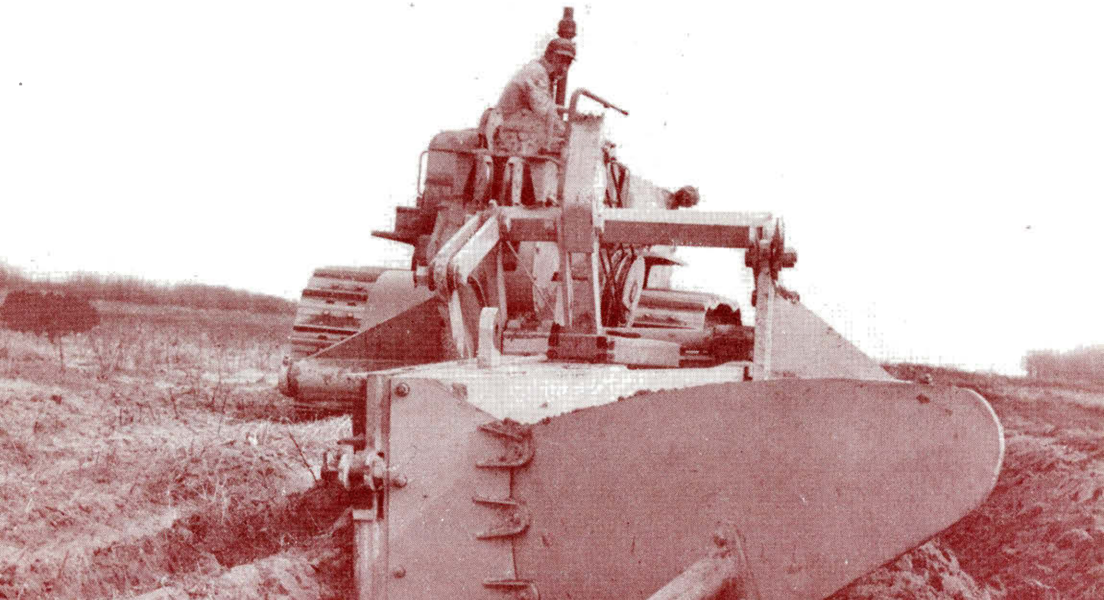
DEEP PLOWING

to Improve Sandy Land



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DEEP PLOWING

to Improve Sandy Land

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Deep plowing of sandy land to improve crop yields and reduce wind erosion has received widespread attention in Oklahoma since the Experiment Station first began testing the idea in Harmon county in 1947. Although the Station's research on deep plowing is not yet complete, the method has attracted so much interest that this bulletin was prepared to answer inquiries about it.

Experiments have progressed far enough to show that on *some* types of loose, sandy soil DEEP PLOWING WILL:

1. Increase crop yields, and
2. Reduce wind erosion.

The research also shows that DEEP PLOWING WILL NOT:

1. Improve the physical condition of *all* types of land, nor
2. Improve crop yields permanently unless followed by proper use of rotations, fertilizers, and soil-improving crops.

On areas where deep plowing is adapted, it is a "once over" proposition. The beneficial effects probably will last 50 to 100 years, provided the soil is properly handled after it is deep plowed.

Deep plowing has been used for some time in California to transfer good soil to the surface after it had been covered by sand or gravel deposited by floods. It also has been used in the Arkansas River valley and a few other locations in Oklahoma where floods had deposited sand on good bottomland.* The success of deep plowing in these places indicated that it might be useful in areas where a loose, sandy surface soil was underlaid by a layer containing a higher proportion of clay. This idea is being tested in research started in January, 1947. Results up to the spring of 1950 are summarized in this bulletin. Further research is under way.

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* See Okla. Agri. Exp. Sta. Bul. No. 282 (1944).

BENEFITS OF DEEP PLOWING

Deep plowing of sandy land adapted to this treatment can increase crop yields and reduce wind erosion. These benefits can be obtained on loose, sandy soils where a subsoil containing from 10 to 25 percent of clay lies near enough to the surface to be reached with special plows now available. However, the method is not suitable for all sandy-surfaced soils (see page 19). The productivity of a subsurface soil when transferred to the surface by deep plowing depends on several factors, including its organic matter content, its clay content, its physical structure, and its supply of plant nutrients.

A cloddy condition resistant to wind erosion can be produced by cultivation on a sandy soil having more than 8 percent clay. Therefore deep plowing will reduce the hazards of wind erosion on loose, sandy land if there is a subsurface layer containing more than 10 percent of clay.

Increasing the clay content of a sandy surface soil also provides a more favorable condition for the growth of young plants, for two reasons. First, plants obtain nutrients from the soil principally by taking them from the surface of clay particles through absorption by the root hairs. When the clay content is low, there is less surface from which the plants can obtain food. Second, the higher the clay content of a soil, the more water it will hold. Increasing the clay in the surface will provide a more favorable condition for the survival of alfalfa seedlings; and, where a soil improvement program is used, it will be more favorable for the production of wheat and rye.

The effect of deep plowing is permanent, at least in terms of a man's lifetime. Subsequent treatment will not be required more often than once in 50 to 100 years, if the soil is properly managed after being deep plowed.

Deep plowing not followed by proper soil management can be merely a form of soil mining. Loose, sandy land which has been cultivated for a long time without growing legumes or applying manure has more organic matter in the subsurface than in the surface layer. Deep plowing brings this organic matter to the surface and thus causes a *temporary* increase in crop yield. But the benefit will last only a few years unless steps are taken to *maintain* the supply of active organic matter in the surface soil. If it is not maintained, yields will soon become as poor or poorer than they were before the land was deep plowed.

Many sandy soils are low in organic matter, nitrogen and phosphorus. Some of them are lacking in potassium. Therefore if deep plowing is to develop a more permanent and productive type of agriculture on such soils, it must be followed by mineral fertilization and the growth of soil-building legumes.

EXPERIMENTAL RESULTS

Field tests of deep plowing to improve loose, sandy-surfaced land were started in Harmon county in 1947. While these field studies were under way, soil data from other parts of the state were examined to determine the areas where deep plowing might be used if the idea proved practical in the Harmon county tests. More recently, various types of plows have been tried.

One of the deep-plowing experiments in Harmon county was on the H. V. Treadway farm 5 miles north of Hollis. Data were obtained for only one year. More extensive tests on the W. F. Wilkinson farm 7 miles north and 6 miles east from Hollis are still under way. In all tests, the deep-plowed plots are compared with adjacent plots which are double listed, a method of tillage common on such soils in that area. Both locations had a loose, sandy surface soil with a subsurface layer containing more clay. Table VII (page 17) shows the mechanical composition of the surface and subsurface soils on the experimental areas.

Effect On Crop Yields

TREADWAY FARM, 1947

On the Treadway farm, one part of a field was plowed 16 inches deep, another part 10 inches deep, and a third part was double listed. Different fertilizer treatments were applied. The effect on cotton yields in 1947 is shown in Table I. This land produced 807 pounds of seed

TABLE I.—Cotton Yields on Deep Plowed and Listed Land, With and Without Fertilization; H. V. Treadway Farm, Harmon County, 1947.
(Pounds per acre)

Tillage Treatment	Fertilizer Treatment			
	Unfertilized	Phosphate*	Nitrogen & Phosphate**	Avg.
	Yield of Seed Cotton			
Double listed	807	938	959	901
Plowed 10 in. deep	1,199	1,352	1,406	1,319
Plowed 16 in. deep	1,395	1,592	1,613	1,533
	Increase Due to Treatment			
Double listed	---	131	152	94
Plowed 10 in. deep	392	545	599	512
Plowed 16 in. deep	588	785	806	726

* 20% superphosphate, 150 pounds per acre.
** 16-20-0 fertilizer, 75 pounds per acre.

cotton per acre without special treatment. Plowing to a depth of 10 inches, without fertilization, increased the yield almost half; and plowing to a depth of 16 inches increased it almost three fourths. Deep plowing (16 inches), plus nitrogen and phosphate fertilization, almost doubled the yield. Only one year's data were obtained at this location.

WILKINSON FARM, 1947-1949

The portion of the Wilkinson farm being used for deep plowing experiments has a loose, sandy surface soil varying from 8 to 12 inches in depth and containing about 3 percent of clay. The soil layer just below this contained from 15 to 20 percent of clay. Part of the experimental area was plowed about 15 inches deep in January, 1947. The remainder was not deep plowed, but was double listed each year. The plowed and unplowed portions were each divided into three parts. On one, a rotation of cotton, milo, and cowpeas was grown. Alfalfa was planted on another; and a rotation including vetch and rye was started on the third. Various fertilizer treatments were given each plot. (Results of the fertilizer applications are discussed on pages 10 to 15.)

Cotton. – Effect of the various treatments on the yield of cotton grown in a rotation with cowpeas and sorghum is shown in Table II. As an average of the three years, the listed plots produced 432 pounds of seed cotton per acre and the deep-plowed plots 730 pounds, without fertilization.

Sorghum. – Table III and Figure 1 show the effects of the various treatments on the grain and forage yields of the milo grown in the rotation. The increase on the deep plowed area, without fertilization, was 7.2 bushels of grain (56 percent) and 464 pounds of forage (61 percent), as an average of the three years.

Alfalfa. – Alfalfa was planted on a portion of the deep-plowed area and also on an adjacent strip which had not been deep plowed. (This was primarily a fertilization experiment, which is discussed on page 13.) On the part which was not deep plowed, the stand was very thin and practically no yield was obtained, even where fertilizer was used. On the deep-plowed portion, without fertilization, 580 pounds of hay per acre was obtained in the first 1949 cutting, and 444 pounds in the first 1950 cutting. (Table V, page 14.) Fertilization with superphosphate increased these yields to as high as 2,216 pounds and 885 pounds, respectively.

Higher hay yields could be expected on similar soils in central Oklahoma, due to the greater rainfall.

The failure of alfalfa on the land that had not been deep plowed was principally due to the difficulty of obtaining a stand. Young alfalfa seedlings do better on a soil with 15 to 25 percent of clay than they

TABLE II.—Cotton Yields on Deep Plowed and Listed Land, With and Without Fertilization; W. F. Wilkinson Farm, Harmon County, 1947 to 1949, Inclusive.

(Pounds per acre)

Fertilizer Treatment (annually	1947		1948		1949		Average	
	Double listed	Deep plowed	Double listed	Deep plowed	Double listed	Deep plowed	Double listed	Deep plowed
Yield of Seed Cotton								
No fertilizer	251	698	556	948	490	545	432	730
20% superphosphate, 150 lbs. per acre	403	763	643	1,101	599	708	548	857
4-12-4 fertilizer, 250 pounds per acre	687	850	1,046	1,352	926	926	886	1,043
Increase Due to Treatment								
No fertilizer	---	447	---	392	---	55	---	298
20% superphosphate, 150 lbs. per acre	152	512	87	545	109	218	116	425
4-12-4 fertilizer, 250 pounds per acre	436	599	490	796	436	436	454	611

will on soils low in clay content (1 to 5 percent). However, alfalfa will make a fairly good growth on loose, sandy soil overlying a loam or clay loam subsoil high in natural fertility if a stand can be obtained.

Rye and Vetch.—Abruzzi rye and hairy vetch were planted in alternate years on adjacent plots of deep-plowed soil and soil given the usual tillage. Vetch production was very poor due to heavy grazing by jackrabbits on the small plots since there was very little other green food on the surrounding area. More experimental data are needed to compare the relative crop producing capacity of winter crops as compared with summer crops on this type of land.

Use of Fertilizer

ON ROW CROPS

Land deep-plowed in 1947 was divided into plots to test the effects of different methods of fertilization. Similar fertilizer treatments were applied on corresponding plots of normally tilled land. The results of

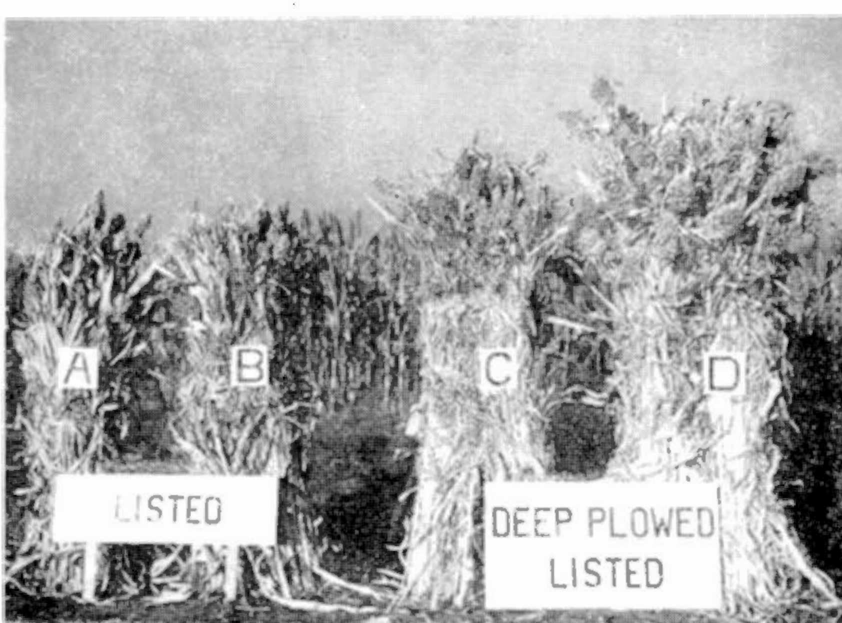

Fig. 1.—Dwarf Milo Grown in 1948 in Experiment on Wilkinson Farm.

Plot "A" was neither deep plowed nor fertilized. It yielded 11.4 bushels of grain per acre. Plot "B" was not deep plowed, but superphosphate had been applied on cowpeas in 1947; yield was 12.5 bushels. Plot "C" had no treatment except deep plowing in January, 1947; yield was 20.7 bushels. On plot "D," deep plowing and the residual effect of superphosphate and cowpeas produced 31.6 bushels per acre.

TABLE III.—Sorghum (Milo) Grain and Forage Yields on Deep Plowed and Listed Land, With and Without Fertilization; W. F. Wilkinson Farm, Harmon County, 1947 to 1949, Inclusive.

Fertilizer treatment*	1947		1948		1949		Average	
	Double listed	Deep plowed	Double listed	Deep plowed	Double listed	Deep plowed	Double listed	Deep plowed
				GRAIN (bushels per acre)				
Yields								
None	3.9	11.2	11.4	20.7	23.4	28.3	12.9	20.1
20% superphosphate, 150 lbs. /A.	6.1	13.3	12.5	31.6	24.3	24.9	14.3	23.3
4-12-4 fertilizer, 250 lbs. /A.	10.0	16.6	16.3	28.0	27.0	26.4	17.8	23.7
Increase Due to Treatment								
None	--	7.3	--	9.3	---	4.9	---	7.2
20% superphosphate, 150 lbs. /A.	2.2	9.4	1.1	20.2	0.9	1.5	1.4	10.4
4-12-4 fertilizer, 250 lbs. /A.	6.1	12.7	4.9	16.6	3.6	3.0	4.9	10.8
				FORAGE (pounds per acre)				
Yields								
None	447	980	1,160	2,020	667	666	758	1,222
20% superphosphate, 150 lbs. /A.	479	1,162	1,435	3,165	840	712	918	1,680
4-12-4 fertilizer, 250 lbs. /A.	778	1,453	1,400	2,800	852	726	1,010	1,694
Increase Due to Treatment								
None	---	533	---	860	---	—1	---	464
20% superphosphate, 150 lbs. /A.	32	715	275	2,025	173	45	160	922
4-12-4 fertilizer, 250 lbs. /A.	331	1,006	240	1,640	185	59	252	936

* Fertilizer applied on cotton. No fertilizer applied to the cowpeas or milo crop except in 1947.

these comparisons are presented in Tables I and III, and in Figures 1 and 2. In 1948, an additional area was deep-plowed for the purpose of setting up further fertilizer comparisons.

Results of the fertilizer trials to date indicate that:

1) Crop yields can be increased on these soils simply by applying commercial fertilizers, without deep plowing (but the erosion hazard still remains).

2) Deep plowing improves the physical condition of the soil, so crops can take advantage of fertility improvement practices.

3) Deep plowing must be followed by proper soil management practices to maintain or improve crop production.

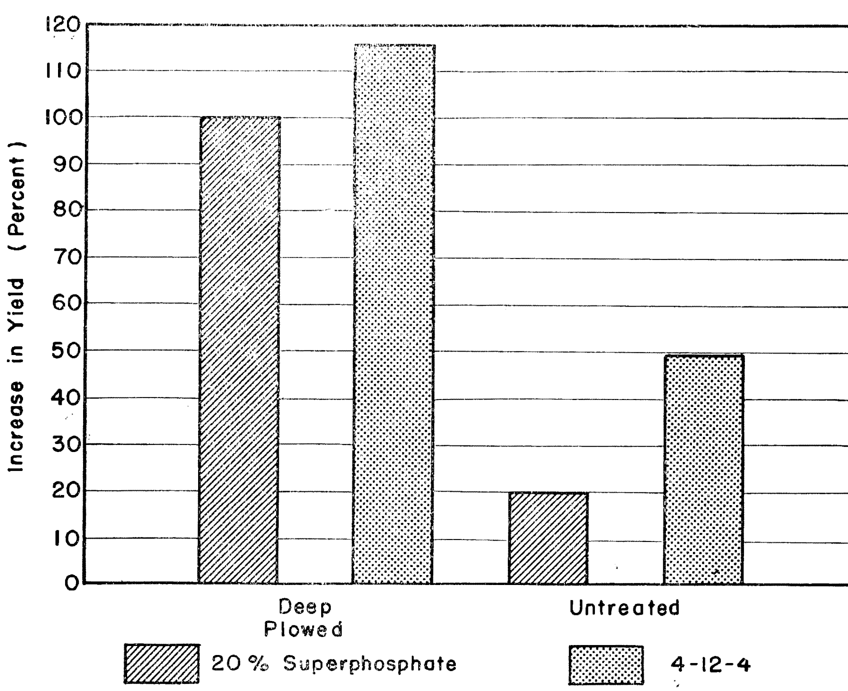

Fig. 2.—Comparative Effect of Fertilization on Deep Plowed and on Untreated Land. Deep-plowed soil, because of its better physical condition, gives more response to fertilizer and general good soil management than does the original sandy surface soil. This graph shows the percentage that crop yields were increased by fertilization on deep-plowed and on untreated land. (Increases shown are an average for cotton, sorghum grain, and sorghum forage, for the three years 1947, 1948, and 1949, on the Wilkinson farm.)

The large increase in yields the first year after deep plowing, even when no fertilizer was used, suggests that plants are being benefitted by organic matter brought up from the subsurface layer. On the Treadway farm the organic matter content of the subsurface soil was twice as high as in the surface layer. (.73 percent and .36 percent, respectively.) That this condition is characteristic is indicated by soil analyses made on eight other farms where deep plowing has been tried. On these eight farms, the average organic matter content of the surface layer from the deep-plowed land was .48 percent as compared to .28 percent on adjacent areas. Both these percentages are rather low. A good sandy loam in southwestern Oklahoma will contain 1.5 percent or more of organic matter.

The data in Tables II and III show a rather rapid decline in yields on the area deep plowed in January, 1947. This decline is probably due in part to the rotation and method of fertilization used in this experiment. Table IV gives a comparison of cotton yields in the rotation in 1949 with those obtained where cotton followed cotton on the land deep plowed in 1948.

ON ALFALFA

A special phosphate fertilizer experiment was made with alfalfa, because of the value of that crop as a soil improver. Fertilizer treatments as shown in Table V were made on both deep-plowed and normally tilled land. Both areas were also limed. On the area which was not deep plowed, the stand was very thin and practically no yield was obtained, even where lime and phosphate were applied; therefore the results shown in Table V and Figure 3 are for the deep-plowed area only. Field observations indicated that alfalfa planted in rows so that the crop could be cultivated would be superior to a solid planting for seed production.

TABLE IV.—Comparison of Cotton Yields in Rotation With Yields When Cotton Followed Cotton on Deep-plowed Land; 1949, Wilkinson Farm.

	Yield of Seed Cotton (pounds per acre)	
	In rotation, following sorghum	Cotton following cotton
Unfertilized	545	762
250 lbs. per acre of 4-12-4	926	1,307
75 lbs. per acre of 16-20-0	----	1,307
200 lbs. per acre of 7-16-0	----	1,253

TABLE V.—Effect on Yield of Alfalfa of Applying Superphosphate and Rock Phosphate to Deep-plowed Soil at Different Rates and by Different Methods.*

Fertilizer treatment (pounds per acre)	Hay Yields; First Cutting (pounds per acre)		
	1949	1950	Average
No treatment**	580	444	525
Superphosphate			
300 after plowing	1,682	700	1,191
150 before plowing; 150 after plowing	1,701	695	1,198
450 after plowing	2,163	880	1,521
300 before plowing; 150 after plowing	2,216	885	1,550
Rock phosphate			
400 after plowing	1,235	580	907
200 before plowing; 200 after plowing	1,055	630	842
600 after plowing	1,108	645	876
400 before plowing; 200 after plowing	1,710	750	1,230

* All treatments were duplicated on land which had not been deep plowed, but only a very thin stand was obtained.

** Average of three plots in 1949, two in 1950.

Available phosphate was low in both surface and subsurface. Phosphate applied before the land was deep plowed was put on in January, 1947. Limestone at the rate of one ton per per acre was worked into the soil after the land was deep plowed. The remaining phosphate treatments were applied in September, 1947.

Fig. 3.—Alfalfa on Deep-plowed Sandy Land.

The plot on the left was deep plowed and fertilized with superphosphate. That on the right was deep plowed but received no fertilizer. Both plots were limed. On similar land not deep plowed the stand of alfalfa was thin, consequently the yield was practically nothing, even where lime and superphosphate were applied. The thin stand did produce a good seed crop in 1950.

The superiority of superphosphate over rock phosphate as a source of phosphorus for the alfalfa as shown in Table V probably would not be as great further eastward in Oklahoma, where there is more rainfall.

On some of the deep-plowed plots, part of the phosphate was applied before plowing. This was tried on the theory that fertilizer placed deeper in the ground would remain moist for longer periods of time and thus give plant roots more opportunity to take it up. However, the yields show no advantage for this method of application, except in the case of rock phosphate applied at the rate of 600 pounds per acre.

More data are needed before making recommendations concerning fertilization of alfalfa on deep-plowed soil. Stands were poor on both deep-plowed and untreated plots in 1947. A reseeding made in the fall of 1948 made a good crop on the deep-plowed plots in the spring of 1949, but web-worms and dry weather severely reduced the yield of a second cutting. The first 1950 cutting was stunted by dry weather.

*TABLE VI.—Effect of Deep Plowing on the Mechanical Composition of Surface Soil.**
(Percent)

Farm	Before Deep Plowing			After Deep Plowing		
	Sand	Silt	Clay	Sand	Silt	Clay
Sam Holmberg, Erick	90.8	5.5	3.7	77.0	12.7	10.3
Lee Bond, Ft. Cobb	90.0	6.3	3.7	69.8	12.5	17.7
Percy Ware, Mangum	86.8	9.5	3.7	64.5	12.5	13.0
Arzie Gamble, Hollis	94.8	2.5	2.7	75.3	13.7	11.0
Willie King, Altus	94.7	2.1	3.2	82.5	5.3	12.2

* These samples were collected by Jim Tomlinson, Farm Coordinator, Oklahoma Agricultural Experiment Station.

Effect on Erosiveness of Surface Soil

Previous experiments* show that, under Oklahoma conditions, sandy soils containing less than 8 percent of clay in the surface layer are quite susceptible to wind erosion when row crops are planted on them, but that a cloddy condition resistant to wind erosion can be produced by cultivation where the soil contains more than 8 percent of clay.

On five areas where farmers have tried deep plowing in cooperation with the Experiment Station, the percentage of sand in the surface layer has been increased from less than 4 percent to an average of more than 12 percent after deep plowing (Table VI). Table VII indicates that these soils are fairly representative of other sandy-surfaced land in Oklahoma which might be improved by this treatment.

* Author's unpublished data.

TABLE VII.—Mechanical Composition of Typical Soils Improvable by Deep Plowing.

County	Surface Soil				Subsurface Soil			
	Depth (inches)	Composition (percent)			Depth (inches)	Composition (percent)		
		Sand	Silt	Clay		Sand	Silt	Clay
Beckham	0-10	90.8	5.5	3.7	20-30	70.0	15.8	14.2
Caddo	0-20	92.1	4.6	3.3	20-24	72.2	5.2	22.6
Caddo	0-8	83.3	11.9	4.8	8-16	62.2	16.7	21.1
Greer	0-10	94.3	2.2	3.5	10-20	70.1	12.4	17.5
Harmon*	0-10	92.5	6.2	1.3	10-16	69.5	11.4	19.1
Harmon**	0-6	86.5	7.0	6.5	12-18	64.5	14.0	21.5
Harmon	0-15	94.5	2.4	3.1	15-24	74.0	9.0	17.0
Harmon	0-18	96.0	1.0	3.0	18-30	69.0	12.0	19.0
Jackson	0-17	92.5	4.0	3.5	17-27	56.5	14.5	29.0
Kay	0-24	76.4	17.6	6.0	24-36	54.1	20.4	25.5
Pontotoc	0-16	71.7	23.0	5.3	16-24	55.4	21.0	23.6
Washita	0-8	85.6	9.6	4.8	8-16	68.2	11.2	20.6

* Wilkinson farm; area used for alfalfa fertilization tests.
** Treadway farm.

CHOOSING LAND FOR DEEP-PLOWING TREATMENT

Soil Types Improvable by Deep Plowing

Figure 4 shows the major areas in Oklahoma where deep plowing can be used to improve the physical character of loose, sandy land. In general, these are areas where a high percentage of the soils contain less than 4 percent of clay in the surface layer and 10 to 25 percent of clay in the subsurface layer. On such areas, enough subsurface soil can be brought to the surface by deep plowing to increase the clay content of the surface layer to 8 percent or more. The hazard of wind erosion on cultivated land is considerably reduced where the clay content of the surface is above 8 percent.

Figure 5 shows a good example of a soil profile that can be improved by deep plowing. The surface layer is about 12 to 14 inches deep. It is a loose, sandy soil which is low in organic matter and contains less than 3 percent of clay. When cultivated, it is very susceptible to wind erosion. The darker colored subsurface soil contains 17 to 20 percent of clay.

Figure 6 shows a field where deep plowing would be needed only on

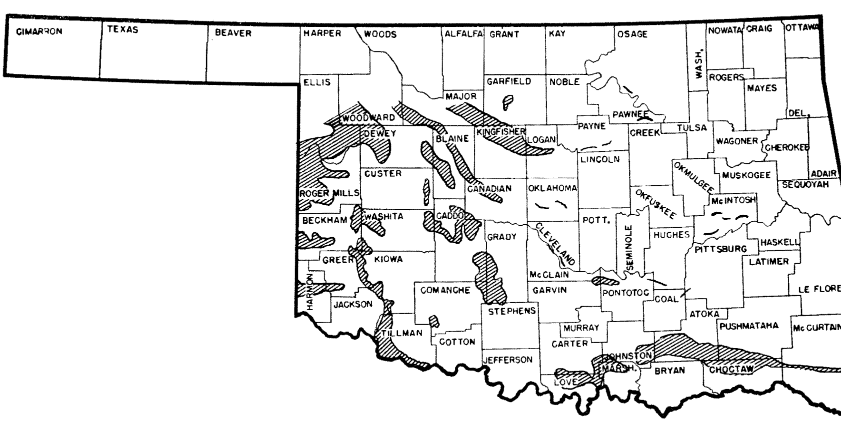

Fig. 4.—Areas Where Soil Improvement by Deep Plowing Is a Possibility.
The areas indicated are those where the clay content of loose, sandy land could be increased to 8 percent or more by deep plowing to bring up a layer of subsurface soil containing more clay than the surface. Cultivation produces a cloddy surface resistant to wind erosion on sandy soils in Oklahoma containing more than 8 percent clay.

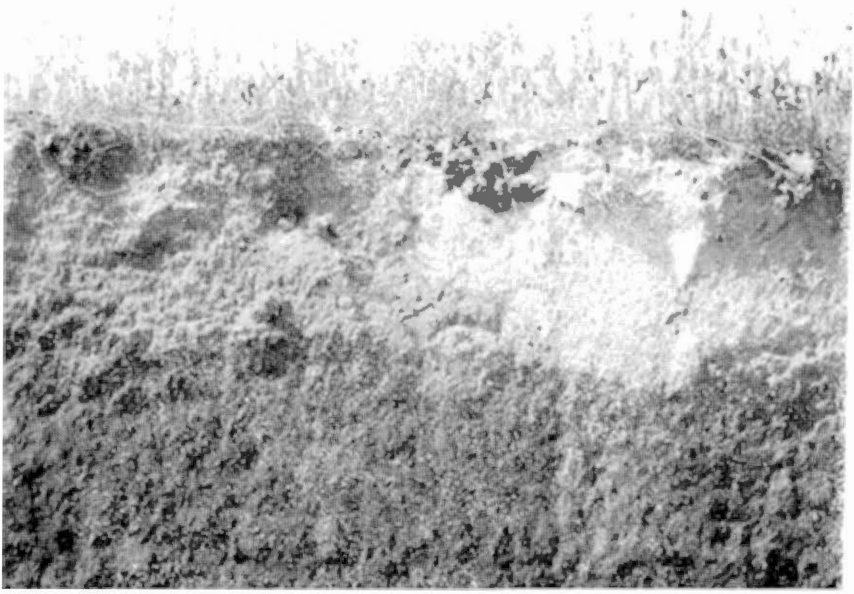

Fig. 5.—A Soil Where Deep Plowing Would Improve Surface Texture.
The loose, sandy surface layer is 12 to 14 inches deep and contains less than 3 percent of clay. The subsurface layer has 17 to 20 percent of clay. Such a soil profile offers an ideal opportunity for improving the physical condition of the surface by deep plowing.

the sandier areas. The remainder already has enough clay in the surface soil.

Where Deep Plowing Would Be Harmful or Useless

Figure 7 shows a soil which would be injured by deep plowing. The clay content of the subsurface layer is very high. If such a subsoil were transferred to the surface, it would slow up the intake of moisture and be very unfavorable for good root development.

Figure 8 shows a soil where deep plowing would give little benefit. It is a deep, sandy soil containing very little clay. If the subsurface layer contained more organic matter than the surface soil, yields would be temporarily increased by deep plowing. But the benefit would disappear as soon as the newly exposed organic matter was used up. Deep plowing on this type of land would be merely a form of soil mining, eventually leaving the land as poor or poorer than it was before it was deep plowed.

Two rather large areas of sandy land in northern Oklahoma would not be helped by deep plowing. One of these lies along the Salt Fork of the Arkansas River. The other is along Beaver Creek in the Panhandle.

Non-sandy Soils Where Deep Plowing Might Help

A deep plowing demonstration on dense clay soil was conducted on the Paul Christ farm, located in the Washita River Valley southeast of Maysville, Okla., on March 1, 1950. The subsoil which was transferred to the surface by the 30-inch plowing varied in texture from a loam to a clay loam. Corn planted on this area in the spring of 1950 produced 65 bushels per acre. The land had not produced a good crop during the past 16 years.

Further investigation may show other areas where deep plowing might be valuable. For example, soils of the High Plains containing a high percentage of silt are very subject to wind erosion when they are dry and not protected by growing vegetation or crop residues.

Fig. 6.—Only Part of This Field Would Benefit From Deep Plowing.

The soil in the foreground contains enough clay to resist wind erosion because it develops a cloddy structure when cultivated. The soil in the background is a loamy fine sand which is moved easily by the wind when not protected by a vegetative cover.

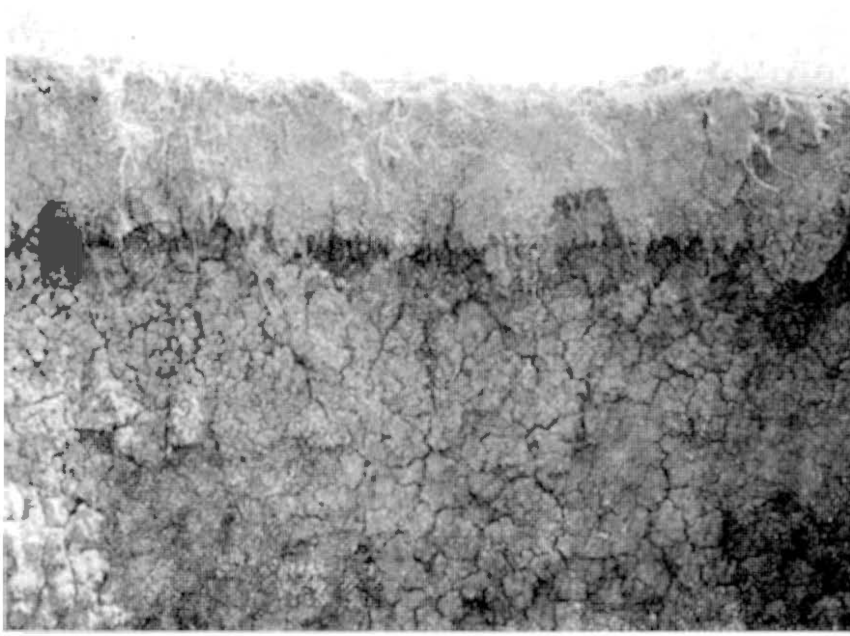

Fig. 7.—Deep Plowing Would Injure This Soil.

This subsurface soil has a very high percentage of clay, as indicated by the large and numerous shrinkage cracks. Deep plowing would put too much clay on the surface. Too much clay slows up the absorption of rainfall, especially when the clay is low in organic matter content. Organic matter in a clay soil produces a granular structure having openings through which water can penetrate.

If the subsurface soil under this type of land contained the right amount of clay, a cloddy surface might be developed by deep plowing which would be more resistant to wind erosion when not protected by crop residue.

It is also possible that some medium textured soils might benefit from deep plowing. These would be soils where the organic matter content of the surface layer had been greatly decreased by cropping and where the proper subsurface conditions existed. Proper subsurface conditions would include (1) the right quantity of clay and (2) an organic matter content higher than that of the surface layer. Deep plowing normally would not be recommended for a medium textured soil that still contains much of its original organic matter and has a high crop-producing capacity.

Large areas of medium textured subsurface soils in western Oklahoma were uncovered by wind erosion during the Dust Bowl period from 1933 to 1937. This land was classified by some investigators as severely damaged by wind erosion. However, it has been producing good crops of wheat whenever climatic conditions were favorable, because the availability of plant nutrients in these subsurface layers is high and the structure is favorable for moisture absorption and root development.

How Clay Subsoils Form Under Sand

Clay is formed in sandy soil as a result of the chemical weathering of certain minerals, principally the feldspars. The quantity of clay formed in a sandy soil will depend upon the time factor and intensity of the weathering processes.

Many of the soils in central and western Oklahoma which could be improved by deep plowing were formed on sandy material transported

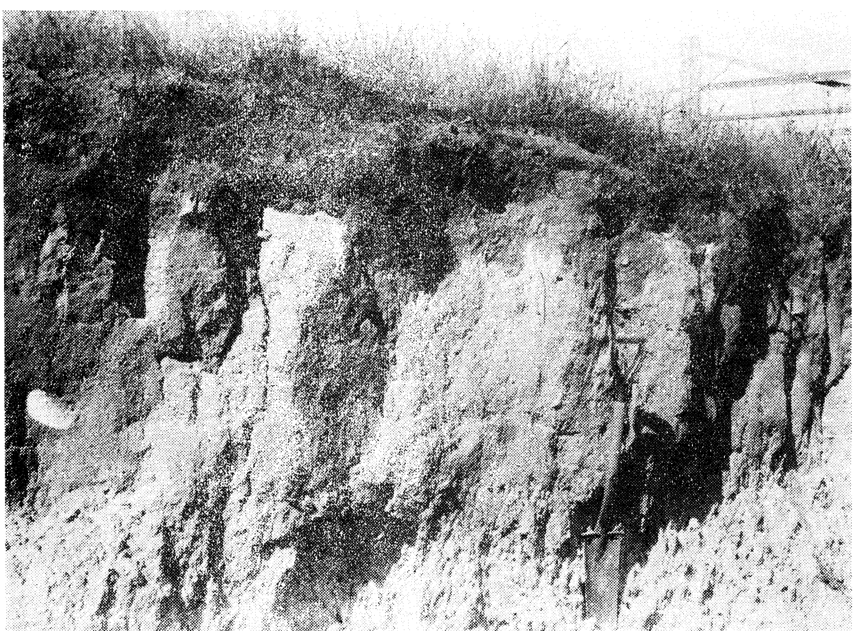

Fig. 8.—Deep Plowing Has No Permanent Value Here.

On deep sandy soils such as this one, there is no layer having a higher clay content than the surface soil. Deep plowing on a soil of this type might have temporary value by bringing to the surface unused organic matter in the subsurface layer. But crops would soon use up this new organic matter, and the land would be no better than before. Use of soil-improving crops in a rotation would be a better method of improving fertility here.

from the Rocky Mountain area. These sands contained a high percentage of feldspar; and, consequently, zones of clay accumulation are found from 8 to 20 inches below the surface in areas where the time factor has been long enough for the clay to form and be carried downward in sufficient quantities.

The clay content will be very low in young sandy soils formed on sandy material deposited by either water or wind, and on older soils which have developed on sandstones composed principally of quartz grains and containing very little feldspar. Figure 8 represents such a soil.

EQUIPMENT FOR DEEP PLOWING

Where Sand Is Shallow

Where the surface layer of loose, sandy soil is not more than 10 to 12 inches deep, an ordinary 18-inch moldboard plow with an extension on the moldboard can be used (Figure 9). The moldboard extension is needed to keep the subsurface layer, which contains the clay, from falling back into the furrow. This plow will operate efficiently at depths up to 15 inches.

Any rubber-mounted tractor weighing 5,000 to 6,000 pounds would pull an 18-inch plow in loose, sandy soil at a depth of 15 inches, where 5 or 6 inches of the lower part of the furrow slice contains from 15 to 20 percent clay. The picture shown in Figure 9 was taken while drawbar pull was being measured. It varied from 3,000 to 4,000 pounds

Fig. 9.—Moldboard Extension Controls Furrow Slice on 18-inch Plow.

For depths up to 15 inches an extension on the moldboard of a regular 18-inch plow keeps the subsoil from sliding back into the furrow. The plow in this photograph was bringing about 5 inches of a loam subsoil to the surface. The sandy surface layer was about 10 inches deep. The drawbar pull required (see text above) was being measured when this picture was taken.

for a single bottom plow turning a furrow 18 inches wide and 15 inches deep.

Where Sand Is Deeper

LARGE MOLDBOARD PLOW

Figure 10 shows a large moldboard plow which was used in several Oklahoma fields during the past year. This type of plow is used in California to turn under coarse sand and gravel washed onto good agricultural land by flood water. It will plow 42 inches deep, cutting a furrow 30 inches wide. A crawler-type tractor with a rating of 130 horsepower is needed to pull this plow, under average conditions.

The large moldboard plow leaves the land in ridges, and extra work is needed to level these ridges after plowing is completed.

This plow does not scour readily in wet subsoils containing around 25 percent clay. Under those conditions, therefore, it takes more power

Fig. 10.—This Giant Reaches Down 36 Inches for a Loam Subsoil.

A plow of this type can be pulled by a 135-horsepower crawler tractor under average conditions. After plowing, the furrow ridges must be leveled off with other equipment. This picture was taken during a test on the farm of Sam Holmberg, near Erick. Mr. Holmberg is one of the experiment station's "pilot farm" cooperators.

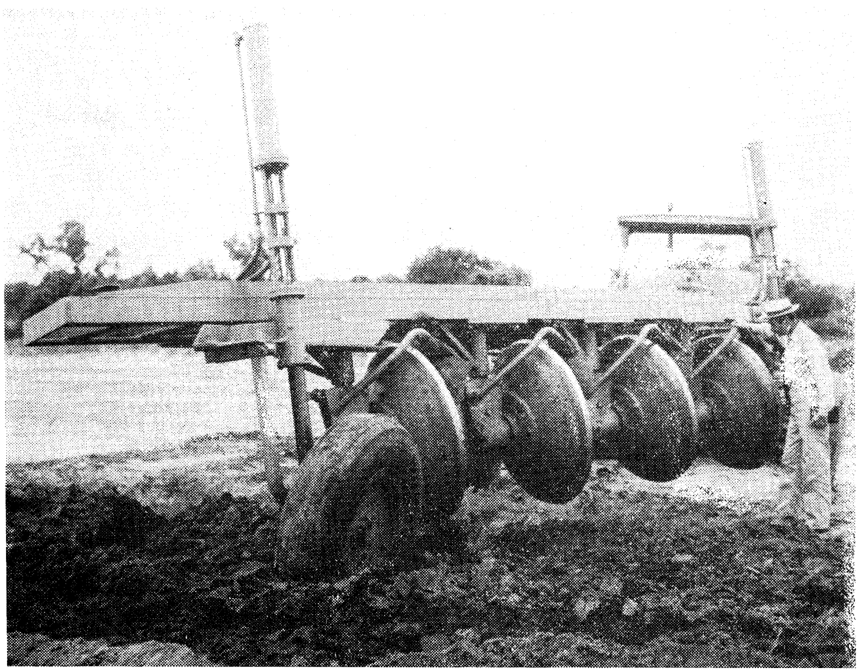

Fig. 11.—Another Deep-digging Giant for Improving Sandy Surface Soils.
This disk plow operates efficiently at depths of 20 to 30 inches, each disk cutting a furrow about 17 inches wide. Regardless of the implement used, the object of deep plowing is to increase the percentage of clay in the surface by bringing up a layer of loam subsoil. The higher clay content helps reduce wind erosion. It also puts the soil into a better physical condition to take advantage of fertility-improving practices used after the land is deep plowed.

to pull the plow, and the subsoil layers are not properly transferred to the surface.

LARGE DISK PLOW

A large disk plow of the type shown in Figure 11 has also been used to deep-plow sandy land. The disks are 44 inches in diameter, and each cuts a furrow about 17 inches wide. It operates efficiently at depths from 20 to 30 inches. The draft is slightly less than that of a moldboard plow operating at the same depth.

The disk plow works more effectively than the moldboard plow in sticky soil. It leaves the land nearly level, and little or no extra work is required to prepare a seedbed.

MANAGEMENT OF SOIL AFTER DEEP PLOWING

Much of the benefit of deep plowing can be lost if the soil is not managed properly. In general, this means the same fertility maintenance practices must be used as on any other sandy to medium textured soil in the same area.

Packing the Soil

Mechanical packing may be necessary to prepare a good seedbed for row crops the first season after land has been deep plowed. Winter rainfall in central and western Oklahoma is too low to be depended upon to settle the soil, which is left very loose by the deep plowing.

The soil can be packed for row crops by setting tractor wheels about 7 feet apart and marking off the field so the rows are 3½ feet apart. If a row-crop tractor is being used and a marker is not available, the operator can double back on each track. This will pack the soil twice in every other row. Alternate rows will be packed only once by the front tricycle wheels. The rows that are only packed once could be packed again if necessary by going over the field in the same manner again, shifting over one row at the start.

Cross Cultivation

Before rows are marked off, many deep plowed soils should be cross-cultivated with a spring tooth cultivator or some other implement which will mix the surface and subsurface layers. This is especially important where the newly developed surface layer contains more than 20 percent of clay.

What may happen if land is not properly cross-cultivated after deep plowing in shown in Figure 12.

Fertilization

Most of the loose, sandy soils in central and western Oklahoma which can be improved physically by deep plowing are low in organic matter, available phosphorus, and available nitrogen. More experimental work will be needed to arrive at more exact fertilizer recommendations for various crops when planted on deep-plowed land. Meanwhile, it is suggested that a fertilizer such as 5-10-5 applied at the rate of 150 to 250 pounds per acre will increase cotton and sorghum production unless summer drouth is very severe. A fertilizer with approximately equal proportions of nitrogen and phosphorus, such as a 16-20-0, would be preferable on sandy soils containing a good supply of exchangeable potassium to one having relatively less nitrogen, such as a 4-16-0 under average conditions.

Fig. 12.—Cross Cultivation on Furrows Helps Avoid This.

The alfalfa in the foreground was planted on deep-plowed land that was limed but was not cross cultivated after plowing. The raw, unfertilized subsoil was left in strips instead of being mixed with the sandier surface soil before the alfalfa was seeded. Alfalfa seedlings could not survive on the subsoil strips. The excellent alfalfa in the background is on land fertilized with superphosphate after being limed.

Cropping System

In southwestern Oklahoma, the major part of the rainfall comes during the summer months. This is more favorable for crops like cotton, cowpeas, and sorghums than it is for winter-growing crops like vetch or small grain. Furthermore, deep plowing of loose, sandy land results in a soil which is much lower in organic matter than the better wheat soils. More research is needed to provide information on proper crop sequence and the behavior of different crops under different systems of soil management on deep-plowed land.

Over a period of time, the use of soil-building crops such as alfalfa should add enough nitrogen to a deep-plowed soil to grow good crops of small grain. However, in areas where cotton is adapted it is probable that net income will be higher from cotton than from small grain on deep-plowed land, even though alfalfa can be grown on it. More research is needed on this subject.

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