THE SOIL SURVEY.

By A. R. Whitson.

A survey of the soils of the state was authorized by the last Legislature and funds provided for two years. This work has been under the co-operative administration of the Geological and Natural History Survey and the College of Agriculture. A second co-operation between the state organizations on the one hand and the Bureau of Soils of the United States Department of Agriculture on the other has also been arranged and the work of the past two years has been carried on under this co-operation. The plans outlined at the beginning of this work included the making of a reconnaissance survey of the portion of the state lying north of the areas of which a preliminary map of the soils had already been made by the Geological and Natural History Survey, and a detailed map of all the older sections of the state. During these two seasons approximately 3,200 square miles have been covered in the reconnaissance survey and 3,500 square miles in the detailed survey. Detailed maps have been completed in Waushara, Iowa, and Waukesha counties and the map of Fond du Lac is nearly completed, while those of La Crosse and Juneau are about half finished. These maps cannot be published until the chemical analyses of the soils of these counties are completed. It is of the greatest importance that the work of the preliminary survey in the northern part of the state especially, be completed as rapidly as possible. There is a great demand for such soil maps from intending settlers and it is very desirable that accurate information be available.
Supply of Plant Food in Wisconsin Soils.

One of the most important objects of the soil survey is a full determination of the amount of the essential elements present in the various soils of the state which are necessary to plant growth. Exact knowledge concerning all parts of the state can only be had after the soil survey is completed, but some estimate of the amount of phosphoric acid, which is apt to be the limiting factor in most soils, can be made in some of the more important classes. The analyses so far made on the clay loam soils and types closely connected with these, occurring in the north central part of the state, including Marathon, Lincoln, Taylor, and Clark counties, show an average of .16 per cent while the subsoils show .134 per cent. The silt and clay loams of the northwestern portion of the state, including Chippewa, Gates, Barron, Polk, St. Croix, and Pierce counties, have an average of 13 per cent in the soil and .107 per cent in the subsoil. The sandy soils of this section of the state have an average of .10 per cent in the surface and .108 per cent in the subsoil. The average in the Marnette clay loam soils is .11 per cent and the sands .08 per cent. The red Superior clay of the Bayfield region averages .09 per cent and the sands .07 per cent. The clay loams of Waushara county average .09 per cent and the sands .06 per cent. The clay loams of Waukesha county average .17 per cent and the sand .04 per cent.

But a matter of even greater importance than the average amount of this essential element is the variation in the amount shown by different fields. In the clay loam soils in the northwestern area, for instance, the total phosphoric acid ranges from .08 per cent to .17 per cent. The sands of Waushara county vary from .01 per cent to .15 per cent. The clays of the Superior region range from .07 per cent to .13 per cent while the sands of that area range from .05 per cent to .10 per cent. Still greater variations are shown in the soils of the sections which have been cropped for a longer period. The sands of Waushara County, for instance, vary from .01 per cent to .15 per cent, while those of Waukesha vary from .01 per cent to .06 per cent. Such variations show the necessity of large numbers of determinations, especially of phosphoric acid in all the important soil types mapped. Effective effort by the state to aid her farm-
ers in the maintenance and increase of her soils will only be possible after a comprehensive knowledge of their chemical composition has been gained.

Extent of Land Subject to Erosion.

In making up the following estimate of the land subject to erosion in the state the work of the soil survey has been used as a basis. In this survey two classes of land subject to important degrees of erosion are defined and mapped; first, those areas on which erosion is so serious as to practically prevent clearing and cultivation; and second, areas subject to serious erosion determining to a considerable extent the plan of rotation and crops grown, although not actually preventing cultivation. Moderate erosion takes place on a considerable portion of the land not included in these two classes. In Iowa county the area belonging to the first class amounts to 11.5 per cent of the total area of the county and that belonging to the second class amounts to 24.9 per cent. This is the only county on which we have at present complete data for this use. Based on that and considering all available data regarding topography and physical character of the soil, it has been estimated that the land subject to severe erosion amounts to one and one half million acres, while that subject to serious erosion is two and a half million acres in extent. While it is true that these areas which are subject to very severe or to quite serious erosion do not form a very large fraction of the state, there is a very much larger area on which the erosion is important. Although this erosion is of less damage to any given farm, the total loss over the whole state is undoubtedly several times that on the area where it is locally much more pronounced.

There are two ways of lessening loss by erosion. One is by its prevention through the use of such devices as terracing, deep plowing, and various plans for preventing the development of gulleys. The other is the adopting of a more extensive type of farming in which the steeper portions of the land can be used for pasturage so that the soil has constantly a protecting sod. It must, of course, be recognized that our rainfall, on account of its distribution largely in the early summer and being quite light in the late summer and fall months, is one not calculated
to produce the best pasturage, so that the use of much land for pasturage purposes is not usually considered profitable. Undoubtedly, however, material improvement can be made in our pastures. There is perhaps no other subject of equal importance which has had so little consideration in agricultural literature as the treatment necessary to the maintenance of good grasses.

It seems to the writer impracticable at present to attempt to prevent these losses by enacting laws which would require farmers to follow specific instructions for their prevention. But certainly the importance of this matter is so great that full data bearing on it should be gathered and careful studies made to determine methods for its prevention under the conditions of our agriculture, and these should be followed by a proper educational campaign. The collection of this data is one of the important objects of the soil survey, so that as this survey progresses, the state will have on hand more and more complete knowledge of the extent of this loss in the various sections of the state.

*Development of Marsh Lands.*

The three or more million acres of marsh lands in the state awaiting development offer large opportunity for increasing the agricultural lands of the state and the population which may be supported. While it is true that these lands have some drawbacks in regard to fertility, it is believed that the great majority of marshes will yield satisfactory results when properly handled, that is, when given the right kind of fertilizers, and planted to the crops to which they are adapted. Nevertheless, there are two or three conditions which are clearly retarding the rate at which these lands are being drained and developed. The most important of these is the condition of our drainage law which at present makes it impossible to condemn or remove by any proceeding dams which interfere with proper drainage of many marsh areas. It is, of course, true that much land must necessarily be included in the flowage of valuable water power sites and that in many cases the value of the water power is much greater than that of the land flowed. On the other hand, there are, undoubtedly, many marshes the drainage of which is now impossible where the value of the land when
could be reclaimed is far greater than that of the water power which has been or could be developed. It would seem that some provision should be made for the determination of which of these interests is the more important by a properly constituted state commission which would have power to act in individual cases brought before them.

Another very serious difficulty in the organization of drainage districts and in fact, of any co-operative method of drainage is that met with in the legal proceedings necessary to effect proper organization. The very nature of the work is such as to make cooperation necessary and to give the corporation when organized, power to control all lands within the district. This, of course, necessarily gives rise to suits for damages by individuals remonstrating against the organization of the district. Unfortunately, however, many attorneys have so low an idea of legal ethics that they go to practically any limit to continue or develop a feeling of dissatisfaction among a minority of the farmers in the region to be organized into the drainage district. In many cases farmers have seemed to be practically at the mercy of attorneys although they were clearly anxious to avoid litigation at the beginning. As an illustration of the expenses of one of the first drainage districts may be mentioned one in which the money actually expended on digging amounted to $9,800 and all organization expenses amounted to $9,900, of which $4,000 was for attorney's fees. The writer has no suggestion to make in regard to the prevention of this difficulty but desires to call attention to it distinctly as the one factor which probably more than anything else is delaying the development of our marsh lands.

It is of the utmost importance that, if possible, something be done to remedy these two difficulties and so to make possible the drainage of a large part of our valuable marsh lands. These lands would be rapidly developed were it not for these difficulties since, in large part, they occur as portions of farms the uplands of which have already been developed. This relation of marsh land to upland gives marsh land a much greater value than it would have if it were all in one body so that entire farms would consist of marsh land.
Experimental and Demonstrational Farms.

In order to make effective the work which the state is doing through the soil survey and the Experiment station to aid in the development of her agricultural resources, it is important that a number of experimental and demonstrational fields be located on each of the chief types of soil. The success of the few such fields now in operation is such as to warrant a very considerable increase in their number. One such farm has been located on the sandy soil of the northwestern part of the state at Spooner—but the need for help on the older soils of the great central sandy section including Waushara, Adams, Portage, Juneau, Monroe, Jackson, and portions of adjoining counties, is much greater. Two or three demonstrational fields or marsh soils should also be established. Most of the land needed for such experimental and demonstrational fields could probably be secured free of cost so long as used for such purposes, and the expenditure of a few thousand dollars in the maintenance of these demonstrations would be repaid many fold in a single decade by the improvement in the management of these and other special types of soil.

Loss of Fertility in Manure.

The state of Wisconsin has encouraged all lines of live stock farming and especially dairying for a number of years through its support of the Agricultural College and various agricultural societies. This has unquestionably been a large factor in the development of the wealth of the state and is a matter of good business judgment. It is probable, however, that a misconception has developed as to the possibilities of maintaining the fertility of the soil in systems of farming where stock raising predominates. It has been so generally stated in the Agricultural Press that by feeding all crops grown on the farm to the stock maintained and returning the manure to the soil the fertility of the soil could be indefinitely maintained, that it is necessary to call attention very distinctly to two radical sources of error in this conclusion. First, there are losses, which are in part avoidable but in part unavoidable, of the chemical elements contained in the crops used for feed when removed from the soil, before they can be returned to the land in the form of
manure. These are through the fermentation and leaching of the manure in the stables and yards. A conservative estimate indicates that the annual loss of fertility from the manure produced by all classes of animals in the state has an actual value on the farm of between ten and twelve million dollars. It is highly probable that one half of this could be saved by the use of proper methods for the handling of the manure. Our climatic conditions are such as to render the use of the liquid manure cisterns, so commonly used in European countries, out of the question during the winter season. The problem of properly taking care of manure in our stables in one yet unsolved for our conditions. With the decrease in the amount of stock produced on the farms, the amount of bedding is frequently insufficient to absorb the liquid manure and some material suitable for this use should be, if possible, provided. The immense quantities of peat and moss accessible in the state exceptionally well adapted to such use would seem to warrant a thorough study of its suitability for this purpose. Not only will the peat prevent the loss of the most valuable part of the manure, but it will add large quantities of nitrogen and organic matter.

Second, the humus or organic matter of the soil which is so essential to the maintenance of a good tilth and to the water-holding capacity of the soil as well as for its chemical action on the rock particles of the soil itself, cannot be maintained on the average stock farm by the use of barnyard manure alone. Careful studies have shown conclusively that even the use of heavy applications of manure on land in tilled crops such as corn or tobacco, for twenty to thirty years has resulted in a constant loss of humus. A very much more effective method of maintaining the vegetable matter of the soil is by plowing under of green manuring crops. In climates which make possible the growth of two crops in a season, the regular or money crop can be grown during the first part of the season and this followed by a legume crop to be used as a cover and green manuring crop and turned under the following spring. The short season of Wisconsin together with the frequent lack of rain during the latter part of the summer makes this practice largely out of the question. It will, therefore, frequently be necessary, where the development of humus is a matter of prime importance to give
up the use of the land for a season or two to the growth of a leguminous crop, all of which is to be plowed under, or to plow under the second crop of clover rather than to cut it for feed or seed. It must also be realized that soils which are deficient in organic matter are usually deficient in available supplies of phosphate and frequently potash, so that the use of some mineral fertilizers for the growth of these green manuring crops will be desirable. However, these elements applied in this form will become again available to other crops by the decomposition of the organic matter later on. The agriculture of Wisconsin probably demands nothing more important today than an active educational campaign emphasizing the importance of humus in the soil and effective methods of maintaining and increasing it.

FERTILITY LOST IN CITY SEWAGE.

A preliminary study is now in progress planned to determine the amount of phosphoric acid, nitrogen and organic matter being lost in the city sewage and the possibilities of its recovery for use in agriculture. This work has been done on the Madison Sewage Disposal Plant by Dr. P. P. Peterson of the soils department. The raw sewage is found to contain approximately 82 lbs. of $P_2O_5$ per million gallons and the sewage of the city amounts to 2.3 million gallons per day, indicating a total content of approximately 190 lbs. of $P_2O_5$ daily or approximately 70,000 lbs. annually. This would be equivalent to 500,000 lbs. or 250 tons of acid phosphate fertilizer containing 14% $P_2O_5$.

The raw sewage is first allowed to settle for 24 hours in the settling tank after which it is drawn off and passed through the filter beds. The sludge which settles in these settling tanks is drawn off once each year and allowed to run to waste in the marsh. The sludge contains a large amount of organic matter containing, of course, large quantities of nitrogen and about 2% of the organic matter in phosphoric acid. This represents a little over one-third of the total. Another portion of the phosphoric acid is absorbed by the filter beds as the effluent passes through it. Somewhat more than half of the total phosphorus in the raw sewage is left in the sludge and in the cinder beds which would be the amount that could with comparatively little difficulty be recovered for use. The nitro-
gen and organic matter would also have considerable value. In all probability the use of limestone filter beds would be more effective in absorbing the phosphorus than the cinder beds, and if that could be removed more often than is now the practice it is quite probable that their content of phosphoric acid would be important and certainly the use of the limestone itself on agricultural lands would be helpful. Further work is necessary before practical methods of recovering and handling the sludge and the filter bed material can be devised. If it should prove practicable to recover at small cost half or more of the phosphorus now being lost in the sewage of cities, a very important advance will have been made in the conservation of this important element.