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Determinants of Seed Quality

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DETERMINANTS OF SEED QUALITY

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The quality of seed at any point in time reflects the significant factors that have acted upon them in the past. Thus, seed are a product of their history in the same manner as are nations and people. Yet, there is a difference. People (and nations) are active participants in their historical development. Their thoughts, passions, creativity and actions based thereon are the raw staff of which history is constructed. Seed on the other hand are acted upon during the flow of time: their's is a passive role.

Look at a seed. It is alive - it had a beginning and its end is already predetermined by its biological nature. From the seed's beginning until its end it will be influenced by a host of factors or events - some natural and some man-made. Some of the factors or events will be traumatic and exact their toll from the vigor and longevity of the seed. It is these together with the seed's inheritance that comprise the determinants of quality.

Inheritance

Fertilization of the egg cell by the sperm nucleus is the beginning of a seed. The heritable complements contributed by the male and female parents comprise the code that will determine the biological characteristics of the embryo, endosperm and plant produced by the seed. Certain weaknesses that contribute to seed quality problems may derive from either or both parents. Lindstrom 1/ and Haber 2/ have shown, for example, that inbred lines of corn differ in seed vigor and longevity and that these differences are heritable. The recent work of Chang 3/ dramatically

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1/ Lindstrom, E. W. 1942. Inheritance of seed in maize inbreds and hybrids. Genetics 27: 154.

2/ Haber, E. S. 1950. Longevity of the seed of sweet corn inbreds and hybrids. Amer. Soc. Hort. Sci. Proceedings 55: 410-412.

3/ Chang, Sylvia. 1970. Physiological study of differences in quality and longevity among seed of two inbred lines of corn and the hybrid. M. S. Thesis, Mississippi State University, State College, Miss.

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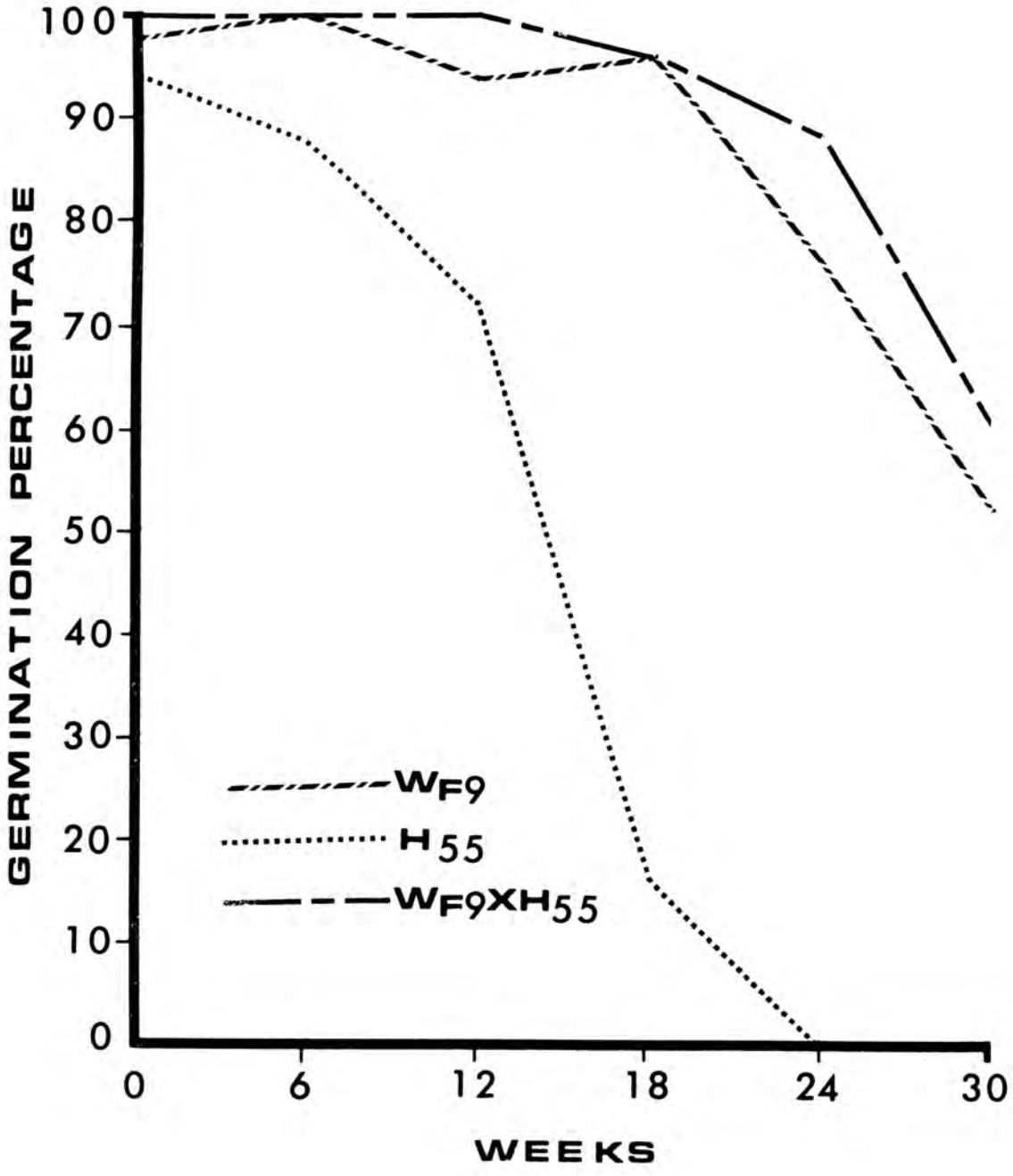


Figure 1. Germination percentages of seed from three lots of corn seed at intervals during 30 weeks storage at 30°C.-75% R.H.

illustrates the influence of inheritance on seed quality. Longevity of seed of two inbred lines of corn and their hybrid at 20°C-75% R.H. are compared in Figure 1. The three "lots" of seed were produced in the same area, at the same time and handled in the same manner.

There are many other examples of direct genetic influences on seed quality. Certain varieties of beans are more susceptible to mechanical injury than others. The older type black seeded soybean varieties had thick, tough seed coats and were quite resistant to field deterioration and harvest damage. The current varieties have thinner, more fragile seed coats which contribute to many seed problems.

The seed producer can do very little about genetic weaknesses that result in quality problems except, perhaps, to take special precautions or to simply not produce the variety.

Source of Seed

Selection of planting seed for seed multiplication is one of the most important steps in producing quality seed. While it has not yet been demonstrated that low vigor seed beget low vigor seed, other attributes of quality are influenced by seed source. These include varietal purity and mechanical purity. Certainly, planting varietally mixed seed or seed containing weed seed are good ways of insuring that the resulting seed crop will also be varietally mixed and contaminated with weed seed. Source of planting seed is, therefore, one of the determinants of seed quality.

Field Contamination

Other varieties, other crop and weed seed contaminants in seed derive from three sources: (1) contaminants in the stock seed used for seed production; (2) contaminants in the soil on which the seed are produced; and/or (3) contaminants in the equipment used for harvesting, drying, cleaning, etc. Of these three, field contamination is probably the the most important. Seed should always be produced on the "cleanest" land.

Selection of land for seed production should be based on the land's history. If it were used to produce another variety of the same crop the previous year, then chances are good that some of the seed shattered to the ground will volunteer and contaminate the field. In similar manner, if the field were overgrown with weeds the previous season or seasons, the soil will act as a reservoir and replenish the weed populations.

Seed should be produced on fertile, uniform, well-drained land free of weeds and volunteer plants.

Growing Conditions

The fertility of the soil on which the seed crop is produced, its uniformity, drainage, and fertilizers, insecticides and herbicides applied, as well as other cultural practices have a great influence on both seed quality and seed quantity. Plants have a remarkable capacity to compensate for deficiences in their environment by a reduction in quantity of seed produced rather than their quality. Indeed, this capacity is essential for survival of the species for if the quality of seed were strongly affected by mineral or other deficiences, then a species could not spread into marginal lands. This is not to say that good fertilization and cultural practices are not essential for seed production. No seed producer is interested in greatly reduced seed yields.

Growing conditions contribute in many ways to seed quality problems. Non-uniform land or soils mean non-uniform growth and maturation of crops. It might also mean heavy weed infestations in some areas such as those that are poorly drained. Harvesting non-uniform fields is always a problem. Some seed are too dry - others are too green (high in moisture). The weedy patches are harvested along with portions of the crop that are relatively free of weeds, thus, spreading the weed seed problem throughout the entire mass of seed.

The professional seed producer takes into account not only the source of his planting seed but the land on which the seed crop is to be produced and then manages the crop for maximum yield of clean, high quality seed.

Post-Maturation - Pre-Harvest Conditions

After fertilization the seed develops in the relatively well protected "womb" of the ovary or fruit. It is quite secure from the rigors of the environment except for insects and diseases until the time of maturation.

Seed attain functional maturity at the time maximum dry weight is accumulated. For many kinds of seed this occurs at moisture contents much to high for mechanical harvest. For example, wheat, barley and oat seed are about 40% moisture at the time of maturity, corn about 35%, rice 32-35%, and soybeans about 28-30%. As the seed continue to decrease in moisture content after maturation they come more and more under the influence of the field environment. In effect, the interval between maturation and harvest, which may be a few days or several weeks, is a period of storage. And, field conditions are seldom favorable for storage.

Growing conditions contribute in many ways to seed quality problems.

The field environmental factors that have the most detrimental effect on seed quality are temperature (too high or too low), relative humidity (high), and precipitation (frequent). These can act singly or in combination to cause a substantial reduction in quality before the seed are ever harvested.

Some data illustrating the effect of the pre-harvest environment on seed quality are given in Tables 1 and 2.

Harvesting

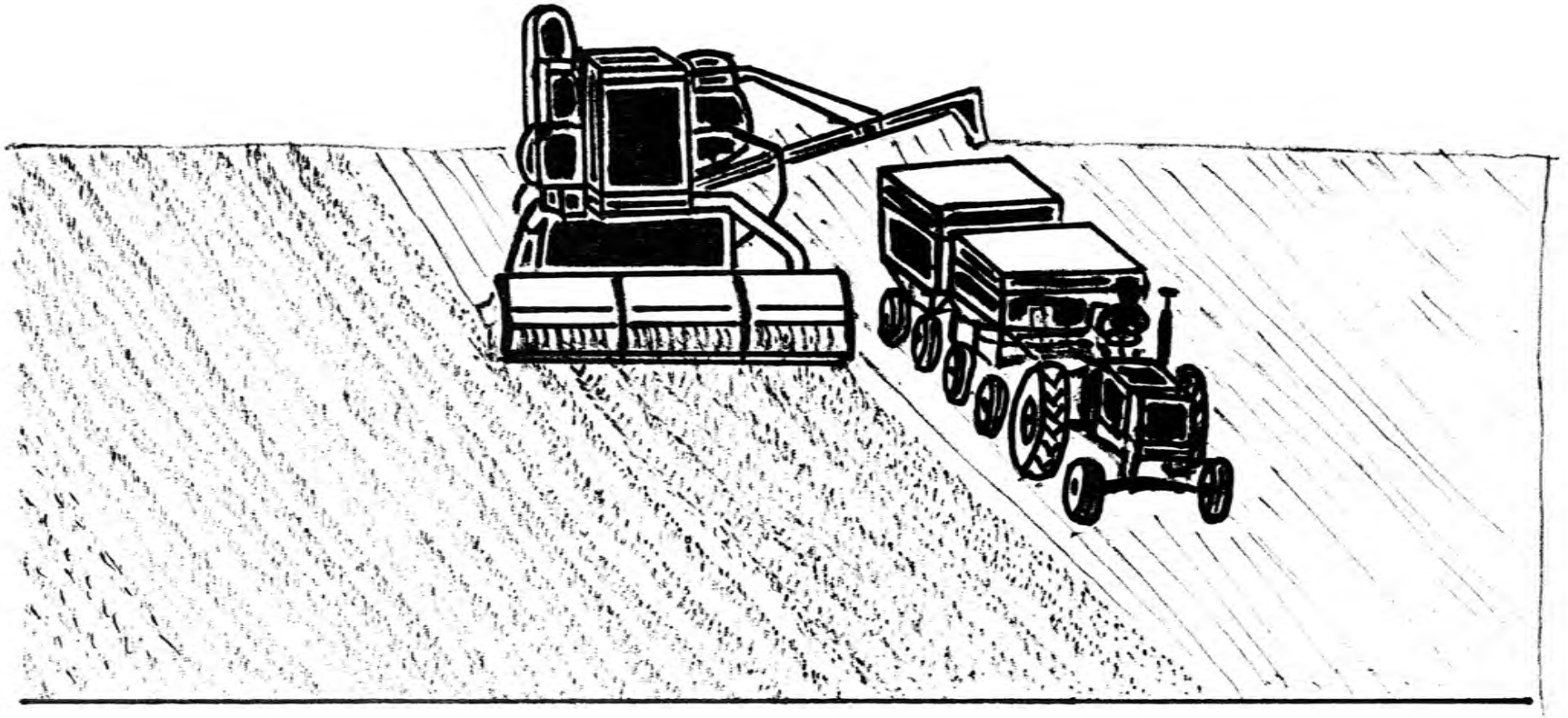
The method of harvest, the time of harvest, and the procedures used to "handle" the harvested seed crop are all important determinants of seed quality. We have already discussed the role of the pre-harvest environment in determining quality. It follows, therefore, that minimization of field exposure through harvest at the proper time is critical. Climatic conditions, of course, may not be favorable for timely harvest. In this event, harvest should be accomplished just as soon as weather conditions permit.

The equipment used for harvest are always a potential source of mechanical injury. Harvesting and threshing are accomplished by mechanical action. If the mechanical action is not properly controlled then the same forces that thresh the seed can cause serious injury. Proper operation of the combine harvester or other threshing equipment is one of the most critical factors in seed production.

Seed that are harvested at moisture contents too high for safe storage must be placed under aeration or in the dryer as soon after harvest as possible. "Field heat" combined with the heat produced by respiration of the seed and green material mixed therewith can quickly lead to deterioration of the seed. Both aeration and drying are "timely" operations, that is, if thery're not done on time, then their effectiveness is greatly diminished. The damage from heating and high seed moisture content will already have occured.

Aeration and Drying

We have already touched on these determinants of seed quality. Bulk storage bins for seed should nearly always be equipped for aeration regardless of how low seed moisture content is at harvest. Aeration will remove the field "heat" of the seed and gradually reduce seed temperature as the ambient temperature decreases with the progress of the season for all harvested crops. Timely and proper aeration will also prevent the damage that can be caused by moisture migration in a bulk stroage bin as the ambient temperature either decreases or increases.



The method of harvest and the time of harvest are important determinants of quality.

Table 1. Germination percentages of cottonseed as related to position of boll on plant and period between boll opening and harvest.

Weeks after Boll Opening	Boll Position on Plant		
	Bottom	Middle	Top
1	77	81	78
3	53	56	84
6	22	55	84

Unpublished date, Seed Technology Laboratory

Table 2. Effect of field weathering on germination of 1970 crop of Dare soybeans.*

Date Harvested	Moisture Content	Germination %
Oct. 9	19	93
Oct. 16	20	93
Oct. 26	21	81
Nov. 3	15	83
Nov. 24**	13	80
Dec. 6	18	76
Dec. 11	20	48

* Fall of 1970 was characterized by a prolonged rainy period that generally delayed harvest.

** First killing frost occurred a few days before Nov. 24.

Unpublished data, Seed Technology Laboratory

For seed harvested at moisture contents above 15-16% drying is essential. Drying should be initiated just as soon as the seed can be transported from the field to the dryer. The longer the delay between harvest and the onset of drying, the greater will be the reduction in seed quality.

The following data taken from Saul [4/] illustrates the effect of temperature and seed moisture content on grain quality or grade of field shelled corn. The "allowable safe storage times" refer to those beyond which quality is reduced one grade. Bear in mind that the reference is to grain quality - by the time grain quality is reduced one grade the seed quality would have long been zero.

Allowable Safe Storage Times for Field Shelled Corn (days)

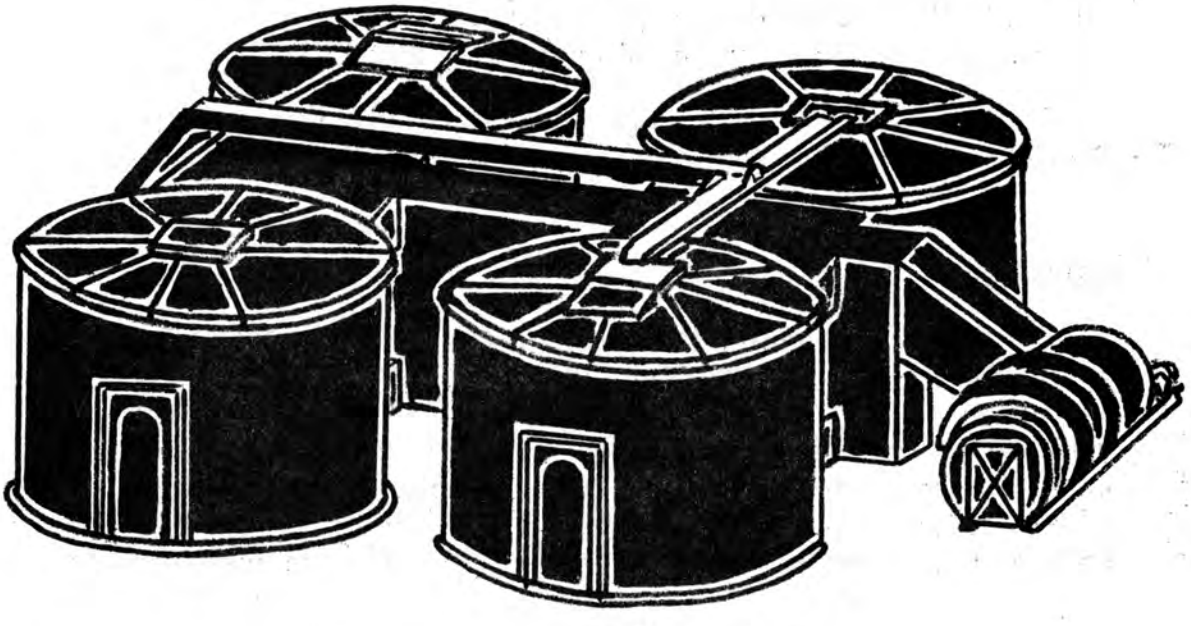
Grain Temp °F	Grain Moisture Content			
	15%	20%	25%	30%
75	116	12	4	3
70	155	16	6	4
65	207	22	8	5
60	259	27	10	6
55	337	35	12	8
50	466	48	12	10

Seed drying involves the transfer of heat to evaporate moisture from the seed, the transport of evaporated moisture out of the seed mass, and the transfer of moisture from the interior of the seed to the surface where it can be evaporated. These processes require equipment and facilities which are adequate to the task, and which can be rigorously controlled.

Handling

The conveyors, elevators and other devices used to transport seed from harvester to dryer or bulk storage, out of bulk storage into the processing plant and then on through bagging can have on important influence on quality of seed.

[4/] Saul, R. A. 1968. Effects of harvest and handling on corn storage. Proc. 23rd Corn-Sorghum Res. Conf. ASTA. 23: 33-36.



Aeration and drying are timely operations.... if they are not done on time, then their effectiveness is greatly diminished... the damage will already have occurred.

Every mechanical device used in handling is a potential source of seed injury and contamination. All conveyors must be thoroughly cleaned before they are used to handle a different variety or crop. Thus, the types of handling devices used should permit thorough cleaning or, preferably, be of the self-cleaning type.

All kinds of seed are subject to mechanical damage and should be handled as carefully as possible. Some kinds of seed are more susceptible to injury than others and some types of conveyors are more injurous than others. It is most important, therefore, to match the conveyors to the seeds. For example, one should never use augers to convey seed soybeans.

Most types of conveyors used for seed will cause only a very minimum of damage if operated properly and maintained in a good condition.

Processing

During processing the seed are prepared for packaging and marketing by cleaning, size-grading, density grading, and treating. The efficiency and effectiveness with which these tasks are accomplished very often determine whether the seed are marketable or not. Weed seed and other crop seed have to be removed within certain allowable standards. Shriveled and small seed, broken seed, and rotten seed have to be removed to improve both quality and appearance of the seed and enhance customer appeal.

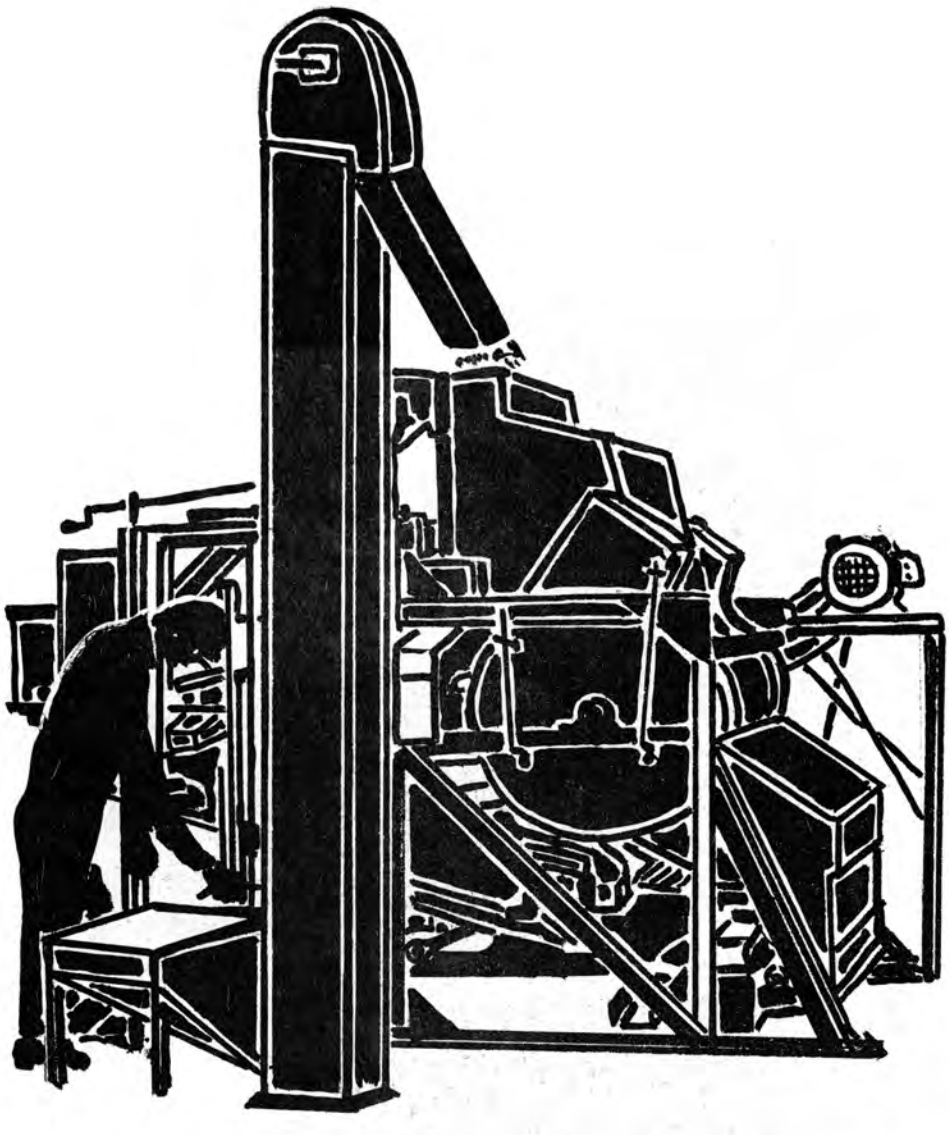
Two factors are most important in processing: (1) the proper equipment must be available; (2) the operator of the processing plant must be knowledgeable about both seed and processing machinery. All too often seed are cleaned with almost total disregard of the types of material that have to be removed and by operators who are primarily concerned with getting so many bags through the plant each day.

Processing equipment are also a source of contamination and should be thoroughly cleaned each time a different variety or kind of seed enters the plant.

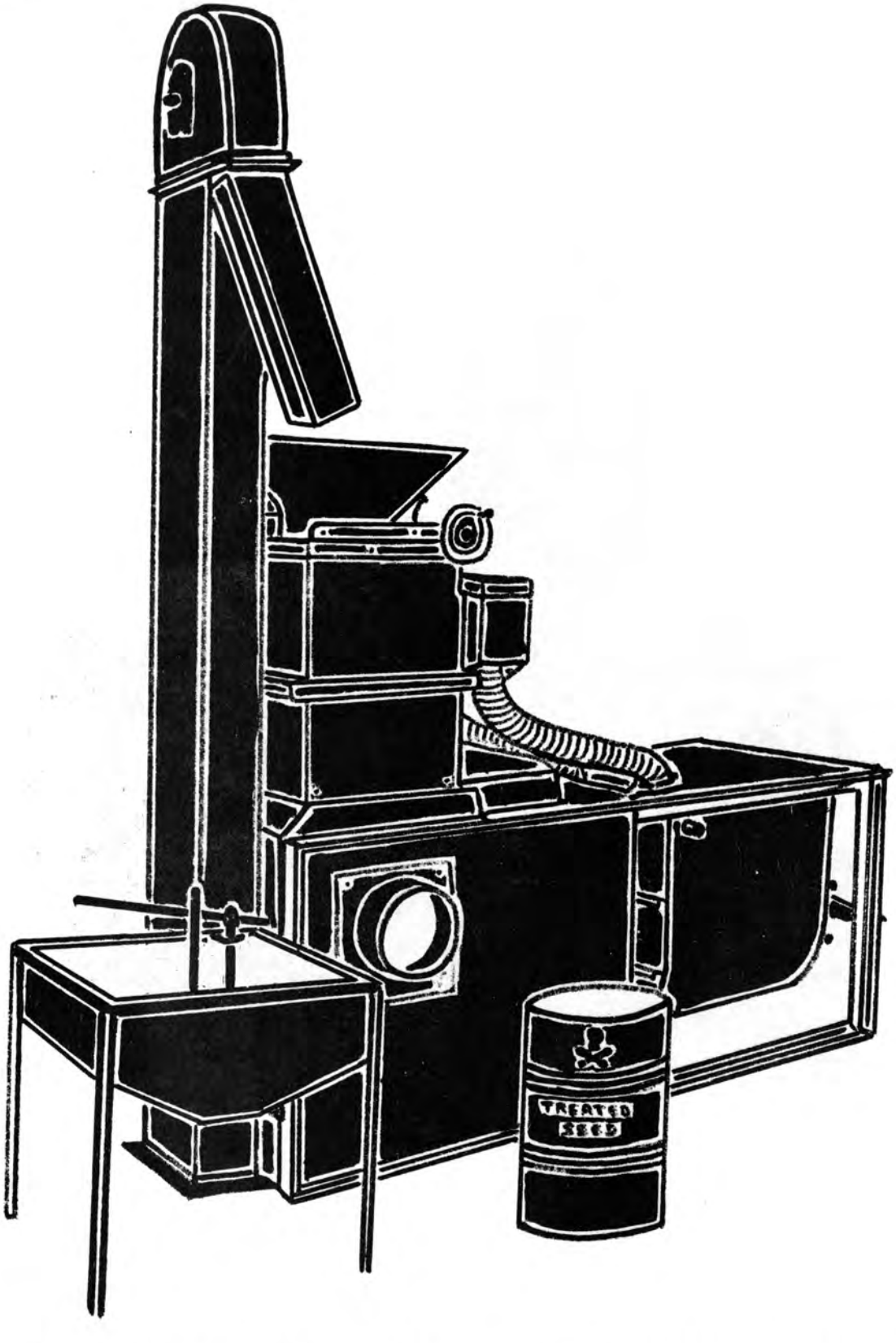
Treating and packaging are processing operations. Both must be in accord with recommended procedures.

Storage

Seed must usually be stored for a period of time after bagging before they are distributed to retail outlets. Storage, however, is not restricted solely to this period. We must also consider the period of storage in bulk



Processing prepares the seed for packaging and marketing by cleaning, size-grading, density grading and treating.



Treatment of seed with recommended fungicides and insecticia maintains and enhances quality.

before processing and the period of storage in the retail warehouse before the seed are sold.

Most "storage" problems do not originate in storage - they are only noticed there. Climatic conditions in the U. S. are sufficiently good to maintain viability and a reasonable level of vigor from harvest to planting time provided good quality seed are placed in storage. Storage, regardless of how favorable, does not improve seed quality. Indeed, even good storage conditions are often inadequate to prevent loss of quality when the seed are badly weathered and mechanically damaged. The first and most important consideration in storage, therefore, is to produce high quality seed.

Age

Other things being equal, chronological age of seed is an important determinant of quality. Seed are alive and like all living things are subject to the degenerating processes of aging. During aging seed vigor declines at a much more rapid rate than germination percentage. Therefore, old seed, might have a reasonably good germination but be so low in vigor that they are practically worthless for planting.

Homogenity

A seed lot is defined as a definite quantity of seed uniform throughout its parts for the quality attributes stated on the label. Many lots, of course, do not meet this definition. We have already considered non-uniform seed production fields as a determinant of quality. This non-uniformity of seed fields is often reflected in non-uniform seed lots. Portions of the lot may contain different levels of contaminants or even entirely different contaminants.

The seedsmen should make every effort to identify non-uniform seed lots and blend them as necessary to achieve uniformity.

Summary

The quality of seed is a product of their history. From fertilization through planting,seed are subjected to many conditions and operations which determine quality. These include: genetic characteristics and peculiarities of the kind and variety multiplied, source of seed, land selection, growing conditions, pre-harvest environment, harvesting procedures, aeration and drying, handling and conveying, processing, storage, chronological age, and homogentiy. The complete quality control program insures that the detrimental effects of the conditions and operations to which seed are subjected are minimized.

Proper storage protects the seedsmen's considerable investment of capital, energy and time.