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MANURING THE SOIL.

JOHN FIELDS.

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EXPERIMENT STATION, Stillwater, Oklahoma.

MANURING THE SOIL.

JOHN FIELDS.

SUMMARY.

Without going into detail as to the various considerations that may affect the results of manuring, at the present stage of our agricultural practice, the chief points to be observed in manuring are:

1. To manure the soil. Use all of the manure produced, prevent losses by washing away, quit burning straw, haul manure onto the fields somewhere, sometime, somehow.

2. Manure the highest and poorest spots, give a good application at one time—from fifteen to twenty two-horse loads—and manure another place next time.

3. Manure with reference to the time of rainfall, to the next crop which is to be grown, and to the other work which must be done. Late fall and winter, when other work is not pressing, is a good time. Light top-dressings may be applied to wheat in the fall.

4. Growing crops for green manuring alone is not the most profitable method. Pasture them and plow under the remainder when about mature. This applies chiefly to cowpeas. If sorghum is to be plowed under, it should be while the stalks are green and juicy so that they will decay quickly.

INTRODUCTION.

The tendency everywhere in cultivating new soil has been to pay but little or no attention to the conservation and improvement of fertility. It is customary to refer to the fertility of new soils as 'limitless, unbounded, and inexhaustible'. Enthusiasts speak of the vast natural fertility of the soils and many who till the soil come to believe what they hear and give no heed to facts and the teachings of experience. This bulletin is issued in the hope that it may call to mind the really great opportunities for soil improvement possessed by Oklahoma farmers, and to partially clear away some of the difficulties that have appeared in the way of the use of farm manures.

SOIL FERTILITY.

By soil fertility is meant, in a general way, its productive-ness—its ability to produce a paying crop. Variations in the degree of fertility produce variations in the crops produced. Soil fertility depends upon three things:

1. The supply of moisture. Soils may be either too wet or too dry to produce a crop. They may be too hard or too loose, too coarse or too fine, and thus unable to retain sufficient moisture for crop production.

2. The mechanical condition. Texture, ease of working, tith, cold, warm, are general terms referring to mechanical condition. The available supply of moisture is greatly affected by the mechanical condition of the soil.

3. The supply of plant-food. By this is meant the chemical elements which are removed from the soil by plants and which must be present in the soil for crops to be grown and matured. Nitrogen, potash, and phosphoric acid are the principal substances constituting plant-food. (A brief explanation of the function and nature of these substances is given in Okla. Bulletin No. 32 and in the Annual Report for 1899.)

It is not the purpose of this bulletin to argue for the practice of manuring and to present a case in its defense. It is a fact that the application of manure to the soil is essential to continued, successful crop production, and those who dispute this fundamental principle, as a principle, will find nothing of interest in what follows.

The application of manure, on the other hand, is a matter that should be investigated by every farmer and results that seem peculiar are often produced and are difficult of explanation.

MANURING.

Under this general head are two subdivisions:

1. The use of manure produced by animals and of refuse material such as straw, corn stalks and the like.

2. Green manuring, or plowing under of all or part of a crop grown either solely for this purpose or in part for pasture.

The effect of the application of manure of any sort to the soil is to modify the supply of plant-food, the mechanical con-

dition, and the capacity for holding moisture. In practically all cases, the supply of plant-food is increased and a larger amount of it is placed at the disposal of succeeding crops. The mechanical condition, and consequently the capacity of the soil for water, is altered. For a time, until the soil settles and rains fill it with moisture after plowing, the effect may be harmful. After this condition is met, the results are usually beneficial.

It is upon this point that the profitable manuring of Oklahoma soils hinges. The time of application in reference to the periods of ample rainfall and to cultural methods determines whether or not beneficial results will be secured the first season. And since in farm operations, immediate results largely determine opinions of methods, it is thought by some that manuring is not profitable.

EXPERIENCE OF FARMERS.

Among the questions included in an inquiry concerning the experience of farmers in the raising of wheat (Reported in Okla. Bulletin No. 47) was the following: "What has been the result of manuring wheat ground?" To this inquiry, 52 out of 118 reported trials with manure, thus implying that the other 66 had not tried it on wheat land. Six of the 52 reported unfavorable results from using manure on wheat.

The following are the condensed statements of those reporting adversely:

"Manured ground grows too much straw; not as good." "Bad results." "I think the land better for wheat without manure while it is new." "Heavy manuring has not proven a success here (Cleveland County) causing too rank straw and, in nearly every instance, late maturing and rust." "Manure on fresh land causes wheat to fall and rust." "It makes too much straw and does not fill."

The following are the condensed statements of those who have good results from using manure on wheat:

"Results better in second year; too much straw the first." "Good results from manure." "Good results from manuring." "Manuring light after wheat is sowed has given best results." "Sometimes it does not do well to manure too heavy." "Light manuring is good, heavy makes the wheat fall." "Heavy manuring makes too much straw." "Have manured some hard spots with good results." "Good results." "Good results." "Will increase yield one-half if proper amount is used." "Have manured a few patches with good results." "Light top-dressing with stable manure increased yield." "It makes a large increase in the crop." "Manured three acres last

year and think wheat was two bushels better on it." "Good results; would not manure too heavy." "Manured thin land with fifty per cent increase in yield." "Good results." "Better yield." "Manure is all right if not too heavy." "On hard land it is all right." "Manuring is all right but there is not enough of it done." "Good results." "Tried small area, great success." "Very good results." "Good results." "Good results." "I have only this to say of manure—that it is the best work that I do to my wheat." "Good results." "You can't get too much. Head the wheat high and let all the litter on the ground to turn under." "Good results." "Think manuring of some kind very essential to invigorate the wheat plant." "Fresh stable manure and ashes, either from wood or straw, have paid largely for their application." "Increases the yield one-fourth." "With good results by top-dressing and working in with harrow and disk." "Manuring will increase yield one-fourth." "Top-dressing increased yields one-third, results of plowing under depend on supply of moisture. Manured ground ripens wheat earlier." "Good results." "Where manured, I get one-third more." "It pays to manure." "Paid well." "Good on land manured and plowed early." "Good results." "Farmers will have to manure their land to make wheat profitable." "Fine results." "Use all I can get with gratifying results."

When variations in seasons and soils and the rainfall and temperature of the wheat seeding season are considered, it is remarkable that the results of practical experience so strongly favor the application of manure to wheat lands. The report, "Top-dressing increased yields one-third, results of plowing under depend on supply of moisture", states the case exactly. In seasons when there is an abundant summer rainfall, manure plowed under will decay and settle down. On the other hand, in dry seasons, and especially if the soil is not well cultivated soon after plowing, manure which is plowed under will keep the soil open and make it dry out easily. The seed then goes into a dry soil, germinates poorly giving a thin stand, and starts off the wheat in a weakened condition.

This makes the manuring of land sown continuously to wheat difficult, and in such cases, it would appear that a top-dressing, well worked into the surface of the soil, would be the best and safest practice.

RESULTS AT THE STATION.

The following table taken from Bulletin No. 47 of this station is inserted, being of interest in this connection. An acre has been sown continuously to wheat since 1892. During the first six years, no manure was applied. In the summer of 1898, 15,720 lbs. of stable manure were applied to the south half of the acre and in 1899, another application of 11,350 lbs. of well-rotted stable manure was put on. Both halves of the acre were treated exactly alike in all other respects. The yields for the last four years were as follows:

WHEAT, HALF ACRE PLATS.

YEAR	Plat No.	YIELD PER ACRE		Treatment
		Grain Bu.	Straw Tons	
1896-97.....	1	17.8	1.13	Unmanured
	2	17.9	1.14	Unmanured
1897-98.....	1	7.0	.57	Unmanured
	2	7.5	.66	Unmanured
1898-99.....	1	30.6	1.65	Manured
	2	12.0	.68	Unmanured
1899-00.....	1	36.8	2.50	Manured
	2	18.1	1.17	Unmanured

In each case where manure was applied, the land was plowed in July and kept well-worked until seeding time. Figured on a cash basis, with wheat at fifty cents per bushel, thirteen and one-half tons of manure produced an increased yield of wheat amounting to a little more than eighteen and one-half bushels worth \$9.25. The residual effect on the soil was such that no manure was applied last fall and it is safe to assume that less than one-half of the benefit from the use of the manure has yet been realized.

The results of manuring wheat land have been discussed rather fully for the reason that the use of manure on wheat presents peculiar difficulties and possibilities of loss during the first season.

MANURING AND CROP ROTATION.

When a succession of crops is grown, the problem of manuring the soil is much simpler than when wheat is the sole crop. Greater opportunities are afforded for choice in the matter of time of application of manure, and there is less possibility of loss because of the drying of the soil. There is practically no danger of loss by leaching when manure is applied in the winter in this climate, and the soil is usually sufficiently dry so that loads may be readily drawn through the fields. It is thus possible to put manure on land that is to be used for corn, cotton, Kafir corn, castor beans, and other spring crops. If the land is plowed early, the spring and early summer rains will settle the soil and lessen the danger which exists when manure is applied in a dry time of the year. Another factor favoring winter manuring is the more comfortable working temperature

at that time of the year and the lack of urgent work that must be done.

As the use of manure becomes more general, discussions as to the best time to apply manure will arise and experiments to test this point will be made. At present, however, the great need is that farmers generally should save and use the manure produced on the farms and put it on the soil. It now matters little when or how—the one great thing is to form the habit of using the manure that is produced in the towns and on the farms.

SOURCES OF MANURE.

As previously indicated, anything that grows on the farm and is in such condition as to decay and become a part of the soil is classed as manure. The passing of feed through animals does not add anything in the way of fertility. When grain and forage are fed, about three-fourths of the plant-food which was in the feed is excreted either in the dung or urine, the amounts varying with the kind of animals. The location of the feed lot should be such that this plant-food can be saved and returned to the soil. Expensive arrangements for the prevention of leaching and loss of plant-food are not necessary. But the manure pile should not be located in a draw, or on the bank of a creek where each rain will wash away valuable plant-food. A level spot or a small alkali spot make ideal places for the storing of manure until such time as it can be hauled into the fields.

Corn and cotton stalks and other rubbish in the fields are easily cut down and plowed under. This method requires but little more labor than raking together and burning and adds much to the fertility of the soil. When such material is dragged together and burned, both the nitrogen and the organic matter are lost, and both are greatly needed for the perpetuation of soil fertility.

Wheat straw instead of being burned should be used as much as possible and converted into manure to be returned to the soil for the benefit of future crops. It should never be burned.

Farmers near cities and large towns can procure large quantities of manure for only the labor of hauling it. Manure

from livery stables is usually very rich, only a small amount of straw being used, and heavy grain feeding being the usual custom. The only difficulty with which the experiment station has met in procuring manure from stables in Stillwater has been inability to haul it away fast enough. It has been a grand opportunity to get something for nothing and the station has taken advantage of it and manured portions of the farm so that they are now in a high state of fertility. Other portions have been left unmanured for comparison, but if the farm were conducted for profit, all of it would have been manured.

GREEN MANURING.

The chief object of green manuring, or plowing under of crops, is to increase the supply of organic matter in the soil and to improve its mechanical condition. Some plants when plowed under actually increase the store of plant-food in the soil. These are known as leguminous crops and those that are successfully grown in Oklahoma are cowpeas, soy beans, peanuts, and alfalfa. The first of these is best suited for green manuring, but it is preferable to pasture the cowpeas off before turning them under. This can be done successfully by sowing cowpeas after wheat as described in the Annual Report for 1900, page 49.

Some very sandy soils have been benefited by growing a crop of sorghum and plowing it under after it has attained nearly full growth. The land should, of course, not be planted to crops immediately after plowing under a heavy crop of sorghum.

SOIL EXHAUSTION.

As frequently considered, soil exhaustion is taken to mean lack of plant-food caused by continuous cropping without manure. It means much more than that, and includes a change in mechanical condition which hinders the growth of crops. This is brought about in many cases by the loss of organic matter. The failure of a soil to produce a satisfactory crop does not argue that there is a deficiency in the supply of plant-food in the soil.

The application of manure to the soil of the station farm produced such marked results that an experiment was begun last season to determine whether or not the benefit was entirely due to the plant-food in the manure, or was in part produced

by the change in the mechanical condition brought about by the organic matter in the manure. No definite results have yet been secured but the indications of the work up to this time are that the application of plant-food in the form of chemicals does not produce as satisfactory results as when applied in barnyard manure.

But few Oklahoma farmers have a thorough appreciation of the extent to which commercial fertilizers are used in the eastern and central western states. The use of artificial manures is crowding westward and many farmers in Iowa, Missouri, and eastern Kansas find their use necessary. It is not the intention to even suggest the desirability of using commercial fertilizers in Oklahoma, except possibly by gardeners and growers of small fruits. On the other hand, the evil day should be put off by caring for and using farm manures while the soil is yet comparatively new. Carelessness in such matters is nothing short of vicious.

WHEN TO MANURE.

As has been indicated, the time of manuring should bear some relation to periods of greatest rainfall. The following tables give the average monthly, seasonal, and annual rainfall of nineteen stations in Oklahoma and Indian Territories, calculated from data furnished by C. M. Strong, Section Director, Oklahoma City, Okla.

FALL AND WINTER RAINFALL.

AVERAGE OF NINETEEN STATIONS.

October	November	December	January	February	March	Total
2.64	2.02	2.09	1.79	1.12	2.11	11.79

SPRING AND SUMMER RAINFALL.

AVERAGE OF NINETEEN STATIONS.

April	May	June	July	August	September	Total
2.92	4.93	3.84	4.50	2.53	2.27	20.99

Of a total average rainfall of 32.76 inches, 20.99 inches or nearly 65 per cent falls during the months from April to September inclusive. This fortunate distribution of rainfall is the controlling factor in crop production in Oklahoma, and requires study so as to manure without loss the first season.

Generally speaking, manuring of the wheat crop is difficult because of the need of saving all of the soil moisture for the germination of the wheat. And as a general rule, if it is possible to do otherwise, wheat should not immediately follow the

plowing under of manure. Green manuring may precede almost any spring crop, for the reason that this process usually diminishes the number of weeds. But applications of stable manure should, in most cases, be followed by some clean culture crop.

If cowpeas are grown for pasture and green manuring, they may follow wheat, being planted as soon as the wheat is cut. They will furnish considerable pasture during the late summer and fall, and may be plowed under during the late fall or winter. The land will then be in condition for a crop of oats, to be followed again by wheat and cowpeas. Stable manure may be hauled into the fields during the fall and winter, and applied to land that is to be used for corn, cotton, castor beans, Kafir corn, sorghum, broom corn, and similar crops.

SOIL MOISTURE.

Attempts to follow Kafir corn or sorghum with wheat have very often resulted in failure. "Kafir corn ruins the land" is an expression frequently heard in conversation with farmers. When the matter is studied, it is found that, after all, it is largely a question of the supply of moisture in the soil. Kafir corn grows a large mass of forage and uses the soil moisture up until the time of wheat seeding, and the wheat goes into a soil without sufficient moisture for the germination of the seeds and the growth of the plants.

Early plowing of land for wheat does little but prepare the soil so that it will take in water and keep it. Working the soil, keeping the surface loose, helps out a dry season by holding the water in the soil. Cultivation at the proper times is much to be preferred to manuring when there is no opportunity for the soil to fill with moisture before a crop is to be planted. The effect of a given crop on the moisture content of the soil has more to do with the yield of the next crop than does the amount of plant-food removed from the soil.

Cultivation and manuring—as much as possible of each—and study and knowledge of the true effect of different crops on available soil moisture are essential to a profitable and improving system of farming. The day of crop failures, worn out farms, and purchase of fertilizers should be put off by the use of things at hand that cost only energy, time, and labor to utilize and possess.