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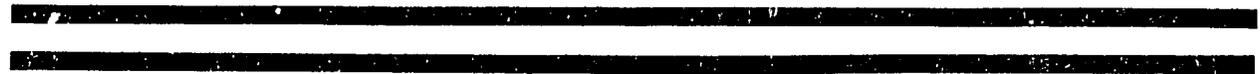
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QUALITY CONTROL IN
PROCESSING FOUNDATION SEED

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**QUALITY CONTROL IN PROCESSING^{1/}
FOUNDATION SEED**

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Quality control, as a system of accepting all units within established tolerances and rejecting all outside these tolerances, is the basic principle behind our production system. Our assurance that cars and equipment will perform as expected, with relatively trouble-free operation depends upon quality control. The nutritive value and safety of our food, the quality of clothing, the safety and effectiveness of medicines, all depend on quality control systems.

Certification itself is a quality control system designed to serve the seedsman who produces and sells seed, and to serve the farmer who buys seed. Regulations on seed stocks, generations, field standards, and labeling requirements are the certification tolerances which distinguish between the "accepts" and the "rejects."

Foundation seed are the heart of certification, and quality control must be a major part of every Foundation seed program. Anything less than the highest quality breaks down the certification system, and causes financial loss to seedsmen, farmers, and taxpayers.

Certification regulations establish field and laboratory tolerances for Foundation seed.

A serious gap in continuous quality control of Foundation seed is the general lack of acceptable guidelines for processing. Generally processing is left to the individual program.

Foundation seed programs must produce many small lots of a wide range of crops and varieties. These often include small lots of new crops, or crops not ordinarily grown for seed in that particular area. Such conditions complicate the problems of seed production, and generally require actual upgrading of seed quality during processing.

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Quality control in seed processing can be spelled C-A-R-E. It can be effective only when it is based on a well-planned, organized processing facility which can produce acceptable seed when operated properly. Such a facility is itself most of the quality control system, so this discussion is limited to processing plant factors affecting seed quality.

The purpose of processing is to remove undesirable materials from field-run seed, alter seed condition to improve plantability, apply protective chemicals, and package them in easily-handled and marketable containers. In such an operation, quality control should be concerned with three phases:

1. Removing undesirable materials
2. Preventing contamination
3. Maintaining lot identity

Each of these is a separate part of the processing plant and its efficient management.

I. Removing undesirable materials

During processing, seed are moved through machines which remove material to improve seed purity, germination, or plantability.

Processing operations can be divided into several steps in a specific sequence. First is RECEIVING seed into the processing plant. Seed may then go into STORAGE for later processing, or go directly into processing.

The first operation is CONDITIONING AND PRECLEANING. This includes removing appendages from the seed, removing large pieces of trash, or hulling the seed.

The next step is BASIC CLEANING. The air-screen machine is the most common basic cleaner. Some seed come from the field in good condition and require only cleaning on the air-screen machine.

It is usually necessary to use special SEPARATING OR UPGRADING machines to remove a specific contaminant. These separate crop and weed seed by differences in physical characteristics.

When all undesirable material has been removed, the seed are ready for BAGGING. A fungicide or insecticide TREATMENT may be applied

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before bagging. The seed may then be SHIPPED directly to certified seed growers, or held in STORAGE until they are needed.

Complete processing depends on differences in physical properties of seed. If a difference exists and a machine is available which can distinguish between the seed at an efficient capacity, they can be separated. As a means of guaranteeing seed quality, Foundation seed programs should have available complete selection of machines to separate seeds differing in SIZE, LENGTH, SHAPE, WEIGHT, SURFACE TEXTURE, COLOR, AFFINITY FOR LIQUIDS, or CONDUCTIVITY. No single machine can separate seeds that differ in all these characteristics.

SIZE is the most common difference between seeds. The air-screen machine - the basic seed cleaner - uses a series of perforated sheet metal or woven wire screens to separate seed of different sizes. One or more air blast separations then remove light material.

Two types of screen sizings are made: (1) scalping, in which good seed drop through the screen openings while larger material is carried over the screen to a separate spout, and (2) grading, where crop seed ride over screen openings while smaller particles drop through the screen. A series of scalping and grading screens can remove all material larger or smaller than crop seed. The heart of the air-screen machine is the 200-plus different sizes and shapes of screen perforations available.

WIDTH AND THICKNESS are used to grade hybrid seed corn and to separate many weed or other crop seed. Width and thickness separations are made by turning a seed on edge, or standing it on end, to present its width or thickness dimension to a screen perforation. Seed below a certain width or thickness drop through the perforation; larger seed will not go through, and go out a different discharge spout.

LENGTH differences are common among seed, and are frequently used to remove undesirable seed. The indented cylinder and the disk separator make length separations. The indented cylinder separator is a revolving cylinder with many small indents in its walls. Seed are fed into the cylinder as it turns, and each seed has an opportunity to fit into one of the indents and be lifted. Long seed will not fit completely into the indents, so they are not lifted as the cylinder revolves. Shorter seed will be lifted, dropped into the liftings trough, and carried out a separate spout.

The disk separator is a series of revolving disks. Each disk is a cast iron wheel with many small undercut pockets cast into its sides.

As the disk turns through a mass of seed, each seed has a chance to sit in a pocket. Long seed will fall out; short seed will sit inside the pocket and be lifted up out of the seed mass and dropped into a separate discharge spout.

Seed enter the machine at one end, and move through the series of disks. Each disk rejects or lifts out seed as the mass moves through the machine. A series of disks with different pocket sizes can make several length grades in one machine.

SHAPE varies widely among seeds. The size separation made by the air-screen machine uses some differences in shape, especially when triangular-hole screens are used. The indented cylinder and the disk separator also use shape to some extent as a function of length. However, the spiral separator specifically separates round-shaped from flat-shaped seed.

The spiral separator is a simple vertical series of spiraled flights. A mixture of flat and round seed is fed onto the top of the inner spiral. As the mixture moves down the spirals, round seed roll faster and their velocity increases until they jump over the edge of the inner flight of spirals, into an outer flight where they go out a separate discharge spout. Flatter seeds cannot roll fast enough to jump into the outer spiral, so they slide down the inner spirals to a discharge spout. Flat and round seeds are thus separated in the spiral separator by differences in ability to roll.

SURFACE TEXTURE - relative roughness or smoothness of the seed coat - is a common difference between seeds. The roll (dodder) mill and the draper belt separate seeds that differ in surface texture. The magnetic separator, the buckhorn machine, and vibrator separator also use some differences in surface texture to separate seed.

The basic unit of the roll mill consists of two long cylinder-like rollers, covered with a velvet or flannel material, mounted side by side so that they touch down their entire length. They are mounted at a slight angle from one end to the other. A mixture of smooth and rough seeds is fed onto them at the high end. As the rollers revolve up and out, rough seeds are caught by the nap of the velvet or flannel roll covering, and are thrown up against the side of a curved shield mounted above the rollers. Seed strike the shield at an angle, bounce back and hit the roller at a higher position than that from which they started. The rollers continue to catch seed and throw them against the shield, until rough seed are carried up over the edge of the rollers and fall into a separate discharge spout.

Smooth seed are not affected by the nap of the roller fabric, so they slide down to the lower end and drop into a discharge spout.

The draper belt is a tilted flat-surfaced belt that moves uphill. A mixture of rough and smooth seed is fed into its center. Smooth seed cannot get a solid footing on the moving belt, so they slide downhill and fall off the low end. Rougher seeds can come to rest on the moving belt, and are carried upward and fall off the upper end of the belt. Absolute differences in surface texture such as the roughness of dodder and smoothness of alfalfa are not necessary for a separation by the draper belt or the roll mill. Sharp edges, sharp points, or projections on many seeds are sufficient for a separation.

Many seeds differ in COLOR. More color separations by electronic color sorters are made each year, particularly on larger crop seeds. These machines pass each seed before an electronic sensing device which compares the seed with an electronic pattern or color background. If the seed's color is acceptable, it is allowed to fall into the good seed spout. If the seed color is not in the acceptable range, a compressed-air nozzle blows the seed out of its normal flight path into a separate discharge spout.

Color sorters have relatively low capacity, but their versatility makes them valuable to Foundation seed programs.

Seed also differ in AFFINITY FOR LIQUIDS, or the ability of their surface to absorb liquids. The magnetic separator and the buckhorn machine separate seeds by this difference. The magnetic separator feeds the seed mixture into a mixing chamber where a small amount of water or other liquid is added. Some seeds absorb moisture and become damp, while others do not.

Finely-ground iron powder is fed into the mixing chamber and blended so that each seed has a chance to contact the iron powder. If the seed held moisture, it will hold powder. The seed mixture is then passed through a magnetic field. Seeds which absorbed moisture and held iron filings are attracted by the magnet, and are carried out to a separate discharge spout.

The buckhorn machine is very similar in operation, except that it uses finely-ground hardwood sawdust or bark instead of iron powder.

When moisture comes into contact with a seed such as buckhorn, the seed surface becomes sticky, which causes sawdust to stick to the

seed. A moistened buckhorn seed ends up in the center of a ball of saw-dust, and can be removed by a gravity separator or an air-screen machine.

Many seeds differ in WEIGHT or SPECIFIC GRAVITY. The gravity separator, the stoner, the aspirator, the pneumatic separator and the air blast of the air-screen machine all make separations by weight differences.

Weight separations are made in comparison with a standard such as a moving stream of air. Seed of different specific gravities are fed into the air stream. The air is adjusted so that light seeds are lifted up by the air blast, while heavier seeds are not lifted and settle down through the air stream.

The specific gravity separator separates seed on a perforated deck with an adjustable air stream moving through it. The air stream is adjusted to lift light seed while heavier seed lie on the deck surface.

Then the stratified layers of seed are separated by the inclination and reciprocating motion of the deck. Since the deck surface is mounted at a slight angle, light seeds held up by the air move downhill and discharge from the low side of the deck. Heavy seeds lie on the deck surface, and the reciprocating motion tosses them uphill until they are carried to the high end of the deck to a separate discharge spout.

The gravity makes a graduated separation from the lightest seed at the low end of the deck to the heaviest seed at the high end of the deck. The stoner, however, makes only a two part gravity separation--a heavy and a light fraction. The seed mixture is fed onto the center of the deck while an air stream moves through it. Air stratifies the seed so that light seed flows to the downhill end. Deck motion moves heavy seed toward the high end. The stoner will separate rocks from beans, sand from clover, and salvage good seed from waste products coming off the high end of the gravity separator.

Both the gravity separator and the stoner operate by passing air through a mass of seed. The aspirator and pneumatic separator make a similar separation on a seed-by-seed basis. They lift light seeds up through an air column into separate discharge spouts. Heavier seeds fall through the air blast into a discharge spout.

The aspirator pulls a negative-pressure air stream through a separating column. The pneumatic separator forces a positive-pressure air blast through a separating column.

Seeds also differ in their ability to hold or CONDUCT AN ELECTRICAL CHARGE. Many conditions affect a seed's conducting properties, but differences between seeds can be used to make some difficult separations. A typical electrostatic separator has a conveyor belt which carries a single layer of seed beneath an electrode where either of two types of separations may be made. In the pinning separation, the electrode sprays a high intensity electrical charge onto the seed. Poor-conducting seed absorb and hold a charge, stick to the grounded conveyor belt and are carried to a discharge spout. Good-conducting seed lose their charge readily and drop into a separate spout.

The second type, the lifting separation, passes seed through an electrical field created by a different type of electrode. Here, charges in the seed are rearranged, and some seeds are attracted to the electrode and are lifted into a different flight path as they fall from the belt. Other seeds react less to this electrical field and follow a normal flight path to a separate discharge spout.

These separators are the tools by which seed quality is controlled and improved during processing. A Foundation seed program should have and use all separators needed to keep seed quality high.

II. Preventing contamination

The weakest point in most seed programs is the care taken to prevent contamination or mixing of seed during processing. The processor is always under pressure at harvest-time to receive and clean seed as rapidly as possible. All equipment must be completely cleaned before a new lot is introduced, but this takes valuable time and the processor is always tempted to take short cuts.

Foundation seed programs cannot afford to take shortcuts, but they are under the same pressure to do the most in the least time. Careful cleanup cannot be overlooked or given sloppy, half-hearted attention. The time required for a complete cleanup can, however, be cut to a fraction of the usual time by effective design and arrangement of the plant, and by efficient management during processing.

Care in design and layout of a processing plant and in equipment selection and installation can eliminate many potential sources of contamination. Many changes can be made in existing plants to eliminate sources of contamination that increase cleanup time. A few of these are:

1. General plant

a. Floors

Floors should be smooth, easily swept, without cracks or rough spots that hold seed. Concrete floors should be smooth-surfaced and finished with floor sealer. Wood floors can be covered with tempered masonite or similar materials to eliminate cracks.

b. Walls

Walls should be smooth, at least up to the height to which seed bags or boxes are stacked, or to which seed can spill or scatter. Studs of frame walls should be covered to eliminate corners which hold seed and are hard to clean.

c. Cleanup equipment

Every plant should have at least one heavy duty industrial vacuum cleaner and an air compressor delivering air under at least 150 PSI pressure.

2. Bins

- a. Inside of bins should have no cracks or ledges where seed can lodge. Wood or cribbed bins should be lined with sheet metal, with overlapping edges of the sheet metal all pointed downward on the inside to avoid ledges, and all edges and seams brazed or soldered smooth. The ideal bin is made of heavy sheet metal, welded on the outside, and reinforced with angle iron mounted on the outside, so that its inside surface is completely smooth and free of cracks and ledges.
- b. Inverted angle iron, or wood cut in an inverted "V" shape, should be mounted on top rims of bins to eliminate ledges. The bin discharge gate should be removable so the slides holding it in place can be cleaned. The end of the slides should be left open for easier cleaning.
- c. Bins should not be mounted side-by-side with common walls, because of the danger of seed spilling over into adjoining bins. The feed spout into such a bin should extend well

below the top of the wall to avoid overflow. The feed spout should be kept in good condition so that it will not leak seed into other bins.

- d. Floor and roof supports immediately above bins should be sealed off or covered with inverted angle iron or "V" cut wood to eliminate ledges which hold seed.

3. Elevators and conveyors

- a. Where possible, self-cleaning continuous-bucket elevators should be used. Properly operated, these do not spill seed and are completely self-cleaning.
- b. Mixtures in belt-and-bucket elevators can be reduced by:
 - (1) Keeping the head and discharge spout in good condition to prevent scattering seed into bins or machines.
 - (2) Installing spacers between the belt and the buckets to reduce amount of seed lodging behind the buckets.
 - (3) Sealing off open ends of head and boot pulleys, or using pulleys with closed ends.
 - (4) Mounting the elevator a few inches above the floor, so that boot inspection slides can be opened for cleanout. Elevators should not be mounted in pits too small for cleanout access.
- c. Augers should not be used.
- d. Vibrating conveyors, properly used, are self-cleaning.
- e. Belt conveyors should be installed with ample space around them for easy cleanout.

4. Separators

Cleanout characteristics of separating machines cannot be altered greatly, but proper installation can reduce cleanout time. When possible, machines should be mounted above the floor on frames or posts for easier cleanout beneath them. Space must be left

around machines so that all trapdoors and inspection plates can be opened, and for ready access to all sides.

Discharge spouts and pipes should be installed for easy cleaning. Also, they should not spill seed onto the floor during operation.

Smaller machines with little vibration can be mounted on casters or on frames with casters. They can then be rolled out during plant cleanup.

5. Receiving facilities

Receiving elevators should be self-cleaning continuous bucket types. Receiving pits can be constructed without cracks or ledges in the corners or on the covering grate.

Toteboxes loaded from the combine, trucked to the plant, and moved by forklift directly into storage eliminate at least one handling of the seed, and offer less opportunity to introduce contaminants.

6. General management

General cleanliness in the plant should be stressed to keep plant personnel constantly aware of the necessity of preventing mixtures. Floors, corners, ramps, and similar areas should be kept well-swept. Dust or dirt should not be allowed to accumulate on ledges, machines or building structures. Unused screens, machines, pallets, boxes and other equipment should be cleaned before they are stored.

When harvest of different fields can be controlled to some extent, receiving and processing can be scheduled to reduce number of cleanouts.

Only one variety or lot should be in the processing area at any one time. Seed awaiting processing should be kept in the storage area.

III. Maintaining Lot Identity

The importance of complete identity of every lot and bag of seed at all times is obvious. Lack of identity and traceable records on a lot would defeat the basic purpose of certification.

Since both the condition and the containers of seed lots are changed during processing, adequate records and proper labeling during processing are essential.

A. Records

Complete processing records trace the seed from the time it is received at the plant until it is sold or shipped, with full details of all operations. A processing plant record system includes full records on:

1. Receiving
2. Drying and/or temporary storage
3. Processing, treating and packaging
4. Testing
5. Storage
6. Inventory
7. Shipping/sales

B. Labels

1. An efficient lot numbering system which will maintain separate identity of each lot is essential. A system of coded lot numbers can show any necessary information including crop, variety, field number, year grown, and individual lot.
2. Each incoming container of unprocessed seed should be labeled with both tags and stencils or container numbers.
3. Records should indicate the identity of the lot in the cleaning process at any given time. Storage bins, handling bins, and toteboxes should be numbered, and identity of bins or boxes used should be entered in the records.
4. Each cleaned-seed container should be stenciled with at least a lot number, in addition to the tags attached to it.

5. Warehouse storage should be divided into smaller numbered areas as an additional safeguard. Clipboards, small blackboards, or signs should be attached to each warehouse stack for quick identification and inventory control, and to prevent accidental delivery of the wrong lot.
6. Color coding of bags or stencilled lot numbers helps identify seed by variety or crop.

Equipping and managing your processing plant to remove all undesirable materials in the seed, to prevent contamination of seed in the plant and to keep complete identity of each bag of seed at all times is the best possible quality control system. It is an essential part of every Foundation seed program.

IV. Basic Quality Control

After management techniques and processing have been upgraded to improve quality and maintain identity, a quality control system is easy to develop and operate. Such a system should help identify problems affecting seed quality, how they can be corrected in current seed lots, and how they can be prevented in future lots. The basic steps in a simple quality control system include:

1. Sampling all incoming field-run seed.
2. Analyzing the samples to evaluate seed purity and germinability, and to identify all factors which reduce seed quality.
3. Using this information to get more efficient processing, and to prevent recurrence of the problem.
4. Sampling and analyzing at all stages to evaluate the effectiveness of each operation.

A. Sampling

Sampling techniques used for bulk grain and bagged seed can be used to draw representative samples of field-run seed.

B. Sample Analysis

After the sample has been drawn and before the lot is processed, the sample should be completely analyzed and evaluated.

Analysis and evaluation tests which can be conducted to provide quality control information include:

- (1) Performance tests
 - germination test
 - vigor test
- (2) Purity and mechanical condition tests
 - moisture test
 - analysis-classification test
 - sample separation test

Germination, vigor, and moisture test procedures are standardized and well-known. The analysis-classification test, however, provides basic information beyond standard purity classification, so it must be more comprehensive than the usual purity analysis. Its purpose is to separate into groups and identify all classes of materials which affect seed quality.

Exact classification of each particle in the analysis-classification test will depend upon its effect on seed quality, and will vary among crops. For example, a commercial seed company divides garden pea samples into the following types of materials which affect seed quality:

- (1) Full-size crop seed of healthy, normal, true-to-type appearance
- (2) Free foreign material
- (3) Adhering foreign material
- (4) Mechanically damaged seed
- (5) Insect-injured seed
- (6) Physiologically-damaged seed
- (7) Mixtures and offtypes

Each type of material must be evaluated to determine how it affects seed quality, and if it should be eliminated or prevented. Information obtained from this evaluation should answer these questions:

- (1) What is the material or damage?
- (2) What effect does it have on seed quality?
- (3) When did it get in, or happen to, the seed?
- (4) Can it be removed in the normal processing operations?
- (5) Is specialized processing required to remove it?
- (6) Is it impossible to remove?
- (7) Will specialized seed treatment or handling be required to minimize its effects?
- (8) What can be done to keep it out of future lots?

C. Eliminating the Problem

This information can then be used to adjust, alter, or add to processing and production operations to eliminate the problem in the current lot, and prevent its recurrence. This may involve using different screen sizes, discarding more low quality seed from the lot, adding a machine to the processing line, readjusting the combine, or even changing field production or weed control practices. Once the problem, its nature, and its source have been identified, however, it can be eliminated.

D. Continuous Sampling and Analyzing

Samples should be drawn and analyzed from each processing machine or operation so that both good seed and waste products can be thoroughly evaluated. These questions should be answered:

- (1) Is the problem being removed?
- (2) Are too many good seed being lost?
- (3) Should more seed or material be removed?
- (4) Is this processing step necessary and effective?
- (5) Are additional processing steps necessary?

Every Foundation seed program should have some quality control system. Sample analysis and evaluation can be done either under a working arrangement with a testing laboratory, or by the program's own facilities. Equipment and trained personnel to do its own quality control work should be a regular part of the program. Basic quality control facilities need not be elaborate and usually require only a small investment, but they will probably pay higher returns in the long run than any other phase of the program.