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SOIL BLOWING AND ITS CONTROL IN COLORADO

By J. F. Brandon and Alvin Kezer

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SOIL BLOWING AND ITS CONTROL IN COLORADO

By J. F. BRANDON[1] and ALVIN KEZER[2]

Wind erosion is today the most active, the most potent, depleter of soil fertility on the Great Plains. It is one of the greatest natural hazards in winter wheat production. Great Plains soils are noted for their high fertility; but this, as in all soils, is largely bound up in the upper, humus-bearing zone. It has taken nature centuries to create this rich top soil. To lose the top soil in a storm or series of storms is to lose for immediate crop production nature's efforts for centuries.

Soil blowing has become a greater factor in Plains agriculture as it has become older; not because the hard, sweeping winds have become more intense, but because the natural soil-binding sod rootlets of the original vegetation have become more thoroughly disintegrated. The farmer has seen this very grave hazard grow more intense within recent years. These years quite generally have been adverse for crop production. For that reason there is too much popular tendency to ascribe the more recent severe soil erosion to

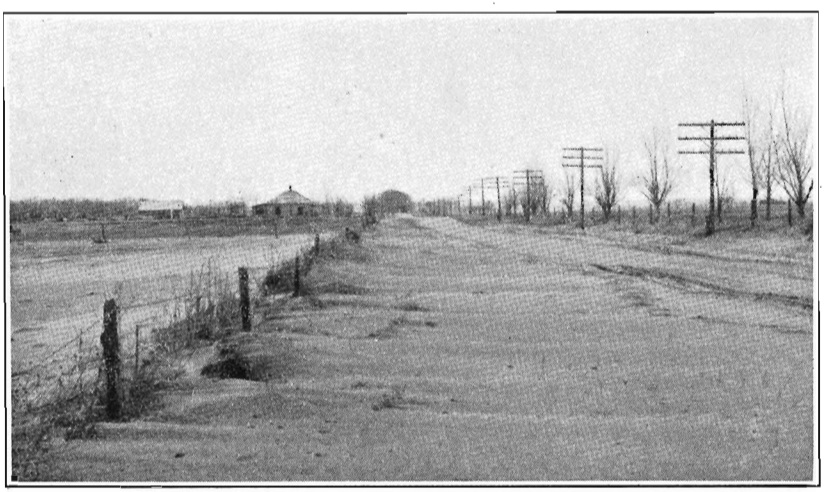

Figure 1.—Soil moved by wind. A very little of the right kind of cultivation would have prevented this movement.

the lack of ample or well distributed rainfall. The amount and the intensity of soil blowing does vary with the season. There are many contributing factors regulated by the seasonal weather, but the fact must be recognized that we do not have today, nor can we incorporate

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by means of annual crops, a soil binder as efficient as the original sod rootlets. Methods of soil management in vogue during the early years of Plains agriculture may have to be changed radically to meet this new menace that threatens the very foundation of our agriculture, the soil. We must now shape our program to meet this new problem, which will be a regular menace to our Plains agriculture.

The Soils of the Great Plains Region of Colorado

Colorado Plains soils vary from almost pure blow sand to tight, hard adobe. The greater percentage, however, is made up of clay loams, silt loams, and sand loams, popularly referred to as "hard" lands. The terms "hard" and "soft" are used quite generally to differentiate between the lands originally supporting a typically short and a semi-tall native vegetation, respectively. The hard lands vary widely in the percentages of sand they contain, the popular term "soft" not being used until the percentage has reached the point where the soil has very little or no cohesive properties. One might add the further descriptive local terms of "semi-hard" and "semi-soft". It is on the high sand-bearing soils, among those with the original short native grass vegetation, that the soil erosion and blowing problem is today the most acute.

The Season of Greatest Soil Erosion and Its Correlation With the Peak of the Yearly Wind Movement Over the Plains of Colorado

Soil blowing may occur during the fall and often during the winter. The period of greatest danger is the early spring, when the

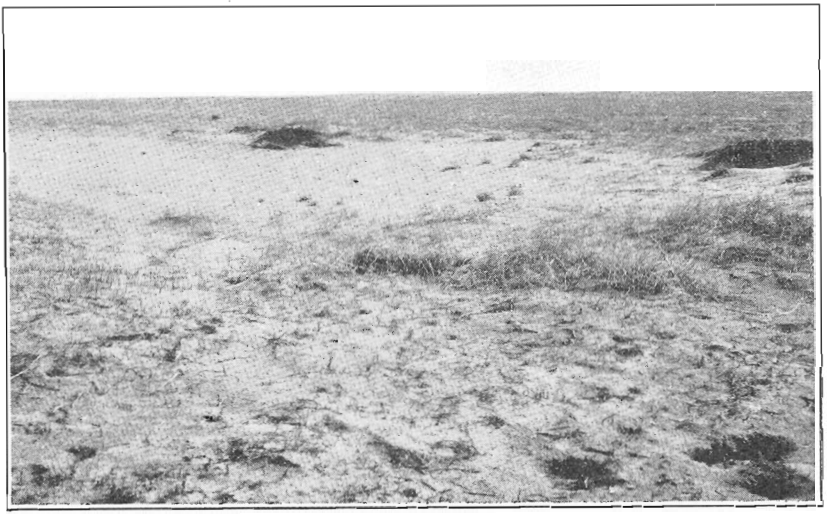

Figure 2.—"Blow spots" or "blowouts" are starting on this field.

highest average monthly wind velocities of the year are encountered at a time when the land is driest. Soil blowing may continue on into the late spring and even into the early summer, if not stopped by cultural control measures or by the normal growth of spring vegetation.

Low pressure areas, passing eastward across the continent, set up conditions of severe atmospheric unrest, manifested by hard, driving winds and sometimes accompanied by precipitation. Fall is the period of decreasing, and spring is the period of increasing, precipitation over the Plains. It is natural, then, that spring should be the period of most severe, as well as most frequently recurring winds of soil blowing velocities. Spring is also the period when the soil is the most susceptible to being moved by winds. The winter, besides being the dormant vegetative period, is naturally one of weathering, tending to break down any cloddy surface. Many soils not susceptible to blowing in the fall may be so in the spring. It is quite essential that the farmer be able to recognize a blow condition, so that he can correct it before the first windstorm has started movement. "A stitch in time saves nine" is certainly applicable to cultivation aimed at correcting a blow condition of the surface soil. A soil becomes increasingly difficult to control each time it is allowed to blow unrestrictedly. The best time to control soil blowing is before the movement has actually started.

The Prevailing Soil Blowing Wind Direction, and Something of Its Nature in Colorado

The prevailing directions of the hard, soil-eroding winds in Colorado are from the north and northwest and the south and southeast. In the fall and early spring, the soil-blowing winds nearly always will be from the generally westward direction. Later in the spring, these winds may also come from the south, southeast, or southwest in the proportion of about two to every four or five. These are prevailing wind directions, it must be emphasized. Winds may reach soil-blowing velocities occasionally from nearly any point of the compass. One of the very worst types of windstorms is one which springs up viciously from one direction, and then, without abating, swings one fourth to one half the way around the compass, finally to settle down and blow from the northwest or the southeast.

It generally takes a velocity of at least 30 miles per hour to start any considerable soil movement on the hard lands of Colorado. Once soil has begun to blow, it will again start to move with a velocity no higher than 8 to 12 miles per hour.

As a general rule, a soil-blowing wind will come up sometime during the forenoon and die down again at evening. However, it is the exceptional windstorm that causes the greatest havoc. Soil-blowing storms have been known to come up during the night, barely

abate at sunup and sundown, and finally blow themselves out during the following night. It is these long continued, high-velocity winds that tend to set some rather securely-anchored soils into motion.

Types of Surface Soil Likely to Blow

Any comparatively level field devoid of a covering of either dead or dormant vegetative matter will blow if finely pulverized or tightly and smoothly crusted. The more sand the soil contains, the greater the likelihood of blowing. The soil is pulverized finely almost every fall after a crop of beans has been removed, and often in the

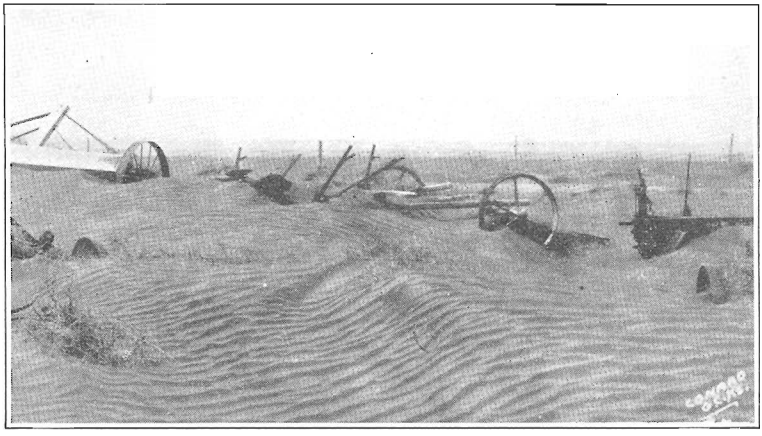

Figure 3.—A dirty deal in real estate.

spring on winter wheat and rye fields if the winter has been more or less open, i. e., devoid of snow covering. The bean land should be listed, the furrows at right angles to the prevailing wind direction, just as soon as the crop is removed, unless, by chance, ample late fall rains have wet the surface and subsoil sufficiently to germinate and grow winter wheat or rye to a good ground cover stage. It is hard to list in dry soil, but the job can and must be done to prevent almost certain severe soil erosion. The dormant crop land should be lightly furrowed at intervals across the field, the furrows at right angles to the prevailing hard-wind direction. The furrowing implement should be a shovel type, such as will lift clods to the surface, rather than a disk type, which grinds and pulverizes. Such a furrowed field may blow slightly, but it cannot sweep until the made furrows are filled and the clods disintegrated. Once this condition has been reached, the only future protection is to re-furrow the field, using the undisturbed ground between the first furrows. The duckfoot, or field cultivator, with a part of the shanks and shovels removed, has been very effective in field trials for creating this light-furrow type of soil-blowing protection. The corn cultivator, with

shovels instead of sweeps, is also effective. If these precautions fail to prevent erosion, the lister is next brought into use. The lister is more severe on the winter wheat or rye, but still not so damaging as continued, uncontrolled soil blowing. Just enough lister furrows at the right intervals to stop the sweep is all that is necessary. In other words, sweep blowing is prevented by trapping the field's own loose soil at frequent intervals. It is sweep blowing that is damaging to the seeded dormant crop, and as an eroding agent. The latter condition is often present on the winter wheat and rye fields of the Great Plains after the spring melting of a deep covering of snow. This slick, crusted soil offers a real opportunity for creating a non-blow surface, if only the blocks of this crusted surface are up-ended before the first windstorm. The spike-tooth harrow, properly weighted so that it does not ride over, will create a nicely clodded surface that will stand through repeated windstorms. Just enough teeth in the harrow should be used to accomplish the object effectively. Also, the spring-tooth harrow, with just enough teeth to produce a cloddy surface, might be used. Repeated windstorms over a crusted surface not only erode, but also deflocculate. It is very essential that the blow hazard of the smoothly crusted field be recognized in advance and the surface corrected while there is still cohesion enough for creating the non-blow, cloddy surface. Failing in this, one must resort to the shovel furrowing implements, as in the case of the finely pulverized surface, and finally to the lister.

Soils Likely to Blow, Classified on the Basis of the Previous Crop

Bean land is positively the worst blow hazard in Colorado. Not only that, but it is without doubt the hardest type of soil to change over into a non-blow condition. This is because the crop is cultivated late in the summer, is harvested early in the fall during a period of naturally diminishing rainfall, and the harvesting machinery may still further fine the soil to a depth of sometimes 3 inches. Further, the crop leaves no root-clump that may be up-ended. However, this is no reason for totally dispensing with this important cash crop. It is only necessary to recognize fully the grave blow hazard of bean land soil and then take the necessary precaution to render it blow-proof. Such a soil can be rendered free of soil erosion only by listing as soon as the crop is removed, then cultivating the ridges, and finally "busting out" the middles as the blow situation warrants.

The next most dangerous blow hazard is row crop land, such as corn or sorghum, from which the crop has been harvested close to the ground. Such a soil, however, is usually hard and tight, with the beginning of winter, and if not trampled by stock, generally can be rendered blow-proof by means of the shallow-furrowing types

of implements which will also up-end the root clumps. This land should **never** be seeded to a winter dormant crop unless fall rain-

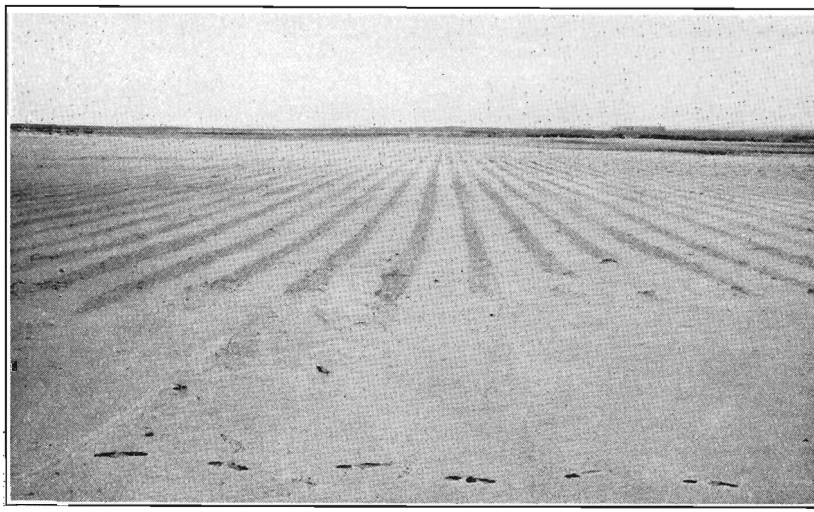

Figure 4.—This sandy field was listed. Listing did not stop completely wind movement of soil, but it kept most of the soil in the same field.

fall has been sufficient to insure a good ground cover growth before cold weather. Stock should not be allowed to trample over such unprotected soils.

Probably the next greatest blow hazard is cornstalk land that has been winter pastured, particularly by sheep. As a very general rule, cornstalks should not be winter pastured; rather, the corn should be cut, preferably in strips, and hauled out for lot feeding, either dry or from a silo. Such land should not be fall seeded, no matter whether the crop has been removed in part or in entirety, unless moisture conditions are sufficient to insure considerable top growth before cold weather. Such land, if hard, will rarely start blowing. If it starts, it generally can be stopped by the shallow-furrowing implements mentioned previously.

Probably the next greatest blow hazard is fallow land seeded to winter wheat or rye that has never emerged, or which has attained no appreciable top growth. Furrow-drill seeding makes this blow hazard appreciably less, and is to be recommended for the high midwestern section of the Great Plains, but it does not insure immunity.

The small grain or other closely spaced stubble lands will rarely blow unless the dry vegetable matter largely has been destroyed during the fall and early winter. This is why fall plowing of stubble

Figure 5.—Contour listing prevents wind and water erosion and holds rainfall until it soaks into the soil.

land normally is not to be recommended away from the foothills, on the Great Plains. Such land may be listed without increasing the blow hazard appreciably, if for any reason fall working is desired.

Method to Follow in Stopping a Soil-Eroding Field

Once a field has started to blow, the condition will grow worse unless control methods are put into use. During hard, sweeping windstorms, "eternal vigilance" is necessary to prevent blow spots from involving vast areas. Once land has started to blow, "the devil's to pay," is another old-time expression aptly descriptive. It is necessary to be on the alert with a shovel-type furrowing implement. The choice between the lister and the more shallow-furrowing types depends on the seriousness of the blow situation and on whether the blowing field is seeded. The blow spot should be worked, beginning always on the windward side. Some try to work into the wind, toward the source of the blow spot, but find their furrows leveled almost as fast as they are made. Every cultivation should try to raise clods to the surface, not alone to create furrows. It is poor practice to try to trap too dense a sweep of moving soil with light, shallow furrows. The movement should be broken at its beginning or source, so that each furrow will have only the soil from the intervening space to trap. This observation shows the basis for determining the width of spacing between the furrows. Whenever one finds the soil riding over the furrows, they are too wide apart or have been left too long. The furrows must be spaced closely enough to absolutely break up the soil sweep. If the land is not seeded, listing will nearly always prepare hard land

soil to resist any and all subsequent windstorms, but the lister must penetrate hard, tight soil below, so as to lift clods to the surface. Preliminary or beginning blow spots will nearly always be the high point or points, or the more sandy spot or spots, of the field. If these are held, the remainder of the field may need little attention.

Every sweep-blow-stream, no matter how dense nor how big the area involved, starts from a single, or several single spots. On

Figure 6.—Listing a smooth, barren field in the fall is a good method for reducing soil blowing and catching drifting snow.

the windward side, the air may be practically free of dust particles up to these fountainheads of blow soil. To break up that blow stream, control cultivations **must** start at the source and precede the high wind.

If soil is blowing over from an adjoining field of different ownership, and the neighbor will not break up his blow spot, the situation is serious. Unless broken, this blow stream ultimately will weather down and start any soil in its path not actually protected by a rank top growth of winter wheat or rye, or by a dense, tight covering of dead vegetative matter. The only recourse of the one taking the brunt of this soil-stream attack is to list enough land, at right angles to the blow direction, to trap all soil blowing onto his land. This relief is only temporary if the blow source is not worked. In fact, it is futile to try to hold cropped land in the path of one of these sweeping, soil-particle-bearing streams through many storms.

State law, in the Plains States, should make it mandatory that each land owner or operator control the soil blowing on land under his jurisdiction. There is no justification in a careless or independent land operator allowing his blowing soil to involve a seeded field of winter wheat or rye of a neighbor who happens to be in the path of the sweeping soil stream. The least such a law could do would be to empower the neighbor to trespass and work out the soil blowing at its source on his neighbor's land.

Some of the Mechanics of Soil Blowing

Heavy particles of soil can remain partially suspended only when the wind is high. They cause damage when allowed to sweep unhampered over a wide space of territory. Any obstruction in the path of these sweeping streams of blowing soil will knock down and trap a portion. Often thistles, or other weed clumps, will be found buried on wind-swept fields. A thick, dense stubblefield covering of weeds will break up a very serious sweep of wind-borne soil, though the plants along the edges bearing the brunt of the attack ultimately may be buried. A woven wire fence will become partially buried by soil knocked down and trapped, if repeated storms sweep dirt particles to and through it. Even a barbed wire fence will trap some soil out of sweeping streams that may be directed toward it. These practical examples give proof that wind-borne soil particles react very much like wind-borne snow particles under the same conditions. They show positively that to break up the groundline sweep of these winds is to render them incapable of

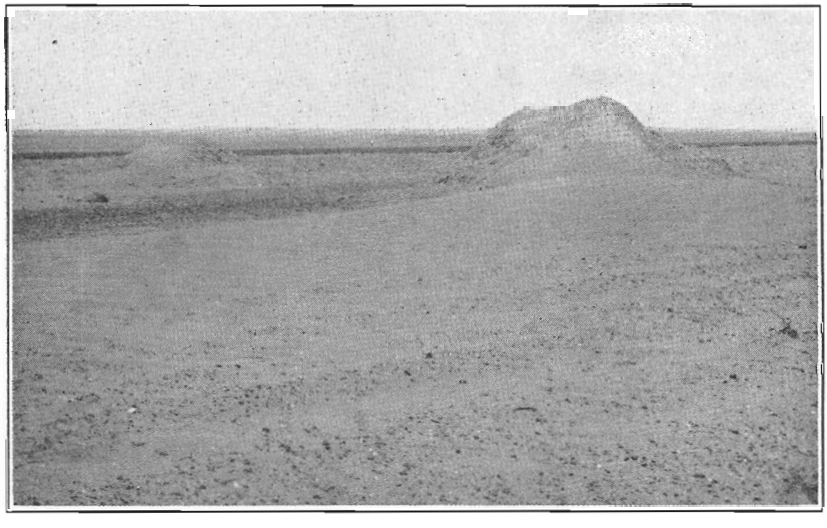

Figure 7.—Soil wind erosion. This severe damage could have been prevented by listing.

carrying soil, or snow, particles. Soil blowing control consists of setting up obstructions to break the sweep of the hard, driving winds on the ground. This is exactly the action of the furrows, made at right angles to the wind direction. They must be close enough together to slow this surface wind so that it cannot carry soil particles across. The furrows are most effective when cloddy. Theoretically, there is a blow condition even after cultivation, but by intermittently trapping the soil, the damaging sweep blowing is prevented. Thus, the blow spot is confined to its original area, and no permanent loss of valuable top soil is suffered.

There is probably no other agricultural region in this country where the hard, driving winds hug so closely to the ground. This is largely because there is no natural cover of shrubs or trees.

These cardinal facts, along with the knowledge that the original soil-binding sod rootlets are largely or wholly disintegrated and gone, emphasizes the necessity of giving more serious thought to the problem of soil erosion on the Plains.

The Development Trend as Affecting the Present Soil-Blowing Problem

Great Plains agriculture has pioneered along lines dictated by commercial demand, and not as the list of adapted crops would indicate. The crop asked for and produced by the developing, expanding Great Plains was wheat, both spring and winter. So sharp and so outstanding was this development, particularly during the past 15 years, that many not familiar with the response of various other crops to the environment have falsely concluded that wheat is the only crop the Plains can produce. This has been the history of every other agricultural region yet developed in this country. Each had pioneered by producing one crop to the general exclusion of a list of other adapted crops. The impression also became general that those regions could produce only that one crop. Later on, depleted or unbalanced fertility, lessened market demand, or insect or disease plagues, have invariably interfered to force more general diversification in cropping practice. Today soil erosion seriously threatens to force a more diverse crop production program onto the Plains Region. Too large an acreage in winter dormant crops, particularly following falls that have been so devoid of rainfall that the crop cannot develop well-matted top growth, is dangerous blow territory. It is more dangerous when seeded, because it is less amenable to the most effective tillage control. The soil blowing problem is much less severe in a given region if there are interspersed fields that may be listed, or that have a dense cover of dead vegetative matter. The furrow drill for fall-seeded crops recently has come into wide use. This has not prevented fields of winter

wheat and rye from blowing, as has been proved during recent years, but tends to reduce blow danger. The high proportionate acreage of winter dormant crops should be reduced. Then the reduced acreage should be seeded, preferably with the furrow drill. A diversified farming program for the Plains, using adapted crop varieties, will leave a high percentage of the land covered over winter with dead vegetative matter, or unseeded, so that it can be listed.

Cropping Plans to Thwart Soil Erosion

Strip farming, the strips at right angles to the prevailing hard-wind direction, has proved very effective in minimizing soil erosion on the more sandy soils of Colorado. On these light soils, it has been found that May winds will often reach such velocities as to fill in the furrows of the lister-planted crop before it has emerged, or before it has attained sufficient size to hinder soil movement. The writer has seen corn on the higher portions of these light soil fields that had escaped the early spring burial but which remained dwarfed all summer because of its unequal battle with the wind to hold the soil intact. To overcome this hazard, some have evolved the plan of seeding their crop in strips of 10 to 20 rows, with strips of dead vegetable matter in between. These undisturbed strips are then seeded to a later crop after the first crop has attained sufficient size to be effective in breaking up the ground sweep of the hard winds. This later crop is usually beans, because of their readily salable nature.

Strip farming may be recommended as a general practice all over Colorado on the hard as well as the soft lands, the strips running east and west. The nature of the crops in the strips will depend very much on the nature of the soil, and also on the crop needs of the farmer. The more diversified the crops, with livestock to utilize the forage feeds, the more stable will be the farming and the less the percentage of land in winter dormant crops. However, the grain farmer using alternate fallow, with 50 percent of his land in dormant winter crop, can still have very good soil-blowing protection, providing his strips of crop and dead stubble with weeds are not too wide.

The width of the alternate strips of crop and dead vegetative matter will depend on the type of the latter, and on whether the soil type is a sand or a loam. Narrower strips on sandy land are equally effective with wider strips on the loam soils. Wider strips in corn, the stalks left standing all winter, are equally effective with narrower strips in small-grain stubble or other closely-spaced vegetative matter. These are adjustments that must be determined by the man actually handling the land.

Figure 8.—A duckfoot cultivator leaves the soil surface cloddy and rough.

The high market value of dry beans compared with corn, grain sorghums, and broomcorn has induced some sandy land farmers to have too high a proportion of their stripped land in beans. One must be ruled by the soil-blowing protection needs, not by the current market value of the crops. Soil erosion **must** be controlled or the land will be destroyed.

Straw and Strawy Manure in Controlling Soil Blowing

On fallow land seeded to winter wheat, there are nearly always high points, very often the more sandy portions of the field, which experience teaches are likely to develop into dangerous blow spots with the advent of spring. If this danger is anticipated, and heavy, wet straw from a stack bottom or strawy manure is applied during the fall, it usually will weather into the soil so as to be real protection against those hard, driving winds that are nearly sure to test the stability of any soil before the advent of growing conditions the following spring. Such an application of humus and fertility-bearing material can only result in the same or greater yield of the crop, as numerous experiments over the Plains disclose. To be effective in actually stopping an already developed blow spot, the surfacing material must be heavy, wet, strawy manure, something with cohesive properties enough to hold even after the moisture has been evaporated. Forcing the strawy material into the top soil with a Campbell-type packer is often helpful.

If manure is available, it is a very excellent plan to topdress the

seeded winter wheat fields during the fall and winter. While there is at present no evidence of depleted fertility of the Plains soils, experiments show that humus and fertility can be added as a top dressing without in any way lowering the yield.

The diversified farmer keeping livestock and fallowing his land every fifth to sixth year, and using winter wheat as the crop on fallow, will find the top-dressing of that crop a very satisfactory outlet for his accumulated manure.

Winter Pasturing by Livestock—Influence on Soil Erosion

Winter is the period of low precipitation, which nearly all falls as snow. When the precipitation is comparatively high, the snow is likely to render field pasturing impossible. When light, the surface soil is dry and in good shape to be fined and powdered by trampling hoofs, particularly of sheep. A fined surface will blow, even among partially standing cornstalks.

As a general rule, late fall and winter pasturing of dead vegetable matter should never be attempted on the Plains of Colorado. The less a dry surface soil is pulverized during the winter season, the better. Cornstalks are good feed. They should be cut, not pastured, and cut from east and west strips, and fed in dry lot as dry feed or as silage.

It has been urged repeatedly, and may be suggested again, that feed crops be carried in reserve from years of comparative plenty,

Figure 9.—Corn and beans in strips reduce soil blowing and snow drifting if the cornstalks are left standing during the winter.

so that the pasturing of dead thistles on stubble land will not be necessary during dry winters preceded by dry seasons. Close trampling of stubble fields under these conditions may render even comparatively well-anchored soils susceptible to erosion. If thistles are to be relied on as winter roughage, they should be cut and fed in dry lot. The percentage of soil likely to blow must be kept at an absolute minimum.

Windbreaks of Trees and Shrubs Very Effective in Helping to Break Up the Groundline Sweep of the Hard, Soil-Eroding Winds

It has been found within comparatively recent years that certain previously-overlooked trees and other recently imported trees and shrubs can be established in windbreak plantings on the treeless Plains of Colorado. They must be protected, during the early years necessary for establishment, from the encroachment of vigorous, well-adapted forms of vegetative growth anxious to take advantage of the young tree or shrub's comparative helplessness. The more recently discovered hardy varieties of trees and shrubs are not, as a rule, from our own humid region, but from the lower altitudes of our own nearby mountains and from climatically similar regions about the world. Because past efforts to establish windbreaks of trees and shrubs have been unsuccessful is no reason to expect certain failure today. We should again make an effort to correct the naturally treeless aspect of our Colorado Plains region. If successful, our soil-blowing problem should be lessened very appreciably.

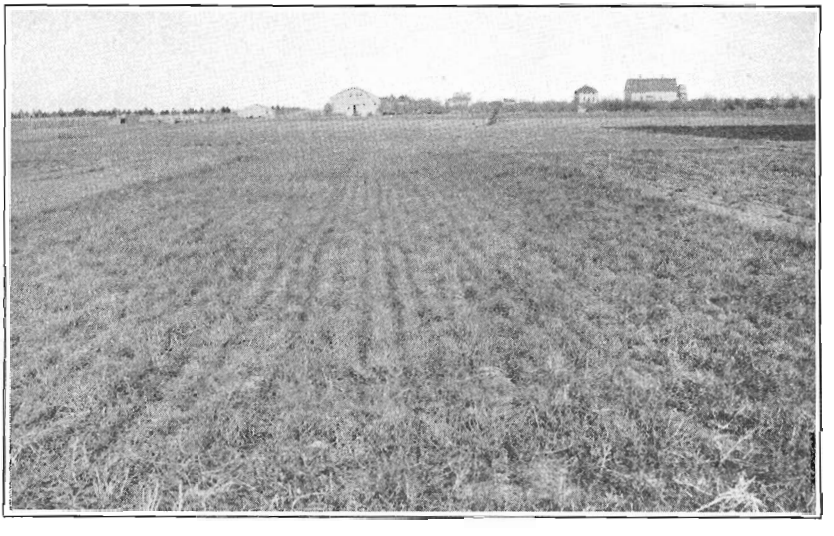

Figure 10.—A good stubble cover protects the land through fall, winter, and spring.

Suggested Diversified Rotations for the Plains Regions of Colorado

Any well-diversified rotation presupposes livestock and an acreage in native sod. The acreage in sod should not be less than 25 percent of the farm unit on the "hard" lands, and up to 100 percent on the "soft" or sandy lands. As has been stated before, Plains soils vary physically all the way from quite light sand, precariously held by a semi-tall native grass vegetation, to tight, hard, clay loam, covered in the native state with a typical short-grass sod. However, the loam and sand loam soils predominate, and as a class within definite regions, are adapted to common crops and to rather definite sequences in rotations.

A year of fallow is to be recommended for the soils of the western edge of the Central Great Plains which have enough cohesion to resist summer soil erosion, once every 4 to 6 years, even in a farming system involving livestock. This year of fallow not only adds more certainty to the production of the chief cash crop, winter wheat, but also tends to rid the soil of obnoxious annual weeds.

Rainfall is so erratic, especially during years of low precipitation, that the greatest certainty of production lies in a wide variety of adapted crops. This also gives opportunity to strip farm and to have a wider variety of winter vegetative cover as wind-erosion protection.

For the Hard Lands of Northeastern Colorado

One of several crop sequences may be suggested for northeast-

Figure 11.—The furrow drill leaves the land rough and reduces danger of blowing.

ern Colorado as follows: Twenty percent in fallow (put in) on spring-worked small-grain stubble, 20 percent in winter wheat on fallow, 5 percent in corn, 10 percent in dry beans, and 5 percent in foxtail millet. The corn, beans, and millet usually would be planted on spring-worked winter wheat stubble land. Ten percent of the acreage could go into corn on fall- or spring-listed corn and fall-listed bean land. Five percent could go into proso (hog millet) on fall-listed bean land and 5 percent into sorgo (cane) on spring worked foxtail millet stubble land. Ten percent could be put into barley on spring-worked corn land, and 5 percent into winter wheat on proso land, seeded in the stubble without previous working. Such a rotation would leave 5 percent in proso to be put in on spring worked sorgo ground. Such a rotation is shown below:

	Field 1	Field 2	Field 3	Field 4	Field 5
Percent of cropped land	20	20	20	20	20
Crop	Fallow	Winter wheat	5% corn 5% beans) 5% beans) 5% foxtail millet	5% corn) 5% corn) 5% proso 5% sorgo	5% barley) 5% barley) 5% winter wheat 5% proso

For the Hard Lands of Southeastern Colorado

The following is one suggestion for southeastern Colorado hard lands: Twenty percent in fallow, 20 percent in winter wheat planted on fallow land, 5 percent in grain sorghums, 5 percent in barley, 5 percent in dry beans, and 5 percent in cowpeas. The sorghums, barley, dry beans, and cowpeas could all be on spring-worked winter wheat stubble land. Five percent of the land could be grain sorghums on fall-listed or spring-worked sorghum stubble. Five percent might be planted to grain sorghums on spring-worked barley stubble, 5 percent to grain sorghums or broomcorn on fall-listed bean land, and 5 percent to oats or barley on fall-listed cowpea land. Five percent of the acreage could be put to dry beans on spring-worked sorghum stubble-land. Ten percent could be planted to grain sorghums or broomcorn on fall-listed or spring-worked sorghum stubble-land. Five percent could go to sorgo (cane) on spring-worked oat or barley stubble. The type rotation is illustrated below:

	Field 1	Field 2	Field 3	Field 4	Field 5
Percent of cropped land	20	20	20	20	20
Crop	Fallow	Winter wheat	5% grain sorghum 5% barley 5% beans 5% cowpeas	5% grain sorghum 5% grain sorghum or broomcorn 5% grain sorghum or broomcorn 5% oats	5% beans 5% grain sorghum or broomcorn 5% grain sorghum or broomcorn 5% sorgo

These rotations involve all the leading adapted crops of the two extreme parts of the Colorado Plains, except oats in the Northeast, in sequence where experimental findings show they will yield well. They fallow every acre each fifth year, permit strip farming, and leave 45 and 30 percent of the land, respectively in the Northeast and the Southeast, in small grain, or closely-spaced stubble, and another 20 and 35 percent, respectively, in row-crop, or widely spaced stubble, over the winter period. A part of this wide-spaced stubble-land may be fall listed with equal prospect for a yield the following year with little, if any, less soil-blowing protection. A part of the cornstalks should be left standing in east and west strips, and the sorghum should be harvested so as to leave strips of high-cut stubble in the same directions. They have 10 and 15 percent of the land, respectively, in dry beans during the growing season, listed out during the winter. The acreage seeded to winter wheat is largely, or wholly, on fallow where it has the very best opportunity of attaining considerable top growth before winter. Crops seeded on proso stubble should never give any trouble from

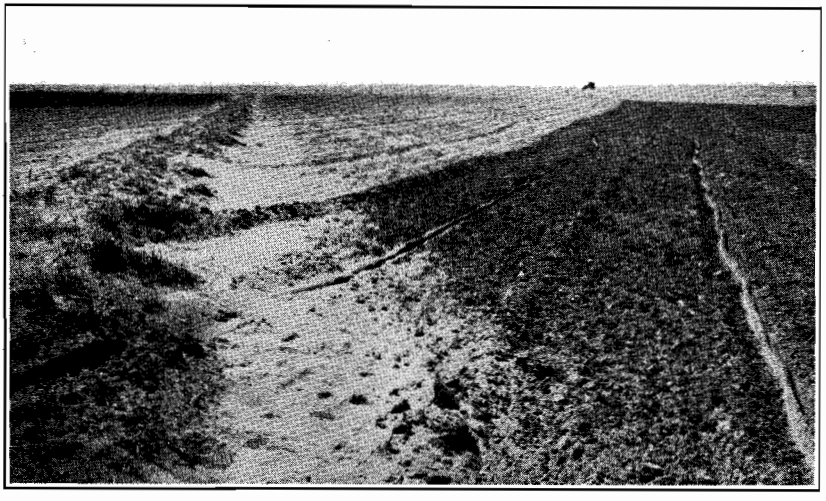

Figure 12.—Disking did not stop the blowing here. Ordinarily disking pulverizes the soil too much. Disking when the soil is wet may leave clods on top and thus check blowing.

soil erosion. If oats are desired in the Northeast rotation, they may be substituted for a part of the barley, or they may take the place of the foxtail millet.

These same rotations are quite well adapted to the more sandy lands of the same two regions by leaving out the year of fallow.

Midway of the Arkansas-South Platte Divide, one would choose

the Northeast or the Southeast crop system, depending on whether the grain sorghums regularly mature, and whether they out-yield corn. Assuredly, the cowpeas and the broomcorn would be left out.

Summary

Soil-blowing is the most important agricultural problem confronting the Plains farmer of Colorado today.

Soil-blowing control is incident to and bound up with the breaking up of the groundline sweep of the hard, driving winds of the winter-spring period.

The best soil-blowing protection is a well-anchored, dense cover of dead or dormant vegetative matter.

Necessary summer cultivations should not unduly fine the surface soil. A flocculent condition of the surface soil is difficult to recreate, once it has been destroyed by grinding, pulverizing implements.

Cultivation to control soil-blowing spots should not only create furrows, but should go deep enough into the hard, tight subsoil to lift clods to the surface. Cultivation which only moves loose blow soil is not effective as erosion control.

Furrows intended to break up a blow spot must be not only deep enough to lift clods to the surface but must be close enough together that the soil blown from between will not ride over.

The fountainhead of any soil-blowing stream can be broken up by roughening the surface by means of furrowing implements that penetrate deeply enough to lift flocculent, cloddy soil to the surface. These may eventually be eroded down into blow soil and the furrows leveled, in which case the middles must be "busted out", raising another lot of clods to the surface.

A blow condition never corrects itself nor stays confined to one spot. The sweep of soil particles tends to weather down and to set in motion any and all soils in its path, no matter how blow-free they may be within themselves.

Blow spots must be worked. Nothing is more essential in a blow-control program for any region.

A high percentage of the soil must be kept covered with dead, or well developed, though dormant, vegetative matter during the winter. The effectiveness of this natural soil-blowing protection must not be reduced by excessive or injudicious winter pasturing.

A windbreak of hardy shrubs and trees should be established around the farm. Crops should be planted in east and west strips, so as to leave each strip of open ground flanked by a strip well covered with dead or dormant vegetative matter.