BASIC SEED PROCESSING

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One of our seed producers has for many years taken great pride in the fact that most of his soybean seed lots easily meet certification standards for purity, weed seed, and germination before processing. He is somewhat of a fanatic on weed control and harvesting. His seed fields are immaculate and harvesting is so carefully managed that the combine-run seed are cleaner than many producer's seed after processing. He practices preventive processing.

Preventive Processing

If all seed producers were equally fanatic about weed control and harvesting, and I should add, blessed with highly fertile, level, uniform land - seed processing would be a breeze. Unfortunately, most seed producers do not or cannot achieve the results of our exemplary seedsman, and have to depend heavily on processing to bring their seed up to acceptable standards.

Seed processing has become increasingly important with the advance in level of mechanization of crop production, harvesting, and handling operations. When seed and grain were hand harvested and threshed - as they still are in some countries - they were much cleaner than after the introduction of the stationary thresher. In turn, seed and grain from a stationary thresher were much cleaner than those harvested with a combine. The combine is incredibly efficient but not very selective. It gathers and more-or-less threshes everything in the field - the crop, weeds, ant hills, insects, crayfish mounds. I used the term "more-or-less threshes" because some of the material is not threshed (pods, heads,) while other material is over-threshed (fragments, splits). As a consequence of the efficiency of modern harvesting equipment, the threshed product is a mixture of good seed, unthreshed material, broken seed, pieces of stems and leaves, dead and crawling insects, pebbles, soil peds, and sometimes a few unmentionable things. The nature and quantity of the extraneous material mixed with the seed determines the need for and comlexity of processing. In the case of our exemplary seed producer, basic cleaning is sufficient to raise the physical purity of the seed to the highest level. For other seed producers, however, even complex and costly processing fails to up-grade the physical purity of some lots to an acceptable level.

One of our "old timers" usually starts a talk on seed processing with the statement that, "the best piece of processing equipment is a

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hoe." Despite the antiquity of the idea expressed, it contains a gem of truth. An effective weed control program is the best way to eliminate weed seed problems. And, there are many other things a seed producer can do to improve the cleanliness of combine-run seed, thus reducing processing costs and losses.

When technically and economically feasible, land leveling and the installation of good drainage improves the uniformity of seed fields and facilitates weed control, other cultural practices and harvesting. In cases where the desired degree of uniformity cannot be achieved, roguing or spot spraying of weeds and selective harvesting can eliminate many processing problems. Poorly drained, drouthy, and thin stand areas are usually overgrown with weeds. Harvesting them along with the better areas is simply asking for trouble. The problem areas should be bypassed, harvested later, and either marketed as grain, or marked as lots requiring special processing.

Timely harvesting, proper adjustment and operation of the combine will produce a cleaner product with a minimum of mechanical damage. These things, of course, can be much more easily accomplished when the seed fields are uniform, well drained, and free of weeds.

The equipment and procedures used for loading and unloading grain wagons and bulk bins can be a source of processing problems. Seed lots high in mechanical damage are difficult to process, seed losses are high, appearance is poor and germination is reduced.

Preventive processing requires good management of the entire seed operation. Management must wean its self from near total dependence on seed processing to achieve desired quality standards. Preventive processing involves all the steps and actions mentioned above and all other economically feasible actions and procedures that will minimize the need for processing and prevent processing problems.

Although, I'm not aware of any strict economic studies on the cost effectiveness of preventive processing, it must be very high. Just consider the costs and losses involved in having to re-run seed through the basic cleaner, or use of several finishing machines, or of having to re-process packaged seed, or "dump" seed because of failures to achieve acceptable purity standards. Even when minimum purity standards are achieved such seed are hardly of the type that will enhance a seedsman's reputation with customers.

The purposes of preventive processing are to minimize the need for processing and to prevent processing problems. It permits achievement of high purity standards, reduces processing costs, and minimizes seed losses. It should be the foundation of a seedsman's quality assurance program.

Pre-cleaning and Pre-conditioning

Pre-cleaning or scalping of incoming seed before loading into drying or aeration bins reduces the resistance of the seed mass to the
flow of air, increases the rate of drying, reduces power and fuel consumption, and contributes to insect and storage mold control.

Several types of pre-cleaners and scalpers are available. The simplest types are the single, flat, vibrating screen and the single, "reel" scalpers. These scalp-off and remove the large trash, which may be sufficient for certain kinds or lots of seed. Other types of scalpers have features which permit removal of a greater portion of the contaminants. Scalpers or pre-cleaners with two or more flat vibrating screens and an air system can remove large, small, and light material from the seed mass. Reel type scalpers with aspiration do a similar job.

The maximum benefits from pre-cleaning/scalping are achieved when the operation is done during receiving before loading into drying or bulk storage bins. The pre-cleaner/scalper should have sufficient capacity to "keep-up" with the main receiving elevator. Since pre-cleaning or scalping produces a lot of trash and some dust, provisions for efficient removal and disposal of the trash, and collection of the dust are essential.

An alternative location for the scalper is just ahead of the basic air-screen cleaner, i.e., between bulk storage and the basic cleaner. In some cases this arrangement is satisfactory even though the full benefits of pre-cleaning/scalping are not realized.

Some kinds of combine-run seed have appendages, or contain incompletely threshed, multi-seeded units which interfere with the flowability of the seed, make cleaning difficult, and cause excessive cleaning losses. Pre-conditioning the seed to completely break apart the multi-seeded, incompletely threshed material and to remove the appendages is desirable and often necessary before basic cleaning.

One of the most widely used "pre-conditioners" is the debearder. Seed fed into the debearder are vigorously agitated and rubbed together by stationary and rotating beater bars which completes threshing and breaks off the appendages. "Debearded" seed flow more freely, are easier to clean, have a higher volume weight (test weight), and losses of good seed are reduced. Some uses of the debearder are: to remove the beard from barley seed and the chaffy tip from oat seed (clipping); to break-up flax balls; to de-spine carrot seed; and to de-awn water grass seed in rice. The good seed and other materials are separated during basic cleaning.

Removal of the hulls of some kinds of seed changes their size sufficiently to permit separation of certain weed seed which otherwise cannot be removed. The hulling is accomplished in a huller-scarifier. These procedures are especially applicable to some of the lespedezas. The huller-scarifier, of course, is also used to reduce the percentage of hard seed in alfalfa, the clovers, and other kinds of seed which have seed coats impermeable to water.
Pre-cleaning are pre-conditioning are essentially preparative steps for basic cleaning. They increase the effectiveness and efficiency of basic cleaning and the more specialized cleaning and grading operations. The physical properties of the good seed or contaminants may be altered in ways that permit their separation. Removal of a good portion of the trash and contaminants by pre-cleaning permits closer scalping and grading with the basic cleaner and increases capacity.

Processing plants without a pre-cleaning and pre-conditioning capability when needed are handicapped. The installation of pre-cleaning equipment will usually pay for itself in a few years just by reducing the time and labor spent in re-cleaning seed lots. The additional benefits of a cleaner, more attractive, customer-appealing product are a big bonus.

Basic Seed Cleaner and Principles

All seed lots require additional processing - beyond pre-cleaning - to prepare them for marketing. The type and degree of processing used is determined by the characteristics of the seed lot to be processed and the processing objectives. The primary objective of processing (cleaning) is to clean the seed to a desired level of purity. Additional objectives include: pre-conditioning of the seed for storage or to facilitate basic cleaning; improving plantability, e.g., sizing; upgrading or improving germination; and improving appearance. Except for pre-conditioning, the other objectives are generally pursued after the primary objective has been achieved. The first step toward the primary objective is basic processing or cleaning.

The Air and Screen Cleaner

Basic seed cleaning is accomplished with the air-screen cleaner. The air-screen cleaner is an effective, efficient and versatile seed cleaner incorporating several of the commonly used principles of seed separation. In some cases, the air-cleaner is all that is needed to clean seed to desired quality standards. More often, however, one or more additional cleaning operations are necessary.

The modern air-screen cleaner evolved from the hand-operated fanning mills of yesteryear, which in turn represented an intermediate level of mechanization to hand winnowing and sieving - cleaning procedures of very ancient origin and which are still used in many of the underdeveloped countries. Modern air-screen cleaners are available in a variety of sizes and capacities ranging from small, two screen, "farm" types to high capacity models with 3, 4, 5, or more screens, and 1 to 3 or more air systems. The small, low capacity cleaners are widely used in breeders and foundation seed programs and on farms to clean relatively small quantities of seed. Most high capacity seed cleaning is accomplished with 3 to 5 screen machines with 2 to 3 air systems.

Compared to other sorts of seed cleaners, the air-screen machine is extremely versatile and has a relatively high capacity. Most of the
other sorts of cleaning machines make only very specific two-way separations, e.g., rough textured from smooth seed; short from long material or seed. The air-screen machine, however, makes multiple separations based on differences in gross size, width, thickness, shape, and weight or terminal velocity.

The components of an air-screen cleaner are: a feed hopper for controlled and uniform feeding of material into the cleaning section of the machine; screens or sieves which are fitted into an inclined frame or "shoe"—usually two screens per shoe; a mechanism for shaking or vibrating the shoe—eccentrics; and an air system—usually two, top and bottom, consisting of a fan(s) and an air chest or expansion chamber. Several other mechanisms or components are incorporated in the air-screen cleaner to permit adjustment of the "rate of shake" of the shoe(s), the inclination of the screens, air velocity, to keep the screen perforations open, i.e., brushes, tappers, etc., and to collect and convey the material separated in the machine to the outside.

The effectiveness and efficiency of the air-screen cleaner is greatly influenced by the rate of feed, air velocity adjustments, screen selection and arrangement, the number of perforations that remain clear, the rate of shake, the inclination of the screens, and the use or non-use of several techniques for precision cleaning of seed. The operator's manual for the various makes and models of air-screen cleaners provides basic information on adjustments, screen selection and arrangements for cleaning different kinds of seed, and on maintenance. It should be recognized however, that the recommendations given are of necessity based on average characteristics of lots of a seed kind and average experiences in cleaning them. They are intended as a starting point and not as an all-purpose prescription. Individual seed lots of a kind can vary widely from the average depending on the variety, the area grown, the year, and so on. Good, experienced processors, therefore, "set-up" the air-screen cleaner on the basis of an examination or analysis of the seed to be cleaned.

Pre-processing Examination and Analysis

The pre-processing examination can be as simple as hand sampling the lot and spreading the seed on a clean, smooth surface under a good light for visual examination, or it might involve a complete purity analysis and noxious weed seed examination by a seed testing laboratory. In either case, the purpose is to determine the types and quantities of contaminants that need to be removed to achieve desired purity standards. Special attention should be given to very undesirable contaminants such as weed seed, especially those that are close in size, shape, and weight to the pure seed, and, hence, will require very precise adjustments to remove, or the use of more specialized seed processing machines.

A very experienced processor with good knowledge of crop and weed seed identification can usually reach a decision on screen selection and arrangement for the major kinds of seed processed on the basis of visual
examination alone. Less experienced and expert processors, however, should supplement visual examination or a purity analysis report with the use of hand screens. Hand testing screens are available in the same perforation types and sizes as are the cleaning screens. A small investment in a set of hand screens covering the range in perforation types and sizes used for the kinds of seed handled provides the best basis for screen selection and arrangement.

The use of hand testing screens to establish the "set-up" for an air-screen cleaner to clean a lot of seed requires some basic understanding - on the part of the processor - of cleaning sequences in multi-screen and air machines, and the function and characteristics of the several screen types (perforated metal, woven wire), perforation shapes (round, oblong or rectangular, square, triangular), perforation orientations (parallel, cross, diagonal) that are available, and the methods used to designate dimensions of the screen openings. If a processor does not understand the principles of sieving and the bases for screen selection and arrangement in seed processing, hand screen analysis and visual examination are of little value. He will have to set-up the air-screen cleaner according to the directions given in the operator's manual and hope that the seed lot cleaned is average.

**Screens and Screening**

The effectiveness and efficiency of the air-screen cleaner are largely dependent on proper selection and arrangement of the screens, and adjustment of the air systems. Two basic types of screens with several perforation (opening) shapes are used.

**Flat perforated sheet or plate metal screens** are available with round (circular) openings, oblong (slotted) openings, e.g., "rectangular" openings with rounded ends, and triangular openings. For screens with oblong or slotted openings, the long dimension of the slot is typically parallel to the direction of flow of material over the screen. A "cross-slot" arrangement, however, is also available in a limited number of sizes. The long dimension of the openings in a cross-slot screen are at right angles to the direction of flow.

The sizes of round openings in perforated metal screens are measured - and designated - in terms of the diameter of the opening. For openings $5\frac{1}{2}/64$-inch or greater in diameter, the sizes are expressed in 64th of an inch using only the numerator of the fraction. Thus, No. 6 and No. 18 round hole screens have openings 6/64ths and 18/64-inch in diameter, respectively. For round hole screens with openings less than $5\frac{1}{2}/64$ths inch in diameter, the size of the opening is measured in fractions of an inch using the full "fraction", e.g., 1/12th, 1/13th, ....... 1/25th inch. The method of measurement and designation of screens in the smallest size range changes from 64ths of an inch to fractions so as to permit a finer gradation in size without having to resort to complex and cumbersome numerators for 64th-inch fractions.

The sizes of oblong or slotted openings are designated in terms of width and length of the opening. The width designations are similar to
those for round openings, i.e., openings 6/64th of an inch wide or greater are designated in 64ths of an inch using only the numerator, while openings less than 6/64ths-inch wide are designated in fractions of an inch. The length of the slot is designated in fractions of an inch. Common lengths are 1/4-, 5/16-, 1/2-, and 3/4-inch. In designating the size of slotted openings the width is listed first. Thus, a screen designated as 6 x 1/2, has openings 6/64ths-inch wide and 1/2-inch long.

Two systems are used for measuring and designating the size of triangular openings. In one system the size is designated as the length of the side of the triangle, which is equilateral, in 64ths of an inch. The numerator is usually followed by the word TRI. Thus, a 9 TRI screen has triangular perforations measuring 9/64th-inch along each side. The other system measures and designates the size of the triangular opening in terms of the diameter of the largest circle, in 64ths of an inch, which can be inscribed (fitted) within the triangular opening. The numerator is usually followed by the letter V, e.g., 5V, 7V, etc.

The second type of flat screen used in seed cleaning is the wire-mesh screen. Woven wire mesh screens are available with square and rectangular openings. The sizes of both opening shapes are measured and designated in the same manner, the number of openings per inch in each direction. A 16 x 16 wire mesh screen has 16 square openings per inch in each direction, while a 4 x 16 wire mesh screen has 4 rectangular openings per down the length of the screen and 16 rectangular openings per inch across the screen.

The choice of screen type - perforated metal or wire mesh - depends on the size and shape of the seed to be cleaned, the "closeness" in size and shape of the contaminants to the "good" seed and other factors. Wire mesh screens wear and "tear" more rapidly than perforated metal screens and require constant repair and/or replacement to do a good job of cleaning. On the other hand, the number of openings per unit area, hence opportunities for separation, is much greater in wire mesh screens that perforated metal screens with openings of equivalent size. Furthermore, the "irregular" surface of woven wire -in contrast to the smooth surface of a perforated metal screen - agitates the seed mass permitting a closer and better job of "sifting". The greater number of openings per unit area and the surface irregularity of wire mesh screens make them especially useful in cleaning some of the smaller seed.

Screens with round, square, and triangular openings separate seeds or other particles on the basis of differences in width (flattened and/or elongated seed) or diameter (spherical and "roundish" seed). Oblong or slotted and rectangular wire mesh openings separate seed on the basis of thickness (or thinness). The differences between the thickness and width dimensions of a seed can be illustrated with corn seed. The dimensions of a corn seed are length (tip to top), width (side to side) and thickness (front to back). Wide kernels of corn are separated from narrower kernels with round hole screens of appropriate
size, while thick kernels are separated from thinner kernels with a screen with oblong or rectangular openings.

Although most separations made with screens can be strictly interpreted in terms of differences in length, width and/or thickness, differences in gross size and shape are also involved in a practical sense.

Seed differing in length but similar in width and thickness cannot be efficiently separated by screens, e.g., vetch and wheat seed, de-spined cockleburs and acid delinted cottonseed. Special machines such as the disc separator and the indented cylinder are required to separate short from long seed that are similar in width and thickness.

Operationally, there are two basic types of screen separations: scalping and grading (screening). In a scalping operation, the size of the screen openings is larger than the widest (or thickest) of the good seed. All the good seed and smaller material, therefore, drop through the openings while wider or thicker contaminants and other material are retained on the screen and flow over it. Scalping can be further subdivided into rough scalping and fine scalping. For rough scalping the size of the screen openings are substantially larger than the widest or thickest good seed. Material considerably larger than the good seed are retained on and move over the screen, while some of the material a little larger than the good seed, the good seed, and smaller particles drop through. For fine or close scalping, on the other hand, a screen with openings just larger than the largest good seed is selected to remove a maximum amount of the large material. Rough scalping can be performed at a much higher rate (capacity) than close or fine scalping, hence, rough scalping is usually the basic operation in pre-cleaning and the first operation in basic cleaning.

In grading operations, the size of the openings are smaller than the smallest of the good seed. The good seed, therefore, are retained on the grading screen while smaller material such as immature seeds, small weed seed, "fines", splits, etc., drop through the screen. Grading or screening operations can be further subdivided into rough and fine or close grading in a manner similar to that described above for scalping.

Seed are cleaned in the air-screen cleaner by a series of scalping and grading operations and, or course, by aspiration. The usual sequence or arrangement in a 4-screen air-screen cleaner is rough scalping, rough grading, close scalping and close grading. Alternative arrangements, however, are often required for the different kinds or lots of seed depending on the nature of the material that has to be removed.

The Basic Cleaning Operation

Emphasis has been on the capabilities, features and components of the air-screen or basic cleaner, screen types and perforation shapes, and basic principles of screening. This review has provided the back-
ground needed for discussion of basic cleaning procedures and operations.

Before turning to basic cleaning operations, pre-processing examinations and analyses should be re-emphasized. The pre-processing examination can be as simple as a quick visual inspection of the seed to be cleaned, or it may involve a complete purity test and hand screen analysis. Regardless of its complexity, the pre-processing examination has three main purposes: (1) to determine the types and quantities of contaminating materials that need to be removed to achieve desired purity standards; (2) to provide the information needed for selection and arrangement of screens; and (3) to identify cleaning problems that require special handling, i.e., use of other machines. The limited time spent in looking over and thinking about the cleaning needs of a seed lot before processing contribute to the effectiveness and efficiency of cleaning.

The manufacturer's recommendations are a good starting point for selection and arrangement of screens. Precision cleaning, however, requires modification and adaptation of these recommendations - as suggested by the pre-cleaning examination and hand screen trials - so they will best apply to the seed lot to be cleaned.

In a typical 4-screen, 2 air system cleaner, seed are cleaned in a series of operations involving screenings and aspirations. The function of each operation can best be understood by considering them in the usual sequence.

Top Air: Aspiration is the first step in cleaning. The top air is adjusted to remove dust, other fines and light chaffy materials. In some cases, the top air can be used to remove material normally removed by screening; for example, splits from soybean seed. Whole, good seed should never be removed with the top air!

1st Screen. The first screen is the first or rough scalper. Its function is to remove contaminating materials that are substantially larger in any dimension than the good seed such as pieces of stem, other roughage, soil peds, and unthreshed pods and heads. The openings in the first scalper should be sufficiently large to drop all of the good seed through the upper one-third of the screen.

2nd Screen. The good seed and other material drop through the first scalper onto the second screen which is the first or rough grader. The screen openings are substantially smaller than the smallest of the good seed but large enough to permit the smaller contaminants to drop through. The openings of this screen are usually the smallest in the machine. Maximum effective capacity is obtained when the first or rough grading screen is covered with an uniform layer of seed, one seed in depth at its discharge end.

3rd Screen. The third screen is the second or close scalper. Its openings are usually smaller than those of the first or rough scalper.
and often of a different shape. The close scalper "scalps off" contaminants larger than the good seed which passed through the rough scalper because of size or shape. The material removed might include large, misshapen seeds of the kind being cleaned as well as large weed seeds, large crop seeds, and other material larger than the good seed.

4th Screen. The fourth screen is the second or close grader. Its openings are closer in size to the good seed than those of the rough grading screen. Materials smaller than the good seed but which were too large to drop through the first or rough grader are removed. The materials removed include fragments and splits of the seed being cleaned, immature seed, small weed seeds, and other small material.

Bottom Air. The final separation in an air-screen cleaner is made by the bottom air blast. The bottom air should be adjusted so that a few good seed are removed. This will ensure that a maximum number of immature, deteriorated, insect damaged and other low quality seed are removed, thus, improving germination and appearance.

As previously stated, the screening sequence outlined above is the usual one, rough scalping, rough grading, close scalping, close grading. This sequence, however, should not be considered as fixed or absolute. Other sequences may be required for precision cleaning of specific kinds and lots of seed depending on whether the bulk of the contaminating material in the lot is larger or smaller than the good seed. In cases where most of the contaminants are larger than the good seed, aspiration and the 4th screen (close grader) can handle the small quantity of small material, the first three screens can be set up to do rough, close, and very close scalplings. The reverse would be true in cases where the bulk of the contaminants are smaller than the good seed except that the fourth screen is always a grader. Although the two grading screens usually have openings of different size, this need not always be the arrangement. In lots with a high concentration of small contaminants, it might be advantageous for the two grading screens to have the same size openings.

The perforation shapes for each of the screens are selected on the basis of the shape of the good seed and the characteristics of the contaminants.

Round or Spherical Seed. Round hole scalping and slotted or rectangular opening grading screens are usually used to clean round, spherical, or near spherical seed such as soybeans, hairy vetch, crimson clover. The round perforations of the scalpers drop the good seed while long and large materials ride over. The slotted or rectangular openings of the grading screens hold up the good seed while permitting thinner material such as long weed seeds, splits, etc., to drop through.

Long Seed. The "book rule" for screen perforation shapes in cleaning "long" seed is slotted or rectangular perforations for both the scalping and grading screens. This rule holds for some of the long thin
grass seeds such as fescue but not always for the larger, elongated seed such as rice, oats, wheat, etc. In the case of the latter, the first scalper usually has round perforations, while the first grader has slotted or round perforations, and the second scalper and second or bottom grader have slotted perforations. The point is there is no rule on perforation shape that should be followed invariably. The perforation shapes selected should be the one(s) that do the best job of cleaning consistent with reasonable capacity.

The main adjustments on an operating air-screen cleaner are rate of feed, upper air, screen shake, screen pitch and bottom air. The uses and adjustments of the air systems were briefly considered above. Feed rate is very important. The rate of feed should be slow enough to permit precision cleaning. Over-feeding floods the screens and reduces the effectiveness of the separations, while under-feeding is wasteful in terms of capacity.

The rate of screen shake or the frequency of vibration of the screens has a great influence on screening effectiveness. A proper rate of vibration causes the seeds to turn and tumble, thus, presenting all dimensions of the seed to the screen openings and contributing to the effectiveness of sifting. Too rapid a vibration, however, causes the round and heavy seed to bounce over the screen rather than sift through and reduces the effectiveness of sifting. The rate of vibration adjustment, therefore, is best determined by the results produced. The most common error appears to be too rapid a vibration or shake, apparently deriving from the mistaken belief that increasing rate of vibration is the way to increase capacity. It isn't, as long as the seed flow uniformly down the screen.

Screen pitch or the inclination of the screens does have an effect on capacity. Generally, the steeper the pitch, the faster the seed move over the screen and the greater the capacity. The pitch adjustment should be related to the difficulty of the separations to be accomplished. Difficult separations which are to be effected by very close scalping or grading require that the seed remain on the screen as long as possible to give all undersize seed or materials an opportunity to pass through. In such cases, a lesser screen pitch is needed. On the other hand, if the separation is relatively easy, a steeper pitch will probably not affect the separation, but will increase capacity. Since each screen performs a somewhat different function, pitch adjustments should be considered on an individual screen basis.

Precision in Basic Cleaning

The precision of the basic cleaning operation is determined by the purity standards to be achieved, the nature of the contaminating material, and the availability of other, more specialized cleaning equipment. The economic facts are such that in many cases a seedsman cannot justify the time and seed loss involved in cleaning certain kinds of seed to the highest possible purity unless the market supports a proportionately higher price for super-clean seed.
The time and effort involved in cleaning to the highest possible purity can usually be justified, of course, when noxious seed have to be reduced to a legally established concentration for the seed to be salable. Frequently, however, the removal or reduction in concentration of a specific contaminant can be more efficiently accomplished with one of the specialized "finishing" machines rather than the air-screen cleaner, if or when they are available. As a general rule, the basic cleaning operation should not be specially adjusted to attempt a separation for which it is poorly adapted, when there is another machine in the processing line which can make the separation with ease.

There are several very useful procedures for increasing the precision of the basic cleaning operation for certain kinds or lots of seed. Removal of split seed from lots of large seeded legume seed can be improved by using a screen with "cross-slot" perforations as the final grader instead of a "regular" slot. The long dimension of the slot or oblong opening in a cross-slot screen is at right angles to the direction of seed flow, rather than parallel to it as is the case with regular slotted screens. The cross slot presents the opening in the best position to intercept a split as it moves down the screen.

An oil cloth (slick side down) or canvas apron can be fitted above the top scalping screen to keep long contaminants from turning on end and dropping through the screen and to minimize the number of good seed that "bounce" down the screen and into the top scalplings. These procedures are especially useful in cleaning large round seed such as vetch and soybeans.

When the screen perforation size and shape of the top scalper is such that essentially all the good seed drop through in the upper third of the screen, "blanking" the bottom half of the screen will minimize the amount of long thin scalpings that turn on end and drop through.

In situations where close separations have to be made, the time and action of the seed on the screen is very important. The use of wooden or metal slats across the screen to "dam" the seed flow can increase the effectiveness of the separation. In combination with proper screen pitch and speed of vibration, the dams increase the seed time and "action" on the screen, thus providing maximum opportunity for each seed to contact the openings.

Experienced processors periodically inspect the clean seed and the "screenings" to monitor the effectiveness of the cleaning operation. Many seed lots are not very uniform in terms of the concentration and type of contaminants. Some readjustments, therefore, may be necessary from time to time to maintain cleaning effectiveness at the desired level.

Periodic inspection of the clean seed and screenings also aids in identifying mechanical problems such as "tears" in a screen, or inactive or worn brushes, or other screen cleaning devices. Such conditions should, of course, be identified during the routine but close inspection of the cleaner at the beginning of operation each day and
at intervals thereafter. Effective and efficient cleaning is hardly possible unless the cleaner is properly maintained.

One of the most frequent causes of "poor cleaning" is over-feeding - trying to cram the maximum quantity of seed through the cleaner to meet delivery schedules, or some established output schedule. Most cleaning is a compromise between capacity and effectiveness, but the scale should not always be tipped on the capacity side. Air-screen machines are excellent for cleaning seed, but are very inefficient and expensive conveyors.

Poorly designed air ducting and dust collection systems are another cause of inefficient and ineffective cleaning. The top and bottom air systems in an air-screen machine are designed to remove certain material in the cleaning operation. Improper ducting from the cleaner can create back pressures or turbulence which reduce the effectiveness of aspiration and create dust problems. Sharp angles in the ducting should be avoided.

Properly adjusted and operated, the air-screen machine can clean most seed lots to a high level of purity. Other types of processing and cleaning equipment, however, are usually required to fully meet purity standards and/or to prepare the seed for marketing. These specialized or "finishing" machines are installed as elements of the "processing line" permitting the clean seed coming from the air-screen cleaner to be routed through the one or more machines required for complete processing.

Summary

Basic seed cleaning encompasses pre-cleaning and pre-conditioning as well as the basic cleaning operation. Basic cleaning is accomplished with the air-screen cleaner. The air-screen cleaner is a versatile machine which, if properly understood and operated, can clean many seed lots to the desired level of purity. When this is not possible, cleaning must be completed with other more specialized equipment.