QUALITY CONTROL - A MANAGEMENT TOOL

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In the seed industry as with any industry supplying products for sale to consumers, control of product quality is an extremely important factor in establishing and maintaining a productive and profitable business operation. Today's agricultural environment, coupled with seemingly ever increasing operational costs to the farmer, have and are continuing to result in increasing demands for better quality seed products. To meet these market demands, seed companies must be concerned about quality control programs designed to provide as uniformly high quality seed as possible while still realizing a reasonable profit.

Because of current market demands and pressures for better quality seed, all seed companies, regardless of size, must have some type of quality control program if they expect to remain in business. During the past 20 years many changes have occurred in farming operations and a large number of these changes are dependent on the use of high quality seed for success. Members of the seed industry, whether they are the large companies with world-wide markets, or the small, locally-owned company with a market over one or two counties, must acknowledge these changes and the resulting increase in demands for better quality seed. Quality control is thus an important management tool for all seed companies, for it is through such programs that a company is able to provide the level of seed quality which their customers are seeking.

Every seed company has certain minimum seed quality standards they are required to meet. These are the standards set forth in the various state and federal seed laws. A seed company's commitments to quality control and providing seed quality above the legal minimums will vary, depending on a number of factors, such as company size, crops involved, market demands, advances in cultural techniques, and technological advances in processing and methods of measuring quality. Much of the seed marketed in the United States today exceeds the minimum legal germination levels which means that many seed companies have some type of quality control program designed to provide improved seed quality.

Several basic steps are necessary for a seed company to establish or expand a formal quality control program. These steps include:

1. Management decision to strive for improved seed quality.
2. Identification of objectives and goals of quality control program, including areas where quality is important.
3. Establish organization necessary to meet goals and objectives.
4. Establish operational procedures and standards for improving and controlling seed quality.

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Figure 1. Quality control is an important component of seed operations.
Use of quality control programs as a management tool in the seed industry, requires consideration of all of the above points. I would like to discuss each of these points in more detail, placing primary emphasis on establishment of procedures and standards in a quality control program.

Implementation or expansion of a quality control program in a seed company requires some level of investment in personnel, facilities, and operating capital. The first step in proceeding with establishing or expanding a quality control program thus requires a commitment from a company's management group to make the necessary investments to implement and maintain a quality control program and to work toward improving quality of the seed products they market. After a company commits itself to a program to maintain and improve seed quality, the real task begins.

To identify objectives of a quality control program, consideration must be given to the various factors involved in seed quality. Seed quality involves four general areas and an effective quality control program must consider all of these areas.

1. Physiological quality
   A. Germination
   B. Vigor
2. Physical quality
   A. Purity
   B. Physical condition (mechanical damage, size, etc.)
   C. General appearance
   D. Moisture content
   E. Freedom from insects
   F. Plantability
3. Genetic quality
   A. Varietal purity
4. Pathological quality
   A. Freedom from seedborne diseases

To identify objectives for a quality control program, a company must first review each of the above areas in terms of what is currently being done. This then establishes a base on which to build or expand a company's quality control program. As was mentioned previously, the basic objective of a seed company's quality control program is to provide as high seed quality as is possible and/or practical while still realizing a reasonable profit. Inputs are necessary from all phases of a seed company's operation to identify objectives and goals of a quality control program, but the final decision rests on the company's management. There is frequently a delicate balance between cost and quality and it is up to management to consider these factors in determining the value of a quality control program and in establishing quality control objectives and company policies concerning quality.

After the objectives of a quality control program are established, the next step is to provide proper organization within a company to assure that the corporate quality control policies are translated into
specifics and standards. The most effective way to accomplish this is to establish a quality control department with a manager who is responsible for monitoring and controlling quality. For a small company, the quality control department may consist of one individual, while in larger companies a number of individuals may be on the quality control department staff.

A manager may be defined as an individual who accomplishes an organization's or company's objectives through other people. A quality control manager is thus an individual who implements company quality control policies and assures that corporate quality objectives are met by utilizing services of personnel throughout the company. Quality control involves personnel in nearly every area of a seed company operation from the plant breeder, to the field person, to the person in the warehouse and the person analyzing the final product. It is through the use of personnel throughout the company that a quality control manager assures corporate quality objectives are met. The primary function of the quality control manager is to collect quality information from various sources, review the information and assure that all seed distributed meets or exceeds corporate quality standards.

Other duties of a quality control manager may include:

1. Educating company personnel on quality control programs and procedures.
2. Reviewing and updating quality control programs.
3. Investigation of complaints.
4. Meeting with customers.
5. Recommending and establishing quality standards.

Translating corporate policies or objectives for seed quality into specifics or standards is the final step in establishing or expanding a formal quality control program. This is frequently a difficult task. Specific standards for seed quality are of value only if they can be and are controlled and are realistic in relation to cost. Thus, what is desired must be carefully weighed against what is possible or economically practical for each of the four general areas of seed quality - genetic, physical, physiological, pathological.

Sampling

Tests for the various attributes of seed quality are based on evaluation of samples; thus the first prerequisite to a good quality control program is a good sampling program. Results of quality tests are only as good as the sample on which they are based. It is therefore important that good sampling procedures be established and personnel involved in sampling be made aware of the importance of sampling and be educated on sampling procedures and standards. For quality evaluations to be meaningful, they must be conducted on samples representative of the bulk seed lot.
Genetic Quality

Genetic Quality involves trueness to type or variety, or consistency in inherited characteristics. Genetic quality is important to the seed consumer because of field performance factors such as stand establishment, crop development, uniformity, and yield and resistance to diseases. If a consumer receives a variety which is not adapted to his area, is contaminated with high percentages of another variety which develops and matures differently or is susceptible to diseases common to the area, the grower may experience serious reductions in the productivity of the crop and possible total loss. Genetic quality is thus an important attribute of seed quality.

Maintaining varietal purity is a continuing program for seed companies. These maintenance programs include:

1. Renewal of planting stocks at breeder level.
2. Careful selection and isolation of production fields.
3. Close supervision of planting and harvesting operations.
4. Field inspection and roguing of seed production fields.
5. Careful handling of seed lots to prevent mechanical mixtures.
6. Conducting field trials or laboratory tests to confirm genetic quality.

For companies that do not have their own facilities for conducting plant outs, grow-out services are provided by several private companies in the United States. A seed company may engage services of these companies for seed lots where genetic purity is suspected of being a problem.

Standards for genetic purity may be established in several ways. For several types of crops, genetic purity standards are established by state agencies, particularly in the production of certified seed. Requirements for genetic purity are also specified in various Federal regulations. Establishing genetic purity standards within a company may be based on demands of users of a particular crop or they may be developed by the company through inputs from personnel in breeding, production and marketing. In development of genetic standards, consideration must be given to the undesirable off types for each species and standards developed which provide acceptable and realistic genetic quality levels. Genetic uniformity assures the grower maximum yields of top grade produce within the limitations imposed by variation of soil and other environmental factors, and is thus an important consideration in evaluating seed quality.

Physical Quality

Physical seed quality involves a number of different factors. One of the more important aspects of physical quality is purity of a seed lot. Purity of a lot refers to the content of material other than pure crop seed such as inert material, weed seed, other crop seed. Minimum levels of purity are set forth in various state and federal seed laws.
and for most crops purity information is required on seed labels. The higher the percentage of pure crop seed the better the quality.

Purity is determined by the seed analyst’s thorough examination of a representative sample. This analysis may be performed by a qualified company analyst or may be done through various public or commercial seed testing laboratories. Facilities required for conducting purity analysis vary with different crops, and the facilities and procedures used for small seeded species are more involved than for large seeded species. Some specialized equipment is required for conducting purities and personnel conducting the analysis must be well trained and qualified.

Other attributes of physical quality that must be considered to provide a uniform standard seed product include general physical condition (freedom from mechanical damage, seed size, etc.), general appearance, moisture content, freedom from insects, and plantability.

Facilities required to evaluate these attributes of physical quality will vary with different species and the degree of precision desired. Evaluation of seed lots for mechanical damage, general appearance and freedom from insects does not require elaborate equipment. These factors may be evaluated by visual examination under low power magnification and in some cases stains may be used to evaluate mechanical damage. Evaluation of seed size requires the use of hand screens and the number of screens required will vary with the number of species involved, number of sizes and the precision with which crops are being sized.

For larger companies that produce seed of a particular species at several locations, it is desirable to have samples from the different production facilities evaluated for physical quality at a common location. This is particularly important for attributes such as appearance, where individual judgement is involved in determining product acceptability. A centralized checking program provides better assurance of product uniformity and compliance with quality standards between processing locations.

Seed moisture content is an important quality factor to consider at harvest to assure that maximum seed quality is obtained and is a very important factor in assuring that seed quality is maintained in storage. For certain crops such as soybeans and garden beans, seed moisture content is also an important consideration in obtaining satisfactory germination and emergence under field conditions. The moisture content of seed may be determined by various types of electronic testers or by use of a drying oven and scale.

Assuring that seed can be planted with conventional planting equipment requires the use of planter check stands designed to simulate planting equipment that will be used in the field. For crops such as field corn and precision planted vegetables, assuring that the seed can be properly planted and providing planting equipment recommendations is an important quality consideration. Failure to consider plantability for space or precision planted crops will almost certainly result in customer complaints.
Establishing physical quality standards for seed first requires that the various types of tare or undesirable physical characteristics be identified and listed in order of importance in terms of potential sources of complaints or problems.

The next step is to consider each of the undesirable physical characteristics in terms of what can be done to prevent or remove the undesirable components from the crop. Once these two steps are completed, standards may then be developed for the various undesirable physical characteristics, which will provide better quality in terms of customer acceptance and are practical and attainable in terms of a company's ability to meet the standards. Generally speaking, with the seed processing and handling equipment currently available, high levels of physical quality may be attained with most kinds of seed.

To this point the discussion on physical quality has related primarily to the finished product and the impact in the market place. Information on physical seed quality may be used effectively as a management tool in seed company operations to assure that every dollar spent is for a definite and specific purpose.

Evaluation of crops before and during various stages of processing for physical quality, through an in-plant quality control program, assures that each processing step has a specific purpose and can reduce processing expenses by eliminating unnecessary processing operations.

Information on physical quality may also be used by seed companies as a basis for implementing changes in production, processing or handling procedures to eliminate sources of undesirable physical quality. This also can aid in reducing processing expenses.

Information from physical quality evaluations may be used effectively to upgrade the overall quality of a seed lot. Not infrequently a seed lot is not marketable because of low germination and/or vigor. For a number of species it is possible through evaluation of various physical attributes of a seed lot to upgrade germination and vigor sufficiently to permit the lot to be marketed. Routine checking of substandard lots frequently permits upgrading of physical and physiological quality to above standard levels.

Consideration of the physical attributes of seed quality thus serves as a management tool for upgrading the quality of product placed on the market as well as a tool for controlling overall production costs for seed crops.

Another area of seed quality that is receiving increased attention is that of seedborne diseases. In a few states regulations have been established for some serious seedborne diseases, as a means of reducing the spread of seedborne pests and diseases. Because seed health testing requires specially trained personnel and specialized equipment, much of the seed health testing is currently being done in public laboratories.
Pathological tests on seed lots may be used by seed companies to determine effectiveness of production disease control and inspection programs, to determine the effectiveness or need for seed treatments and for seedborne diseases that are hazards to crop production. A company may elect not to distribute contaminated lots on the basis of such tests.

Except in a few cases where seedborne diseases represent a serious hazard to crop production or where states have established regulation for seedborne pathogens, specific standards for seedborne diseases are not being widely utilized. For the more important diseases, private as well as public researchers, are devoting a significant amount of effort toward development of varieties resistant to the diseases.

Physiological Quality

The last area of seed quality, and the one which is currently receiving the greatest emphasis, is that of physiological quality including both germination and vigor. In 1939 the Federal Seed Act was established and required that crop seed in interstate commerce meet minimum germination levels and also required that seed be labeled for germination. This law was enacted to prevent misrepresentation of seed in commercial channels. The Federal Seed Act, along with various state seed laws, provided a reasonable guarantee that seed was of at least a minimum level of viability and was accurately labeled for germination. Along with enactment of the various seed laws, procedures were also developed and published to standardize germination testing. These procedures were designed to measure the maximum germination potential of a seed lot under optimum conditions. Enactment of state and federal seed laws undoubtedly had a favorable effect on the quality of seed in the marketplace and for a number of years germination provided an adequate measure of the physiological quality of seed lots.

In the late 1950's and early 1960's the need for additional physiological seed quality measurements to supplement the standard germination test was identified and by the mid-1960's this need was well documented for a number of crops. The need and demand for these additional physiological quality measures resulted from changes in farming practices such as precision planting, planting crops earlier or under stress conditions, reduced seeding rates, etc., and general advances in agricultural technology, many of which were dependent on the use of high physiological quality for success. Growers as well as seedsmen recognized that two lots of the same variety having identical germination would not necessarily perform the same when planted under identical conditions. Thus it was during the mid to late 1950's that the term vigor began to receive recognition along with germination as a measure of physiological seed quality. Today both germination and vigor are recognized as being important quality measures, by the Seed Trade as well as seed consumers, to better evaluate the field performance potential of a seed lot.

Evaluating the physiological quality of seed requires specialized
equipment and well trained personnel. Conditions for testing the viability of different kinds of seed are specified in the Association of Official Seed Analysts "Rules for Testing Seed" and specialized germination equipment is necessary to maintain the temperature, moisture and light conditions prescribed in these rules. Different kinds of seed require different germination conditions, thus the requirements for equipment increase with the number of species being tested. Germination chambers are relatively expensive and sizable investments are necessary to equip a germination lab for testing a wide array of vegetable and agronomic crops.

The Rules for Testing Seed also specify procedures for planting and evaluation of germination tests and training in seed technology is necessary for personnel conducting germination tests, to provide uniform consistent results.

Germination quality standards may be established in several ways. For a number of crops germination standards are established by the Seed Trade as a whole and seed consumers. With crops such as field corn and lettuce most seed in the marketplace germinates 90% or above. With crops such as these a company must establish their germination standards in line with the rest of the seed industry, in order to be competitive.

For crops where industry standards or germination levels have not been established, such standards may be established relatively easily by individual companies. Minimum germination levels or standards are set forth in the various state and federal seed laws. A seed company would thus establish its standards above these legal minimums at a level that is realistic in terms of being able to consistently meet the standard and which provides an acceptable level of quality to the consumer. As with any quality standard, germination standards are of value only if they can be and are controlled, and are realistic in terms of cost.

Facilities and equipment required for vigor testing are generally more sophisticated and specialized than that required for germination testing. A wide variety of vigor tests have been developed, ranging from the rather simple cold test to sophisticated tests measuring respiration rates of seed. Vigor tests are being used fairly extensively by the Seed Trade in in-house quality control programs. The types of tests conducted will depend on the crops involved, facilities and equipment available, and the particular attribute of vigor being considered (potential for stand establishment, yield or storability).

At the present time the only way vigor tests may be used effectively in regulating or controlling seed quality is as a quality measure in in-house quality control programs by seed companies. Many of the larger companies that have been involved in vigor testing for a number of years have been using various types of vigor tests for some time as in-house quality control tools and have established standards for their vigor testing programs. While vigor tests can and are being used successfully as in-house quality measures, these same tests have too many serious limitations and are not sufficiently standardized to justify
their use in an official or regulatory capacity. Problems that limit application of vigor tests from an official standpoint, such as standardization of procedures, interpretation of results, utilization and application of test results, etc., can be resolved much more readily and effectively in an individual quality control program or laboratory than they can between laboratories.

Vigor tests are an important measure of seed quality, but currently the only area where they have sufficient reliability to permit establishment of standards is in individual quality control programs. As an in-house management tool vigor tests may be used effectively in varietal development programs, seed production operations, seed processing operations to maintain and maximize seed quality, packaging and storage programs and most important to upgrade the quality of product placed on the market.

While many of the larger seed companies maintain their own seed testing laboratories for germination and vigor testing, many public and private testing laboratories are also providing these services. Thus, even the small companies who do not maintain their own testing facilities have access to complete evaluations of physiological quality for the crops they handle.

In the preceding paragraphs I have attempted to cover the primary factors that are involved in developing and establishing an effective quality control program and to review the principal attributes of seed quality in terms of their importance, how they are evaluated and how results of seed quality evaluations can and should be used as management tools in seed company operations. Demands for better quality seed are increasing and seed companies cannot meet these demands unless they establish and use effective quality control programs. Seed Companies, regardless of size, that fail to acknowledge the importance of seed quality and use of quality control in their management systems will soon be out of the picture.

While quality control programs are currently necessary for effective management of seed company operations to meet customer demands for better quality seed, they also offer significant opportunities for improving overall operational efficiency within a company. Frequently quality control programs are viewed negatively and such attitudes generally result from failure to recognize the significant value quality control programs have for seed companies, as well as seed consumers. An effective quality control program benefits the seedsman as well as the consumer and should be viewed by seed companies as an asset and not a liability. An effective quality control program is an essential management tool for seed companies today, and the importance of such programs is almost certain to increase in the future.