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BUREAU OF PLANT INDUSTRY,

Farmers' Cooperative Demonstration Work,

WASHINGTON, D. C.

DEEP FALL PLOWING AND THE SEED BED.

At the commencement of the Farmers' Cooperative Demonstration Work in the Southern States it was found necessary to outline the fundamental principles of good farming and to insist that the tillers of the soil should become familiar with them and practice them as a first step in the betterment of farm life. We have previously stated these first principles, but possibly they should be more fully explained.

PREPARATION OF THE SEED BED.

Prepare a deep and thoroughly pulverized seed bed, well drained; break in the fall to a depth of 8, 10, or 12 inches, according to the soil, with implements that will not bring too much of the subsoil to the surface. (The foregoing depths should be reached gradually.)

The presence of heat, air, and moisture is essential to chemical and germ action in the preparation of plant food in the soil. The depths to which these penetrate the soil depend upon the depth of the plowing, provided the soil is well drained. There is no use in plowing down into a subsoil full of water.

It has been proved beyond question that the roots of plants penetrate the soil deeper and feed deeper in deeply plowed land. Thus, in general, it may be stated that when the soil is plowed 3 inches deep the plants have 3 inches of food; when plowed 6 inches deep, they have 6 inches of food, and when plowed 10 inches deep they have 10 inches of food. The fact that the bottom portions of the plowed land are not as rich in available plant food as the top portions shows the necessity of getting more air and heat down to them by deeper tillage.

The most essential condition for fertile soil is a constant supply of moisture, so that a film of water can envelop the soil particles and absorb nutritive elements. The hair roots of plants drink this for nourishment. If there is any more than enough to serve as films for the soil particles and capillary water, there is too much and it should be drained off. This can be determined by digging a hole 20 inches deep. If there is standing water in the bottom of the hole, it indicates too much water in the soil or subsoil.

The capacity of a given soil to hold film and capillary moisture depends upon how finely it is pulverized and upon the amount of humus in it. Unplowed lands retain but little water. Thoroughly pulverized soil 3 inches deep can not store enough to make a crop.

In all Southern States there are every year periods of drought, sometimes not serious, but generally sufficiently protracted to reduce the crop. The remedy for this is increased storage capacity for moisture. This can be accomplished by deep and thorough tillage and by filling the soil with humus (partly decayed vegetation). The effect of deep tillage has been explained. The effect of humus is to greatly increase the storage capacity of soils for water and to reduce evaporation. A pound of humus will store seven and one-half times as much moisture as a pound of sand, and the sand will lose its water by evaporation three and one-half times more rapidly than the humus. A clay soil will store only about one-fourth as much moisture as humus, and will lose it by evaporation twice as rapidly.

Plants use an enormous quantity of water. An acre of good corn will absorb and evaporate during its growth nearly 10 inches of water. About three-fourths of this amount will be required during the last seventy-five days of its growth, or at the rate of $2\frac{2}{5}$ inches of water a month. This is in addition to evaporation from the soil, which, even with the retarding influence of a dust mulch, will amount to several inches each month in midsummer. In case the land is plowed only 3 or 4 inches deep, though thoroughly pulverized, it will store an amount of moisture entirely insufficient to supply crop requirements in any protracted drought. These shallow and generally poorly prepared seed beds are the principal cause of the low corn yields in the South, and they affect the cotton yields similarly, but not so much, because cotton is a more drought-resisting plant than corn. If planting is done at all, it is folly to prepare a seed bed so shallow as to bring about the almost total loss of the crop some years and a reduced crop every year.

Many farmers plow or cultivate their corn nearly as deeply as they break their land in preparing a seed bed; this leaves no space for roots in the pulverized and aired soil. Roots occupy a large space. If all the roots of a single vigorous cornstalk were placed end to end

they would reach more than a mile, and if allowed by the plowing they will fill the soil to a considerable depth and feed in all portions of it.

THE ROOT SYSTEM OF CORN.

At the Wisconsin Agricultural Experiment Station it was found that when corn was 3 feet high the roots had penetrated the soil for 2 feet and thoroughly occupied it. At maturity the roots were 4 feet deep. At this time the upper laterals were about 4 inches from the surface.

At the North Dakota Agricultural Experiment Station the corn roots had penetrated $3\frac{1}{2}$ feet deep and fully occupied the ground ninety days after planting. (See fig. 1.)

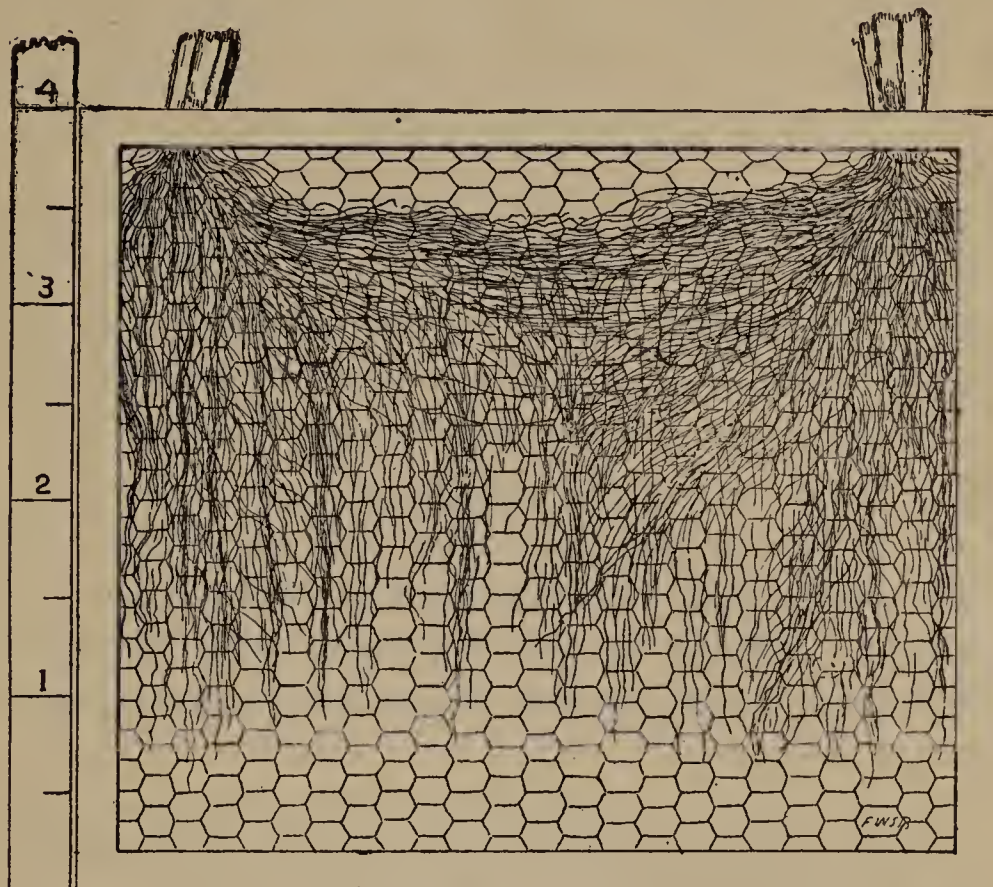


FIG. 1.—Distribution of roots of corn at the end of ninety days. (From Farmers' Bulletin No. 233.)

At the Minnesota Agricultural Experiment Station the corn roots had penetrated 12 inches deep and had spread laterally 18 inches eighteen days after planting. In most portions of the South nothing less than an 8-inch seed bed will insure even a fair corn crop, and 10 inches is safer. Some soils may require more. From 6 to 8 inches of preparation for cotton corresponds to 8 and 10 inches for corn, so far as the requirements of the plant are concerned.

WHAT IS DEEP PLOWING?

Plowing 3, 4, 5, or 6 inches deep is only common plowing. In our instructions nothing less than 8 inches is considered "deep" plowing. We are not advocating a single plowing of 8 inches in depth once in two or three years, but the preparation of an 8-inch seed bed thoroughly pulverized and filled with humus. It should be plowed and cross plowed to that depth, or if cross plowing can not be safely done on account of hills then it should be plowed twice in the same direction and disked thoroughly or the smoothing harrow repeatedly used.

WHEN SHOULD THIS PLOWING BE DONE?

Always plow in the fall before the winter rains set in; the earlier after the first of October the better. Always use a cover crop of oats, barley, wheat, or rye, if possible. Every observant farmer has noted that seeds germinate more quickly and that plants grow more rapidly on fall breaking than on spring breaking. Fall plowing renders more plant food ready for use, while the preparation of the land in the fall saves work in the spring, when everything on the farm is crowding. A cover crop is a net gain. It keeps the soil from washing, it utilizes the plant food that otherwise might escape into the air, and it adds humus. The soil is improved by the crop and winter grazing is provided. In plowed land the loss of plant food is less than in unplowed land; more plant food may be produced and more can be stored. In case a cover crop is used the loss of plant food is slight.

An objection is sometimes urged that fall-plowed soil becomes saturated with water during the winter and remains wetter and colder later in the spring than land left unbroken in the fall. This is true only upon land not sufficiently drained and where the breaking is shallow. Water passes through deep breaking readily, and with reasonable drainage it is ready for planting earlier than lands broken in the spring.

When land is nearly level and drainage poor, the soil should not be flat-broken, but left in ridges or narrow lands about 5 or 6 feet wide, suitable for planting, with a dead furrow between. This provides winter drainage and keeps the pulverized soil out of the water, which is important even if unbroken.

DEEPENING THE SOIL.

The advice to go down gradually is given solely because the inexperienced farmer may try to plow too deeply the first time and bring to the surface too much of the subsoil. The best plan is to double plow; that is, to follow the breaking plow in the same furrow with a narrower plow or a scooter (with sides removed) and go down as deeply as desired. Generally the disk plow may be sent down 8 or 10 inches with impunity if the plowing is done in the fall, and especially if the land is plowed twice or more.

There is no question that breaking and pulverizing to a depth of 8 to 10 or 12 inches is economical. The cost of breaking 10 inches deep when done with a disk plow should not be more than 50 cents an acre in excess of breaking 6 inches deep. Whether a plant has plenty of food all the time or only part of the time makes the difference between a good crop and a poor crop.

IS IT ADVISABLE TO PLOW DEEPER THAN 8, 10, OR 12 INCHES?

The depth of plowing must be determined by the farmer himself. He knows the conditions and is the best judge of the cost. In many sections, if done in the fall it undoubtedly pays to subsoil 15 or 20 inches. This has been proved by some of the best farmers and experimenters in the world. Some subsoils in humid climates have been made so close and compact by the abundant rainfall that air does not penetrate them to aid in preparing plant food. Such fields, therefore, may not show any benefits of subsoiling until after two or more years.

It rarely pays to subsoil land in the spring, and it is never advisable to use the subsoil plow when the subsoil is fully saturated with water, even though the surface be fairly dry. Under such conditions of plowing the clay subsoil is pressed and packed, when the object is to pulverize it and allow the air to act upon it.

EXPERIENCE AGREES WITH THEORY.

No principle in agriculture has been more thoroughly demonstrated than the value of a deep, thoroughly pulverized seed bed.

The Romans plowed on an average 9 inches deep—always three times for a crop, and in stiff lands nine times. They did not call 3 inches “plowing”; it was only “scarifying.”

The Flemish farmers were the first to follow the better lines of agriculture after the Dark Ages. They devoted their efforts to three main points: (1) The frequent and deep pulverization of the soil, (2) the accumulation of manure, and (3) the destruction of weeds.

A deeper and more thoroughly pulverized seed bed was the foundation upon which England built an improved agriculture, and this principle has been generally accepted there for more than one hundred and sixty years, until the average production has increased nearly fivefold.

A late letter from Hon. William Saunders, director of the Central Experimental Farm, Ottawa, Canada, states that farmers usually plow shallowly immediately after harvest (August) “to preserve moisture and destroy weeds. * * * In October they commonly plow 8 inches deep. Any plowing done in the spring months is usually shallow, not more than 6 inches deep.” Eight inches of breaking in October in Canada, where frosts penetrate 3 or 4 feet deep, is better for moisture storage than plowing to a depth of 15 inches in the Southern States.

The writer has visited a number of Southern agricultural colleges this year. In every case the directors of their experiment stations favored a deep and thoroughly prepared seed bed.

The Georgia Experiment Station bulletins repeatedly urge a deep, mellow, and rich seed bed for corn, and they insist that if the soil is not naturally such it should be made so by deep tillage and the addition of humus.

Bulletin No. 63 of the Georgia Experiment Station, on "Cotton," states that "fourteen years of experimentation have justified certain conclusions that may be accepted as practically final." The following is one of them: "Thorough breaking and commingling of the upper soil, gradually increasing the depth to 8 or 10 inches, using plow and harrow, is more effective than deeper but less thorough pulverizing."

On the sugar plantations of Louisiana the tillage for cane averages 12 to 15 inches in depth.

On the Eva plantation, in the Hawaiian Islands, the average depth of plowing is 30 inches. This plantation produces the largest crops of sugar cane to the acre in the world.

In the Farmers' Cooperative Demonstration Work the importance of a deep and thoroughly prepared seed bed like a garden has been most widely demonstrated. Thousands of tests have been made each year by exact and painstaking farmers to an extent that leaves no possible room for doubt as to the great value of a deep and thoroughly prepared seed bed.

Concretely stated, a deep, thoroughly pulverized seed bed filled with humus has the following advantages:

(1) It provides more food, because it increases chemical action and multiplies bacterial life in a larger body of soil.

(2) It stores more moisture and it loses its moisture less rapidly on account of its cooler lower strata and the presence of more humus.

(3) It increases the number of roots that a plant will throw out.

(4) It allows plants to root deeper and find permanent moisture.

(5) It largely obviates the necessity of terracing, because it holds so much water in suspension that heavy rainfalls will go to the bottom and be held by the drier earth above until they can be absorbed by the subsoil.

(6) Humus enables the soil to store more moisture, increases its temperature, makes it more porous, furnishes plant food, stimulates chemical action, and fosters bacterial life.

EXCEPTIONS DUE TO CONDITIONS OF SOIL AND SUBSOIL.

(1) Never plow below the line of standing water in the soil, because the subsoil can not be pulverized in water. The water level must first be lowered by drainage.

(2) Do no deep fall plowing on light sandy land on dry, semiarid plains, and this especially applies to elevated sandy table-lands. Such

lands can be helped by adding humus and using a winter cover crop of durum wheat.

(3) Do not plow deeply or subsoil in the spring. The subsoil is generally too full of water, and it is too late for much effective action of the air upon the soil and for the winter rains to firm the subsoil before planting for cotton.

(4) Thin gray soils underlaid with yellow or stiff clay near the surface, most of the post-oak flats, and the comparatively level coast lands should be broken in ridges (back-furrowed) 5, 6, or 7 feet wide, according to the crop to be planted. Cotton and corn may be left thicker in the row to offset the wider space between the rows. The dead furrow between the rows should be double-plowed and made as deep as practicable, with a good outlet for the water. This method will gradually deepen the soil, increase drainage, reduce washing, and give a larger and deeper body of loose, aired earth for the roots. This plan is excellent when surface drainage is necessary. Soil to be live and friable must be kept out of standing water winter and summer.

The sugar planters of Louisiana all use the ridge method (generally 7 feet wide) both for sugar cane and corn. The dead furrow is as deep as a plow drawn by 4 or 6 heavy mules can penetrate at the last breaking. This gives an average depth of tillage of 12 or 15 inches.

The adoption of the ridge method on demonstration fields in the Yazoo Delta in 1906 increased the yield of corn from 14 bushels per acre to 70 bushels. No fertilizer was used.

WINTER MANAGEMENT.

In case no winter cover crop is used the soil should be disked or harrowed two or three times during the winter, provided it is dry enough. Give good drainage to all parts of the field.

Any cultivation done after the deep fall breaking should be shallow—not more than 3 or 4 inches deep.

S. A. KNAPP,
Special Agent in Charge.

Approved:

B. T. GALLOWAY,
Chief of Bureau.

SEPTEMBER 15, 1908.

