

Seedbeds for Wheat and Grasses.

by

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Seedbeds for Wheat and Grasses.

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Alfalfa would probably have been grown in Kansas as a staple crop long before it was generally recognized as such, if those who first introduced it into the state had more thoroughly understood the nature of leguminous plants. Many attempts were made to grow alfalfa which resulted in failures because the work of preparing the seedbed for the crop was done in the same manner that all farm work was done in the early history of Kansas. All that was thought necessary was to turn over the sod; plant the seed and expect a crop. If a few farmers tried to grow alfalfa and through lack of the proper conditions of the seedbed the crop was not a success, it was given up as a crop not adapted for that particular section of the state in which the attempt was first made to raise it.

Thus it is with many agricultural crops, the reason why they do not prove profitable is because they do not receive proper attention.

The preparation of seedbeds, although a subject which probably interested Adam, and has interested every peasant and farmer since his time, is today a subject in which every tiller of the soil is interested - in fact every producer of wealth is interested. Not only must it be necessary for the successful agriculturist and farmer of the twentieth century to thoroughly understand, at least the fundamental and rudimentary principles of tillage but it should be an interesting and pleasant study to thoroughly understand the moisture problems which he has to solve, as related to soil texture, to the conservation of soil moisture, and the relation of bacteria to soil fertility and plant growth. To a lack of interest on the part of some and indifference of others is due the fact that even today certain methods of farming are in practice simply because these methods were used by the preceeding generations. These methods may be and often are, entirely out of date. Some make attempts to learn why work ought to be done

and how best to do it, but many do not. If the practical man takes no interest in the study of agriculture he can have little if any real pleasure in his work and financially he will be far behind the man who farms scientifically.

A virgin soil, such as a field recently cleared of a heavy growth of timber, or prairie lands where the soil is deep and mellow like those of the Great Plains region of the United States, makes an ideal seedbed for a number of years with very little preparation. When the soil of the Great Plains was entirely new it was not necessary to think of getting ready for a crop by much preparation of the seedbed. No preparation was necessary other than simply breaking the sod and smoothing it down again. Most work was done in this way in planting any crop and the soil responded to such treatment remarkably well because it was rich in humus; rich in available plant-food; and was made porous by the decay of roots, so that the oxygen of the air would circulate freely. In fact all of the requisites for a fertile soil were locked up under the prairie grass, in the form of available plant-food, so that the product of the soil after it was once broken up and cultivated, has astonished the world and there is still enough plant-food to last for generations.

In many sections of Russia where the climate and general conformation of the land corresponds closely to the land of the middle states of the United States, and in fact in nearly all old farming countries, there has long been felt the need of giving especial attention to the preparation of seedbeds if a crop was to be expected.

Any soil no matter how fertile, will in time become partially exhausted in fertility and will have to be handled with special care if it produces as it should. The time that the soil remains fertile, of course, depends upon the kind of soil. In areas such as Kansas and

Nebraska, although the soil is very fertile for the first few surface feet it is very shallow compared with soil of timber districts, and for this reason the fertility will decrease rapidly unless preventive means are used. The object of this thesis is to discuss briefly the principles which underlie the condition of the soil in the preparation of seedbeds for wheat and grasses and the different methods of accomplishing the work, which are in common practice in Kansas. More careful work in preparing ground for wheat will probably be done in the future than has been done in the past because of the decreasing fertility of the soil. Tame grasses to be used as pasture and for the production of hay are being sown more every year, and a good seedbed for so important a crop requires considerable preparation, probably more than the average farmer realizes. The same principles hold true for both wheat and grasses, but a little more work is required in preparing the seedbed for grasses than for wheat. The principles will be discussed as follows:

Soil Moisture.

The soil moisture problem is probably the most important problem with which the farmers of the arid and semi-arid regions have to deal. Even the retention of a very little moisture in the soil at a time of drouth, may save a crop, and if after several months of dry weather, well prepared seedbeds show a few per cent more moisture than a poorly prepared seedbed the extra work and expense is often well paid for.

Statistics show that in the humid portion of the United States, having about forty inches of rainfall per annum, nearly fifty per cent of the water flows off into the streams, partly by surface drainage and partly by slow percolation through the soil, to underground streams. The other fifty per cent either evaporates from the surface or is

transpired by the plants. In the arid regions, such as the areas of Kansas and Nebraska west of the one hundredth meridian, there is an average rainfall of about twenty inches annually and only about ten per cent of this is lost to agricultural crops, thus leaving almost as much available moisture for the plants as in the humid districts, such as eastern Kansas and Missouri. It appears from this that, other things being the same, the effects of dry periods need not be more disastrous to vegetation in the arid than in the humid regions, if the moisture that falls in the drier climate can be retained in the soil. In making a comparison, however there are several conditions to consider. The humidity of the atmosphere differs greatly, thus making a difference in the rate of evaporation of water.

In the humid portions of the United States evaporation from free water surfaces is equal to only about thirty inches per annum, while in the arid portions it is over twice as great. This shows the great importance of keeping a dust mulch on the surface of cultivated land. Another difference is the rate at which the capillary water of the soil settles away from the surface by capillary attraction. In the humid districts the subsoil is usually deep and porous, making it possible for the free water in the soil to continually find its way to underground streams and channels. In the other districts referred to this gradual settling away of the free and capillary water is greatly retarded by the impervious compact subsoil. This condition of the subsoil apparently offsets the bad effects of evaporation in the drier countries, thus tending to equalize the moisture conditions. It is evident however that greater precautions must be taken to conserve what moisture does fall where the annual amount of rainfall is small than where there is a great amount.

Subsoiling.

In certain localities of Kansas when subsoiling for wheat has been done, the results show that if the subsoiling is followed by a dry season no beneficial effects have been noticed from breaking the subsoil. In fact the extra work seems to be injurious, for capillary attraction tends to draw the surface water down as deep as the subsoil is loosened, thus spreading it out over a larger area and making it more difficult for the roots of plants to obtain a sufficient supply. If the season following the subsoiling is an average dry or a wet season, good effects are often seen. Even where subsoiling does not pay the first year it may have beneficial effects later, but taking an average of many experiments in Kansas, corresponding closely with those of North Dakota, the conclusion is that the increase in yield of wheat is no more than sufficient to pay the expense of subsoiling, unless it is impossible to retain the annual rainfall in any other way.

Some subsoils may be so compact that they must be loosened in order to develop available plant-food, but generally it will pay better to put the extra time and work upon the surface soil rather than to subsoil.

Bacteria in the soil.

Much work has been done recently in the way of investigating the action of bacteria in the soil and there is undoubtedly much to be learned yet in regard to bacteria as affecting the fertility of cultivated lands. It will not be inappropriate to dwell briefly upon this subject here, because of the close relation between the growth of bacteria and thorough aeration and drainage of the surface soil. The actual plant-food in many of the so-called "worn out" soils, such as those along the Atlantic seaboard and some districts of the eastern states, is sufficient to sustain plant growth for an indefinitely long

time if the proper condition of soil texture and growth of bacteria can be obtained. This restoring of fertility or unlocking of the unavailable plant-food in the soil, and converting it into available food for plants, thus changing it from potential to active fertility, is the greatest problem of agriculture.

Of the plant-food elements in any soil nitrogen is usually the first to be exhausted. This difficulty is overcome by the introduction of leguminous plants and by green manuring. The ultimate benefit to the soil which leguminous plants impart must come through the action of microorganisms in the soil. When any vegetable or animal matter is mixed with or becomes a part of the soil, it undergoes a process of decay or fermentation by which insoluble or unavailable forms of plant food are changed into forms which may be absorbed by the roots and built into the cells and tissues of plants. This process of decay and chemical change is caused by bacteria in the soil. The peptonizers convert the crude nitrogen into soluble peptones and albuminoses. These peptones are acted upon by the ammonifiers, or those bacteria which form ammonia. After this the nitrifying bacteria convert the ammonia into nitric acid which forms the nitrates, and the nitrogen of plants is taken from the soil in the form of soluble nitrates. These are not all of the changes brought about. The starches, sugars, and cellulose are fermented and converted into organic acids. These acids in turn form soluble phosphates and potassium salts, which are soluble and are available to plant roots. Carbon dioxide is the final product of bacterial decay and is as a result freely present in soil waters. The carbon dioxide acts upon silica and combines with potash, producing carbonates.

Thus we see there is a digestion process going on in all fertile soils, due to bacteria and the conditions affecting the development of

these organisms are: 1. a sufficient supply of humus in the soil to serve as food for the bacteria. 2. a neutral or slightly alkaline reaction, which can only be maintained in a cultivated field by frequent and thorough cultivation. The cultivation stimulates bacterial growth and prevents free acid from accumulating.

The texture of the soil controls the growth of bacteria as it is from the film of water and the ^{very} minute air spaces between the particles of soil that the necessary oxygen is obtained. If the ground is plowed wet or allowed to cake through lack of cultivation, the lack of air prevents the growth of micro-organisms. It may truly be said that the number of micro-organisms in a soil bears a definite relation to the cultivation of the soil, varying directly as the amount of cultivation. This is the reason why summer fallowing is so beneficial. Fallowing without stirring the surface will not give the best results. Sod contains fewer bacteria than cultivated areas.

Tests for the actual number of bacteria in different soils have been made at different experiment stations and taking a fair average of several tests, it is estimated that the number of bacteria in one gram of different soils varies from one million to many millions in the surface soils, gradually decreasing to but a few thousand per gram in the deeper soil or subsoil. This is a very wide range and only gives a person an idea of the great number of organisms in a fertile soil. It is a point to be observed also that the bacteria in a productive soil are of vital importance and that it is only by proper cultivation that the largest number can be given an opportunity to grow.

Methods of preparing seedbeds.

Plowing as deep as convenient, depending somewhat upon the

condition of the soil and the amount to be plowed, is the general custom in most of the large wheat districts when the plowing is for wheat. The mould-board plow is used mostly but disc plows are used in some sections of the wheat districts. After plowing, the ground is usually harrowed two or three times, and if it is necessary, and time permits, discing is often done after the plowed ground has settled. Just how much harrowing and working of the soil, after it has been plowed in good shape, will prove profitable, is often a rather difficult problem to solve and there cannot be any definite rule set.

A thorough understanding of the principles upon which cultivation is based and a practical application of these principles is the only safe rule to follow. Every year the season will differ from those of former years; dry weather will come at a different time; and it is not always possible to do work when it will be most beneficial, but there is one thing true for all seasons, and that is that if a farmer thoroughly understands how and when to most effectively apply scientific facts to the tilling of the soil, no work need ever be done which will not have a beneficial effect upon the crop grown and upon the land.

Many experiments have been worked out with wheat and the preparation of seedbeds for wheat, and there is probably no better way of showing the difference between good and poor work than by giving the summary of some of these experiments.

The following is the summary of several experiments upon the cultivation of wheat and a special study of the moisture and temperature of the soil under the Campbell and ordinary treatment. The results are the averages for two successive years, and although not strictly conclusive, are valuable because the work was done thoroughly and the details noted carefully. The work was done by J. H. Shepperd and A. M. Ten Eyck, at the North Dakota Experiment Station.

1. Fall plowed land yielded one bushel per acre more than spring plowing, as an average for several years' trial.

2. Wheat sown in drills and cultivated gave twelve pounds less than that sown in the ordinary way.

3. Ground plowed with a secretory disk gang plow yielded fifty pounds less grain per acre than that plowed with a mouldboard plow.

4. Subsoiling land gave an increase of fifty-four pounds per acre, but at a greater expense, so there was a loss of forty-two cents per acre.

5. Harrowing land immediately after plowing gave an increase of thirty-nine pounds per acre in yield.

6. Land packed with a subsurface packer gave one bushel and six pounds greater yield than that not packed.

7. Deep plowing gave forty-three pounds more grain per acre than shallow plowing, and a profit of thirty-seven cents per acre was realized.

8. Rolling and harrowing land after seeding gave an increase of three bushels and eleven pounds per acre, and one dollar and twenty-five cents per acre was realized as the result of a single trial, in 1898.

Experiments were also made at this time, comparing the Campbell treatment of soils with the ordinary treatment, resulting in favor of the Campbell method as regards moisture and evenness of temperature of the soil. The loose blanket over the lower layers of soil had its effect in keeping the soil at an even temperature. There was one and eighty-four hundredths per cent more water in the first six inches and forty-three hundredths per cent more at a depth of twenty-one to twenty-four inches in the Campbell plot. The principles upon which the Campbell system of ^culture is based are undoubtedly correct, and the methods used are practical, and if

carried out in every particular are an improvement over those used by even the best farmers.

Listing Wheat ground.

Listing wheat ground to prepare for another crop of wheat has been, and is still being practiced in some localities of Kansas and Oklahoma, especially where the wheat fields are large.

The object of discussing the preparations of wheat seedbeds by the use of the ordinary corn lister, is not to advocate such a method of tillage but is rather simply to discuss the advantages and disadvantages of such a method.

As a first requisite the ground to be listed must be free from large weeds and any unusually heavy trash or stubble, as a lister will not do the work of a plow in turning over stubble.

The usual plan is to list immediately after the former crop is removed where wheat is to follow small grain, thus checking the weeds over a large area at once and at a time when usually the ground is in an excellent condition for plowing. Of course the ground is not always in the best condition after harvest but as a general rule it is in better condition then than later in the season.

When the work is done properly the weeds and crab-grass which always start immediately after harvest may be checked entirely, this alone being a great advantage over plowing, with the same horse power at command, as the listing is about three times more rapid than plowing, and as experiments prove that in all wheat districts the earlier the plowing the better, there is a great advantage in this respect also, as one-third of the ground is stirred at the first listing.

In many of the wheat districts in Kansas, Oklahoma, and Nebraska, there is generally considerable dry plowing done in August. The first plowing may be, and usually is done while the ground is in excellent

summer tilth condition, but before the plowing season is over there is generally a lack of moisture in the soil, due to prolonged dry weather and growth of weeds, consequently there is considerable late dry plowing done which seldom proves to be profitable.

The dry weather does not always come at this time of the year, but judging from the past, we may expect dry Augusts, and it is during the dry seasons that listing has its advantages, for after the fields have been disked the loss of moisture is much less than when there is a good growth of weeds and grass to sap the moisture from the soil. A person might be inclined to think after the first listing that the work is almost finished. The first listing however, is but just the beginning of the work required. It is no small matter to level the ridges, but when once the field is smooth again the seedbed will probably be in as good a condition as it is possible to get it by plowing at the same depth.

Splitting the ridges with the lister pulverizes the ground well so that it may be leveled with a plank or smoothing harrow. It is however almost impossible to make the lister run under every ridge successfully as it cannot be held steady enough. To overcome this difficulty it is a good scheme to list but half of the ridges at first. This leaves every other large ridge with one-half a ridge on both sides of it, and in a shape so that a disc harrow running squarely on top of the remaining ridge will cut it up thoroughly to a depth of several inches. In this way the soil under every second ridge, or one-fourth of the surface, is not stirred very deeply, (depending on the depth the disc cuts), but the top is left in a very mellow condition with no very large ridges.

A good disk harrow running squarely on the ridges ought readily to cut in the ridge to a depth of four to six inches, thus leaving

the entire surface mellow and with the stubble evenly mixed through the surface instead of all laying at a certain depth in a thin layer, which is liable to break the capillarity between the surface soil and the subsoil.

In order to do the most effective work the disc should be about eight feet wide when the ridges are forty inches wide, and set so that the center disc, which runs squarely on top of a ridge will cut the deepest. When this much work is done with the disc weighted heavily there ought not to be any trouble in smoothing the field by the use of plank or harrow.

So far the amount of work actually done, i.e., double listing or its equivalent, does not equal the work required to plow the same area. Taking this into consideration one more discing would not be putting too much work on the ground, and after the second discing of the entire surface one planking immediately afterwards is all that is necessary to leave the ground almost entirely smooth.

In order to do the best work by the second discing the disc should be run at an angle of about 45° with the ridges. It is a little more difficult for horses to walk angling with the rows but it is not impossible and when run angling in this way the machine works smoothly, cuts just as deep and levels the ground much better than when run straight with the ridges.

Such a method of preparing ground for wheat may seem like a great deal more work than that required by the usual plowing and harrowing method, but everything considered the difference in the actual work done is but slight, the condition of the weather being the same. Where wheat is to follow wheat or oats there is nearly always volunteer wheat or oats to contend with. If conditions are favorable it requires a strenuous effort to keep this volunteer crop in check upon a plowed

field; about the only way is by the effective work of a disc harrow. Where the wheat grows upon the ridges there is little trouble to subdue it and this is sometimes another advantage worth considering.

To compare more closely, setting the good points in favor of plowing against those in favor of listing, a summary might be made as follows:

1. The listing has the advantage of stirring the ground early and stirring it often, at the time when tillage has the most beneficial effects.
2. Where a certain number of teams are depended upon to put in a wheat crop the listing is ahead, for after the first listing it is not necessary to hurry the work.
3. When the latter part of the plowing season is dry the stubble ground may be too dry to plow while the ridges may be worked down readily.
4. A finer more mellow surface condition may be obtained after listing, unless considerable work can be done upon the ground after plowing, which is not usually the case.
5. There is never any danger that the volunteer wheat cannot be killed where there are ridges to work down.

Points in favor of the ordinary method:

1. When plowed well there are no rough places in the field as there are sure to be where listing is done.
2. The ground is all stirred to a greater and more uniform depth.
3. The plowing method can be made less work, although if done well it will not be less work.
4. Plowing is a little easier on the horses.
5. In a wet season plowing can be done just before seeding, if necessary and the ground will be in a smooth condition, ready for seeding.

Nothing has been done in the way of experiments, comparing such a method of listing as discussed here with ordinary plowing and harrowing.

In the fall of 1905 an eighty acre field near Clifton, Washington County, Kansas, was prepared in the manner stated above, i.e., listed early; every other ridge double listed; every other ridge split with disc; disced on angle of forty-five degrees and planked, the work being done with one lister and a seven-foot disc. In most places in the field the surface of the ground was as level as plowed ground (would have been) and every square foot of the field was in almost perfect seedbed condition.

The entire eighty acres was listed before the ground was too dry to plow well, and although there was very little rain from the middle of July to the second week in September, there was sufficient moisture under the ridges so that the ridges could be worked readily while ground in neighboring fields was altogether too dry and hard to plow. Volunteer wheat covered the field soon after the first listing, as there had been a great deal of wheat shattered at harvest. There was not a spear left however at seeding time.

The wheat got a good start; made a hardy growth in the fall and during April and May showed as good vitality as any wheat near by in other fields.

Although this is written before the crop of wheat is ready to harvest and nothing can be said as to the yield of the crop, everything indicates that the seedbed was fully as good as if it had been prepared in the usual manner.

There is an advantage in the summer on account of dry weather and the volunteer wheat was destroyed. Listing is a practical method of preparing the ground for a large wheat field, but it may never be extensively popular in Kansas, as the custom of plowing and harrowing is too widely practiced, but if such work is done correctly the good

effects of summer fallowing can be secured while preparing the ground for wheat.

Seedbeds for meadows.

Practically all agriculturists agree that in growing grasses and clovers more failures can be traced to improper methods of seeding than to any other cause.

A good meadow ought to last from six to eight years with a profitable return from every acre each year. This will be possible only when the young grass starts out with a strong vigorous growth and continues this thrifty growth. If the young plants are to do this they must have the proper foundation to build upon, and this means a thoroughly prepared seedbed, which will show its effect as long as the meadow proves profitable.

Thoroughly pulverizing the surface is not sufficient where the subsoil is of a compact texture. Grasses and legumes being comparatively deep rooted crops any loosening of the subsoil has a good effect upon them.

The fact that after grasses as well as wheat are once started the soil will not be touched again, except perhaps a slight scratching on top, is sufficient to show the necessity of having an absence of weeds. There is no process of cleaning weeds out after a meadow is once sown except the breaking up of the sod and re-seeding.

Plowing six to nine inches deep should be a minimum depth, and subsoiling from six to twelve inches below the plow line will generally prove profitable where a permanent meadow is desired, but the deep loosening of the soil should precede the seeding by a year or six months, to allow the soil to become firm again. In loosening the soil in this way, the surface soil is not turned under but still the soil is aerated to a beneficial depth.

If the subsoil is such that the roots can penetrate it,

loosening only quickens the growth of the plants, and makes them much stronger. The subsoil once loosened will not go back to its original texture although it can be made firm again, and if the surface soil cannot be made very firm again before seeding it would be much better not to subsoil at all. The firmer the ground to a depth of several inches the better shape it is in for sowing grasses. There must be, of course, enough loose soil on the surface to cover the seeds deep enough so they can get moisture, but there should not be three or four inches of extremely loose and mellow soil upon which to sow the seed. If a hard rain should pack the surface down smooth usually once or twice harrowing thoroughly with the ordinary harrow, is sufficient to loosen the top.

When grasses or alfalfa are sown in the spring the ground to be sown should be plowed to a good depth some time before planting. An ideal way would be to plow one spring, expecting to seed the next spring, especially where the land is poor, but few farmers feel like letting their land lay idle a whole year. Deep plowing early in the fall and dressing the surface in the spring is generally practiced. This allows the bed to settle through the winter and it can be worked early in the spring, after the texture of the soil has been improved by the action of frost.

Any field which is not well drained is not adapted for a meadow. There are a few grasses which will thrive in low, damp fields, but even they thrive best on well drained land. Liberal applications of lime improve swampy land and it is often practical and profitable to use lime where the land is valuable. Potash in some form is always beneficial for a meadow.

Farther than advocating a liberal supply of barnyard manure on all wheat and grass land before seeding, the subject of fertilizers

will not be discussed here.

The following tables show the effect of fall treatment upon fields which are to be used as seedbeds in the spring. The time between the fall test and spring test was about three months, from Dec. 18", 1905 to Mar. 29", 1906, and the winter was very dry during almost the entire period, making the test a very valuable one.

Per cent of moisture in different plots.

Fall test.

Depth	Ground plowed late and disced	Plowed and not farther treated	Plowed early and disced	Stubble left untouched
	per cent	per cent	per cent	per cent
1st 12 inch	24.43	25.74	24.58	not taken
2nd " "	24.63	25.62	25.62	" "
3rd " "	16.08	15.15	13.59	" "
4th " "	15.05	14.33	12.05	" "
5th " "	17.00	16.26	14.93	" "
6th " "	17.16	17.26	17.01	" "
Total average	19.06	19.06	17.96	

Spring test.

1st 12 inch	25.66	26.85	31.06	26.75
2nd " "	24.73	27.74	26.63	24.25
3rd " "	19.18	20.42	34.47	23.09
4th " "	16.25	16.76	17.59	19.22
5th " "	16.27	17.33	19.38	16.43
6th " "	17.57	18.53	17.92	20.77
Total average	19.94	21.27	24.51	23.42

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This test shows that the early plowing has a tendency to affect the rate of evaporation more than the late plowing. It also shows that where there is a thick stubble left on the ground over winter there will be more moisture in the soil in the spring than where the ground is plowed late or not disced after plowing.

Under no circumstances should land be plowed in a wet condition. There is a great temptation many times to plow immediately after a rain but it is far better to plow land too dry rather than too wet. The effects of wet plowing are always plainly visible in the first crop following it, and for several years afterwards there will usually be a difference in the growth of plants upon the land plowed wet and upon that which was plowed in the proper condition.

The accompanying pictures show the texture of dry soil, some of which was stirred in a wet condition and the rest was stirred when there was just enough moisture in the soil to make the ground plow well.

Samples of soil moisture taken in March from the listed field mentioned in another part of this thesis do not show any marked difference in the per cent of moisture in the part of the field which was listed early and in excellent condition for plowing and the sections of the field which were listed very wet and dry.

The wet listing was done when water could be squeezed from a hand full of the soil. The ridges being worked down afterwards, when the ground was in good condition, except for the clods on the surface, the detrimental effect of the wet plowing and the too dry plowing was not as great as would have been the case if ordinary plowing had been done.

However, even as it was, there was enough difference in the appearance of the wheat just before heading time so that there was a distinct line discernable, due to the difference in the color of the

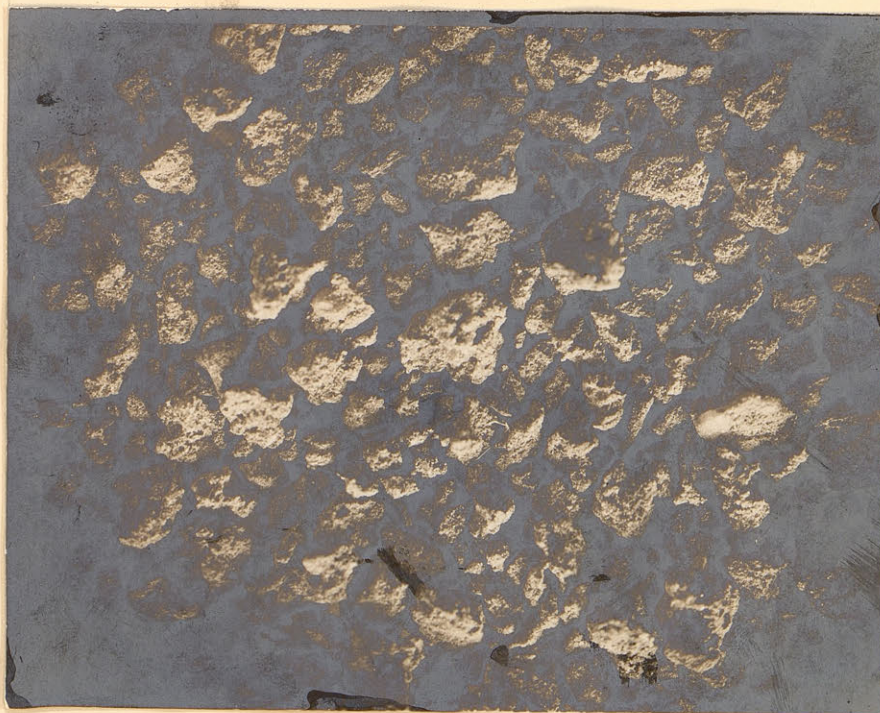
wheat, where the very best listing was done beside the wet and dry listing. The wet listing and that which was done when the ground was in just the right condition for plowing were done the same week, in July.

The pictures show plainly the difference in the texture of soils plowed wet and soils which were plowed in excellent condition for plowing, as appearing under a microscope.

Soil in good condition for plowing.
ordinary sandy loam.



Soil too wet for plowing.
ordinary sandy loam.



Soil in good condition for plowing.
one-half clay and one-half humus.



Soil too wet for plowing.
one-half clay and one-half humus.

