Cooperative Extension Service

NORTH DAKOTA STATE UNIVERSITY - FARGO, NORTH DAKOTA 58102
UNITED STATES DEPARTMENT OF AGRICULTURE COOPERATING

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SOIL CONSERVATI[illegible]

Wind Erosion Control on ▸Summerfallow ▸Continuous Cropland

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INTRODUCTION

The CONSERVATION GOAL of farmers and ranchers throughout North Dakota should be the control of soil erosion on agricultural lands. This will require that all crop and grassland management decisions take into account the possible future loss of the soil resource. CONSERVATION KNOWLEDGE, now available, can accomplish this goal.

THE PROBLEM

Soil erosion by wind can be a serious problem on all soils, depending on climatic factors, condition of vegetative cover, soil factors and cultural practices used in crop production. Increasing farm size, larger farm tillage machinery, increased acreage devoted to crop production and season of tillage have increased field size and the potential for soil erosion on farms and ranches throughout North Dakota.

FALL PLOWING and SUMMERFALLOW are two farming practices considered to be the major contributors to the problem of soil erosion by wind in North Dakota. Acreage figures on the amount of fall plowing are not available, however, it is estimated that there are about 4 million acres. The acreage of summerfallow (Fig. 1) has increased substantially since 1954 and is strongly influenced by Federal farm programs.

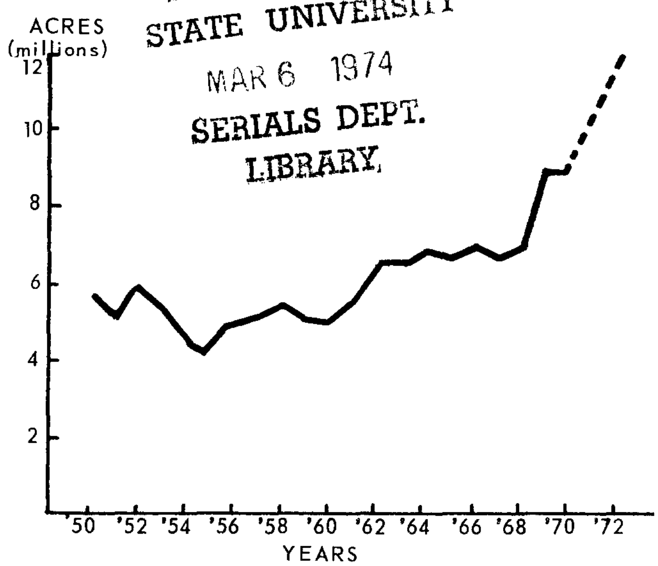

FIGURE 1 - Trend in summerfallow acres in North Dakota (estimated for 1970 and 1972).
Source: N. D. Crop and Livestock Statistical Reporting Service

WIND EROSION FACTORS

A field's susceptibility to wind erosion depends on the interaction of eight major factors. These factors include:

1. SOIL TEXTURAL CLASS
2. SOIL CLODDINESS
3. SURFACE COVER OR RESIDUE

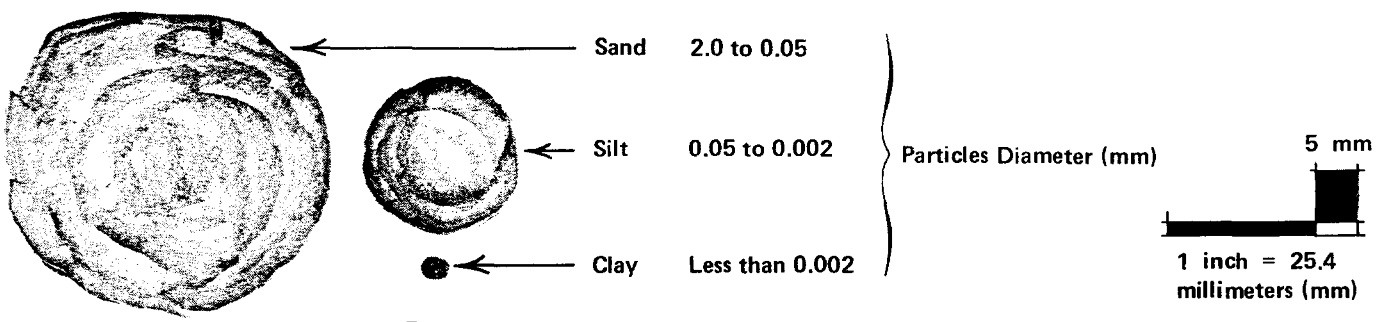

FIGURE 2 - Relative size of individual soil particles.

4. **SURFACE ROUGHNESS**
5. **CLIMATE (precip., temp., and wind)**
6. **FIELD WIDTH**
7. **WIND DIRECTION – FIELD LAYOUT**
8. **WIND BARRIERS – ANNUAL AND PERENNIAL**

Soil erosion by wind can be controlled by (1) improving surface soil structure and (2) reducing the force of the wind at the soil surface. Soil structure can be improved by increasing the ability of individual soil particles to cling or clump together, forming stable aggregates or clods. Wind speed near the soil surface can be reduced by growing and/or maintaining a vegetative cover on the land.

SOIL TEXTURE refers to the per cent by weight of individual size particles - sand, silt and clay, in a soil. The size difference among particles is shown in Figure 2. Individual soil particles are bound together into soil aggregates or clods by clay particles and decomposed organic matter.

The dividing line between erodible and non-erodible soil particles, aggregate or clods is about 1 mm (millimeter) in diameter. Soil particles or aggregates in this size range have a thickness of a dime. Soil particles having a diameter of 0.1 to 0.5 mm (medium and fine sands) or about 1/10 to 1/2 the thickness of a dime, are highly erodible. A soil containing 20 to 30 per cent clay and 50 to 60 per cent silt forms aggregates or clods large enough and of adequate numbers to resist wind erosion. In comparison, a soil containing a high percentage of sand (70 per cent or more) and less than 7 per cent clay is potentially highly erosive because few aggregates of non-erodible size are formed to resist erosion.

A soil's ability to resist erosion by wind is related to the size of individual soil particles and the ability of these particles to cling together, forming stable aggregates or clods. SOIL CLODDINESS (Fig. 3) can be influenced by adding crop residues and growing grasses and legumes in the rotation. The products of residue decomposition increase the ability of a soil to form aggregates or clod structure. However, soils high in sand content form only slightly stable aggregates or clods and remain highly erodible. Therefore, several conservation practices, crop residues, strip cropping and tree wind barriers may be required on these soils to effectively control wind erosion.

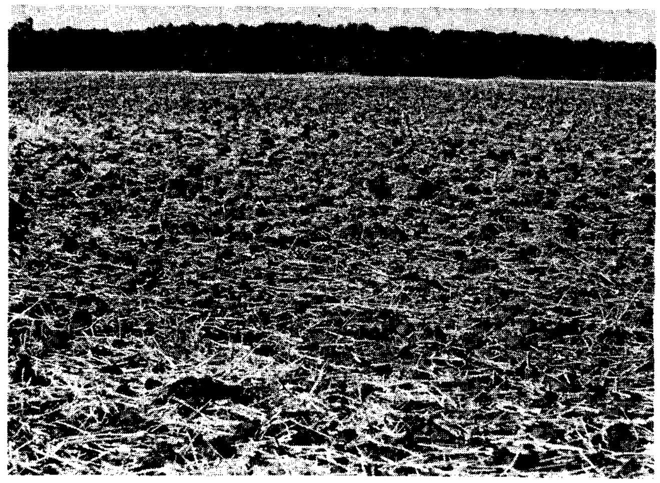

FIGURE 3 - Surface clods and crop residue protect soil.

CROP RESIDUES (Fig. 4) protect the soil by reducing the force of the wind on the soil surface. The effectiveness of crop residue for soil protection depends on the kind, amount and position of the residue in relation to the soil surface.

FIGURE 4 - Standing residue, excellent soil cover.

Residue Facts:

- Small grain straw or stubble is more effective on an equal weight basis than coarse residue such as corn stalks. To be equally effective, 2 to 3 times the amount of corn stalks are required per acre as compared to the finer small grain residue.

- Residue standing erect or in a slanted position will protect the soil more than if laying flat on the soil surface.

- Growing grasses and small grain crops are effective in soil erosion control as they reduce the wind force at the soil surface and are well anchored.

FIGURE 5 - Soil ridges increase surface roughness.

Soil ridges (Fig. 5), formed through cultivation, like anchored plant residue and surface clods, increase SURFACE SOIL ROUGHNESS. These erosion control factors used alone or in combination act as miniature wind barriers. Wind erosion control research has shown that soil ridges formed by cultivation, two and one-half inches high and at right angles to the prevailing winds, can reduce soil loss from 30 to 50 per cent compared to a smooth surface. Ridges higher than 4 or 5 inches tend to increase wind speed and wind turbulence at the ridge crest, where most soil erosion occurs. Soil ridges trap eroding soil particles between the ridge crests and stop their movement across an eroding field. However, if a field is too wide and the wind is strong the space between ridges fills with soil and becomes ineffective in trapping soil particles.

Soil erosion occurs primarily when exposed soils are dry. The CLIMATE of a region, influence of precipitation, temperature and wind, determines the soil erosion loss potential. If surface soil aggregates contain enough moisture (Fig. 6) to support plant growth, soil erosion will not occur. However, the influence of climatic factors acting in combination often cause exposed soil to dry out and/or break down, allowing soil erosion to occur. Reduction of wind speed is the best protection against the influence of the factors of climate acting on a bare soil.

Once soil erosion has started, FIELD WIDTH (Fig. 7) greatly influences the intensity of soil loss, The rate of soil erosion increases with distance across a field, depending on the ability of the wind to carry soil and the erodibility of the soil. The increase in erosion across a field is called avalanching and is defined as the progressive accumulation of eroding soil particles on the downwind side of a field.

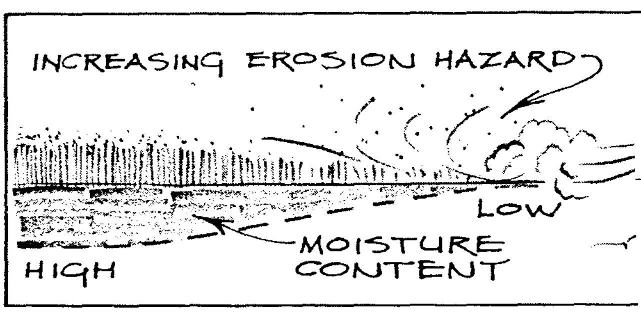

FIGURE 6 - Soil erosion will not occur if soil surface is cover.

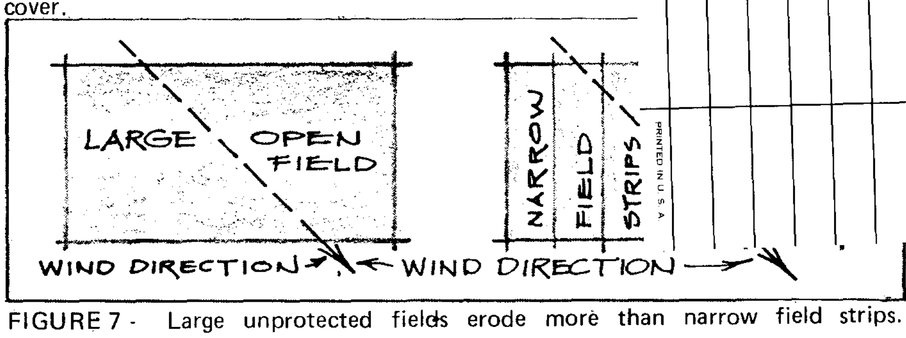

FIGURE 7 - Large unprotected fields erode more than narrow field strips.

FIELD LAYOUT or orientation in relation to the prevailing WIND direction should be given consideration when developing a farm conservation plan. Wind, although blowing from all directions throughout the year, has a prevailing direction or blows from a particular direction more than any other direction. Winds in North Dakota generally have the greatest average speed during the fall, late winter and early spring when cover by winter snow and growing crops is least. Prevailing wind direction (Table 1), based on U. S. Weather Bureau records, differ by location in North Dakota. Prevailing winds at Grand Forks, North Dakota have a north-northwest (NNW) direction and at Minot, North Dakota a northwesterly (NW) direction.

TABLE 1 - Prevailing wind direction by months for several North Dakota locations.[1/]

	PREVAILING WIND DIRECTION			
MONTH	BISMARCK	DEVILS LAKE	FARGO	WILLISTON
January	WNW	NW	SSE	W
February	WNW	NW	N	NE
March	WNW	NW	N	NW
April	WNW	NW	N	SE
May	SSE	NE	N	SE
June	WNW	SE	SSE	SE
July	SSE	NW	S	SE
August	E	SE	SSE	SW
September	WNW	NW	SSE	SW
October	WNW	NW	SSE	SW
November	WNW	NW	S	SW
December	WNW	NW	S	SW

1/ Adapted from Climate of North Dakota. Ray Jensen, 1972.

Fields are most often oriented so that the prevailing wind blows across the shortest distance. Fields oriented with the narrowest side perpendicular (Fig. 8) to the prevailing wind provide the best protection against wind erosion. With prevailing winds midway between compass points north-south or east-west oriented fields of equal width provide equal protection (Fig. 8-1). However, as the prevailing wind erosion direction approaches parallel flow to field length, the opposite field orientation will provide the best soil protection (Fig. 8-2). Fields should be oriented and conservation practices applied to provide maximum soil protection during seasons of the year when wind erosion forces are strongest and when the least vegetative cover is available. This will usually be during the late fall, winter and early spring.

The use of WIND BARRIERS and/or COVER CROPS will usually provide the additional field wind erosion protection required to maintain soil loss at a minimum level. Wind barriers must be combined with other erosion control practices, outlined above, to be most effective.

Wind barriers and cover crops usually are referred to as annual or perennial conservation practices. Annual conservation practices include plantings of small grain cover crops; corn, flax, sunflowers and possibly sorghum barriers or strips. These crops must be planted annually on fields where additional soil erosion protection is necessary. Field tree plantings are the most common perennial wind barrier used for soil erosion control throughout the state. However, certain perennial grasses have a potential for use in soil and water conservation programs, especially in western North Dakota.

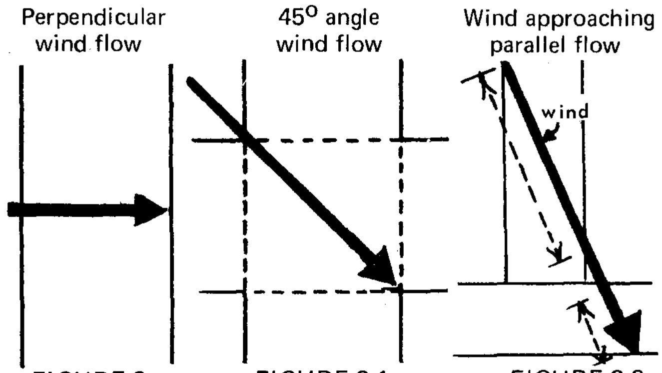

FIGURE 8 FIGURE 8-1 FIGURE 8-2

When planning a system of annual or perennial wind barriers it must be remembered that the most effective wind erosion protection is obtained for a distance of only 10 to 12 times the height of the barrier. Too wide a spacing between barriers will result in ineffective wind erosion control.

PERENNIAL BARRIERS

Field Shelterbelts

The taller growing tree species which develop a medium density are the most effective in reducing the speed of the wind and distributing the winter snow catch farther out into the field. Studies have shown that field tree plantings (Fig. 9) can reduce wind speeds as much as 50 per cent at a distance of

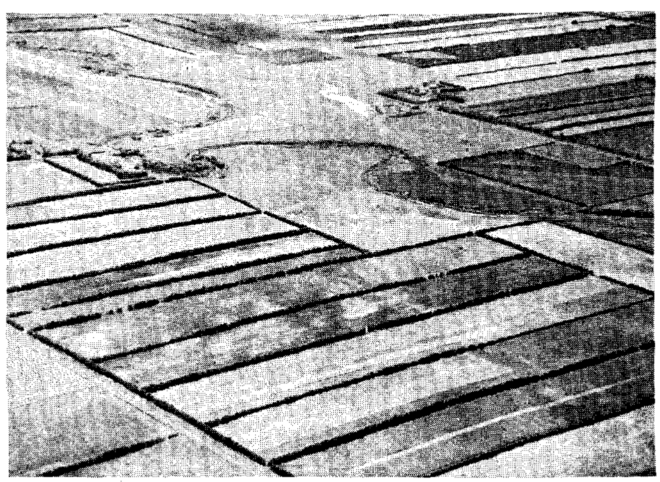

FIGURE 9 - Single row tree planting.
Photo by State Soil Conservation Committee.

10 tree heights downwind and about 20 per cent at a distance of 20 tree heights. These wind speed reductions can change a potentially erosive wind into a non-erosive breeze. Single row tree plantings properly spaced and used in combination with other soil conservation practices provide excellent protection against wind erosion on highly erodible soils.

FIGURE 10 - Tall wheatgrass barriers.
Photo by USDA, Agricultural Research Service.

TALL WHEATGRASS

A system of tall wheatgrass barriers (Fig. 10) is the newest of soil conservation practices. The use of tall wheatgrass for soil erosion control has been studied by the USDA Northern Plains Soil and Water Research Center, Sidney, Montana. The barriers have been found to be highly effective in preventing soil erosion by wind. A field system of tall wheatgrass barriers offers an additional bonus—trapping of winter snow (Fig. 11). Studies indicate that the barriers, properly spaced, can trap enough snow and store as much soil water during the first winter as a conventional 21 month fallow system under western North Dakota conditions. The practice offers the greatest potential for use on sandy soils because wind erosion is a major problem, soil erosion by water is not likely to occur, and the practice of summerfallow is questionable in terms of soil moisture storage.

The use of tall wheatgrass barriers is being recommended for use in western North Dakota on sandy soils and on medium textured soils where erosion by water is not likely to be a problem. To date, research has been done primarily with double rows of tall wheatgrass spaced 36 inches apart. A single row or narrow solid seeding is suggested for trial use. Barriers should be spaced not more than 50 feet apart, adjusted to fit tillage and harvesting machinery. Seeding rate is 20 seeds per foot of row. Planting depth should be about one inch, on a firm seedbed in early spring or in the stubble following harvest if soil moisture is adequate. Double row barriers may require cultivation to control weeds the first and second years following establishment.

ANNUAL BARRIERS

FLAX STRIPS FOR BARRIERS

Flax strips (Fig. 12) are the most common annual barrier planted on summerfallow land for wind erosion control. Flax is an excellent crop for reducing soil erosion on summerfallow. Its growth remains erect after freezing if seeded early enough. Occasionally, mild fall weather permits flax to grow longer than necessary for effective soil protection. The longer fall growth period allows the flax to use soil moisture and plant food intended for next year's crop. However, soil moisture is usually replaced from snow trapped between the barriers. Growing flax in narrow strips (Fig. 12) reduces the area from which plant food is removed.

Flax barriers should be planted by August 1 in the northern half of North Dakota and by the second week of August in the southern half of the state. Late planting will not produce effective barriers. Seed the flax strips in a northeast-southwest direction or across the prevailing wind direction to provide the best soil protection. Flax planted at the proper time will grow to a height of 15 to 24 inches.

FIGURE 11 - Tall wheatgrass barrier, showing winter snow accumulation. Photo by USDA Agricultural Research Service.

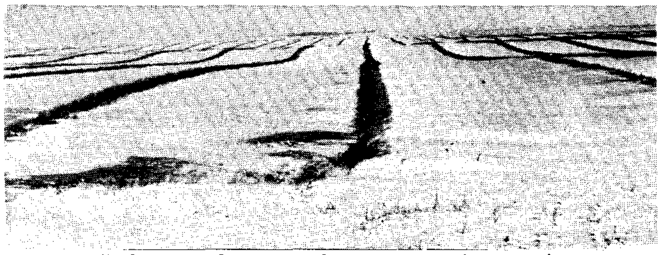

FIGURE 12 - An effective flax wind barrier.

Planting two to four drill rows of flax at normal spacing and seeding rates will provide effective barriers. The flax strips should be spaced 25 to 35 feet apart. The narrower spacing between barriers is recommended on sandy soils. Spacing between strips should be in multiples of tillage machinery width to permit fall ridging of the field if necessary. Properly spaced barriers will trap more snow and provide the most effective winter cover.

SMALL GRAIN COVER

Small grain cover crops, oats and barley, are most often planted on the heavier soils for erosion control. Small grains, following a fall frost, fall to the ground, providing a vegetative mat for soil protection. Consequently, snow held on the field is generally less and creates less spring water problems than other annual wind barrier systems. Studies at the USDA Northern Plains Soil and Water Research Center, Sidney, Montana have shown that an oat cover crop on summerfallow can reduce soil loss more than 55 times that occurring on unprotected summerfallow.

Under western North Dakota conditions soil moisture removed by the cover crop during the fall growth period was replaced by seeding time the following spring. Studies in eastern North Dakota have shown that with excessive fall growth of a barley cover crop high levels of nitrate nitrogen were removed from the soil. Flax strips used less nitrate nitrogen under similar conditions.

The recommended seeding rate for oats or barley cover crops is one-half bushel per acre. Seed the cover crop by the last week of August in northern areas and by the first week of September in southern areas.

Red River Valley farmers often broadcast their cover crop with broadcasters mounted on pick-up trucks (Fig. 13) or mix the cover crop seed with the fertilizer (Fig. 14) being applied on sugarbeet land. Following the broadcast operation the field is cultivated (Fig. 15) to ridge the soil and cover the seed.

FIGURE 13 - Broadcasting oat cover crop using battery powered broadcaster.

FIGURE 14 - Broadcasting fertilizer and oat cover crop on next year's sugarbeet land.

FIGURE 15 - Cover crop field following cultivation and fall growth period (photo by Pembina SCD).

TAME MUSTARD

Tame mustard is being used as a summerfallow cover crop on a limited basis in north central and north eastern areas of the state. Research information on the use of tame mustard is not available in North Dakota. Field observation indicate that broadcast seedings (Fig. 16) are very effective in trapping snow and protecting summerfallow throughout the fall, winter and spring months. The field shown has a snow pack of about 10 to 12 inches. The field was planted in early August with a broadcast seeder at 2-3 pounds of seed per acre.

FIGURE 16 - Broadcast seeding of tame mustard.

Strip planting of tame mustard (Fig. 17) appears to trap less snow than the broadcast seeding. The mustard strips shown were planted with a regular grain drill modified to seed four double rows over a 14-foot width. The strips were seeded in early August, using 5-6 pounds of seed per acre seeded. Field observations indicate that after freeze-up mustard does not maintain a uniform growth density throughout its height because of leaf loss and smaller stem growth near the top of the plant. Therefore, the effective distance of wind protection is reduced. Strip plantings should be spaced a maximum of 20-25 feet apart. Narrow strips, 4 drill rows wide, planted at normal seeding rates per seeded acre are suggested for trial use.

FIGURE 17 - Alternate strips, tame mustard on summerfallow.

CORN, SORGHUM, SUNFLOWERS

Corn, sorghum and sunflowers have been used to a limited extent throughout North Dakota to protect bare soil following potato harvest, open summerfallow fields and to protect specialty crops such as pinto beans from the action of wind during harvest operations.

Pioneer work in demonstrating the value of corn strips (Fig. 18) in protecting potato fields was done in the Park River area during the 1930's. On the heavier textured soils two rows of corn spaced at 50 to 75 foot intervals are effective in reducing wind erosion on fields with limited cover. If corn is planted, select a hybrid adapted to your area. Planting should be completed by mid-June to obtain a tall growth before frost. Several cultivations may be required to control weeds.

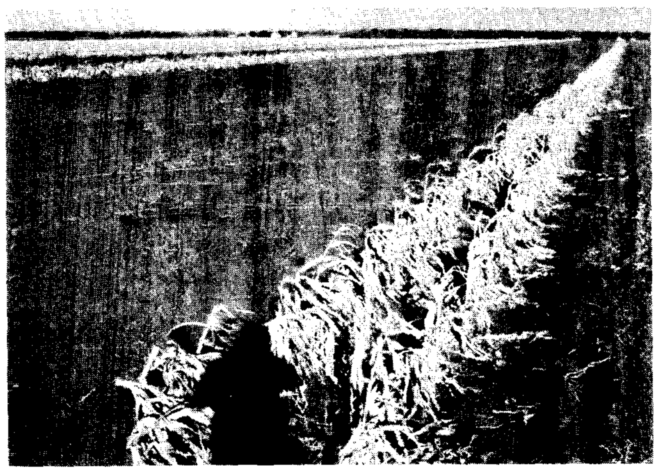

FIGURE 18 - Corn strips protecting potato field. (Photo by Walsh County SCD).

Studies have shown that double rows of sorghum or sunflowers are effective in providing soil protection. However, these crops use more soil moisture during the growing season than can be replaced from spring snowmelt. At Minot, North Dakota soil nitrate nitrogen levels and subsequent crop yields were lower between barrier rows than on unprotected fallow or the area between barriers.

Sunflowers planted on summerfallow for wind erosion control are sometimes harvested for seed. Under this system the sunflowers are usually planted following the first fallow tillage operation in late May. The shorter stubble remaining following harvest (Fig. 19) will provide less soil protection than full grown plants, therefore, the barrier spacing should not be more than 25 to 50 feet, depending on the susceptibility of the soil to erosion.

Another method of providing summerfallow soil protection is to plant double rows, 6 to 7 inch drill spacing (Fig. 20), of sorghum or sunflowers in mid-July. These crops can be seeded deeper than flax and may be a better choice in a dry season. The interval between barriers should not be more than 25 to 50 feet. Seeding must be earlier than flax to obtain as tall a growth as possible before frost.

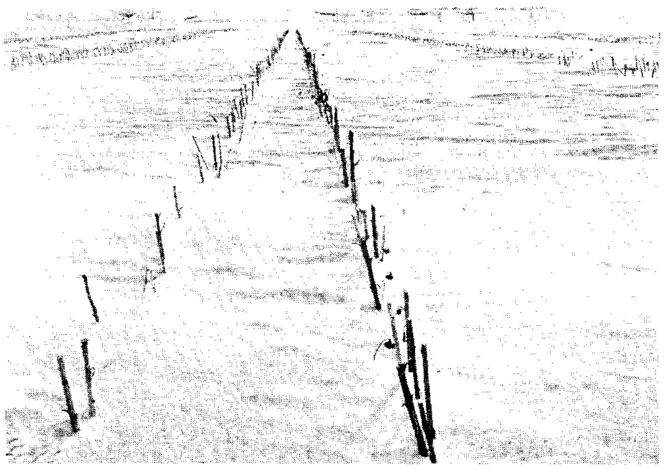

FIGURE 19 - Sunflower barriers harvested for seed.
Photo by North Central Experiment Station, Minot, North Dakota.

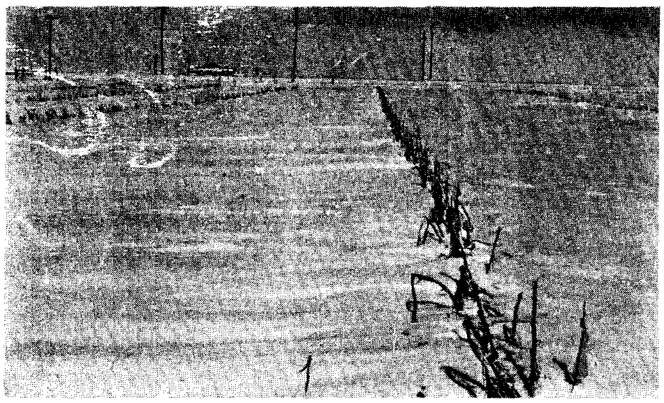

FIGURE 20 - Winter appearance of mid-summer seeding of sorghum or sunflowers.

PROTECTING NON-FALLOW CROPLAND

The most common method of protecting non-fallow cropland is to leave the stubble from the harvested crop standing until the following spring. Studies have shown that the amount of soil moisture stored is greater with standing stubble than from a bare surface. The amount of moisture stored from winter precipitation will vary, depending on prevailing winter conditions and how moist the surface foot of soil is at freeze-up time. If the surface soil is relatively dry at freeze-up less spring runoff will occur. Fields to be summerfallowed should not be fall tilled unless weeds are a problem. Crop residue on fall tilled fields will hold more snow the more erect stubble is left on the soil surface.

Fall tillage is required on heavier textured soils in eastern North Dakota and on some wet soils to permit the preparation of a satisfactory seedbed in the spring. Protection against wind erosion is provided by plowing or cultivating so as to leave a rough surface and stubble exposed on the surface (Fig. 21).

FIGURE 21 - Rough plowing of heavy soils.

THE BEST PROTECTION FROM EROSION BY WIND OR WATER IS AN ADEQUATE VEGETATIVE COVER. PRODUCTION PRACTICES THAT PRODUCE HIGH CROP YIELDS WILL PROVIDE MAXIMUM PROTECTION OF THE SOIL SURFACE AND SUBSTANCES WHICH BIND SOIL PARTICLES INTO SMALL NON-ERODIBLE SIZE AGGREGATES OR CLODS.

PLANNING ASSISTANCE

Contact your local Soil Conservation District for assistance in developing a farm conservation plan.

COST-SHARE ASSISTANCE

Cost-share assistance may be available through the Agricultural Stabilization and Conservation Service (ASCS) under the Rural Environmental Assistance Program (REAP). The Soil Conservation Service may also cost-share certain conservation practices if you are located in a designated Great Plains Conservation Program county.

Acknowledge the assistance of Dr. Armand Bauer, professor of soils, Soils Department, NDSU; and Ed Weimer, agronomist, and Don Aho, state resource conservationist, Soil Conservation Service, Bismarck, N. Dak., in preparation and review of circular contents.

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