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George Stewart
The Seed Situation In Utah

BY

GEORGE STEWART

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UTAH AGRICULTURAL EXPERIMENT STATION

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THE SEED SITUATION IN UTAH
BY GEORGE STEWART.

A. INTRODUCTION.

Due to the use of poor seed, the farmers of Utah lose yearly many thousands of dollars. Often single farms suffer to the extent of several hundred dollars. The most regrettable and yet the most hopeful thing about the seed situation is that these losses are largely preventable.

Abundant areas of unoccupied public lands have hitherto been within the reach of practically any wide-awake tiller of the soil. The farmer was more nearly sure of larger haystacks and more bushels of grain or potatoes if he doubled the size of his fields than if he attempted more thorough cultivation. These conditions are now, however, largely outgrown. A new West looms on the horizon, a West of keen competition and of high-priced land. Tracts that were sold for a few dollars a generation ago, now change hands at anywhere from fifty to five hundred dollars an acre. With such valuable lands under cultivation, acre-yields must grow apace or the harvest cannot pay interest and taxes on the farm, much less compensate for labor and equipment. Better farming must be practiced. Improved tillage can do much but not all; better crops are necessary. These may be different crops, such as sugar-beets on land formerly used for grain only, or they may be superior strains of crops already in use.

I. THE SEED PROBLEM.

Importance of Good Seed. Good seed is primarily essential in the production of good crops because the plant is a direct descendant of that plant from which the seed came. Because of this, the plant can develop into nothing for which the seed does not supply possibilities. Of the factors that influence crop yields, seed has, up to the present, been given the least consideration. On this account it seems likely that the easiest gains may come by focusing attention here.

Not only is the farmer interested, but also the gardener and the florist. Housewives will welcome any improvement in the quality of home-used products. Such betterment means to them less work, more satisfactory expenditures, and more delicious as well as better-appearing foods. Seed for the home flower garden interests them directly. Business men, too, will
gain by any great improvement of seed since better, if not cheaper, products will reach them.

**What is a Seed?** A seed is the connecting link between two generations of crop plants; it transmits life from the plants of one year to those of another, or from those of one period of years to those of another period. Seed from poor plants are nearly sure to produce poor plants. It is not much more reasonable to expect heavy yields from low-yielding seed than to expect sugar-beets from carrot seed.

When germination begins, the seed-coat absorbs water and the seed swells; the embryo, or germ, sends out rootlets and leaves; the starch stored in the seed undergoes a chemical change that enables it to supply sugar to the growing plant. Not until the sunlight causes chlorophyll to develop in the leaves and the roots take up water and mineral food, is the plant able to sustain itself independent of the food stored in the seed.

This stored-up food maintains the plant until it can support itself. On this account, the use of badly shrunken seed is attended by considerable risk.

**Composition of Commercial Seed.** Careful study shows commercial seed to contain various kinds of material. In general they are:

I. Seed True to Kind
   1. Mature
      (a) alive

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Fig. 1—Machines for threshing and cleaning small lots of pure seed. (Minn. Station)
THE SEED SITUATION IN UTAH

2. Immature
   (a) shrunken seed
   (b) empty hulls

II. Seed of Other Crops and Other Varieties of the Same Crop

III. Inert Matter
   1. Earth
      (a) small gravel
      (b) dust
   2. Organic
      (a) broken stems
      (b) chaff
      (c) manure

IV. Injured Seed
   1. Broken Kernels
   2. Blemished Kernels
      (a) diseased
      (b) frosted
      (c) hard-shelled
      (d) insect-injured
      (e) soaked

V. Weeds
   1. Noxious
      (a) common
      (b) not common
   2. Not Noxious

   All samples of seed do not contain all of these impurities nor do they contain them in anything like constant percentages. The material named by any one of the sections or sub-sections may compose nearly the entire quantity of foreign substances. The seed may be practically pure and viable, that is, have the power to grow in the proper length of time, or, it may consist largely of empty hulls or shrunken kernels, as is the case with oats cut green. Some of the blemishes are due to lack of care, others to fundamentally wrong conditions. For example, wet or insect-injured seed results usually from improper storage, while disease or frost injury may have been unavoidable, though the disease probably indicates nothing more than that greater care in seed selection was necessary. Stems, broken kernels, and some weeds separate out in screening.

Good and Poor Seed. Good seed (1) is true to kind, (2) will grow readily, (3) is healthy, (4) is free not only from
weeds but from others impurities, and (5) must be adapted to the climate, the soil, and the cultural methods of the district. Seed that lacks any one or more than one of these five qualities is poor. The presence of any deceit brands seed as poor, mainly because it is not reliable. If old seed be bleached with chemicals to hide age, or if cheap seed or inert matter such as sand be added, the sample is said to be "doctored."

Fig. 2—Pure Red Clover Seed. Weedy Red Clover Seed. Which kind do you plant?

Losses Caused by Poor Seed. Poor seed causes one or more of three distinct kinds of positive loss to the farmer: namely, (1) a greater expense for good seed, (2) poor crop stands, and (3) the introduction of weeds.

(1) Clover seed costing about $4.50 a bushel on the market, contained so many impurities that a bushel of clean, viable seed from various samples would have cost $5.88, $6.90, $5.40, $5.10, $5.94, $4.59, $7.56, $11.48, $22.00, and $23.65. In one sample of old orchard-grass seed, less than one percent was alive. After making deduction for other faults, a computation showed the cost of one bushel of good seed to be $703.80. Timothy sold in one store in three grades at $1.60, $1.40, and $1.35 a bushel. Computed to a bushel of good seed these samples cost $1.62, $1.68, and $57.25 respectively. Redtop seed sold in another place in grades at 13.7c and 8.5c, and 5.4c a pound, and cost respectively 17.7c, 81.3c, and 30.7c a pound for good seed. Thus in many cases cheap seed is poor, costing more for actual quantity of good seed than do better grades.

(2) But the extra cost represents only a part of the loss. Seed that does not grow or is weak produces poor stands and thereby cause a loss in a lower yield which uses as much land and requires as much cultivation as a full stand. Any bare spots
fill with weeds while a complete stand may smother them.

(3) Weed seeds added in planting, by increasing the number of weeds present, require additional labor to remove them. Extra work is required to harvest a weedy crop, to say nothing of the actual injury done by lowering the yield, by injuring the quality, and by reducing the selling price.

Weed seeds are usually small—so tiny in fact that it is hard to realize how many there may be in a pound of seed. In one sample testing 1-5 of one per cent weed seed, there were 990 weed seeds for each pound of seed sown, or 9,900 to the acre. Another lot of seed tested 3,000 to the pound, which was 45,000 to the acre, while a particularly bad lot introduced 5,000,000 to the acre. If 4-5 of these grew, nearly one hundred weeds would feed from each square foot of soil in the entire field. Manifestly little else could exist on the same area.

Besides, weeds particularly bad are often introduced in poor seed. Canada thistle, Russian thistle, bindweed, tumbling mustard, or dandelion may creep into field or garden any time unless the farmer inspects seed, irrigation water, and manure or hay brought from a distance. A keen look-out for weeds that are extremely troublesome pays, because they are much more easily kept out than eradicated. All of these losses are serious. Anywhere from slight injuries to a loss of the entire crop may result. In some instances a particular weed has compelled a farmer to stop growing some crop.

**Interest in Good Seed.** Good seed interests the community in a number of ways.

1. It keeps better.
2. It germinates sooner.
3. The crop grows faster.
4. The plants are more healthy.
5. As a result, greater yields and better quality are secured.

Some seedsmen admit they carry poor seed, but maintain that they must do so because it pays better than the more expensive "high grades." In most cases, however, our seedhouses are doing their best to promote a cleaner and a more healthful condition.

Too many persons buy seed without knowing what they ought to buy, and much less what any given sample contains. A rather general lack of information about seed prevails. Both business man and farmer sometimes lack knowledge. Too often even
the scientific worker is in the dark. More study of seed is needed.

**Methods of Improvement.** In this as in any work, two general methods prevail. They are (1) education of the people and (2) compulsion by law.

Compulsion alone can never succeed for a number of reasons. (1) Co-operation so necessary to real success is lacking. (2) Intelligent effort which promises the most far-reaching results does not operate. (3) Nearly everybody resents compulsion unless he understands the reason and acknowledges the justice of it. On this account seed laws fail in many cases. Often, too, the enactment are not wise in all their provisions, because, as already pointed out, there is a general lack of wisdom, if not of information, in regard to seed. Legislators have not always written the best possible seed laws. In some cases they have delayed advancement by unwise provisions or by using undue restraint. When such conditions arise, the statutes not enforced become useless, doing not only no good but sometimes actual harm.

The desirable means of bringing about better seed conditions is by laying the problem before the people, giving them what facts are available, and procuring their co-operation in solving the problem. Let once the spirit of betterment get well on foot, and it will accomplish considerable. In such cases improvement will advance in three ways: (1) By a healthful attitude toward better seed; (2) by a careful testing of seed to find out whether it is satisfactory; and (3) by a selection of seed from the field, in order that positive improvement may come. Testing is only a negative factor which rules out the undesirable, but which does not introduce the desirable. The first remedies are to select whenever possible in order to get the best, and to test always in order to keep out the worst. Only public broadmindedness can secure these results by encouraging farmers, gardeners, and florists to be satisfied with nothing but the best within reach.

If everybody were well informed and also interested in seed problems, it would not be long until we should be well on our way towards a proper solution. Just what is the seed situation in Utah? Here is one difficulty at the very outset. No one knows exactly—perhaps not even closely. In order to be interested in anything, a person must know something about it. Conversely, in order to find out much about a problem, the investigator must be interested in it. Until recently the seed situation not only in Utah but throughout the West was in an alarming condition;
people were not interested because they had no accurate information; no investigations were likely to come until somebody was sufficiently interested to start them.

II. HISTORY.

Seed-houses. Things might in this fashion have gone on almost indefinitely, had not a cause of interest sprung up. This cause happened to be a commercial one, and hence it was given consideration. A few years ago, the need for seed merchants manifested itself in a degree intense enough to cause a number of seed-houses to begin business. It is human to be dissatisfied with the quality of purchased product when its poorness would not occur to the consumer if he grew it himself. Take hay, for example. If a farmer's alfalfa contains some barley-grass or June-grass (Bromus tectorum)—sometimes called cheat-grass—he feeds it without worrying, probably without thinking of the injury in quality caused by the grass. Let someone offer to sell him such hay and he sees at once the likelihood of loss in its barbed seed or in its smaller feeding value. So it was with seed.

No sooner had the seed-houses become established as permanent institutions, than they began to call attention to impurities and other weaknesses in the seed they purchased; likewise the farmers who bought from them began to foresee possible loss due to the presence of foreign substances and immature or injured seed in the samples offered for sale. Soon a rather critical attitude in regard to seed grew popular, and some laws, as stringent and unwise as they were hasty, found themselves in the law books of one or two of the western states. A few of the seed laws were good, but, with some over-stringent and others non-applicable to the conditions, a natural reaction set in. Popular opinion and necessity, in some cases, caused such regulations to be so neglected as to become "dead letters." Then the development began again—slowly, and as new information dictated. This was the proper course. It has therefore gained considerable momentum and now promises to end in a wise solution of at least some of the problems related to seed.

Growth of Interest.—One of the causes for the growth of seed-houses was the market for seed outside the State. Buyers of Utah seed naturally took some protective measures against noxious impurities and poor condition. This of course was a spur to the seed merchants and has done considerable to quicken interest in good seed. Semi-quarantine laws and inspection
operating in various localities have further increased the attention given to shipments outside Utah. These restrictions have had two effects, as they must have anywhere under the condition of restriction without and absence of inspection within. (1) Only the best seed is shipped out, leaving the lower grades for the unprotected home markets. (2) Only the better seed would be bought off the farms, leaving the poorer for replanting. This created a condition that would become constantly worse and worse had not a disturbing factor appeared. This disturbing factor was the State Experiment Station which began a campaign for seed improvement. Co-operative tests of varieties and strains were quickly followed by encouragement from the Agricultural College through Farmers' Institutes and County demonstrators. At present some instructors in the high schools in co-operation with the College are working to improve the seed situation through their classes and high school agricultural clubs. Such is the seed situation in Utah today: much poor seed is in use, but a newly-created and rapidly-quickening interest has set in action forces that make not only for increased, but also for widespread attention to seed. The situation is much in need of improvement but is not without hope.

The first means of seed improvement—the creation of a healthful attitude—is already in action. This of course is requisite to the other two,—testing and selection. There is no reason why all three methods should not be operating at the same time. In fact, it is almost impossible for one method to reach the fullest possibilities without helps from the other two. Now since the attitude is right, persons should proceed intelligently to test and select seed.

B. SEED TESTING.

I. General Considerations.

To find out the quality of the seed that is commonly planted, testing for impurities and germination power is the first important step. Let all seed be run over screens to get rid of as much foreign substance as possible. After a thorough screening, an analysis should be made. The most practical method for ordinary purposes is the hand separation of a well-mixed sample into piles containing (1) good seed; (2) broken and injured seed of the same kind; (3) seed of useful plants or of other varieties of the same crop; (4) dirt, chaff, and other inert material; and (5) weed seed.

In the first place it is necessary to get a representative sample
by taking seed from top, sides, middle, and bottom of sack or bin and to mix thoroughly on a cloth, paper, or smooth table.

Fig. 3—Instruments used to separate and examine seeds. (Courtesy Montana Station)

A thin-bladed knife is a convenient tool with which to mix. The person should exercise care not to lose seed or dirt while mixing, as a good test requires careful weighing. When satisfied with the mixing, let the tester divide the sample into two approximately equal parts, discarding one half and mixing the other, and repeat dividing and mixing until the pile is small enough to analyze.

Analysis.—The first step in analysis is to weigh the sample carefully and record the weight. Analysis proper may then begin. This consists of separating the sample into the four or five piles already mentioned. A pair of forceps and a hand lens aid materially, and for small seed, such as grass and clover or alfalfa, are necessary. A needle fastened in a wooden handle or a sharp hat-pin serves to pick out small particles or to separate adhering bodies. After the separation is complete, each pile should be weighed, or closely estimated by counting.

If possible, the weed seed ought to be identified in order to prevent the introduction of bad weeds new in the locality or not yet started on the farm in question. Identification enables the farmer to know just what he is planting, permitting him to exercise choice as to whether such seed is the best he can find at a reasonable price. Many seed resemble each other so closely that only experts with large collections at hand can distinguish them. Every high school should have a small collection of seed gathered in the district, preserved in glass vials or small bottles, and carefully labeled. These are not hard to get while the plant can be seen. Seed is such an insignificant part of the plant that
most people do not recognize the seed of even familiar plants. Yet in spite of this difficulty, the most prevalent weeds ought to be identified. The means suggested, supplemented by reference to such weed manuals as Pammel's "Weeds of Farm and Garden," Georgia's "Manual of Weeds," and Clark and Fletcher's "Farm Weeds of Canada," and numerous available bulletins, enable a large percentage of weed seed to be determined. When uncommon weeds are found, their importance as pests also ought to be investigated. The Experiment Station at Logan will help in this identification if a reasonably large sample of seed is sent.

The Germination Test.—Analysis represents but half the test; germination power next deserves attention. Pure, apparently normal seed may be so low in vitality as to be worse than useless on account of producing poor stands. A simple, practical method of testing is to fill a tin or dinner plate half full of moist sand. Over this, lay a blotting paper or white cotton cloth, then count out from 50 to 250 seeds—preferably 100—and cover with another plate of the same size in order to prevent evaporation. Let these be set in a warm, but not hot place. Another method often used is to mark a heavy cloth into squares, dampen it, and after placing the seed on the proper square, roll it and let stand. This is known as the "rag-doll" test. It accomplishes the same as the plates and the wet sand, but it is not quite so convenient for testing small seeds.

At the end of a few days, some seed will have begun to germinate. These should be counted and cast out after the number and the date are recorded. This should be repeated every day
until no more grow. Not only the number that grow, but the earliness of growth is important, because, if much time is required for germination, the soil may dry out to such an extent as to kill the plantlets. On the other hand those beginning growth at once have a much better chance to get well established before the soil becomes too dry.

The Report.—As suggested, a report of the test should show the analysis and percentage germination. The following form of report gives the most essential information.

<table>
<thead>
<tr>
<th>Kind of seed</th>
<th>Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Proposed use</td>
</tr>
<tr>
<td>Locality to use it</td>
<td></td>
</tr>
</tbody>
</table>

**Test**

<table>
<thead>
<tr>
<th></th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purity</td>
<td></td>
</tr>
<tr>
<td>Injured seed</td>
<td></td>
</tr>
<tr>
<td>Other crop seed</td>
<td></td>
</tr>
<tr>
<td>Inert matter</td>
<td></td>
</tr>
<tr>
<td>Weeds</td>
<td></td>
</tr>
</tbody>
</table>

(Kinds of weed—notes on)

Germination (per cent)

II. DETAILS OF TESTING.

Cereals. The grains present the fewest and the easiest problems of analysis. Wheat, oats, barley, and rye, as well as corn, offer a good beginning point for testing because the seeds are large and clearly distinct from other seed. Moreover, nearly everybody is familiar with the characteristic appearance of them. About all that is necessary with which to begin is a pair of hand forceps.

After a thorough mixing of the sample good kernels, shrunken kernels, broken and injured kernels, other grains, inert matter, and weeds are piled separately. The germination is the most important step that follows actual analysis. High schools might do some valuable and interesting work in this field.

Our small grains are likely to suffer from both weeds and smut. In wheat, seeds of mustard, sweet clover, pigweed, and cockle occur most frequently. Mustard seed is globular, yellow to brown, and resembles radish seed save that it is somewhat smaller. Sweet clover resembles alfalfa but it is not difficult to distinguish the two. Cockle is round and black, is heavy, and has about the same diameter as wheat kernels if they are stood one end. The pigweed seeds screen out readily, but cockle is hard
to remove on account of its passing through so nearly the same size of screen as does wheat. They also resist about the same strength of air current in the fanning mill. Stinking smut of wheat, the most common one in Utah, lives over in tiny black balls on the kernel. These ought not to escape observation. If smut is present the seed should be soaked for ten minutes in a formalin solution, one pint to forty gallons of water, or in blue vitriol solution one pound to five gallons.

In oats, mustard, wild oats, and some grasses are mostly likely to cause trouble. Wild oats are hairy and bear a bent, twisted awn. Grass seeds as a group are easy to pick out, but some are extremely difficult to identify. Oats require the same treatment for smut as does wheat. Barley and rye present practically the same problems of analysis as wheat and oats. Corn is so large that it does not associate readily with ordinary weed seed and smut treatment is not practical since this fungous lives over winter in soil or manure instead of on seed.

**Grasses.** A sample of common grass seed is indispensable for analysis in order that the tester may compare the seed he is examining. The hand lens removes so much uncertainty as to be of primary importance. The chief points of interest in studying grass seed are the shape, the angles, and the barbs on the hull. A careful study of the seed being analyzed enables a rather ready separation from other grasses.

Impurities consist largely of small weed seed, seed of other grasses, and dirt. Pigweed seed, which is small, black, oval-disk in shape, and slightly flattened on one side, often occurs. Sour dock grows in meadows and pastures. Its reddish, triangularly winged seed thereby gets an opportunity to adulterate grass seed. Thistles, with seed small and arrow-shaped and winged, cause much trouble in grass plots and are on this account to be avoided. Dandelion seed is very similar to thistle, but carries only one feathery wing instead of several. Plantain is common in lawns and pastures. Its seed is hard, amber, and elongated-oval in shape. A sharp look-out for these weed seeds generally reveals their presence, and, since screening removes only a part, it is difficult to get rid of them.

About all that can be done in the case of grasses is to find out the kind and the percentage of impurities present and to reject the seed if it is not satisfactory. Proper care of the fields where the seed grows is important, for this will in a large measure prevent adulterants from getting in.

Many kinds of grass seed germinate poorly because of their
being immature or moldy, allowance for which is frequently made by planting extra quantities. A reference to the standard of germination will show how much to expect from each kind of seed as regards germination. Kentucky blue-grass, for example, permits one half the seed to be dead, while timothy requires a ninety per cent test.

**Legumes.** The problems in analyzing alfalfa and clover seed are (1) the close resemblance of seed of some of the species and (2) the great difficulty of separation. Several hundreds of tests at the College in the last two years show Utah alfalfa seed to be adulterated with seed of sweet clover, yellow trefoil, and common pigweeds. A few, though not many, dodder seeds are usually present. Alfalfa, sweet clover, and yellow trefoil each vary so widely in shape, size, and color of seed as to require expert analysis for reliable tests. Perhaps no man living can separate entire samples of poorly matured seed without some error. Let no one feel discouragement, however, for reasonably accurate tests can be made. Sweet clover seed generally has a distinct hook at the hilum, or scar, and gives off a characteristic odor readily detected if the seed is crushed or chewed. Yellow trefoil seed is more plumply rounded at the ends than sweet clover or than alfalfa seed which is kidney-shaped or crowded at the ends into angles. The notch, or hilum, of alfalfa is neither deeply cut nor hooked. So long as the seeds are mature and
normal, practice enables safe and proper separation. Dodder seed is globular, irregularly roughened on the surface in such a way that it resembles a mass of dried potato starch. One side of the dodder seed is considerably flattened, often showing concave instead of convex. Dodder feeds parasitically upon the alfalfa plant by twining about it. Nearly all the weed seed that adulterate grass are found in alfalfa seed—some in one sample, some in another.

Clovers and alfalfa may contain hard-shelled seed which require many days to sprout. If the seed be soaked for forty-eight hours in a vessel into which water runs, the time required for germination is shortened considerably.

Of course no such difficulty is met in handling peas and beans. Trouble with these begin in germination. Because of its being hard to prevent these large seeds from molding, it is sometimes necessary to use a weak formalin solution for disinfecting them.

**Vegetables and Flowers.** Much less can be done in the case of vegetable seed. Most of this part of the seed business is highly specialized, being confined to relatively small areas. The important point is not foreign seed, but purity of varieties. Weed seed is readily detected, but the word of the seedsman must be accepted in regard to earliness, adaptation, and variety. About all that can be done is to deal with reliable firms.

Besides, the question of germination of vegetable seed is not important. Intensity of cultivation in the trucking industry makes it cheaper to plant extra seed and then to thin to the desired stand, than to risk empty rows by stingy sowing. Although garden seed costs relatively high prices by weight, the individual seeds are so small as to overcome this drawback. The grower of garden seed will always do most of the testing.

The flower seed situation differs little from that of vegetables save only that it is still more specialized. Trust in reliable dealers from whom guaranteed stock is purchased is the safest method. The use of cuttings and bulbs from the plants distributes the initial cost until it is not particularly expensive to get good flowers if one is willing to be patient.

**Potato Seed.** The test for seed potatoes is not for weeds but largely for vigor and freedom from disease. The most important means of reaching these ends is selection of seed. The use of potatoes from hills bearing several good-shaped, medium-sized tubers increases yield. Where seed potatoes are chosen
from the storage bins, selection against disease is vital, since disease is very common.

But additional care must follow. Let all badly-infected tubers be rejected. The most common diseases in Utah are scab, Rhizoctonia, and Fusarium wilt. Scab shows in cankerous, scabby wounds; Rhizoctonia shows on the epidermis of the potato as dark brown spots that resist washing and that turn black when wetted; Fusarium shows as a brown ring or as brown spots when an eighth-inch section is cut from the stem end of the potato. All tubers showing Fusarium should be thrown aside when cutting. Plant pathologists recommend that two knives be used in order that one may soak in a solution of mercuric bichloride (HgCl₂) or of formalin after a potato showing Fusarium is cut. To use a disinfected knife after cutting a diseased tuber lessens the danger of spreading the infection to healthy seed.

Since seed slightly infected with scab and Rhizoctonia must plant our fields for the present, the following treatments are recommended:

(1) Soaking seed for one and one-half hours in a solution of four ounces of mercuric bichloride dissolved in thirty gallons of water, or (2) in a solution of one pint of formalin in thirty gallons of water for two hours. The mercuric bichloride (corrosive sublimate) is more effective but is more expensive. Precaution must also be taken since it is fatal to animals if taken
internally. It must also be used in wooden vessels, for it corrodes metal.

III. Standards.

Germination. Below is given the percentage of germination to expect from satisfactory seed.

<table>
<thead>
<tr>
<th>Seed</th>
<th>Per cent</th>
<th>Seed</th>
<th>Per cent</th>
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<tbody>
<tr>
<td>Wheat</td>
<td>96</td>
<td>Alfalfa</td>
<td>90</td>
</tr>
<tr>
<td>Oats</td>
<td>95</td>
<td>Orchard-grass</td>
<td>80</td>
</tr>
<tr>
<td>Corn</td>
<td>93</td>
<td>Timothy</td>
<td>90</td>
</tr>
<tr>
<td>Sorghum</td>
<td>90</td>
<td>Ky. Blue-grass</td>
<td>50</td>
</tr>
<tr>
<td>Millet</td>
<td>85</td>
<td>Red Clover</td>
<td>90</td>
</tr>
<tr>
<td>Beans</td>
<td>96</td>
<td>White Clover</td>
<td>85</td>
</tr>
<tr>
<td>Peas</td>
<td>98</td>
<td>Squash</td>
<td>90</td>
</tr>
<tr>
<td>Sunflower</td>
<td>90</td>
<td>Turnip</td>
<td>95</td>
</tr>
<tr>
<td>Buckwheat</td>
<td>92</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Age of Seed. Most vegetable seed suffers from age though clovers, alfalfa, and grains (except corn) keep long periods before dying. The table shows the length of time they will ordinarily keep. Cool, dry, dark, storage places lengthen the keeping periods.

<table>
<thead>
<tr>
<th>Seed</th>
<th>4 Years</th>
<th>6 years</th>
<th>10 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>Less</td>
<td>More</td>
<td></td>
</tr>
<tr>
<td>Hops</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Onions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parsley</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leek</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhubarb</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C. FIELD SELECTION

Much is being accomplished on experimental farms by testing in rows or in plats the yielding power of numerous varieties of crops in order to find the one best adapted to the climate, the soil, and the cultural methods of the district. Since out of a number of varieties some must be better than others, these varietal tests promise much.

Varietal Tests. The United States Department of Agriculture has broadened this work by keeping in foreign fields a number of men to look for new crops or new varieties of common crops that promise to do well in some section of the United
States with similar soil and climate. Turkey red and durum wheats exemplify such introductions. At experiment stations, new varieties are tested for a number of years before they are recommended to farmers. Many crop plants are found unsuited and are rejected; but a few have been found valuable. It is of first importance to use one of these tested varieties that has been found adapted to the locality and to the purpose in mind. Many farmers still plant simply wheat or corn when they should be growing a variety that has been tested. Workers of the State Experiment Station at Logan can give helpful recommendations if the field and soil conditions are described to them.

**Principles of Selection.** The varietal test is not the end; it is only the beginning. Rapid multiplication of plants and natural selection are constantly at work. Since each seed is capable of becoming a plant, the number of descendants a parent plant may have depends on the number of seeds it can produce. This varies from a few hundred in the case of some crops to a quarter of a million or more for the large Russian thistles or tumbling mustard.

Mere chance would cause some of the many descendants to differ from others, but the law of variation causes each individual to differ from every other. Just as no two people are alike, no two plants are alike. They differ in color, size, shape, rooting, flowering, and in numerous other ways. Oats always bring forth oats, but there are no two oat plants that do not differ. One among several thousand will do best in particular surroundings. It is upon this principle that both natural and artificial selection depend.

Because some one plant out of thousands is more fitted to survive in its particular surroundings, that one plant will grow most vigorously. Now, if all the seeds from any one kind of plant grew, this plant would soon fill the whole earth. Therefore, in the end, not many more individuals can live next year than do this year without crowding out others. Since only a few of all the descendants of a plant can possibly survive, those most fit live and the remaining ones die. Thus nature constantly improves the wild plants by unending, relentless selection. For countless ages, only the most fit of whole races have endured to rear descendants, which in turn are culled out by ever increasingly rigorous selection. The longer this weeding out of the weakest continues, the better adapted the survivors are to cope with their enemies. All our bad weeds originated in the Old World where, for thousands of years, they have been
struggling for existence in cultivated fields. This long, incessant struggle to retain foothold has developed their means of survival.

Because man has put his crop-plants in unnatural surroundings, they have lost the fitness acquired before they were domesticated. The new struggle thus set up causes many variations which afford opportunities for selection. With an ideal in mind, man can improve these plants if he continues to select rigorously and unerringly from many generations of plants grown in the same environment. This is one reason why home-grown seed is better than imported. His ideal must not change nor must his grip weaken by unwise choosing. Only the best can be tolerated.

In all cases it must be remembered that the whole plant is the unit. One kernel of wheat is as good as any other kernel from the same plant, for each seed will tend to produce a plant like the one from which it came. Of course, if a stool of wheat or a stalk of corn has more room, better soil, or more favorable conditions in which to grow, it produces more than one not so favored. It is not fair to judge plants in different conditions against each other, because it is impossible to tell how much is due to greater food, moisture, or room and how much to superior qualities in the plant itself. Therefore, field selections ought to be made in such a way as to choose plants that produce exceptionally well in spite of the fact that they had no advantage whatever. This gives a starting point for a seed plat.

Seed Plats. Every farm of considerable size should have one or more seed plats according to the size of the farm and the number of important crops that are planted each year. If even moderately large acreages of wheat, oats, barley, corn, or potatoes are being grown, the farmer can well afford an acre, more or less, to be cared for as a seed crop. There is little chance of losing, and much of gaining by this practice. It should provide better seed for the farm, and, even if the crop is marketed, it is likely to bring higher returns than any other acre of the same crop. Indeed many farms are devoted largely to the production of clean, high-yielding seed for sale at prices considerable above that of the ordinary product. Of course, the plat or farm so handled will require at little extra care, but not so much as a person might expect.

To start field selection, let the grower go into a field that is going to yield heavily at harvest time. This field should be his own if it bears a heavy yield of good grain, but if his stand is not good it is unwise to choose from it. He can not be sure
that seed from an ordinary yield is of high producing power unless he has had it for several years and can account for the present poor or moderate yield in a rather definite manner.

Small-grains. After choosing a field of small-grain that has a really good stand, the farmer should, just before it is ripe, walk carefully through it to find the part where the stand is fullest and most uniform. Then let him examine the individual plants—the stools, not the separate stalks. The best plant is the one that bears the most grain. Such a plant will usually have a relatively large number of stalks and moderately large heads that are near enough the same height to permit uniform binding or heading. The large heads are likely to be in the small stools, but if the kind of plant just described has large heads, so much the better. As large a number of these superior plants as convenient should be chosen and pulled up in such a way as to preserve the plant entire and uninjured. Of course no stool that has extra room, moisture, manure, or advantage in any way whatever should be selected. On the other hand, if a good plant is found in rather unfavorable surroundings, it may be valuable. But by all means, the selection should be made in such a way as to make sure that the extra yield is due to inherent qualities in the plant rather than to some favoring condition. These plants should be arranged in a row by themselves and further examined to prevent any flaw that may have been over-looked in the field from getting by unnoticed. Any badly bent or rust-infested plants should be discarded because they are weak in these respects.

This grain should now be dried in a protected place to prevent injury from chickens or other animals. If any stools show a marked shattering (shelling out) of grain as compared with the others these should probably be discarded for shattering is likely to cause loss in cases where grain must stand for a time after it is ripe. The original selection must be made when the grain is almost but not quite "dead" ripe in order to observe this quality. Wheat is more likely to suffer in this respect than barley and oats, though some of these grains also shatter considerably.

When all that can be learned about the plants is discovered, they are ready for threshing. Unless the plants are to be kept separate for planting in rows, the grain may be put in one sack and hung in a safe place until planting time arrives, when an analysis and a germination test should be made. After a seed-bed has been thoroughly prepared the grain should be disinfected by immersing it for ten minutes in a solution of formalin one pint
to forty gallons of water. When dry, it may be shown with a grain drill that is free from weed seed and smut spores. If smutty grain has been seeded lately, it is advisable to rinse the drill with some of the formalin solution.

As the grain grows, it should be treated as other fields of the same kind of grain and, in addition, must be kept free from weeds. When it is well headed out, the farmer can profitably walk through, pull out, and burn any plants that show smut in the heads. This enables him to control another wheat smut (loose smut) besides the one he treated for at planting time. It also aids the formalin treatment in the case of oats.

A little later he should cull out other grains, and grain of the same kind if a different variety should have crept in. This process of hand-pulling for cleanliness and for freedom from smut is known as "roguing", and may well continue until it is time to make individual plant selections. At this time, the process already described should be repeated in the seed plat and the selections saved for next year's plat, while the harvest from the entire plat should be saved for sowing the general crop. This requires that the seed plat be large enough to supply all the seed needed on the farm. In a few years, if the farmer will select the best plants and "rogue" his fields, he may offer clean, strong seed for sale at an advanced price.

**Corn.** With corn the process is very similar save for the fact that the stalk and not the hill is the individual plant. Since in much of Utah, one of the problems is to get the corn ripe before frost, it is advisable to select the first-ripened stalks. When the first husks turn white, the farmer should, as in the case of the small-grains, pick out a heavy-yielding field and the best part of that field. Let him now select early plants from areas that have uniform full stands. Total yield of grain is most important; very small ears, suckers, crooked stalks, and malformations of all kinds are objectionable to corn grown for grain. It is of course pre-supposed that the corn is of one variety and adapted to the locality. The husks should be partly stripped back to afford a good view of the ear. An ear well filled at tip and butt, and all over the cob bears more grain than one less completely filled. Deep, close-fitting kernels are also desirable—much more so with dent than with flint varieties. If more than one good-sized ear is borne on the stalk, it is all the better.

Corn needs more attention to dry it properly than do small-grains, because it contains more moisture which may cause molding or freezing if handled carelessly. After the final rejections
are made, the ears may be husked and dried as rapidly as possible without the use of very high temperatures. Even a warmed room may be used to advantage. The unshelled grain should be hung in a sack or on strings in a dry place not exposed to frost which injures the growing power of corn, though it hurts small-grains very little if any.

When planting time approaches, the ears should be tested for germination. A good way is to take ten kernels from various parts
of the ear including the butt, the middle, and the tip in equal proportions—say two kernels at five equal distances along the ear. Small squares ruled on the paper or cloth permit several ears to be tested in one pair of plates or in one "rag doll". If more than one kernel in any test does not grow, the ear from which the kernel came should not be used, for its viability is below ninety per cent. It is better to use only those ears all ten of whose test kernels grew. This can be done if there are a number of extra ears.

In a well-prepared seed-bed—manured on an irrigated farm—the planting should take place as early as safety from frost permits. It is useless to treat seed corn, for the smut of corn lives in manure and in the soil—not on the grain. After planting, cultivation to keep down weeds and proper irrigation are about all the care that is necessary except when ears are planted in rows by themselves to be tested individually. In this case some growers detassel every alternate row or half of each row—the upper half of one and the lower half of the next—thus securing from each ear some seed they are sure is cross-fertilized. The rows are then tested against each other for weight of grain. In this case the detasseled half row is counted the best seed, and corn from the best row is saved for next year’s plat. In the first case however, where the grain was mixed, the original selection and its succeeding steps are repeated.

**Potatoes.** Potatoes respond to somewhat similar selection. Some varieties have much higher-yielding possibilities than do others; therefore, the variety chosen is important. One disturbing factor in choosing potato seed is that some districts cannot use home-grown seed. Practically all the seed used in the South, is shipped from the North. Arizona also imports seed potatoes. In the West, some growers have small farms in mountain valleys which furnish seed for their large farms in the lower valley. In most cases, however, selected home-grown seed is best.

After a good variety is chosen, the next most important thing to consider is disease, which may reduce the yield from 5 to 50, or even 100 per cent. Most diseases can be detected by examining the tubers. Absolute freedom from disease, if possible, is desired.

Sometimes varieties deteriorate, or "run out." This need not happen if proper selection is practiced. There is a tendency to use or sell the marketable potatoes, thus leaving the small ones
for seed. It has been found that potato hills vary a great deal not only in the number of potatoes they produce, but also in the kind. Some hills have from four to eight tubers of much the same size and shape and contain no extremely large ones and not many small ones; others, one large potato and a number of small ones; while still others consist almost entirely of small tubers. Since both very large and very small potatoes are undesirable on the market, hills with a fair number of medium-sized tubers are most desirable.

A set from any potato in the hill tends to produce a hill like the parent. A big potato from a poor hill is not so good for seed as a smaller one from a good hill. It seems that all potatoes in a hill are equally valuable for seed. If such is true, there is no objection to using the small potatoes from desirable hills. If, however, small tubers from a bin or pit are used, most of them are likely to be from poor hills.

Seed selection is so simple that every farmer can follow it successfully. The grower will know which part of the patch has the healthiest potatoes. With a digging fork he can take out a few hundred hills, piling them separately. By examining the piles, he can easily select hills that contain the type he desires. For more technical work, some may desire to study the plants all summer. When such is the case, a peg may be driven close to the hills that promise well. This method has been followed at the Utah Experiment Station. Unpublished data show a vast improvement in potato seed so selected.

Selected seed requires careful storage, and protection from frost and heat. Boxes or crates holding from forty to seventy pounds are convenient, since this method prevents decay of any great number of tubers, and permits quicker shipment.
Where an early crop is desired, the seed may be soaked for forty-eight hours in lukewarm water. This seems to hasten growth a number of days. Another method is to expose well-kept tubers to the light for a few days until green sprouts show in the eyes. The long sprouts that grow when the storage place is too warm sap the strength of the seed, but are useless because they break off in planting.

Note the following by Professor William Stuart, potato specialist of the United States Department of Agriculture. He says:

"During the season of 1911 certain selections were made from strong and weak plants which were being grown on the tuber-unit basis. A record was made of the number and weight of the large and small tubers in each selection, and from these five of the best were selected for planting in 1912. The results obtained in 1912 fully corroborate those of 1911, and the accompanying data give the average yields from the strong and weak plants of the 12 varieties studied:

- **Strong tuber units**—3.28 pounds of primes; 1.18 pounds of culls. **Total**, 4.46 pounds.
- **Weak tuber units**—0.20 pound of primes; 0.51 pound of culls. **Total**, 0.71 pound.

"The strong plants gave over sixteen times as large a yield of primes or merchantable tubers and only a little over twice as many culls as did the weak plants."

**Forage Crops.** With such crops as alfalfa and the grasses, it is highly important that the seed patches be kept clean. In most cases the actual number of weed plants that occur in the fields is not large. They bear so many seeds, however, that a few weeds often mean a very large number of seed. The fields should be harrowed in fall or spring—perhaps both—to kill the weeds just as they start growth. Then as the season advances some grubbing or hoeing and hand-pulling will clean the fields. Larger yields and better prices for clean seed usually more than pay for this extra labor.

Dockage for impurities is always greater than the cost of cleaning, where cleaning is possible. Where it is not, prices are hurt materially if the foreign substances are counted undesirable, whether or not justly so. Recently Utah has lost some markets altogether because of inability to furnish large quantities of clean seed true to type.

Some seedsmen fear that the alfalfa-weevil is carried in alfalfa seed, and as a result have refused to buy Utah-grown alfalfa seed.
The Utah Experiment Station, however, has shown this to be not only unlikely but nearly impossible under ordinary conditions. Moreover, since the method of control worked out by the Station has been practiced, many of the best yields of alfalfa in Utah have been grown in weevil-infested districts. On this account the pest is not dreaded nearly so much as it was a few years ago.

D. A FEW OPINIONS ON SEED IMPROVEMENT.

The importance of improved seed is suggested by Hunt (Cereals in America pp. 14-15) in his quotation from Luther Burbank who estimates the gain if only one extra kernel or potato could be produced on each plant.

"In five staples only in the United States alone the inexhaustible forces of Nature would produce annually without effort and without cost:

- 5,200,000 extra bushels of corn
- 15,000,000 extra bushels of wheat
- 20,000,000 extra bushels of oats
- 1,500,000 extra bushels of barley
- 21,000,000 extra bushels of potatoes

"But these vast possibilities are not alone for one year, or for our own time or race, but are beneficent legacies for every man, woman or child who shall ever inhabit the earth."

"Cultivation and care may help plants to do better work temporarily, but by breeding, plants may be brought into existence which will do better work always, in all places, and for all time. Plants are to be produced which will perform their appointed work better, quicker, and with the utmost precision."

Coburn (Book of Alfalfa, p. 27) says:

"It is a time-worn but no less true saying that good seed is essential to good agriculture. No matter how well the farmer prepares his land, no matter how much time, labor and money he spends on it, if much or all of his seed fails to grow, he will either have a poor crop or be obliged to reseed, thus losing time and labor. Many causes may contribute to prevent a good
stand, but if he can eliminate any one of these, he is by so much
the gainer. Poor seed is a primary and great cause of a poor
stand.

"Before seed is purchased it should be tested for purity
and germination. The adage that a dollar saved is a dollar
earned well applies here; it is an easy matter to waste a dollar
on seed, and when profit depends on avoidance of useless expendi­
ture, the use of inferior seed points its own moral."

E. SEED LEGISLATION.

There is considerable agitation to get seed laws passed in
Utah. We undoubtedly need some regulations to control the
importation, the exportation, and the intra-state sale of seed.
Annually we suffer much loss on account of discrimination
against Utah seed. Here is a quotation from one of our seed-
houses on this subject:

"There is but one way to have pure seeds, and that is to
have the farmer who grows the seed go through the field before
the crop is harvested, and cut out every thing that is foreign.
It does not take a great while, and is of the utmost importance.

"Last fall we tried to buy some Turkey red wheat, and out
of more than thirty samples, not one of them was pure, and we
were obliged to turn down a large order from an adjoining state.

"Again our alfalfa seed is always offered at a lower price,
because there is always sweet clover and mustard seed mixed
with it. Both of these seeds could be quickly disposed of by
"roguing" the fields before the seed is cut. Of course the
seedsman, who handles the seeds, is always blamed for what he
is not to blame for at all, the carelessness of the grower."

In spite of this condition it would probably be unwise to pass
laws without investigating the seed situation. We should be
almost sure to repeat some or all of the mistakes that were made
by other states and that were due to uninformed, hasty
legislation. It seems that the creation of a State Seed Lab­
oratory for testing seed both for purity and for germination would
do much to lessen present discrimination made against our seed
by states that have inspection. Likewise we might prevent the
importation of seed that menaces—say for example, potatoes
bearing a new disease that has not yet troubled us. With such
a laboratory working we could then afford to take sufficient time
to investigate the situation and to pass adequate and applicable
laws for regulation of the seed business. Below is a quotation
from another Utah seedsman's letter in answer to an inquiry:
THE SEED SITUATION IN UTAH

"Each year the purchasers of all kinds of farm seeds become more exacting with respect to purity and germination and in most cases will not consider any seed without the knowledge of its purity. Specially equipped laboratories are necessary for accurately testing seeds for purity and germination. To meet this demand, the United States Department of Agriculture co-operated with the Oregon Agricultural College and the California Agricultural College in establishing and maintaining a properly equipped Seed Laboratory. In view of the increasing importance of Utah and the contributing territory as seed-producing centers, we think steps should be taken to secure the co-operation of the Department with the Utah Agricultural College in establishing a Laboratory for testing the purity and germination of seed."

In the meantime a commission might be appointed by the State Legislature to investigate the seed problem and report in, say two years, with recommendation on helpful legislation. A wisely chosen commission would most probably be able to analyze the condition and start our legislation down the right channels, thus avoiding sacrifice of both time and money. Blind plunging is expensive. Such a commission would constitute the eyes of the State Legislature with which it is to look before it leaps into law to control a nearly unknown condition.

F. SUMMARY.

The seed situation has many phases. Below is a list of those discussed in this circular:

1. Until recently, farmers could increase their yields more easily by using more land than by better cultivation or by the use of better crops.
2. The high price of land largely prevents further increase in this way.
3. Crop and cultural improvements seem to be the logical method of increasing yields.
4. Insects, disease, and weeds hinder proper crop development.
5. Markets are demanding better and better quality in farm products, which can be supplied only by crops of a high grade.
6. Townspeople as well as farmers are interested in better products.
7. Good crops depend on good seed.
8. A seed is the means by which one generation of plants trans-
mits to the next the power to live and to reproduce its characteristics.

9. Commercial and home-grown seed contain many impurities of which weed seed gives most cause for alarm.

10. Good seed is a relative term since no samples are absolutely pure; the best seed is that which is cleanest and strongest.

11. Poor seed may cause poor stands, may introduce weeds, or may cost too much.

12. Our seed situation has not been well understood.

13. Materials for sale are often examined more carefully than are home-used products.

14. Markets outside of Utah gave rise to seed-houses which have commercialized our seed problems.

15. Exportations called for the cleaner and better grades, often leaving seed of poor quality for home sowing.

16. The people of Utah are gradually becoming more and more interested in the seed situation.

17. Education offers the best opportunities for improvement, because laws often fail to operate successfully.

18. Seed-testing is one means of studying seed; it consists of analysis, germination, and report.

19. Analysis ought to be as detailed and as thorough as possible.

20. Forceps, needle, knife, hand lens, and scales are the essential tools; a set of crop and weed seed samples will help in a marked degree.

21. The germinator may consist of plates, sand, and paper or cloth, or of ruled cloth only.

22. Each kind of seed presents distinct problems.

23. Though the accurate detail of seed testing is difficult, untrained persons may make useful tests.

24. Seedsmen must do most of the work on vegetable and flower seeds.

25. High Schools in agricultural districts are the logical institutions to initiate the work and to maintain intelligent interest in it.

26. The United States Department of Agriculture has introduced many new crops.

27. Varietal tests at the State Experiment Station have helped materially in getting adapted crops and in producing better strains.

28. Plants vary widely. This affords opportunity for selection.

29. The entire plant is the unit of selection.
30. Every reasonably large farm needs a seed plat,—perhaps several.
31. Original selections for these plats should be made from high-yielding patches.
32. Plants that have no advantage and yet outyield their neighbors are the desirable individuals.
33. In selecting small-grain, the best yielding stools should be chosen.
34. High-yielding corn stalks, the ears of which mature early, offer starting points for better strains.
35. A sharp look-out for disease-free potato seed is essential.
36. Potato hills that are heavy yielders and that bear smooth, uniform, and shallow-eyed tubers are best.
37. The seed of these selected plants should be harvested separately and stored safely for planting next season.
38. The seed plat should be representative of the farm and well-prepared.
39. Corn especially needs testing for germination.
40. Small-grains should be treated with formalin to kill smut.
41. Potato diseases may be partly controlled by mercury bichloride (corrosive sublimate) or by formalin.
42. The seed plat requires thorough cultivation and weeding.
43. Roguing of small-grains and of forage crops is essential.
44. Alfalfa-weevil is not carried in alfalfa seed
45. Small improvement in crops mean immense total gains.
46. Opinions of eminent agriculturalists consider seed improvement far-reaching.
47. Seed laws have not been uniformly successful.
48. Some seedsmen favor a State Seed Laboratory to inspect both our imports and exports of seed.
49. A seed commission to investigate and report our seed situation to the State Legislature with recommended measures for inspection and control is probably advisable.

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