

1961

EC61-134 Stubble Mulching with Various Types of Machinery

C. R. Fenster

Follow this and additional works at: <http://digitalcommons.unl.edu/extensionhist>

Fenster, C. R., "EC61-134 Stubble Mulching with Various Types of Machinery" (1961). *Historical Materials from University of Nebraska-Lincoln Extension*. 3516.

<http://digitalcommons.unl.edu/extensionhist/3516>

This Article is brought to you for free and open access by the Extension at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Historical Materials from University of Nebraska-Lincoln Extension by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

AGRI

S

85

E7

#61-134

EC 61-134

Stubble Mulching With Various Types of Machinery

E.C. 61-134

C. R. FENSTER

DURING RECENT YEARS, people throughout the Great Plains have become more concerned about wind erosion, especially on the wheat-fallow lands. This has been especially true on lands which are plowed and kept free from residues. Soil blowing on wheat-fallow lands is likely to be a problem from the time the crop is planted until the wheat is about 6 inches high in the spring. Farmers have resorted to early planting, strip cropping, keeping the surface of the land rough at seeding time with lister drills, and occasionally to using plant residues. Research workers report that keeping sufficient residue on the surface has been the simplest and surest way of protecting the land from wind erosion, and that this also aids in the control of water erosion (3, 4). The practice of farming with residue on the surface is called stubble-mulch farming. Stubble-mulch farming is a year-round system of managing plant residues so that the soil surface is protected at all times against erosion hazards (6). It is very important to protect the land throughout the year, even after the crop is established. Lack of adequate soil protection at any time during the season can cause a complete crop loss and considerable soil erosion.

Procedure for Stubble Mulching

Four points that must be considered for successful stubble-mulch farming are: (1) Desire to protect the land; (2) Residues on the land at the beginning of the season; (3) Amount of residue necessary to protect the land prior to and after planting; and (4) Proper equipment, adjustment and use.

First of all, there must be a desire to protect the land. The desire is necessary so that the farmer will take time to select the right equipment and have patience to adjust and use it properly.

The second point to consider is the amount and kind of residue on the land at the beginning of the season. Durability of residue will depend on the type of plant remains. Generally, the residue from legumes decomposes much more rapidly than does the straw from small grain crops. This is primarily due to the higher protein content of the legume residues. High protein, of course, will supply nitrogen for organisms that promote decay of residues (5). The coarser parts of legumes, corn and sorghum may be quite resistant to decay, especially if they are on top of the soil. Oats and barley residues generally decompose more quickly than wheat or rye straw. When residues are partially buried so that they remain in contact with damp soil for a period of time, decay may be rapid. As residues decompose, their effectiveness as a protective cover will be lessened.

Short residues, 3 inches or less in length, are easily covered with soil, which may hasten decay. They are also subject to being washed or blown off the soil. Extremely heavy or long residues may cause clogging of equipment. Where residues are excessive, decay will help to reduce the residue to a desirable amount for ease of equipment operation.

The amounts of residue on a field can be determined by gathering the material from a known area and weighing it. Another way is to use a rule-of-thumb. This will be adequate for most farmers. For each bushel of wheat harvested, about 100 pounds of residue can be expected. For example, if wheat made 40 bushels per acre, the residues will be approximately 4000 pounds per acre. Factors such as weather conditions throughout the growing season, disease, and insects could cause the amount to vary.

The amount of residue necessary to protect the land from wind erosion depends on the way the residue is held in the soil and the length, anchorage and durability of the residue. Based on work done by Chepil and Woodruff (2), it is estimated that there should be about 1500 pounds of small grain residue anchored on the surface of medium-textured soils at wheat seeding time in Nebraska (figure 1). Approximately 2500 pounds per acre will be needed on the sandier soils (figure 2). On the moderately heavy soils, approximately 1000 pounds of residue will protect the land from wind erosion. When coarser residues such as sorghum or corn are present, a greater amount per acre will be required.

Equipment and Its Use for Stubble-Mulch Farming

The fourth basic factor involves tilling the land and yet maintaining a protective cover. It is necessary to know what equipment is available for stubble mulching and how each machine rates in reduction of residue and control of weeds. Implements that can be used for stubble-mulch tillage are: straight-blade machines, sweep machines (sweeps 24 inches wide or larger), rodweeder with semi-chisels or small sweeps, chisel plows, one-ways, and rodweeder. Factors to consider in determining which machine or machines to use in a stubble-mulch program are the amounts of residues the machine will bury on each operation, and the turbulence that the implement will create in the soil by tillage. Each machine will vary in its ability to conserve residues depending upon the depth of operation; width of cut; dryness, length, and kind of residues; and adjustment of the machine. Machinery tires break or grind residues. The finer the residues, the more rapidly they will be worked into the soil and decompose.

Speed of machine travel and the depth of tillage are also factors in the destruction of residues. Sometimes a higher rate of speed causes more residues to be buried. However, speed is important in causing tillage agitation in the soil which may be necessary to kill weeds. Depth of tillage is important, especially with the chisel plows and the disc-type implements. The deeper the tillage operation, the more the residue will be covered with soil.

Recognizing these variable factors in the conservation of residues with various machines, certain general statements can be made about each class.

STRAIGHT-BLADE MACHINES

Straight-blade machines consist of a single blade 6 to 8 inches wide, extending the width of the machine. About



Figure 1—Approximately 1500 pounds of wheat residue per acre.



Figure 2—Approximately 2500 pounds of wheat residue per acre.

10% of the residue will be mixed with the soil on each blade operation. These machines are better adapted to heavy soils or extremely hard and dry soils. They penetrate the soil very well, but need to have firm soil for good shearing action. They are unsatisfactory for tillage in soils containing sedge roots. These sedge roots, often found in the prairie soils, are very tough, and will build up on the blade. This makes the draft extremely heavy, and causes the machine to ride out of the ground.

SWEEP MACHINES

Sweep machines are designed with V sweeps which run under the surface of the soil at depths of 3 to 6 inches. They generally create enough turbulence in the soil for weed control while leaving most of the residues on the surface of the land (figure 3). Sweep machines with 24-inch or larger sweeps can be expected to leave between 50 and 75% of the residues anchored on the soil surface after 4 operations. Increasing the number of shanks on a machine increases the difficulty in going through heavier residues. Machines with 24-inch or smaller sweeps are difficult or impossible to work through heavy residues. More kerf marks are made with closely spaced standards on sweep machines, which in turn buries more residue. Standards going through the soil give added tillage action which may help in killing weeds. In areas where there are sedge roots, sweep blades should have a V angle of 75 degrees or less in order to shed the roots. In designing sweeps for the Great Plains, most implement companies are using sweep V angles from 60 to 75 degrees. Another variation in the design of sweeps is the pitch of the blade. Some sweep blades are almost flat, while others have as much pitch as 37 degrees. Increasing the pitch of the blade increases the tillage action of the soil. However, the greater the pitch, the higher the draft requirements. Trash clearance of a machine is highly important. The greater the clearance, the more readily the machine will clear residue. The minimum clearance between the sweep and frame of the machine should be at least 18 inches. Standards should have at least 24 inches of clearance between one another

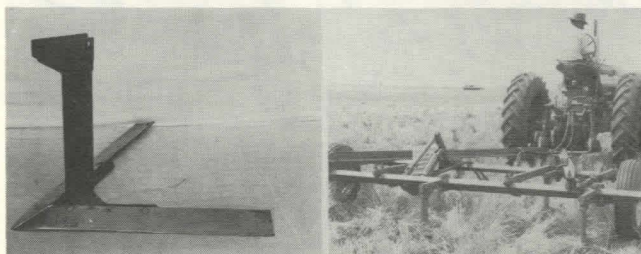


Figure 3—Second operation of a 32-inch sweep machine. Approximately 3500 pounds of residue per acre. To the left is one of the 32-inch sweep blades.

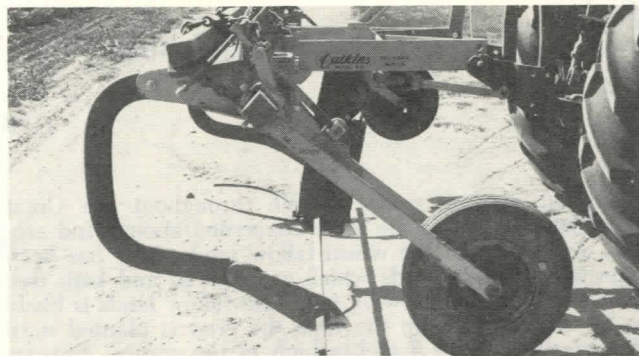


Figure 4—Rotary rodweeder.

and/or the wheels. Rolling coulters placed ahead of the standards for the sweeps may be used. They will help to cut through heavy or weedy residues. Coulters at least 18 inches in diameter are the most satisfactory.

RODWEEDER

Another type of subsurface tiller is the rodweeder (figure 4). It is a simple machine which has a square rod revolving backward under the ground. It has been used extensively in the Great Plains and in the Prairie Provinces of Canada as a secondary tillage tool on fallow land by running the rod several inches below the surface. Generally it is used for one or two operations on fallow land. It reduces the residue about 10% on each operation, which is similar to results obtained with the sweep machines. Rodweeders operated at very shallow depths in two successive operations leave the residue lying loose on the surface. This residue is then easily washed or blown off the land or into bunches.

Rodweeders are ideal for killing weeds. They are especially good for killing grassy weeds such as downy brome-grass and volunteer wheat prior to the time of seeding. The machines give good turbulence in the surface of the soil for good weed control, and at the same time, do an excellent job of packing the seedbed.

ROD WITH SEMICHISELS

The rodweeder can be converted into a subsurface tiller that is suited for the initial operations by attaching a bar which supports narrow teeth or small shovels immediately in front of the revolving rod. These teeth are generally called semichisels. A machine equipped with the semichisels or small shovels penetrates soils that are in a plowable condition (figure 5). The semichisels or small shovels should be tilted just enough to keep the rod in the ground. Too much pitch will cause excessive draft of the machine.

Rodweeders with small sweeps or semi-chisels usually leave 40 to 60% of the residue on the soil surface after 4 operations. They bury slightly more residues than the sweep machines. There are two general types of rodweeders which can be equipped with the semichisels or small



Figure 5—Rodweeder with semichisels will reduce residues about 12 to 15% on each tillage operation.

sweeps. One is an end-drive rodweeder and the other is a center-drive rodweeder. The center-drive rodweeder can be readily equipped with rolling coulters, which increases the ability to work in heavy residues. The end-drive rodweeder may give trouble because of clogging where the drive enters the ground in heavy residues or weeds. However, one implement company recommends the use of a stubble cutter ahead of the machine which will chop and anchor the residues. The stubble cutter is actually a series of rolling coulters bolted together similar to a single disc, and has a place to apply weight.

ONE-WAY DISC

Another machine that can be used with subsurface tillers in a stubble-mulch program is the one-way disc tiller (figure 6). The one-way has been used extensively throughout the Great Plains and Canada for preparation of land for wheat. The one-way disc varies, depending upon the design, in the way it conserves residue. One-ways with large discs 24 to 26 inches in diameter with 5- to 6-inch concavity (of the disc), and spaced 10 inches apart will bury considerably more residue than those designed with the smaller discs (18- to 20-inch disc) with 1½ to 3-inch concavity and spaced 7 to 8 inches apart.

The depth at which a one-way is operated has an important effect on the amount of residues buried. Anderson (1), conducting research work at the Experiment Station in Lethbridge, Alberta, Canada, found that a one-way operated 5 inches deep will bury about 70% of the residue at each operation, while a one-way operated 3 inches deep will bury about 30%. Anderson also reported (1) the one-way disc buries about 50% of the surface material with each tillage operation under normal conditions. The values for each operation, with three consecutive operations, are 47, 25, and 12%, respectively. One of the big advantages in the use of a one-way in a stubble-mulch program is the machine's ability to kill grassy weeds. If the one-way is operated at fairly shallow depths and at 4 miles an hour or faster, it will give a considerable amount of tillage turbulence in the soil, and at the same time leave a large percentage of the residue on the surface. For a shallow operation, the one-way needs to be operated at a long angle so that the discs will till all of the soil uniformly. The tandem disc can be included in about the same class as the one-way. However, it pulverizes the soil more than does the one-way.

CHISEL PLOWS

Chisel plows are generally equipped with 2-inch chisels spaced 9 to 12 inches apart, or are equipped with small sweeps ranging from 12 to 18 inches in width (figure 7). They may leave 50 to 70% of the residue on the soil surface after 2 operations. Because of the numerous shanks, chisel plows are difficult to operate in heavy residue. At



Figure 6—One-way disc equipped with 20-inch discs spaced 8 inches apart with 3-inch concavity.



Figure 7—Chisel plow equipped with 2-inch chisels 12 inches apart.

least 24 inches of clearance from the frame to the bottom of the chisel is needed to work through 3000 pounds of residues: Weedy residues, or residues above 3000 pounds, should be chopped for satisfactory tillage with a chisel plow. The 2-inch chisels are frequently used in the first two operations, followed by sweeps, and then by a straight rod-weeder.

Selecting Tillage Implements

A choice as to which machines should be used for the fallow operations must be based on their ability to conserve residues as indicated in table 1. If the residues are light (2000 pounds per acre or less), the sweep machines or rodweeder with semichisels or small sweeps should be used for all the tillage operations, except possibly the last one which might be done by the straight rodweeder. But if the residues are heavy (3000 pounds or more), the one-way or tandem disc may be used in the first operation, followed by subsurface tillage equipment such as the sweep machine, or the rodweeder with semichisels. Again in the last operation, a straight rodweeder can be used for firming the seedbed and killing weeds. If residues are extremely heavy (4000 to 6000 pounds per acre), the one-way or tandem disc might be used for several operations, followed by a sweep machine or rodweeder. Both the one-way and tandem disc have an advantage in a very wet spring, when grassy weeds such as downy brome grass and volunteer wheat are a problem. The disc-type implements give more tillage agitation of the soil, which in turn gives a better kill of weeds.

F. L. Duley, formerly of the USDA Agricultural Research Service and a pioneer in stubble mulching, has said, "Be sure to give a hard jolt to the weeds on the first operation." If weeds do not wilt down within 30 minutes after tillage, field operations should be changed. Weeds that are not killed by a subsurface tillage operation send out a fibrous root system. These weeds will be more difficult to kill on succeeding operations, especially if the weather is damp and cloudy. Experience has shown that to obtain adequate kill of grassy weeds in the spring in western Nebraska, an early spring tillage followed by another in about 2 weeks is necessary. The second tillage kills the weeds that are missed on the first tillage. No one machine or procedure is the answer to a good stubble-mulch program. The different climatic and soil conditions,

Table 1—Expected percent reduction of residue with various types of tillage equipment.

Type of Equipment	Reduction in each tillage operation %
Sweeps - 30 inches or larger	10
Chisels spaced 9 to 12 inches apart	25
Rodweeder (plain rotary rod)	5 to 10
Rodweeder with semi-chisels or small sweeps	12 to 15
One-way disc 2 to 3 inches in depth	30
One-way disc 6 to 7 inches in depth	70
Tandem disc	50

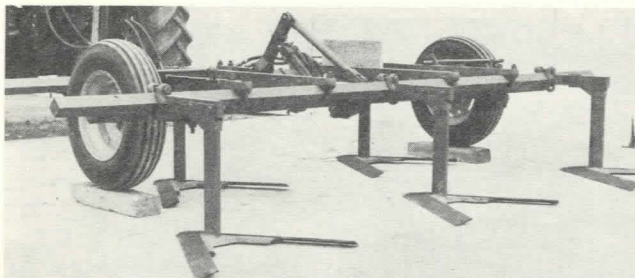


Figure 8—Adjusting a sweep machine. Sweeps must run level.

as well as the variability from year to year at a given location, make it difficult to prescribe standard tillage procedures (8).

Adjustment of Sweep Machines

A problem that has confronted many persons who have been interested in stubble mulching is the operation of the sweep machine. This machine looks fairly easy to adjust, but many people have had difficulty in making it operate properly. Proper adjustment is necessary for satisfactory operation. The first prerequisite is to have a desire to use the equipment. Desire is important because more patience is required with this machine than with a plow. For instance, if a sweep machine is taken to the field and dropped in the ground on heavy residues, it may cause the machine to clog. However, if the operator drops the machine to the ground standing still and eases it back a few feet, it will slide under the residue. The sweeps on the machine must run level when they are in the ground (figure 8). This means that the machine must be set up and adjusted for proper operation (7), which includes tightening of all of the bolts. The tires must be firm, which requires about 40 pounds of air pressure. The proper way to adjust a sweep machine is to set the machine on a level surface such as a slab of concrete, raise the wheels to the desired working depth, and raise the drawbar of the machine above the tractor drawbar to the depth proposed for tillage. Then the machine should be lowered so that the sweeps are near the concrete. Each sweep is then adjusted so that it is level with the concrete. If this procedure is followed, the sweeps will run level in the field. It is very difficult to adjust sweeps in the field, especially on the multiple sweep machines. One sweep out of adjustment often causes the entire machine to come out of the ground and clog with residue. Another factor to consider in the proper operation of a sweep machine is weight. Some companies have a label on the machine which reads, "Use 75 to 250 pounds of weight per foot of cut, depending upon the firmness of the ground." Enough weight should be added on the sweep machine to keep the wheels running firmly on the ground. Excessive weight will cause undue wear on the blades.

Distribution and Chopping of Residues

Sometimes farmers end the tillage season with more

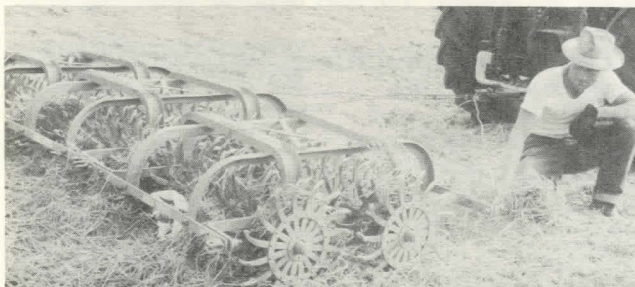


Figure 9—Using a rotary hoe on residues. The rotary hoe is an excellent tool for chopping, distributing and anchoring residues.

residues than they can drill through satisfactorily. They also may have the residues in bunches, which is undesirable. Several machines can be used for chopping, distributing, and anchoring the residues. A rotary hoe, on which the teeth can be set to interlock about 1½ inches, pulled at 6 miles per hour or faster, will improve the anchorage and distribution of the residues (figure 9). The residues must be dry for satisfactory results with a rotary hoe. Where residues are extremely heavy, or high rates of speed cannot be obtained with the machine, one may want to reverse the rear gang of the rotary hoe so that it operates as a treader. The front gang will be operating as a rotary hoe. The gang operating as a treader will keep the front gang clear of residues, eliminating plugging. Another suitable machine is the stubble puncher, which is actually a series of rolling coulters bolted together, with a place for weight. These coulters will punch the residues into the ground, giving better anchorage. A single disc or a tandem disc pulled straight with weight is effective in anchoring and chopping residues. The skew treader may also be used for distributing and chopping residues. Its action is not as violent as that of the rotary hoe. The depth of operation of the skew treader is difficult to control. Sometimes it may penetrate too deeply, causing the seedbed to dry out. The use of a stubble cutter or chopper on heavy residues prior to the initial tillage operations may be desirable for more uniform tillage and planting.

Seeding Small Grain in Residues

Drilling through heavy residues has often been an obstacle in stubble-mulch tillage. The implement companies have recognized this problem and during recent years have designed drills that will seed through heavy residues satisfactorily (figure 10). The hoe drills are generally better adapted than disc drills for seeding through heavy residues. Disc drills may not cut through the residues sufficiently to plant the seed into moist soil. Specifications for a hoe drill that is to be used in heavy residues are as follows: Rows can be spaced 7 to 14 inches apart. There should be at least 20 inches of spacing between each of the hoes. The clearance between the frame and the bottom of the hoe should be at least 17 inches. The narrower hoes should be used to avoid burying the residue. Shoes should not be wider than 6 inches. The press wheels on the drill should pack the seed firmly into the ground, leaving the residues between the rows (figure 11). Open-type press wheels may cause a large amount of residue to be placed over the rows and in bunches. Residues several inches deep over the row often smother the wheat and cause vacant spots in the row.

Stubble Mulching Row Crops

Stubble-mulch farming can be used successfully in the production of row crops. The ground can be prepared with subsurface tillage implements or disc-type implements, then packed with a treader or rodweeder.



Figure 10—Seeding wheat in approximately 1700 pounds of residue with a mulch hoe drill. The drill was equipped with 3-inch shoes spaced 10 inches apart.



Figure 11—Approximately 2000 pounds of residue per acre. Land has been seeded to winter wheat.

Row crops can be planted with a planter equipped with furrow openers or with a lister operated at shallow depth. If the lister is used, it need not scour. The furrows should be only deep enough for a clean seedbed in the row, but not so deep as to cover the residues between the rows (figure 12). Residues should be pushed back from the row 3 to 4 inches on either side. This gives the new seedlings a chance for a more vigorous start. Later the residues can be moved against the established plants without any depressing effect.

The first cultivations can be done with a rotary hoe or skew treader. Later cultivations can be done with large sweeps (18 inches or wider) on a cultivator.

CONCLUSION

Stubble-mulch farming is one of the simplest and surest ways of preventing wind erosion, and at the same time aiding in the control of water erosion. It can be done satisfactorily if a desire is instilled in the farmer to use a complete conservation program, which includes keeping residues anchored on the surface. Good judgment is essential for determining the amounts of residue at the be-

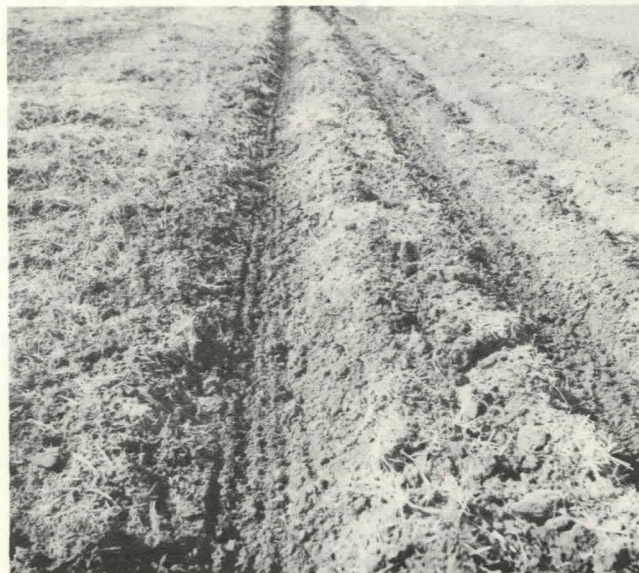


Figure 12—Stubble mulching row crops. Approximately 1600 pounds of residue on the land prior to planting with a moldboard lister.

ginning of the season, and the quantity needed to protect the land from wind erosion. "Proper management" involves the selection of equipment and its use in working with the residues so as to have adequate protection throughout the year.

LITERATURE CITED

1. Anderson, D. T. Handling straw and trash cover—the mechanical aspects. *Agr. Inst. Rev.* 8:13. 1953.
2. Chepil, W. S., and Woodruff, N. P. Estimations of wind erodibility of field surfaces. *J. Soil Water Conserv.* 9:257-265. 1954.
3. Duley, F. L. Stubble-mulch farming to hold soil and water. *USDA Farmers Bull.* 1997. 1948.
4. ———. Stubble-mulch wheat farming methods of fallow areas. *Nebraska Ext. Circ. E. C. 54-100.* 1954.
5. ———. Estimating the amount of crop residue on a field. *USDA Handbook* 136. 1958.
6. Fenster, C. R., Duley, F. L., and Swinbank, J. C. Questions and answers about stubble mulching. *Nebraska Ext. Circ.* 58-123. Revised 1959.
7. Lane, D. E., and Fenster, C. R. Sweep machines, hitching and adjustments. *Nebraska Ext. Circ. E. C. 58-705.* 1958.
8. Zing, A. W., and Whitfield, C. J. A summary of research experience with stubble-mulch farming in the western states. *USDA Tech. Bull.* 1166. 1957.

**EXTENSION SERVICE
UNIVERSITY OF NEBRASKA COLLEGE OF AGRICULTURE
AND U. S. DEPARTMENT OF AGRICULTURE
COOPERATING
E. F. FROLIK, DEAN E. W. JANIKE, DIRECTOR**