, clay, or marsh)..

Remarks:...