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Weed Control Equipment

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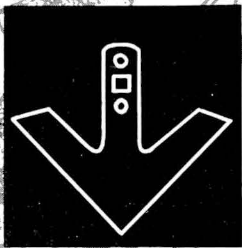
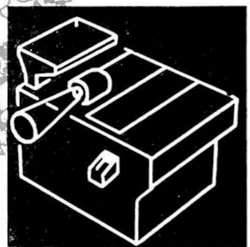
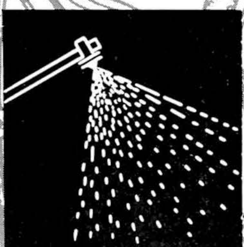




weed control equipment



AGRONOMY AND AGRICULTURAL ENGINEERING DEPARTMENTS
AGRICULTURAL EXPERIMENT STATION
SOUTH DAKOTA STATE COLLEGE, BROOKINGS

Contents

This publication discusses equipment used for weed control. Other publications—"Weed Control Research in South Dakota," "Chemical Control of Woody Plants," and "Weed Control in Lawns and Gardens"—are available at your County Extension office or the Experiment Station Bulletin Room, South Dakota State College, College Station, Brookings, South Dakota.

Funds for this publication were made available from a legislative appropriation to the State Weed Board.

WEED CONTROL EQUIPMENT

Lyle A. Derscheid and H. H. DeLong[1]

Clean seed, proper seedbed preparation, good crop rotations, and sound soil management practices are reliable measures to use in preventing weed infestations. Once weeds have become established, special cultivation practices and chemicals are generally required to eliminate them.

This circular discusses the equipment most commonly used for cleaning seeds, cultivating, and applying chemicals.

Seed Cleaning Equipment

The need for cleaning seed and checking the cleaned seed to make sure it is weed-free is apparent. Recent drill box surveys indicate many weed seeds are being planted with grain.

Grain samples from drill boxes or trucks were tested for purity. So-called cleaned samples of oats, wheat, and barley contained an average of over 140 weed seeds per pound. Flax contained an average of 881 weed seeds per pound. Uncleaned samples contained considerably more.

About 12 percent of the samples contained noxious weed seeds, and nearly 70 percent of them contained secondary noxious weed seeds. One farmer was planting 70 noxious weed seeds per square rod. Another was planting 150 wild oats seeds on a similar area.

Plants from 150 wild oats seeds could produce 250 to 500 seeds per square yard. Plants from these seeds would in turn produce a proportionate number of seeds. This emphasizes the importance of clean seed.

And here are others. One bindweed seed could produce a plant that would cover over one-half of a square rod in one growing season. One hundred mustard plants per square yard would reduce oats or wheat yields 40 to 50 percent.

There are many types of seed cleaning equipment available. But to get good results with any of them, they must be set and operated properly. That includes checking the machine while it is in operation to make sure it is functioning right.

Some of the equipment adapted to use on the farm or in the small seed processing plant is considered here.

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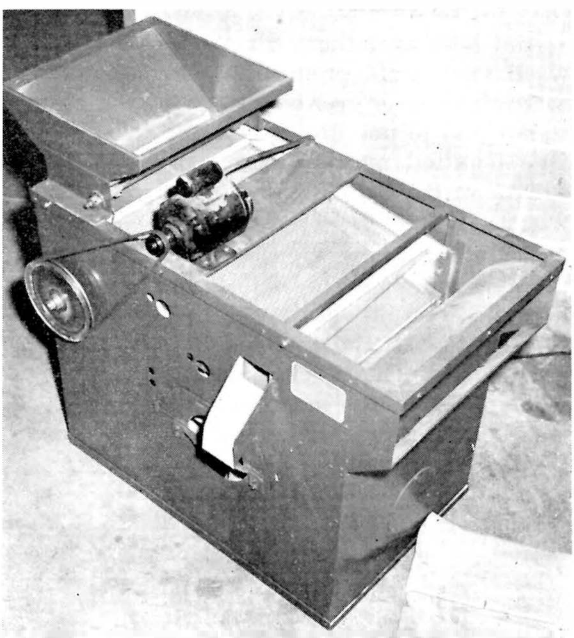
FANNING MILL

The most common seed cleaner is the fanning mill (figure 1). Screens are used in conjunction with an air blast. It will clean and sort out granular products, dust, and different seed sizes.

The screening unit is composed of two or more screens suspended on hangers in such a way that they are moved back and forth and, in some cases, up and down. Since they are sloped, the movement causes the seed to move downward over the screen.

The top screen sorts sticks, straws, and other coarse material out of the seed. This material moves down over the screen and is discarded.

Figure 1. A two-screen fanning mill. It sorts out granular products, dust, and different seed sizes.



The seed drops through the top screen onto the bottom one, which has a finer mesh. Small particles such as small weed seeds and dust drop through it. The seed moves down over the full length of the screen where it drops through an air blast. The wind removes dust, chaff, light seeds, and other lightweight material.

Performance is based mainly upon the careful selection of screens. However, it is important that the grain is not allowed to move over the screen too rapidly. It should be spread in a thin layer to allow the screens to do a proper job of sorting. Likewise, it is essential to keep the screens clean so they can function correctly. Some fanning mills have brushes that move from side to side underneath the screens and keep them clean.

No two cleaning jobs are the same. Screen selection must be done carefully if complete separation and cleaning are to be assured. Screens are generally available with round, triangular, or slotted holes.

If the material to be cleaned is generally spherical in shape, the top screen should have round holes and the bottom screen should have slotted or triangular holes. Beans, wheat, sorghum, and small seeded legumes are examples of seed that generally require such a combination of screens.

For material that is not spherical, such as oats or flax, the best job of cleaning can be done with a top screen that has slotted holes and a bottom screen that has round or triangular holes. Other seeds, such as grasses, require that both screens be slotted. A list of the most common crops in South Dakota and suggested screen sizes for cleaning them are given in table 1.

Fanning mills with three or four screens can do a better job of cleaning seed than those with only two screens. However, they will not separate seeds that have similar shape and size. Seeds of similar shape and size but different weight can be separated with a gravity table. Seeds that vary in width can be separated with a cylinder separator, while seeds that vary in length can be separated with an indent machine (disc separator) or by an "angle sieve."

GRAVITY TABLE

A gravity table (figure 2) can make accurate separations under the most difficult situations. The prime unit is a triangular-shaped perforated table. The table is so baffled underneath that air fed up through it is evenly distributed. The pitch of the table can be adjusted toward the uphill end and toward the discharge side. As illustrated in the figure, a round object will roll from right to left when the machine is properly set. The table has a reciprocating motion that causes the grain to move uphill toward the right.

The adjustable air blast comes up through the perforated floor of the table at such a rate that the grain is partially lifted off the floor. Lighter particles are lifted higher and float down the table toward the left and front where they are discharged. Larger and heavier particles are not lifted as high, and

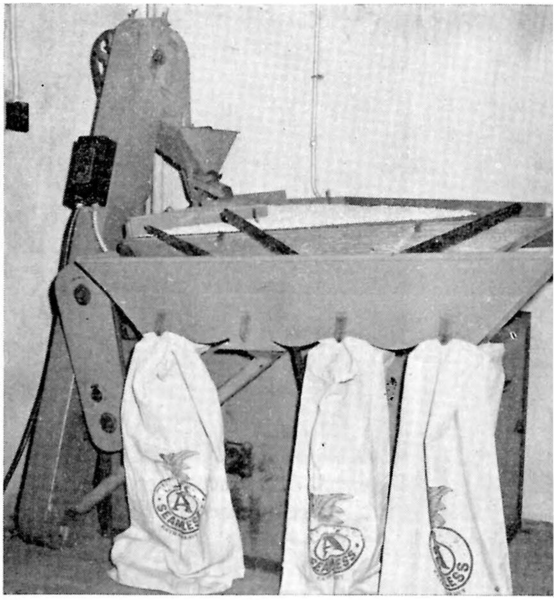


Figure 2. A gravity table. It separates seeds by weight. Light seeds are discharged at the left front and heavy seeds at the right front.

the motion of the table moves them to the right and front where they are discharged.

Other material, intermediate in size and weight, only move part way to the right before they are discharged from the front of the table. Consequently chaff and dust are discharged at the left front, stones and other heavy particles at the right front, and the seed at the middle. The discharge spouts can be varied as to number along the front and exact separations made.

Hardware cloth, perforated corrugated metal, canvas, or other coverings can be used to adapt the table of the machine to many different jobs. When materials that vary considerably in size and

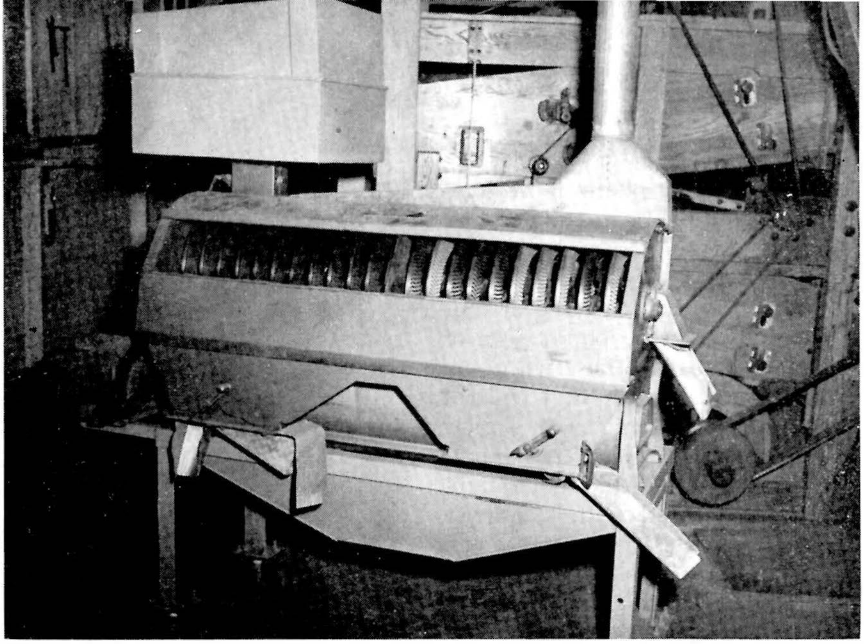


Figure 3. A disc separator. It sorts seeds by length. By using two or three sizes of discs, a like number of seed sizes can be picked out. Coarser material is tailed out at the right.

weight are to be separated, the table can be set at a steeper pitch to increase its capacity.

With careful adjustment of pitch and wind blast, it is possible to separate weed seed from grains which cannot be separated by other devices. It is also especially useful for removing light weight infertile seed. Germination percentages can be raised substantially.

Although a gravity table is very useful for cleaning seed, it is expensive. Because of cost, it probably is not practical for an individual farmer, but it is practical for a seed cleaning establishment or a group of farmers.

DISC SEPARATOR

A disc separator is shown in figure 3. This machine separates on the basis of length. The seed is moved through the machine by a series of discs on spokes. Each disc has a series of pockets on each side

Figure 4. Two sizes of discs used in a disc separator. Those at the left are R4 discs that will sort out mustard, while those at the right are A's and will pick out wheat.

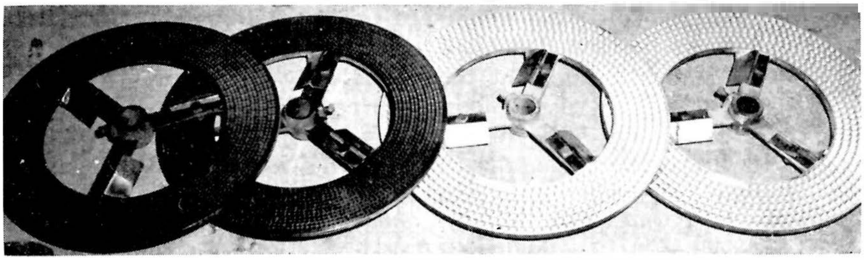


Table 1. Suggested Fanning Mill Screen Sizes for Cleaning Crop Seeds

Crop	Upper Screen	Lower Screen
Alfalfa	1/15 or 1/14 round	6 x 24 slot
Barley	20, 21, or 22 round	1/13 x ½ slot
Bluegrass, Kentucky	26 x 26 Slot	6 x 40 slot
Bromegrass	1/13 x ½ slot	6 x 24 slot or 9 triangle
Buckwheat	14 round	6/64 or ¾ slot
Cane	10 round	1/13 x ½ slot
Clover, Alsike	1/19 round	6 x 32 slot
Clover, Red	1/15 round	6 x 22 or 6 x 24 slot
Clover, Sweet	1/14 round	6 x 24 slot
Corn	28 or 30 round	16 round
Flax	1/18 x ¾ slot	6 round
Flax, Small	3/64 x 5/16 slot	1/12 round
Oats	11/64 x ¾ slot	1/14 x ½ slot or 11 triangle
Rye	12 round	1/14 x ½ slot
Soybeans	20 round	11/64 x ¾ slot
Sorghum, Grain	13 round	1/12 x ½ slot
Sudan Grass	10 round	3/64 x 5/16 slot
Trefoil, Birdsfoot	1/16 round	1/20 round
Wheat	14 round	1/13 x ½ slot
Wheatgrass, Crested	1/18 x ¼ slot	6 x 28 slot or 5 triangle
Wheatgrass, Western	1/14 x ½ slot	4 x 22 slot

as shown on figure 4. Seeds small enough to fit into the pockets are picked up, carried to the discharge spout, and released. Longer seeds move through the spokes of the disc and are tailed from the end of the machine. These seeds are moved from left to right by the baffles on the spokes of the discs.

By using several series of different sized discs, several separations can be made at one time. The first series equipped with small pockets can remove small weed seeds from grain and the grain goes through this series to the next where the grain is removed from coarser material. For example, five or six R4 discs would remove mustard from wheat, a similar number of V5 discs would remove buckwheat, the rest of the discs would remove the wheat. Wild oats and other large particles would go out with the tailings.

All the moving parts rotate so that a machine does not require much power and has a reasonably long life. It has characteristics that are fixed by the size of the pockets in the discs, and it generally takes a different set of discs for each job.

Since it is a laborious procedure to change discs, it is generally advisable to run the seed through a fanning mill (scalper) before putting it through a disc separator. The scalper screen will take out much of the coarse material and the lower screen much of the fine material. The disc separator is then used to remove weed seeds that cannot be removed with screens. The two machines are sometimes set side by side so that a fanning mill with an elevator leg can discharge into the hopper of the disc separator.

A disc separator is particularly useful for removing weed seeds from bromegrass seed or other grass seeds. However, there are numerous separations that can be made. Here are typical separations that can be made:

From Wheat—wild buckwheat, foxtails, mustard, oats, wild oats, or barley

From Durum—short spring wheat and seeds that can be removed from wheat

From Flax—oats, wild oats, barley, and small flax seeds

From Barley—short wheat, oats, wild oats, cross-broken and pearled barley

From Oats—wheat, rye, mustards, wild buckwheat, foxtails, pin oats, barley

From Grasses—dodder, clovers, alfalfa, some grass seeds.

An assortment of discs, including 10 or 12 of sizes MM, A, J, C, R3½, R4, V4½, V5, and V6, will handle most of the seed cleaning jobs required of it on the average farm. Many seeds that will be lifted with discs having different types of pockets are given in table 2.

Table 2. List of Seeds the Various Sized Discs Will Lift or Reject

Type of Pocket	Will Lift*	Will Reject†
V2½	Alsike, timothy, white dutch	Buckhorn, Canada thistle
V3	Red clover, small sweet clover	Thistle
V3½, V3¾	Alfalfa, sweet clover	Hulled quackgrass, large thistle, flax
V4	Mustard, small cracked grain	Small grain, large flax
V4½, V5, V5½	Wild buckwheat, cracked grain	Small grain
V5¾, V6, V6½	Flax, small or broken wheat, large buckwheat	Small grain, quackgrass
R3½, R3¾, R4	Mustard, smartweed	Small grain
R4½, R5, R5½, R6	Small seeds, cracked grain, wild buckwheat	Small grain
K, L	Large wild buckwheat, broken grain	Small grain
M, AC, EE, J	Spring wheat, small or broken durum, pearled or broken barley	Durum, large spring wheat, oats, barley, wild oats
A, MM	All wheats, small barley, hulled oats and rye	Oats, wild oats, ragged barley
B	Barley	Oats, wild oats
RR-SS	Tailless barley	Sticks, stems, etc.
DD	Oats and all shorter grains	Sticks, stems, etc.

*Will lift smaller seeds than those listed.

†Will reject larger seeds than those listed. Rejected material is lifted by discs with larger pockets or tailed out the end.

Like the gravity table, it is somewhat expensive for an individual farmer to own, but it is practical for use by a group of farmers or a seed processing plant.

WILD OATS CLEANER

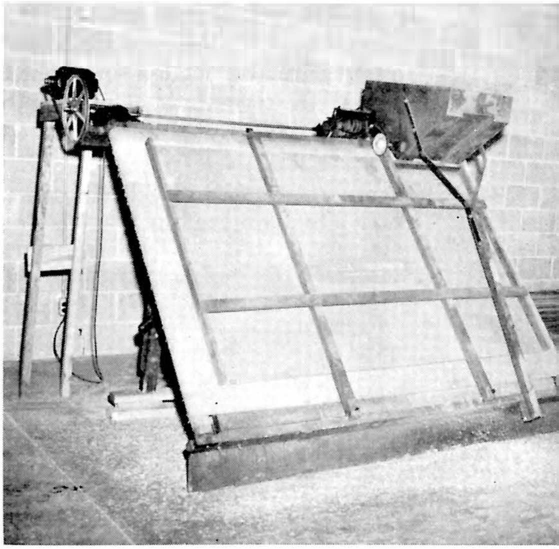
Wild oats seeds are some of the most difficult weed seeds to remove from small grain. Although they can be removed from barley or wheat by using a lot of wind in the fanning mill or by use of a disc separator, they are more difficult to remove from oats. Therefore, a special machine (figure 5) has been devised for use on oats.

The important part of this machine is a wide blanket on rollers. The blanket is set at an angle of about 60 degrees from the horizontal and the seed is introduced at the top so that it rolls down hill. As the seed rolls, the blanket rolls horizontally and the awns of wild oats catch in the blanket and are carried around with it. Wires underneath the blanket remove the wild oats seeds so that the blanket is clean and ready to collect more on the next revolution. The seed oats is discharged at the bottom and center of the machine, the wild oats at the left side.

When wild oats is to be removed, the grain should not receive excessive handling before going over the blanket. The extra handling tends to break the awns of wild oats. If they are broken they will not catch on the blanket and will not be separated from the good seed.

This machine is inexpensive and is practical for use on any farm that has a wild oats problem. The main disadvantage of the wild oats cleaner is that it has a low capacity. No more than 100 or 200 bushels can be thoroughly cleaned in a day.

Figure 5. A wild oats cleaner. The grain dribbles downward, but the awns of wild oats catch on the blanket, which rotates. The wild oats is brushed off when the blanket rotates over a wire underneath the machine. Seed is discharged at the center and wild oats at the left.



Cultivating Equipment

Cultivation is an important part of any weed control program. Cultivation of row crops helps prevent infestation by perennial weeds and helps eliminate most annuals. Intensive cultivation should be used for reducing stands of perennial weeds. Depending on the crop, it is sometimes used before planting, frequently used after harvest, or both. On severe infestations it is sometimes practiced for the entire growing season.

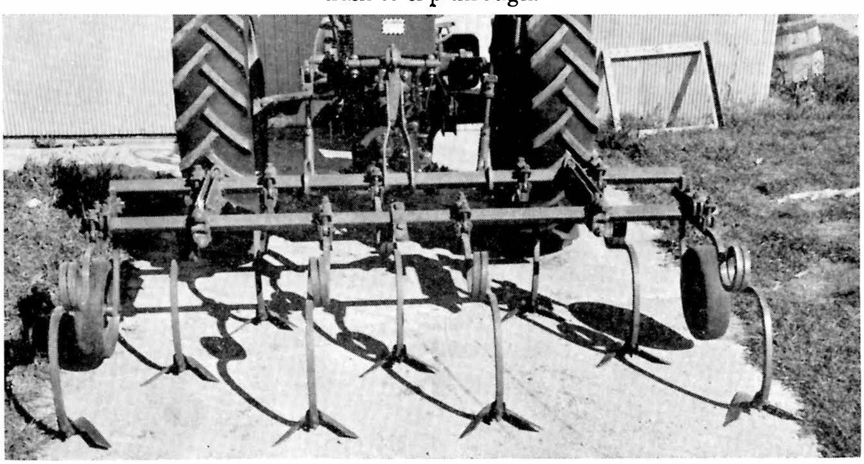
Cultivation is used on perennial weeds to cut the roots 4 inches below the soil surface every 2 or 3 weeks. Food reserves in the roots are needed to produce the 4 inches of growth required to get the new growth to the soil surface. Root reserves are also needed for about 1 more week to produce plant growth above the soil. By cutting the weed roots every time they have produced a week's top growth, the root reserves of the weed are constantly being used. Eventually these reserves will become exhausted and the weed will starve to death.

DUCK-FOOT FIELD CULTIVATOR

Perhaps the most effective cultivator for use in starving perennial weeds is the field cultivator. Some of these cultivators are pulled behind the tractor, while others are mounted on the tractor like the one shown in figure 6.

Regardless of the type of machine used, it should be equipped with duck-foot sweeps 12 to 24 inches in width. The sweeps must overlap 3 or 4 inches (figure 7) so that the tough roots do not slide between them. The sweeps should run flat and they must be sharp in order

Figure 6. A duck-foot field cultivator equipped with sweeps that overlap and run flat at a uniform depth of 4 or 5 inches. The shanks are spaced far apart to allow trash to slip through.



to cut every root. They should be operated at a uniform depth of 4 or 5 inches.

A cultivator equipped with two rows of shanks is satisfactory for use on plowing or on areas that have a minimum amount of trash. However, long straw will get caught on the shanks and plug the machine. A cultivator equipped with three rows of shanks—like the one shown in figure 6—can be used on stubble, as a large amount of trash will slip through between the shanks. It is advisable, however, to use a straw spreader on the combine, as windrows of straw will plug this type of machine.

One of the best ways to adjust a field cultivator is to put the wheels of the tractor and cultivator (this includes depth adjustment wheels shown on the machine in figure 6) on 4- or 5-inch blocks. The cultivator can be dropped to the ground. Everything is then in the same relative position that it will be in when in operation. Adjustments can then be made to put all sweeps flat on the top of the ground.

When the tractor and cultivator wheels are on the ground, the sweeps will be at a uniform depth of 4 or 5 inches in the soil and will be flat. If the sweeps overlap, one can be assured of a good job of cultivating.

ONE-WAY DISK

The one-way disk may be used instead of a duck-foot cultivator in many cases. It has an advantage in that it does not plug when there is a large amount of trash on the ground. It also is more effective for

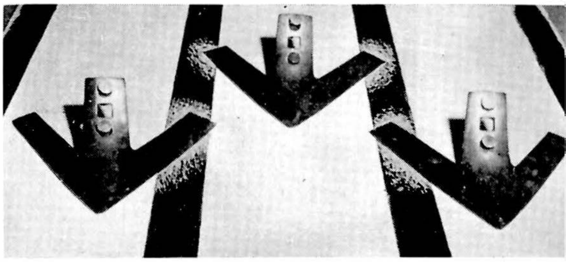


Figure 7. Duck-foot sweeps showing how they should overlap when in operation.

cutting up sod. It has proved to be very satisfactory for eliminating quackgrass or thistles. However, the discs must be sharp and must be operated at a uniform depth of 4 or 5 inches.

SPRING-TOOTH CULTIVATOR

A cultivator equipped with spring-teeth is useful for eliminating quackgrass. A spring-tooth harrow shown in figure 8, or a field-cultivator equipped with flat-spring shanks and bull-nose points are both very satisfactory.

The lifting action of the spring-teeth brings the quackgrass rhizomes (underground stems) to the surface of the soil where they are dried by the sun and wind. It is frequently necessary to cut up an old sod with a one-way disk or disk-harrow before a spring-tooth cultivator can be used. The spring-tooth cultivator should then be used every time the quackgrass produces 1 or 2 inches of top growth. It should be operated at a depth of 2 or 3 inches.

The spring-tooth harrow is easily adjusted in the field, but the spring-tooth cultivator should be adjusted

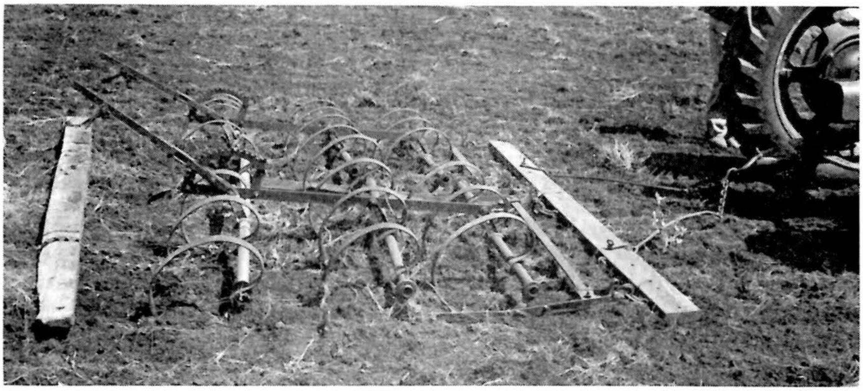


Figure 8. A spring-tooth harrow. The spring teeth lift quackgrass rhizomes to the the surface of the soil where they can dry out and die.

as outlined for the duck-foot cultivator.

Since quackgrass rhizomes catch on the teeth, one must be careful not to drag them to uninfested areas. Some of them may start to grow and infest a new area.

ROTARY HOE

The rotary hoe is rapidly gaining in popularity. It is useful for killing weed seedlings in corn, soybeans, potatoes, or winter wheat or rye. It consists of spoked discs that have hooks around the circumference. These hooks will uproot small seedlings if the soil moisture is right, if the weeds are not too large, and if the machine is pulled fast enough.

To be most effective, the machine should be operated at a speed of 6 to 8 miles per hour. The topsoil should be dry or only slightly moist. The weeds should still be "in the white," that is, they should not have been up long enough to develop a green color. A rotary hoe can be used several times for the same cost as a first cultivation of a row crop.

There may be some danger of breaking the stems of crop plants in the forenoons when they are still turgid and brittle. This can be overcome by waiting for the heat of the day when the plants have lost their brittleness. The warm weather will also assure a more complete kill of weeds.

Chemical Applicators

Most chemicals that are practical for use on large areas can be applied with a low pressure sprayer. Some soil sterilants can be applied with a high volume sprayer, but others must be applied dry. They can be spread by hand or with a fertilizer spreader.

GROUND SPRAYERS

For use on large acreages, a power-driven sprayer is essential. Some sprayers are mounted on trailers while others are mounted on the tractor.

Types of Sprayers

Tractor - mounted sprayers are adapted to small farm use as they are less expensive than the trailer-mounted type. Such a sprayer is shown mounted on a jeep in figure 9. They may be purchased with or without a supply tank. The tank may be mounted on the side of the tractor, on the drawbar, or on a trailer. The boom is generally mounted in front, but mist from the spray may coat the radiator, collect dust, and reduce the cooling capacity. The pump may be driven by power-take-off or by the belt pulley.

The big disadvantage of a tractor-mounted type is the time required to mount and dismount it. This usually means that it ties up a tractor for 2 or 3 weeks during the summer or that the weeds do not get sprayed at the right time.

Trailer-mounted sprayers are best adapted for use on large acreages and on farms that grow several crops. It is easily hitched and unhitched, which means that one can do a small spraying job without excessive loss of time from other work. This makes it easier to spray at the right time.

The tank should be mounted crosswise on the sprayer. If it is mounted lengthwise as shown in figure 10, the spray solution surges to the front end when the tongue is lowered. This makes it difficult to

Figure 9. A jeep-mounted sprayer with supply tanks mounted in a trailer.

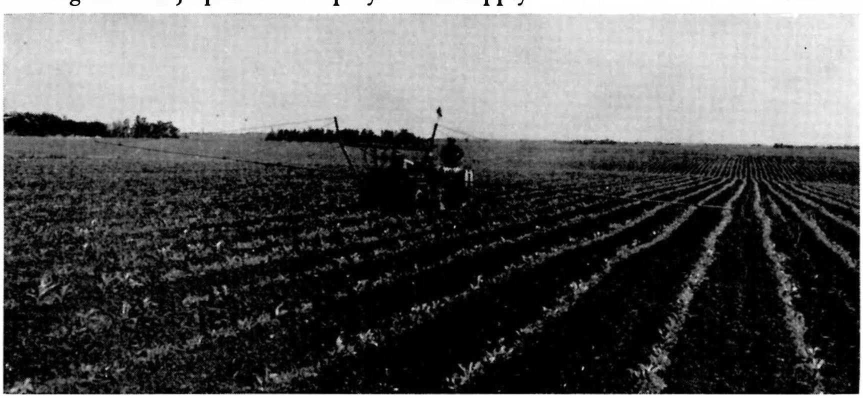


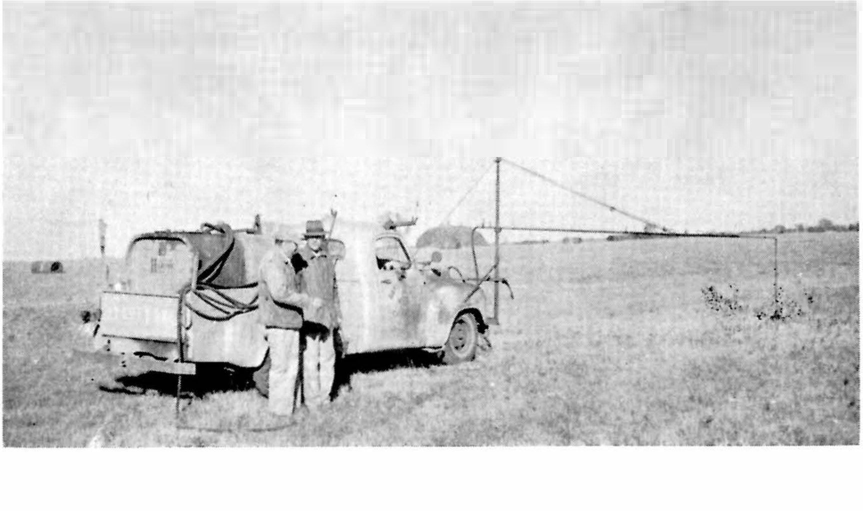
Figure 10. Trailer-mounted sprayer with tank mounted lengthwise. Angle irons support the boom. The nozzles are connected with rubber hose. The auxiliary motor powers a piston-type pump that has a small chamber (below pressure gauge) to cushion the effect of piston strokes and give more uniform pressure.

lift the tongue when the sprayer is not empty. There is also danger that the spray may surge to the rear end and upset the sprayer. The pump may be driven by power-take-off or by an auxiliary motor.

Boomless sprayers utilize three to five wide-angle nozzles to cover a swath 15 to 40 feet in width. They are cheaper than boom sprayers and are usually mounted on a tractor or pick-up truck. Under almost ideal spraying conditions these nozzles often deposit 5 or 6 times as much spray in one part of the swath as in another. This means that enough chemical could be deposited in one part of the swath to seriously injure sensitive crops, such as flax, oats, or corn, while too little chemical is deposited in another part of the swath to kill the weeds.

When these wide-angle nozzles are mounted on a tractor or pick-up truck as shown in figure 11, they are

Figure 11. A roadside sprayer. Wide-angle nozzles are mounted on arms that reach over roadside obstacles. (Photo courtesy of Davison County Weed Board.)



very practical for roadside spraying. The grasses in the ditch will withstand high rates of 2,4-D, so the uneven coverage is not important if enough chemical is applied. This type of sprayer will apply high volumes of water, making it possible to get good coverage of weeds in a dense growth. The nozzles are mounted on arms that reach over bridge abutments, mail boxes, highway signs, and other obstacles. This makes it possible to spray uninterrupted at a rate of speed that is fairly good.

The big disadvantage of boomless sprayers is that a slight wind will distort their spray patterns. This makes it hazardous to spray in crops. On roadsides, one side can be sprayed when the wind is in a favorable direction and the other side can be sprayed when the wind changes to a direction that is favorable to it.

Supply Tanks

The tank may consist of 55-gallon drums or may be made of iron, specially treated iron, or aluminum. The 55-gallon drums or the iron tank will rust. The rust eventually scales off and clogs the nozzles if the tank is not cleaned thoroughly before using. Some people use 55-gallon drums for one spraying season and then replace them. The specially treated iron tanks do not rust badly but are rather expensive. Aluminum tanks do not rust but sometimes break as a result of being bounced over rough fields.

If soil sterilants or other relatively insoluble chemicals are to be used, the tank should be equipped with a mechanical agitator to keep the chemical in solution. The by-pass will generally give sufficient agitation for 2,4-D and other chemicals applied at a low rate per acre.

Kinds of Pumps

There are numerous kinds of pumps that can be used. They should be made of a noncorrosive material. A relatively cheap pump can be used for most chemicals, but a more expensive pump is needed for the application of soil sterilants.

A rubber impeller pump has close fitting curved rubber vanes that revolve inside of an eccentric housing designed to flatten them as they pass the discharge outlet. It is a relatively cheap pump that will create a pressure of about 35 pounds per square inch. The impeller will wear out rapidly if allowed to run dry. However, they can be replaced at a low cost.

A rotary pump uses positive action gear-displacement to create pressure. The gears are frequently made of bronze and will last for several years. The discharge rate depends on the speed. Some pumps have a built-in regulator and by-pass valve that will regulate pressure from 0 to 80 pounds per square inch.

Centrifugal pumps for weed spraying have a single rotating impeller usually made of bronze. It will pump a large volume but does not create high pressure. It is well adapted for use on sprayers that are to be used to apply soil sterilants.

Piston-type pumps are built with one or more plungers connected to a crankshaft. These pistons work inside smooth lined cylinders with a combination of valves to keep the fluid running. The strokes of the pistons tend to give uneven pressure. Therefore it is usually desirable to have a small chamber (figure 10) to cushion the effect of the piston strokes and give more uniform pressure. These pumps are usually designed for high pressure, but some are designed for low pressures alone. These pumps can be used for any type of weed sprayer but are usually more expensive than other types of pumps.

The nylon roller pump is of the "vane" type. It consists of an eccentric housing, a rotating shaft with guide slots, and nylon rollers—driven in the slots but engaging the housing. They pump only after coming up to high speed, when centrifugal force makes them contact the housing.

Valves, Booms, Nozzles

The by-pass valve, pressure regulator, and pressure gauge should be made of noncorrosive materials. The filter may consist of a fine screen, but it should be easily dismounted for cleaning.

Booms may be 16 to 40 or 50 feet long, depending on the capacity of the pump, the volume of spray to be applied per acre, and the acreage to be covered. Booms should be adjustable so that changes in height can be made for each spraying job. The boom height should be regulated by the height of the weeds. It should be high enough so the spray from two adjacent nozzles will meet at the top of the weeds. The boom will generally be 18 or 20 inches above the weed tops.

The boom should be supported by an iron frame, but the tube that carries the spray should be made of a noncorrosive material such as copper or oil resistant rubber. Figure 10 shows a sprayer that has an angle iron to support a rubber hose that connects one nozzle to the next. A boom mounted on a 2-wheel vehicle has a tendency to bounce more when moving over rough ground than one mounted on a 4-wheel vehicle. However, booms mounted on hinges and utilizing springs for support like the one in figure 10 do not bounce badly. Booms mounted on the front of tractors or jeeps as shown in figure 9 often allow mist to coat the cells of the radiator. Dust is collected and the cooling capacity reduced.

Nozzles that produce a fan-shaped discharge give the best coverage of weeds. These nozzles should be spaced so that they will give complete coverage when the boom is 18 to 24 inches above the weeds. The spacing will usually be 18 to 24 inches. Nozzles designed to apply less than 10 gallons per acre have such small orifices that they clog easily.

AERIAL SPRAYERS

Airplanes (figure 12) can spray a large number of acres in a relatively short time. They can also spray when fields are too wet to permit the use of ground equipment. This makes it possible to spray many weeds at the proper time.

The air blast from the propeller tends to displace spray from the

Figure 12. An aerial sprayer in operation. The airplane will fit into the weed control program under certain conditions. (Photo courtesy of Roberts County Weed Board.)

right side of the fuselage to the left, resulting in an uneven distribution of spray in the swath. This is a serious short-coming on susceptible crops, such as flax, but is not as serious on the more tolerant crops of wheat and barley. The addition of extra nozzles immediately to the right of the fuselage helps offset this problem.

The swirl of air caused by the wing tips causes spray to drift farther when applied by an airplane than when applied by a ground rig. This is not a problem in areas of large fields where susceptible crops such as sugar beets, soybeans, and truck crops are not grown. It is a problem, however, around shelterbelts and in areas where the susceptible crops are grown. This drift hazard can be reduced considerably by mounting the boom at least 3 feet below the wing and as far forward as the leading edge of the wing.

Because most sprayer planes carry only 40 to 100 gallons of spray solution, they apply only about 1 gallon of spray per acre. Under these conditions their spraying is limited to the use of 2,4-D, MCP, 2,4,5-T, and similiar chemicals.

HAND EQUIPMENT

For spot treatment of small patches with 2,4-D or other similar chemicals, the knapsack sprayer, similar to the one shown in figure 13, is very useful. The sprayer shown is equipped with a wide-angle nozzle and will cover a swath 4 or 5 feet wide. It is also possible to equip such a sprayer with two nozzles spaced at 18 inches.

If 2,4-D, MCP, 2,4,5-T, TCA, Dalapon, or MH are used, it is just as important that the right amount of chemical be applied to small patches as it is on large fields. If too little is applied, the weeds will not be controlled; if too much is

Figure 13. A knapsack sprayer for treating small patches of weeds. (Photo courtesy of Roberts County Weed Board.)

applied, the tops may be killed without injuring the roots. The amount of chemical needed for a square rod area for several rates of application is given in table 3.

These chemicals can be applied in 1 quart to 1 gallon of water per square rod, depending on the size of the nozzle and the speed that the operator walks. It is best to mark out a square rod plot (16½ feet by 16½ feet) and measure the amount of water required to cover it. If 2 quarts are needed, the amount of chemical for a square rod (table 3) should be measured into each 2 quarts of water used. The same is true for any other amount of water.

Soil sterilants are difficult to apply as sprays unless one uses a hand-boom attached to a power sprayer.

They can easily be applied dry, however. They can either be applied by hand as shown in figure 14 or with a small spreader as shown in figure 15. Larger tractor - drawn spreaders may be used on large patches. However, it is essential to wash the spreader thoroughly after using it as the chemical may corrode the machine to the extent that the rotor will stick. Weed chemicals are

Table 3. Amount of Chemical Needed on 1 Square Rod When Treating Patches

If Pounds of Acid Equivalent per Acre To Be Used Are:	This Much Chemical Should Be Used on 1 Square Rod (16½ ft. x 16½ ft.)			
	2,4-D, MCP, or 2,4,5-T		TCA*	MH
	Contains 4 Lb. per Gallon	Contains 3 Lb. per Gallon	Granular (90% Sodium Salt)	40% Sodium Salt
½	⅔ tsp.	⅞ tsp.	—	—
¾	1 tsp.	1⅓ tsp.	—	—
1	1⅙ tsp.	1¾ tsp.	—	—
1½	2 tsp.	2⅔ tsp.	—	—
2	2⅕ tsp.	3½ tsp.	—	—
5	—	—	4½ tsp.	1 cup
7½	—	—	6¾ tsp.	1½ cups
10	—	—	3 tbs.	2 cups
25	⅝ cupful	11/12 cupful	½ cupful	—
50	—	—	1 cupful	—
100	—	—	2 cupsful	—

*Dalapon is applied at 1¼ times the rate shown for TCA to give same number of pounds per acre. Example: 5 lb. of TCA per acre require 4½ teaspoonsful per square rod. Dalapon requires 4½ x 1¼ or 5⅝ teaspoonsful.

Figure 14. A hand application of dry soil sterilant. One should go over the patch at least twice. (Photo courtesy of Roberts County Weed Board.)

no worse than fertilizers in this respect, however.

If the chemical is applied by hand, it is advisible to cover the patch at least twice. One-half of the required amount can be put on while walking in one direction and the remainder put on while walking crosswise of the patch.

SPRAYER ADJUSTMENT AND CHEMICAL MEASUREMENT

It is essential that a sprayer operator knows how much spray is being applied per acre. It is also essential to mix the water and chemical in the right proportions. If this is not done, the operator runs the risk of injuring his crop with too much spray or getting poor weed control with too little chemical. He must, therefore, calibrate his sprayer carefully and measure his chemical accurately.

Sprayer Calibration

Step 1. Select an area for a test run that is similar to the field to be sprayed. Accurately measure a distance of one-eighth mile or 660 feet.

Step 2. Place the sprayer on level ground and fill the tank with water. It is best to fill it to the brim.

Step 3. Spray the test run of 660 feet. Use the same gear and throttle setting on the tractor that will be used when spraying—usually 3 to 5 miles per hour. Also use the same spray pressure that will be used when spraying – somewhere between 30 and 50 pounds.

Step 4. Return the sprayer to the original filling position, on level ground, and measure the amount of water required to refill the tank to the brim.

Step 5. Multiply "66" times the amount of water required to fill the sprayer. Divide this answer by the width of the spray swath. This gives the gallons applied per acre.

Example: Suppose that you applied 2½ gallons in the test run and that the spray swath was 22 feet wide. 66 x 2½=165; 165÷22=7½ gallons applied per acre.

Figure 15. Application of a dry soil sterilant with a small fertilizer spreader. (Photo courtesy of Roberts County Weed Board.)

Step 6. Determine the number of acres that can be sprayed with one sprayer tankful of spray. Divide the number of gallons in the tank by the number of gallons applied per acre.

Example: Suppose that the tank held 150 gallons and the sprayer was calibrated to apply 7½ gallons per acre (step 5). 150÷7.5=20 acres.

Measurment of Chemical

Step 7. Determine the amount of chemical needed per acre by checking the latest recommendations to see how much chemical is needed to kill the weeds.

Example: Suppose that you wish to spray sunflowers in wheat. You will find that sunflowers require ⅓ to ½ pound of 2,4-D acid per acre when treated at an early stage of growth. Wheat has tolerated as much as ⅓ pound of ester or ½ pound of amine.

Step 8. Use table 4 to determine the number of quarts or pints required to fill the sprayer.

Example: Suppose that you wished to apply ⅓ pound of ester and your chemical contained 4 pounds of 2,4-dichlorophenoxyacetic acid equivalent per gallon. Locate ⅓ pound in the left hand column of table 4. Follow this line across until it is under 4.00 in the top line. The table shows that you need ⅔ pint per acre.

Step 9. Calculate the number of pints needed in the sprayer. Multiply the acres that can be sprayed with one tankful of spray by the number of pints required per acre.

Example: You have determined above (step 6) that your sprayer will spray 20 acres and that (step 8) you require ⅔ pint per acre. 20 x ⅔= 40/3=13⅓ pints. You can put 13⅓ pints or 6 quarts and 1⅓ pints in in the sprayer and spray 20 acres.

Table 4. Calculating the Amount of Chemical to Apply per Acre

When This Many Pounds per Acre Are Applied:	Chemical Contains This Much 2,4-D Acid Equivalent or MCP Acid Equivalent or 2,4,5-T Acid Equivalent per Gallon							Chemical Contains 90% Sodium Salt of TCA	
	2.00	2.64 or 2.68	3.00	3.34 or 3.40	4.00	6.00	6.40	Granular	Liquid
	Apply This Amount on Each Acre							Apply This Amount on Each Acre	
⅛	½ pt.	⅜ pt.	⅓ pt.	3/10 pt.	¼ pt.	⅙ pt.	3/20 pt.	—	—
¼	1 pt.	¾ pt.	⅔ pt.	⅗ pt.	½ pt.	⅓ pt.	3/10 pt.	—	—
⅓	1⅓ pt.	1 pt.	8/9 pt.	7/9 pt.	⅔ pt.	4/9 pt.	4/10 pt.	—	—
½	1 qt.	¾ qt.	⅔ qt.	1⅕ pt.	1 pt.	⅔ pt.	⅗ pt.	—	—
¾	1½ qt.	1⅛ qt.	1 qt.	9/10 qt.	1½ pt.	1 pt.	9/10 pt.	—	—
1	2 qt.	1½ qt.	1⅓ qt.	1⅕ qt.	1 qt.	⅔ qt.	⅗ qt.	—	—
2	1 gal.	3 qt.	2⅔ qt.	2⅖ qt.	2 qt.	1⅓ qt.	1¼ qt.	—	—
5	—	—	—	—	—	—	—	6¼ lb.	1 gal.
7	—	—	—	—	—	—	—	9⅜ lb.	1½ gal.
10	—	—	—	—	—	—	—	12½ lb.	2 gal.
20	10 gal.	7½ gal.	6⅔ gal.	6 gal.	5 gal.	3⅓ gal.	3⅛ gal.	125 lb.	4 gal.
30	15 gal.	11¼ gal.	10 gal.	9 gal.	7½ gal.	5 gal.	4⅔ gal.	187 lb.	6 gal.
40	20 gal.	15 gal.	13½ gal.	12 gal.	10 gal.	6⅔ gal.	6¼ gal.	250 lb.	8 gal.