Equipment for Cleaning Seeds

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Seed as it comes from a field is never pure. Mixed with it are seeds of weeds and other plants. They have to be separated after harvest so as to get pure, live crop seeds for replanting.

Seed from each crop is basically different in physical makeup from the others and can be identified easily. The differences—in size, shape, weight, surface area, specific gravity, color, electrical properties, texture, stickiness, and pubescence—can be measured or sensed by mechanical devices, called separators, which cull unwanted seeds from wanted ones on the basis of one or more of those physical differences.

Seed separators also remove dirt, leaves, stems, and chaff. Cleaning reduces the bulk to be handled and stored and removes moist material that may cause heating in storage. All seed crops, whether of grasses, legumes, grains, vegetables, flowers, fibers, trees, and shrubs, require some cleaning.

In the usual sequence through a processing plant, seeds first go through a precleaning operation. It may include scalping, the removal of material coarse enough to be easily separated by screens; hulling, a completion of the field threshing operation; and scarifying, the scratching of hard-coated seed so that moisture can enter it when it is planted. The processing of seeds of native grasses and other seeds that have awns and appendages usually requires additional precleaning to remove awns and beards.

The seed is then processed on an air-screen cleaner, in which the bulk of the foreign material is removed by screens and air.

The final separation is made on one or more finishing machines, which generally separate only one type of contaminating seed from the desired clean product.

Specific gravity separators will divide seeds according to their weight and size.

Indent disk and cylinder separators will remove long seeds from short ones.

Pneumatic and aspirator separators will separate seeds that present a different resistance to airflow.

Velvet roll separators remove smooth seeds from rough seeds.

Spiral, inclined draper, timothy bumper mill, vibrator, and horizontal disk separators divide seeds according to their shape.

Electronic separators sense a difference in the electrical properties of seeds.

Magnetic separators and the buckhorn machine separate rough or sticky-surfaced seeds from smooth seeds.

Color separators divide the light-colored seed from the dark ones.

Seeds from a thresher or combine brought to a cleaning plant may contain a great deal of trash, green leaves, green weed seeds, and insects. Because of the moisture in the leaves and weed seeds, the seeds cannot be safely stored, or efficiently handled, or accurately cleaned until most of the foreign material has been removed. Many seed-cleaning plants therefore separate the foreign material immediately with a machine called a scalper.

Scalpers are of many types. One consists of a reel of perforated metal screen, which is inclined slightly and turns on a central shaft. Seeds fed into the higher end tumble inside the reel until they drop through the perforations, but longer and larger trash continues through the reel and is discharged separately. Another type of scalper makes the same type of separation with a single, flat, perforated screen, which is mechanically shaken.

The two types are simple devices
intended to remove only large trash. Because some seeds are mixed with small weed seeds as well as large trash, many seedsmen prefer a more complete precleaner to a simple scalper. It is a simple air-screen seed cleaner that makes a separation of light chaff and dust with a controlled air current, a separation of large trash over a large-hole screen, and a separation of small foreign material through a small-hole screen. Most scalpers are arranged to make the air separation before the seeds reach the screens.

Scalping, or rough cleaning, has certain advantages: The mechanical handling is facilitated. Subsequent seed flow is more even. The time required for artificial or natural drying is reduced. Succeeding machines can have a higher capacity.

After scalping, many kinds of seeds can be cleaned without any further preprocessing, but others may require hulling or scarifying.

Hulling is the removal of an outer coat or husk.

Scarification is scratching the seed-coat.

The hulls of some seeds are impermeable to water, and the seeds will not germinate promptly unless the outer coat or husk is removed before the seed is planted. Some legume seeds are hard and must be hulled or scarified if they are to absorb water and sprout promptly and evenly.

Hullers and scarifiers usually abrade the seeds between two rubber-faced surfaces or impel seeds against roughened surfaces, such as sandpaper. The severity of the abrasion or impact must be controlled accurately to prevent damage.

Seeds of a high moisture content are harder to hull or scarify than seeds with less moisture. Because a huller or scarifier adjusted for moist seeds may damage dry seeds, the moisture content usually is determined before hulling or scarifying and the necessary adjustments are made.

Some kinds of seeds that maintain viability for long periods after being hulled and scarified can be processed immediately after harvest and stored until the following season. Others that lose viability quickly can be hulled and scarified shortly before planting time. Hulling and scarification may be performed separately or jointly, depending on the presence of unhulled or hard seed or both.

Some seeds that may require hulling are bermudagrass, bahiagrass, buffalograss, and Korean, Kobe, common, and bicolor lespedeza.

Some seeds that may require scarification are wild winter peas, hairy indigo, alfalfa, crotalaria, subclover, and suckling clover.

Some seeds that may require both hulling and scarification are sweetclover, sericea lespedeza, crownvetch, black medic, and sourclover.

Many native grasses, small grains, and other plants produce seed units that have awns, beards, hairs, glumes, and other appendages, which make them difficult to handle in processing and planting operations because they tend to interlock and cause undesirable clustering. They can be removed by a precleaning treatment, which improves their flow properties, cleaning characteristics, and quality of the seeds.

Especially troublesome awned grasses are species of Stipa, or the needlegrasses, and species of Elymus, or wildrye. In other grasses, like the bluestems and gramas, hairy appendages make the seeds fluffy and bulky.

After scalping to remove excess straw and trash, several mechanical actions may be employed to remove awns and appendages. These include a high-speed thresher, the hammermill, a debearding machine, and a tumbling pebble mill. All employ a vigorous abrading action and must be operated carefully to insure little damage to seed and maximum removal of awns.

High-speed threshing or retreshing of the seed to remove awns without too much seed damage is done by running the once-threshed seed material through the thresher or combine a second time at a high cylinder speed.
A concave setting of minimum clearance and a reduced airblast gives best results. Complete removal of awns by threshing is controlled by closing the seed pan screen so that only deawned seeds drop through into the seed auger. The tailings screen must be opened enough to allow the awned seeds to drop into the return auger and be rerun.

The commonest type of machine used successfully for deawning and debearding is the farm hammermill. The results depend on cylinder speed, size of the screen openings, rate of feed, and condition of the crop. The speed of the hammermill best suited for pretreating is about 50 percent of that used in normal grinding operations—600 to 1,400 revolutions a minute. Long, thin seeds need a slower cylinder speed to avoid loss through breakage. Excessive hammer speed will mutilate, crack, or groat the seeds. If the speed is too slow, awns will not be removed.

Openings in the screen must be slightly larger than the deawned seeds. Oversized screen openings will pass a high percentage of seeds with awns. If the openings are too small, the seeds will be damaged and capacity reduced. Those with slots instead of round openings will handle slender seeds with less breakage.

The mill should be fed to full capacity so the hammers will rub and roll the sufficiently trimmed seeds through the openings. When feeding is reduced, the cushioning effect is also reduced and more seeds will be damaged. Seed moisture should be held within close tolerances. Awns on moist seeds often are limber and will not break off easily; cracking damage results in lowered germination if the seeds are too dry.

The following steps should be followed in adjusting the hammermill:

First, choose a screen with openings slightly larger than the deawned seeds.

Second, start the cylinder at slow speed—fill the mill and keep it full.

Third, examine the seeds after a short trial run. If the appendage removal is incomplete and no damaged seeds are found, advance the cylinder speed about 100 revolutions per minute. Be careful to avoid cracking or otherwise damaging the seeds.

Fourth, repeat the third step until the most trimmed seed is obtained with the least breakage. Small seeds that come through untrimmed should be rerun through a screen with smaller openings.

Seeds of the following species have been successfully processed in a hammermill: Native grasses like blue-bunch wheatgrass, blue wildrye, Canada wildrye, Siberian wildrye, the gramas, the bluestems, the needle-grasses, and tame species like tall oatgrass, bulbous barley, squirreltail, alfilaria, and virgins-bower.

Debearding machines, used to precondition grasses, have a larger capacity, are simpler to operate, and damage the seeds less than hammermills.

Debearding machines have a horizontal beater with arms rotating inside a steel drum. The arms are pitched to move the seeds through the drum. Stationary posts, adjustable for clearance with the arms, protrude inward from the drum.

These machines rub the seeds against the arms and against each other. The time the seeds remain in the machine is varied by regulating a discharge gate. The degree of action is determined by the processing time, beater clearance, and beater speed.

A debearding machine has been used to remove cotton webbing from Merion bluegrass, which was 98 percent pure when it was cleaned properly. The debearder also is used to clip seed oats, debeard barley, thresh whitecaps in wheat, break apart grass seed doubles, remove awns and beards, hull some grass seeds, and polish seeds.

Another precleaning unit that is effective in removing seed hairs and fuzz is the tumbling pebble mill. It has a drum rotating about a shaft inserted
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off center at opposite ends. The mill is loaded with seed and smooth, half-inch pebbles and turned at a slow speed until the rubbing action of the pebbles rolls the fuzz from the seeds into small, round balls. The mixture of pebbles, seeds, and matted fuzz is then run over a scalper to remove the pebbles. The pebble mill is used for removing cobwebby hairs from bluegrass and similar seeds.

Some seeds like black grama, which have fine, flexible, hairlike awns that do not break off when run through a hammermill or debearder, lend themselves to differential burning. The seeds are dropped through a flame, and an instant flashing of awns takes place. The burn exposure must be short to avoid damaging the seeds by excessive heat. Seeds of black grama that were deawned in this way were cleaned and seeded easily.

SEEDS of some native grasses of the Great Plains need little processing. Arizona cottontop, for example, is harvested by heading and then is fine chopped in a hammermill or similar unit. The seed material is reduced in size, and special planting equipment can distribute it without removal of the fuzz or additional cleaning. The same treatment is given other grasses, such as tanglehead, *Trichloris* species, and cane bluestem.

A green forage harvester is used in Texas wintergrass to harvest and chop the seed material for planting in one operation. With grasses such as big cenchrus and Argentine wintergrass, both of which require precleaning to remove spines and awns, the forage harvester is used for the harvest and does part of the job otherwise required of the hammermill in processing.

Some seeds with cottonlike stylets, such as Texas bluegrass, defy processing with hammermills, debearders, and similar devices or planting with regular grass drills. A new development is pelleting. All plant material, including seeds, stems, leaves, and trash, are mixed with a binder, like cornstarch, silvicon, or krilium, and water and extruded through a quarter-inch hole in a die. Pellets made with cornstarch can be planted easily with a corn planter or cotton planter. Silvicon-binder pellets crumble and can be planted easily with a range seeder.

Almost every kind of seed must be cleaned over an air-screen cleaner before any other separations can be attempted. Many kinds can be cleaned completely on this machine and made into a finished product. The air-screen cleaner therefore is known as the basic equipment in cleaning plants. In this unit, screens take advantage of a difference in size and shape, and moving air senses a difference in surface area and density in seeds so that a separation can be made.

A seed mixture, directly from the combine or from any of the precleaning units, flows by gravity from a hopper to the feeder, which meters it into an airstream. Light, chaffy material is blown out, and the remaining seeds are distributed uniformly over the top screen. In a typical operation of a four-screen machine, the top screen scalps or removes large material. The second screen sizes or drops particles smaller than the seeds. The third screen scalps the seeds more closely. The fourth performs a final grading. The graded seeds then pass through a second airstream, which lifts light seeds and chaff into the trash bin while dropping the plump, heavy, crop seeds into a clean chute.

Top screens have openings larger than the seeds to be cleaned. Bottom screens have openings smaller than the seeds. The size of air-screen cleaners varies from the small, two-screen farm model to the modern precision unit, which is so arranged that several top and several bottom screens can be used in one cleaning operation.

Large cleaners, used in commercial seed-cleaning plants, subject seeds to as many as seven screens and three air separations in one pass through the
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**FRACTIONATING ASPIRATOR**
- Column-size control lever
- Air-control damper

**INCLINED DRAPER SEPARATOR**
- Seed hopper
- Flat or rough seed
- Round or smooth seed
- Canvas or plastic draper

**INDENT CYLINDER SEPARATOR**
- Adjustable trough
- Seed-conveying augers

**VELVET ROLL SEED SEPARATOR**
- Feed hopper
- Metal shield
- Velvet rolls

**A—Seed mixture**
**B—Heavy seed**
**C—Expanding air column**
**D—Medium seed**
**E—Light seed**
**F—Chaff**
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The air-screen cleaner uses perforated metal or wire mesh screens. The perforated metal screens are available with round, slotted, or triangular openings. Round-hole sizes range from 0.039 to 1.250 inches in diameter; slotted holes, from 0.039 by 0.500 to 0.375 by 0.750 inch; and triangular, from 0.078 to 0.187 inch in length of each side.

Screens of wire mesh are woven with square or rectangular openings in sizes that range from 0.0117 to 0.286 inch.

Air-screen cleaners with two top screens generally have one round-hole screen and one slotted. The first bottom screen should be slotted; the second should have round, square, or triangular holes.

Each screen is slanted at a slight angle to cause the seeds to roll or slide downward over the openings. The pitch of each screen is adjustable to facilitate accurate separations.

The mechanism that shakes the screens can be adjusted to shake them slowly or rapidly. The experienced operator can adjust the screen shake so the seeds will slide smoothly over the screen or be agitated by the screen motion, as may be required.

The rate of feed can be adjusted to keep the screens operating at nearly full capacity. The airflow in each air separation is usually regulated by means of dampers in the air ducts.

Commercial cleaners have cleaning brushes that travel under the screens to prevent seed from lodging in its openings. Some have mechanical screen bumpers to assist in dislodging seed.

Seeds that have been cleaned with a precision air-screen machine are ready for planting or further processing, depending on the kind and amount of remaining contaminant. Some weed seeds and particles of foreign material are so near the same size, shape, and weight as the crop seeds that they cannot be separated with the air-screen cleaner. One or more finishing separators are then used.

The specific gravity separator senses a difference in density or specific gravity of seeds to make a separation. It was developed to separate ore from clay or dirt and to grade ore in arid mining districts.

The gravity separator employs a flotation principle. A mixture of seeds is fed onto the lower end of a sloping perforated table. Air, forced up through the porous deck surface and the bed of seeds by a fan, blows the lightest material to the top and stratifies the seeds in layers according to density. An oscillating movement of the table "walks" the heavy seeds in contact with the deck uphill, while the air "floats" the light seeds downhill. The seeds traveling to the edge of the table range from light at the lower end to heavy at the upper end. The discharge can be divided into any number of density fractions.

The deck is the heart of the gravity separator. Deck coverings of linen, plastic, woven wire, and perforated metal have been used to distribute air uniformly beneath the seeds. A closely woven covering gives best results for small seeds, such as those of bentgrass. Large seeds, like corn and soybeans, require a coarse weave or larger opening. The covering materials must stand abrasion. Decks are furnished lint-free air that will not clog their openings.

Several adjustments are available to match machine performance to seed mixture and separation requirements. Feed rate is critical and should be adjusted to provide an even supply and a uniform covering of the deck at all times.

Airflow through the deck should be adjusted to allow heavy seed to stay in contact with the deck while moving light seeds up through the seedbed. An oversupply of air causes mixing while an inadequate supply will not stratify the light seeds at the top.

The tilt of the deck is adjustable. The inclination should be great enough that light seeds will flow down to the lower end. The oscillation rate of the table should be fast enough so that
HORIZONTAL DISK SEPARATOR

FLAT SEED DISCHARGE SPOUT
FEED PORT
ROTTING TABLE
SPHEROIDAL SEED DISCHARGE SPOUT

ELECTRONIC SEED SEPARATOR

FEED HOPPER
SEED-CONVEYOR BELT
ELECTRODE
ADJUSTABLE DIVIDERS

BUCKHORN MACHINE

SEED FEED
WATER SPRAY
CONVEYOR
MIXING CHAMBER
CLOVER AND SAWDUST-COVERED BUCKHORN SEED

MAGNETIC SEED SEPARATOR

SEED FEED
WATER SPRAY
IRON POWDER SUPPLY
MAGNET DRUM
MIXING CHAMBER
WEED AND CRACKED SEED
CLEAN SEED

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heavy seeds in contact with the deck will move to the upper end.

The gravity separator will separate seeds of the same size but of different densities. It will also separate seeds of the same density but of different size. It will not separate a mixture of sizes and densities. For example, a sized mixture of dirt, seeds of wild geranium and crimson clover, and gravel may be separated. The geranium and weevil-eaten clover will be discharged at the low side of the deck, rocks and dirt at the upper side, and good crimson clover seeds in the middle.

The indent disk and indent cylinder separators take advantage of a difference in seed length to make a separation. Both types use pockets or indentations to lift short seeds from a mixture and reject long seeds.

The indent disk separator consists of a series of disks revolving together on a horizontal shaft inside a close-fitting housing. Each disk has many pockets or cups on each face. As the disks revolve through a seed mixture, the recessed pockets lift out short seeds and drop them in a trough at the side of the machine. Rejected long seeds are conveyed through the disk spokes to the end of the machine and discharged through the tailings opening.

When seeds or material of varying lengths are to be removed or graded by length, the mixture first encounters disks with small cups and then disks with cups progressively larger from inlet to discharge. When only one separation is required, many disks with the same size of indent are used in a machine to increase capacity. Removable vanes attached to the spokes of the disks serve to move seeds through the machine, agitate them, and bring them in contact with the cups.

Size and shape of the disk pockets are the important variables. Disk pockets are made in two basic shapes with many sizes for each.

The “R” pocket derives its designation from “rice” and was designed to remove broken rice grains from whole grains. The lifting edge, being flat, will lift out cross-broken or flat seeds and reject round seeds.

The “V” pocket derives its name from “vetch” and was designed to remove round seeds. The round lifting edge tends to reject tubular or elongated seeds. Disks with other letter designations are designed for specialized separations.

Other important adjustments are disk speed and rate of seed flow through the separator. Disk speed is adjusted to obtain proper emptying of the pockets. Speed too slow or too fast will allow seeds to leave the pockets before the proper discharge point. The seed level in the machine and the rate of discharge may be controlled by removing or adding vanes attached to the disk spokes or adjusting the height of the discharge gate. Adjustments within the machine make it possible for liftings from the various disks to be either discharged or returned to the head of the machine for further recleaning.

The indent disk separator can be used to lift vetch from oats or wheat and crimson clover from ryegrass and fescue seed. Small particles such as seed of dodder, dock, sorrel, or plantain can be separated from fescues and ryegrasses.

Indent cylinder separators perform separations on the same basis as indent disk separators—that is, on a difference in seed length.

The indent cylinder separator has a horizontal rotating cylinder and a movable separating trough. The inside surface of the cylinder has small, closely spaced, semispherical indentations. When a seed mixture is introduced into one end of the cylinder, short seeds are lifted by the combined effect of fitting into the indents and centrifugal force. Near the top of the rotation, they drop into an adjustable trough inside the cylinder. A spiral conveyor in the bottom of the trough moves the lifted material to the end where it is discharged. Usually the cylinder is slightly inclined, so that
rejected long seeds will flow in the cylinder to the discharge end by gravity.

Cylinders are available with indents of many different sizes, but all indents in one cylinder are of the same size. The cylinder is changed when a different size of indent is required.

Two adjustments for obtaining the desired separation are cylinder speed and position of the adjustable trough. With indent cylinder separators, centrifugal force helps hold the seeds in the pockets and thus affects the distance traveled before dropping out. Cylinder speed is adjusted therefore to lift seeds nearly to the top of the arc. Excessive speed will not allow seeds to drop from the indents. A speed that is too slow will not lift short seeds from the mixture. The separating edge of the adjustable trough should be positioned to catch the desired fraction of the dropping seed.

The indent cylinder separator can make separations, such as sloughgrass from meadow foxtail, long barley from oats, and dock or sorrel from orchardgrass or fescue. The cylinder can also be used for sizing oats and rice and grading hybrid corn by length.

Pneumatic and aspirator separators use the movement of air to divide seeds according to their terminal velocities. This refers to the velocity of air required to suspend particles in a rising air current. Density, shape, and surface texture affect resistance of a particle to airflow.

When a seed mixture is introduced into a confined rising airstream, all particles with a terminal velocity less than the air velocity will be lifted. Seeds with higher terminal velocities will fall against the airflow. Regulation of the air velocity, the most important variable, can be adjusted by changing the speed of the fan or the size of the air inlet.

In a pneumatic separator, the fan forces air through the machine by creating a pressure greater than atmospheric. In an aspirator, the fan is at the discharge end and induces a vacuum, which allows the atmospheric pressure to force air through the separator.

One type of aspirator separator is the scalping aspirator. A rough separation is made when a seed mixture is dropped into a rising air column that has a velocity slightly below the terminal velocity of the heavy, plump seeds. The leaves, trash, and light seeds rise with the air and are deposited in an enlarged settling chamber. The denser, plumper seeds fall through the incoming air into a receiving bin below.

Another type of aspirator is the fractionating aspirator. When a seed mixture is introduced into the lower end of an expanding air column, heavy seeds fall against the airflow, and light seeds are lifted. Air velocity through the expanding column lessens and gradually drops out seeds with lower terminal velocities. Each outlet along the column receives a lighter fraction of seeds; the mixture thereby is separated into several divisions.

Pneumatic separators can make many precise separations, such as lifting seeds of meadow foxtail from seeds of Alta fescue.

The velvet roll separator classifies seeds according to a difference in texture of seedcoat. The separator consists of two parallel, inclined, velvet-covered rolls in contact with each other. They revolve outwardly. An adjustable shield conforms to the rolls and is held just above them. When a seed mixture is fed onto the upper end of the rolls, the smooth seeds travel downhill between them and are discharged at the lower end. Rough-coated seeds, caught in the velvet, take a bouncing path between shield and rolls and are thrown over the sides. The discharge from the side of the rolls is caught in several divisions. The roughest seeds are ejected first.

Several adjustments are available to obtain the desired separation. The clearance between rolls and shield should be great enough to allow all seeds to pass freely. The rate of feed is adjusted to allow all seeds to come in
contact with the rolls. Angle of incline of the rolls may be increased if the surface texture difference of the seeds is great. The speed of the rolls should be increased to discharge all rough-coated seeds over the side of the rolls.

Many pairs of rolls are mounted one above another to gain capacity. The unit is sometimes called dodder roll, because it often is used to remove rough-coated seeds of dodder from smooth legume seeds. Other common separations are dirt clods from beans and clovers, seeds of timothy from seeds of alsike clover, and unhulled from hulled lespedeza.

The spiral separator makes a division of seeds according to shape or the degree of its ability to roll. The separator resembles a stationary, open-screw conveyor standing on end. A mixture, fed onto the spiral at the top, slides or rolls down the inclined surface. The fast-rolling seeds gain speed and are thrown by centrifugal force into an outer housing, which directs them to a chute below. The sliding or slow-rolling seeds remain on the inner inclined surface and enter a second chute at the bottom.

The spiral separator has no moving parts. The only adjustment is the rate of feed, which should be light enough so each seed may act independently. Increased capacity is gained by placing several spiraled surfaces in the same housing. The chief disadvantage of the spiral is lack of flexibility. Often a different diameter or incline is desired to match a range of seed samples. This device is less versatile than other seed cleaners, but it is simple, inexpensive, and quite useful in a seed-cleaning establishment. The spiral is used to separate rape, vetch, and soybean seeds from wheat, oats, and ryegrass; whole vetch from broken vetch; and crimson clover from rape and mustard seeds.

The inclined draper separator senses a difference in shape and surface texture to separate seed on an inclined plane. A mixture to be separated is metered onto the center of an inclined draper belt traveling in an uphill direction. Round or smooth seeds, which roll or slide down the draper faster than the draper is traveling up, drop off and are caught in one hopper. Flat and rough-coated seeds are carried to the top of the incline and dropped into a second hopper.

Belts with different degrees of roughness may be used as the draper. A rough canvas belt is used when rolling tendencies of the seed are predominant. A smooth, plastic belt may be employed when sliding action is desired for the lower fraction. Other important variables are feed rate, draper speed, and angle of incline.

The rate of feed should be slow enough to allow each seed to act independently. The draper speed may be varied to simulate a shorter or longer length of incline. The angle of incline is set to assure rolling or sliding of the desired lower fraction.

To gain capacity in commercial operations, many belts are used one above another in a single machine. Typical separations made by the inclined draper separator are seeds of crimson clover from grass seeds and vetch seeds from oats.

The horizontal disk separator takes advantage of differences in shape and surface texture to determine whether seeds slide or roll when subjected to centrifugal force.

Seeds, confined to the center of a flat rotating disk by a stationary circular plastic fence, are metered to the outer part of the disk through adjustable outlets. Centrifugal force causes round or smooth seeds to roll or slide off the disk. Irregular or rough seeds remain on the disk and are raked off into a different hopper.

The rate of feed through the outlets is adjusted so that each seed moves independently. The horizontal disk is similar to the spiral separator, but it is more selective because it has a disk speed control that can change the pro-
Flow Diagrams of Steps in Seed Cleaning

SEED CLEANING

OATS AND VETCH

LEGUME

WHEAT

BARLEY

Receiving Hopper

Air-Screen Cleaner

Debearder

Velvet Roll

Length Separator

Gravity Separator

Seed Treater

Sacking Hopper

BLUEGRASS PROCESSING

Receiving Hopper

Air Screen

2 Screens

Debearder

Air Screen

4 Screens

Length Separator

Gravity Separator

Heavy Dirt, Rocks and Such

Light Seed, Straw and Chaff

Clean Seed Sacking and Sewing

CORN PROCESSING

Dryer

Sheller

Air-Screen Cleaner

Ring Grader

Width and Thickness Separator

Rounds

Thicks

Length Separator

Seed Treater

Sacking and Sewing

Storage
portions of seed retained or thrown off. An added capacity is obtained by mounting many disks on a single vertical shaft. The horizontal disk separator will separate dodder seeds from alfalfa, curly dock from red clover, and other mixtures in which one seed has a greater tendency to roll or slide than another.

**Electronic separators divide seeds on the basis of differences in their electrical properties. The degree of separation depends on the relative ability of seeds in a mixture to conduct electricity or to hold a surface charge.**

Electronic or electrostatic separators have been used for many years to separate minerals, but their application to seeds is relatively new. Their use offers the possibility of making separations that have been difficult or impossible with conventional equipment.

A thin layer of seed is conveyed on a belt through a high-voltage electrical field, where it is given a surface charge. This charge is like the one that is picked up by a comb passed through the hair.

As the belt rounds a pulley, seeds that have quickly lost their charge fall in a normal manner from the belt. Seeds that are poor conductors and slow to lose their charge adhere to the belt and fall off gradually. Dividers in the drop path can then be positioned to collect any fraction of the distribution desired.

Among the many adjustments are feed rate, belt speed, electrode position, voltage, and divider position. Preliminary research has been conducted to determine the effect of these variables, but much is still to be learned. The moisture content of the seeds is important, because the ability of a seed to conduct electricity is affected by changes in its moisture.

Some of the separations that have been made with commercial electronic separators are seeds of watercress from rice, leaf material from raisins, chaff from ground coffee, ergot from bentgrass, and johnsongrass from sesame.

Experimental units have separated seeds of bachelor’s-button from Alta fescue and ryegrass and seed of curly dock from red clover.

**Magnetic separators take advantage of the surface texture and stickiness of seed to make a separation.**

A seed mixture and a proportioned amount of water and finely ground iron powder are mixed in a screw conveyor or other mixing device. In the presence of moisture, the powder will adhere to rough, cracked, and sticky seeds. When the mixture is fed onto the top of a horizontal revolving magnetic drum, smooth or slick seeds that are relatively free of powder fall from the drum in a normal manner. Rough-textured or sticky seeds, coated with iron powder, are attracted by the magnetic drum and stick to it until they are removed by a rotary brush or a break in the magnetic field.

The degree of successful cleaning depends largely on the extent of the difference in seedcoats; the proper proportioning of water, iron powder, and seed; and the thoroughness of the mixing operation.

The magnetic separator is excellent for removing seeds of weeds like dodder, buckhorn, plantain, and mustard from alfalfa and clovers. Dirt and cracked seeds may also be removed from them. Hulled johnsongrass can be separated from alfalfa by using an emulsified oil with the water to help the grass seeds pick up and hold the powder.

The buckhorn machine is a special unit designed primarily to remove buckhorn plantain from seeds of legumes, such as crimson clover, alfalfa, and red clover.

Normally the buckhorn plantain and the legume seeds are so similar in size, shape, weight, and surface texture that many of the buckhorn cannot be completely removed by the air-screen cleaner, gravity separator, or other common cleaning machines.

The buckhorn seed has a mucilaginous surface, which becomes sticky
when dampened and will pick up finely ground sawdust. Thus a larger, rough-surfaced, less dense seed unit is formed. Smooth legume seed will not take on any of the sawdust.

A buckhorn seed mixture and a sufficient amount of water and sawdust are mixed in an auger or continuous-type paddle stirrer. The enlarged buckhorn seeds then can usually be removed with an air-screen cleaner. The specific gravity or the velvet roll machines may be used to complete the separation if necessary.

The timothy bumper mill separates seeds on the basis of a difference in shape. It is a special machine developed to remove weed seeds.

The timothy seed mixture is fed onto the lower corner of the upper end of a small rectangular metal plate, which is inclined slightly in both directions but more in the lengthwise direction. A back-and-forth movement of the plate, parallel with its short side, is smooth in one direction but is stopped with a bump in the other. Round timothy seeds roll downhill lengthwise of the plate between bumps and fall off the end. Irregular-shaped seeds are gradually bumped uphill across the plate and fall off the side.

In the commercial machines, many plates are suspended in two identical frames, which are bumped together simultaneously. With proper adjustment of feed rate, bump intensity, and plate inclination, the timothy bumper mill will separate alsike clover, Canada thistle, sorrel, ryegrass, quackgrass, and other seeds from timothy.

The vibrator separator is a newer machine that makes a division of seed on the basis of a difference in shape and surface texture.

As in the timothy bumper mill, the seed mixture is fed near the center of the upper end of a rectangular deck inclined both sideways and endwise. The deck is activated by an electromagnetic vibrator. Flat or rough seeds climb to the high side of the deck. Round and smoother seeds roll, tumble, and slide to the low side.

The endwise tilt induces both seed fractions to travel to the discharge end, where they drop off and are kept separate by dividers.

The tilt of the deck may be adjusted both sideways and endwise to provide a wide range of deck inclinations. Decks can have various textures, ranging from smooth metal to rough sandpaper, depending on the seed components that are being separated. The intensity of vibration can be regulated by a rheostat controller in the electrical circuit. To increase capacity, multiple decks may be mounted in a rigid frame and powered by a single vibrator. A properly adjusted vibrator separator removes seeds of curly dock from crimson clover, dogfennel and hedgesmustard from timothy, rippleseed plantain and ergot from bentgrass, dodder and lambsquarters from carrot seeds, and sweet vernal grass from ryegrass.

The color separator separates the seeds on the basis of a difference in color or brightness.

One type of machine picks up the seeds on a series of suction fingers and carries them past a phototube, where they are judged for color or brightness and ejected into separating containers one at a time.

Color separators are practical for larger seeds, like those of beans and peas. They have not been used for smaller seeds because of the low capacity involved in scanning the particles individually.

Many factors should be considered in designing a seed-cleaning plant.

Handling and cleaning the seeds should be possible without mixing or damaging and with a minimum of equipment, personnel, and time.

The seed separators, elevators, conveyors, and storage bins should be arranged so seeds can flow continuously from beginning to end, yet flexible enough to bypass a machine or return part for recleaning.

Other factors to be considered are kinds of crop seeds to be cleaned, kinds of contaminating crop and weed seeds,
EQUIPMENT FOR CLEANING SEEDS

volume of seed to be handled, method of handling (bulk or sacks), type of conveying system (pneumatic or mechanical), and location of shipping and receiving facilities.

The commonest plant layout is the multistory design, in which machines are placed in a vertical processing line and seed flows by gravity from one to another. This arrangement requires a high, reinforced structure and many workers to operate equipment on the several floors.

Single-story plants are increasing in popularity because of the emphasis on reduced cost of structures, less labor, varietal purity, and the need for special processing of certain crops.

There is no all-purpose machine that will remove all the objectionable material from the different kinds of seed. Each unit in a cleaning sequence is employed to make a specific separation. The machines used and their arrangement in the processing line depend on the crop being cleaned; the condition of the crop (partly or completely hulled); the type of other materials present (rocks, sticks, stems, leaves, dirt, weed seed); the size of the contaminating material compared to the crop; and the proportions of each in the mixture.

When a seed lot to be cleaned arrives at a processing plant, a sample is first analyzed to determine which machines to use and the best flow pattern through the plant. Combined seed ordinarily requires one or more precleaning treatments.

If the seed lot includes a high percentage of large trash, green leaves, green weed seeds, or insects, it is first rough cleaned on a scalper. If a large percentage of the seed is unhulled, it is often necessary to hull the entire lot.

A lot containing hard seed may be scarified during the precleaning sequence or some time after cleaning is complete, depending on its ability to maintain viability after processing. Many grains and most grasses are given a debearding or deawning treatment with either the hammermill or debearder. Many native grasses require special treatment to remove troublesome appendages.

After precleaning, most of the remaining contaminants are removed with an air-screen cleaner. Some lots, with a minimum of excess material, may be finished by this machine, but most will need further processing with finishing machines to make first quality seed. This unit is also capable of accurate sizing for thickness and width with the selection of proper screens.

The finish cleaning may be accomplished by many machine arrangements, but an indent disk or cylinder usually is next in line. These units separate weed seeds that are different in length and also may be used to divide the lot according to size.

The specific gravity separator will next split off light and heavy contaminants with most of the cut being usable seed. The “middlings” or mixture fractions may be rerun on another gravity separator or a different type of machine for further cleaning.

Further processing will depend upon the characteristics of the specific contaminant remaining. Rough weeds are removed by the velvet roll; seeds of irregular shape by the spiral or inclined draper; and seeds with rough or mucilaginous surfaces by the magnetic or buckhorn machine.

The separator selected generally is the one that will remove the most contaminating materials with the smallest loss of crop.

Manufacturers have developed outstanding seed-separating equipment, but the knowledge and skill of the operators remain most important.

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