# TESTING SEEDS AT HOME.

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## THE IMPORTANCE OF HAVING GOOD SEED.

The importance of seed testing is recognized not only by professional seedsmen, but also by intelligent farmers. The necessity for testing seed arises from the fact that not every seed contains a living germ. The absence of a living germ makes the seed useless for the reproduction of its kind. To find out what proportion of the seeds in a sample contains germs capable of growth is therefore the object of all seed testing.

Good seed is essential to successful 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 "come up" he will either have a poor crop or will be obliged to reseed, thus losing time and labor. Many causes may contribute to prevent him from getting a good stand, but if he can eliminate any one of these he is by so much the gainer. Poor seed is a great cause of poor stands.

The farmer and the gardener get seed from one of two sources—they either grow it themselves or buy it. If the former, there is less danger of its being poor. The chief source of poor seed is careless handling in harvesting and storing. If seed gets too damp, mold will destroy much, or the seed will begin to sprout, then dry out, and the germ will be killed. If seed is bought, the chance of getting a poor quality increases many fold. If all seed was bought from reliable dealers, there would be far less cause for complaint, but farmers too often buy seed where they can get it the cheapest. They pay their money for trash that is either full of harmful weed seeds or has a liberal admixture of old and dead seeds.

Whenever large quantities of seed are purchased, they should be tested for purity and germination. The table on the following page gives the result of a few tests out of the many that were made in the Department seed laboratory last year of seeds bought from supposed reliable seedsmen.

The old adage that a dollar saved is a dollar earned will apply to the purchase of seeds. It is an easy matter to waste a dollar on seeds, and when profits depend upon cutting down useless expenditure, the use of inferior seed can not be too strongly condemned.

*Germination tests of seeds.*

| Kind of seed. | Per cent of germination was— | Per cent of germination should be— |
|---|---|---|
| Bean, Burpee's bush lima | 72 | 95 |
| Bean, Dwarf, pink-eyed wax | 77 | 95 |
| Cabbage, Drumhead | 67 | 95 |
| Cabbage, Luxembourg | 67.5 | 95 |
| Carrot, Mastodon | 58 | 85 |
| Clover, scarlet | 4 | 90 |
| Japan | 5 | 76 |
| Corn, Egyptian sweet | 76 | 92.5 |
| Corn salad | 39 | 80 |
| Cucumber, White wonder | 72 | 92 |
| Eggplant, New York improved thornless | 62 | 85 |
| Grass, Kentucky blue | 10 | 50 |
| Orchard | 31.3 | 80 |
| Texas blue | 1 | 50 |
| Lettuce, Golden ball | 64.5 | 90 |
| Muskmelon, Shumway's giant | 69 | 92 |
| Muskmelon, Surprise | 64 | 92 |
| Onion, Early round white Dutch | 58.5 | 85 |
| Oats, Scotch white | 79.3 | 95 |
| Parsley, Beauty of the Parterre | 53 | 75 |
| Pea, Dr. McLean | 88 | 98 |
| Pepper, Cranberry | 42 | 85 |
| Pumpkin, Winter luxury | 65 | 92 |
| Radish, Chartier | 63 | 95 |
| Rape, Dwarf Essex | 79.5 | 95 |
| Salsify, Sandwich Islands | 49.5 | 83 |
| Spinach, Mett's crumpled leaf | 43.5 | 89 |
| Tobacco, White burley | 0.25 | 88 |
| Tomato, Lorillard | 72.5 | 90 |
| Watermelon, Cole's early | 88 | 92 |

The standard of germination in oats is 95. This places the normal loss from nonviable seeds at one-twentieth part. In the sample of oats reported in the table the loss was slightly more than one-fifth. There was four times as much waste in this sample as there should have been. The White Dutch onion seed germinated 58.5 per cent. The loss in this case was 1 pound in every $2\frac{1}{2}$, while the normal waste should have been less than 1 pound in 7. The loss on Egyptian sweet corn reached $1\frac{1}{4}$ pecks in 5. The normal loss should not exceed 1 peck in 13.

A farmer sowing a meadow to Kentucky blue grass and buying such seed as that reported in the table would pay for 9 bushels of dead seed out of every 10 bushels purchased. There is always a great deal

of loss in this as in most grass seeds, but it should not exceed 5 bushels in 10. Here is a clear loss of 4 bushels out of every 10 bought, which, at $1.65 per bushel, is worth considering. The normal waste in orchard grass seed is 1 bushel in 5, but the sample tested contained almost 3½ bushels of worthless seed out of 5. At present orchard grass brings about $2 per bushel. This makes a net loss of about $7 on a purchase of 5 bushels of seed. It is unnecessary to give other examples of the loss which farmers suffer by purchasing poor seed. The table affords ample illustration.

## METHODS OF TESTING SEEDS.

Many seedsmen and a few farmers test their seeds. The method generally followed is to throw a handful of seed into a box full of earth, and decide by the way it comes up whether the seed is good. This is better than no testing at all, but it is impossible to get accurate results in this manner if the seeds used are not counted.

Another method is to make a shallow trench in sand, scatter in the seeds as thickly as is recommended for the variety, and wet with warm water. The seeds germinate rapidly, and the merit of the sample is judged by the stand in the row. When the seeds are not counted, no accuracy is possible. Besides, it is well known that the amount of seed thought necessary per running foot of drill, or per acre, is from two to four times as much as would be required if the seeds used had a high vitality.

Some people think that if seeds are thrown into water the good ones will sink and the dead seeds will float, but this notion is not supported by facts. When seeds float it is often because an air bubble has become attached to them or because they have not become wet all over the surface. Several experiments were made to test the germination of seeds that sink and those that float. Wheat was used in one set of experiments, and the average of all tests showed a germination of 68.3 per cent for the sunken seeds and 72 per cent for those that floated. In another set of experiments lentil was used, and it was found that 75.4 per cent of the sunken seeds and 86.7 per cent of those that floated germinated.

The germination of seeds depends on a proper supply of heat and moisture. For accuracy in testing, darkness is also essential. Seeds will germinate through a considerable range of temperatures, but the number of germinating seeds decreases as we depart from the optimum, or most favorable, temperature. If seeds are subjected to temperatures higher or lower than the optimum, germination will proceed more slowly, and when either extreme is passed it will cease. All seeds do not have the same temperature limit. Seeds of tropical plants need more heat to germinate than those from plants growing in northern latitudes or on high altitudes. Certain seeds have been known to germinate upon ice. Nobbe records an observation by

Uloth on the root of a maple seedling which penetrated a short distance into solid ice. Wheat has been known to germinate at the freezing point.

The following table, showing the effects of given temperatures upon the germination of seeds, is taken from Nobbe's Handbuch der Samenkunde. The column under *a* indicates the number of seeds germinated; that under *b* shows the number of hours required to germinate that number under the fixed temperature.

| Seed. | 16° C. (60.5° F.). | | 25° C. (77° F.). | | 31° C. (88° F.). | | 37.5° C. (100° F.). | | 44° C. (111° F.). | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *a* | *b* | *a* | *b* | *a* | *b* | *a* | *b* | *a* | *b* |
| Barley | 100 | 72 | 92 | 72 | 24 | 144 | | | | |
| Buckwheat | 100 | 72 | 100 | 24 | 100 | 24 | 100 | 48 | | |
| Cabbage, early, small | 100 | 56 | 100 | 32 | 100 | 48 | | | | |
| Cabbage, late, large | 100 | 48 | 100 | 24 | 100 | 48 | | | | |
| Clover, scarlet | 100 | 32 | 100 | 24 | 100 | 24 | 100 | 24 | | |
| Clover, red | 100 | 32 | 100 | 24 | 100 | 24 | 100 | 24 | | |
| Corn (maize) | 80 | 144 | 68 | 56 | 100 | 48 | 100 | 48 | 12 | 80 |
| Cucumber | 76 | 216 | 100 | 96 | 100 | 32 | 100 | 48 | 60 | 120 |
| Flax | 100 | 32 | 100 | 23 | 100 | 47 | | | | |
| Lucern | 100 | 32 | 100 | 24 | 100 | 24 | 100 | 24 | | |
| Muskmelon | 4 | 290 | 100 | 120 | 100 | 48 | 100 | 48 | 20 | 96 |
| Oats | 100 | 80 | 100 | 48 | 100 | 80 | | | | |
| Radish, round, white | 100 | 32 | 100 | 24 | 100 | 32 | 100 | 48 | 36 | 96 |
| Radish, long, white | 100 | 192 | 100 | 48 | 84 | 96 | | | | |
| Rye | 100 | 56 | 100 | 32 | 100 | 80 | | | | |
| Rye grass, English | 100 | 216 | 100 | 120 | 100 | 72 | | | | |
| Sunflower | 100 | 32 | 100 | 32 | 100 | 24 | 100 | 48 | | |
| Timothy | 76 | 168 | 100 | 144 | 88 | 148 | | | | |
| Tobacco | 100 | 192 | 100 | 108 | 88 | 168 | | | | |
| Wheat | 100 | 56 | 100 | 32 | 100 | 48 | | | | |

## PROPER CONDITIONS FOR TESTING SEEDS.

The best temperature for the germination of most seeds is shown to be 25° C. (77° F.), while for a few this optimum is 31° C. (88° F.) and 37.5° C. (100° F.). But seeds germinating under natural conditions seldom have the advantage of this optimum temperature.

In testing seeds, therefore, since it is necessary to get as near the natural conditions as possible, the temperature should be kept at between 18° and 20° C. (64° and 68° F.). This has been found to be the normal temperature for germination. Usually the heat of an ordinary living room will be sufficient for home testing, but if the temperature is likely to fall very low during the night it is better to provide a little heat during that time. More harm will result from a considerable decrease of temperature than from a slight increase. In the European seed-control stations seeds are tested at a constant temperature of 18° to 20° C. (64° to 68° F.). For grass seeds the temperature is forced up to 30° C. (86° F.) during six hours of the twenty-four, this variation in the heat being found advantageous.

Moisture is as important as temperature. Before a seed can sprout it must absorb water and swell. Though the swelling of a seed is a necessary preliminary, it is not always followed by germination, for the absorption of water is a purely mechanical process and does not imply vitality in the seed. The entrance of water into the seed is dependent upon the structure of the seed coats. When these are hard and impervious, as is often the case in leguminous seeds and in nuts, water gains admission slowly and germination is retarded. In cereals and in most garden seeds the seed coats are easily penetrated by water, the seeds swell rapidly, and germination is prompt. Experiments have proved that seeds will absorb moisture and swell in a damp atmosphere, but that for germination, contact with water is necessary. An atmosphere saturated with water vapor is not sufficient to induce germination. Flaxseed kept in a saturated atmosphere for nine days, and seed of kohl-rabi kept under the same conditions for twenty-two days, did not germinate (Nobbe, Handbuch der Samenkunde). Too much water is equally injurious. As a general rule, seeds will not germinate well when immersed in water. It is necessary to have the seeds in contact with some medium from which they can obtain an abundant supply without allowing water to stand around them.

Light exerts a harmful influence upon germination. Experiments have shown that seeds placed under colored glass did not germinate as rapidly as those which were in complete darkness. Even more important than the exclusion of light is the free access of air and the escape of the noxious gases generated by germinating seeds. When germination has commenced, carbonic acid gas is given off, which must be allowed to escape, or growth will be checked.

## SELECTING SAMPLES.

Selecting the sample to be tested is a matter of great importance. It must be a fair sample, including both good and bad seeds. If the quantity to be tested is considerable, small amounts should be taken from different parts of the mass. These small samples, thoroughly mixed, form the larger sample out of which the proper number of seeds is to be counted. In case the quantity of seed is small, say one-half pound of clover seed, pour the seed from the package into a pan, taking a small spoonful occasionally from the stream. From the quantity thus secured a sample for testing is taken. The number of seeds used in testing depends upon the size of the seed and upon the quantity at disposal.

If the sample is large enough, 100 seeds of the larger kinds and 200 to 400 of the smaller seeds are taken. The increased number is a check upon error in counting small seeds. In counting out the seeds a fair number of small and immature ones should be selected as well as the large and plump ones. There is reason to suspect that in some

tests only fine-looking seeds are used. These would, of course, give a higher percentage of germination than could be sustained by the entire sample. In selecting grass seeds for testing, care must be taken to use only such as contain a grain. In some kinds of grass seeds there are many empty glumes which it is difficult to distinguish from those containing a grain. A simple way to separate them is to wet the seed, spread it out on a plate of glass, and hold the plate up to the light. The empty chaff will appear translucent, while the good seed will be opaque.

### KEEPING A RECORD.

Although for the results usually desired in home seed testing it is not absolutely necessary to keep a record, yet such a record, if well made, will be found to contain much valuable information. A few items will always need to be recorded, in any event, such as the date of beginning the test, the name of the variety, the number of seeds, and the number of germinated seeds removed from day to day. It is dangerous to trust anything to memory. Mistakes are sure to occur, and the test will then be useless.

### LENGTH OF TIME REQUIRED.

The length of time a test should continue depends upon the seed. In the seed-control stations ten days has been accepted as the proper time for most seeds, but a few require a longer period, namely:

| | Days. |
|---|---|
| Esparsette, serradella, beet-seed balls, rye grasses, timothy, carrots | 14 |
| Grasses, except meadow and rye grasses, and timothy | 21 |
| Meadow grasses (*Poa*), coniferæ (except white pine), birches, alders, acorns, beeches, and hornbeams | 28 |
| White pine and stone fruits | 42 |

The seeds should be examined each day, and those that have germinated should be removed and the number recorded. A seed is considered as germinated as soon as the root breaks through the seed coats.

Under favorable conditions more than one-half of the seeds in a good sample will germinate in a much shorter time than that given above. The rapidity with which the seeds germinate is some indication of the vigor of the embryo, and determines the germinative energy.

The number of days in which more than one-half of the seeds in a good sample should germinate has been fixed as follows:

| | Days. |
|---|---|
| Cereals, clovers, peas, vetches, flat peas, flax, dodder, poppy, cabbage, radish, spurry, chicory | 3 |
| Squashes and pumpkins, cucumbers, beans, spinach, lupine, buckwheat, burnet | 4 |
| Beet, timothy, serradella, bird's-foot clover, rye grasses, meadow foxtail, reed grass | 5 |

| | Days. |
|---|---|
| Redtop, hair grass, chervil, carrots, fennel, esparsette, sorghum | 6 |
| Spruce, fox-tail grass, sweet vernal grass, canary grass, *Deschampsia*, *Trisetum*, *Poa*, crested dog's tail, velvet grass, red and sheep's fescue | 7 |
| Fir, pines (except white pine), maple | 10 |
| White pine[1] | 14 |

In nearly every test, especially of leguminous seeds, there will be some that remain hard. These can not be regarded as dead seeds, because their condition is due to the hardness of the seed coats. The number of such seeds should be recorded.

### SPECIAL CARE NEEDED IN TESTING BEET-SEED BALLS.

In testing beet-seed balls special care is necessary in recording the number of germinated seeds. The balls must be left in the test

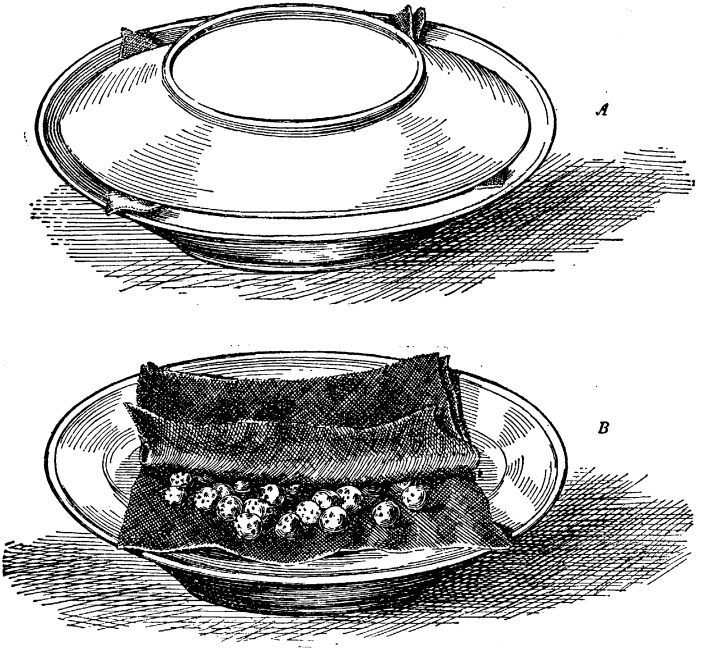


FIG. 23.—Simple germinating apparatus. *A*, closed; *B*, open.

during the entire period of fourteen days, but whenever a seed has sprouted it must be cut out with a sharp knife; or the root may be allowed to grow two or three days and then broken off and counted. The roots will either not grow out again, or, if they do, can not be mistaken for fresh ones. Either operation is very simple, and can be done by any one without the least trouble. The removal of the germinated seed or of the young roots is the only sure way of making an accurate test of the germination of beet-seed balls. One hundred seed balls should produce at least 150 seedlings.

[1] Yearbook, U. S. Department of Agriculture, 1894, p. 399.

APPARATUS.

The apparatus used for home seed testing should be as simple as is consistent with a reasonable degree of accuracy. Any method that complies with the conditions given above—a proper amount of heat, moisture, air, and the exclusion of light—will give good results. Fortunately, these conditions are so easily fulfilled that the most inexpensive apparatus will answer. Perhaps the simplest and at the same time the most satisfactory is the following:

Take two plates and place in one of them a folded cloth; wool or flannel is preferable, since it remains moist for a long time, but any cloth will do. The cloth should be free from dyes that will come out in water, since they may contain chemicals that would be injurious

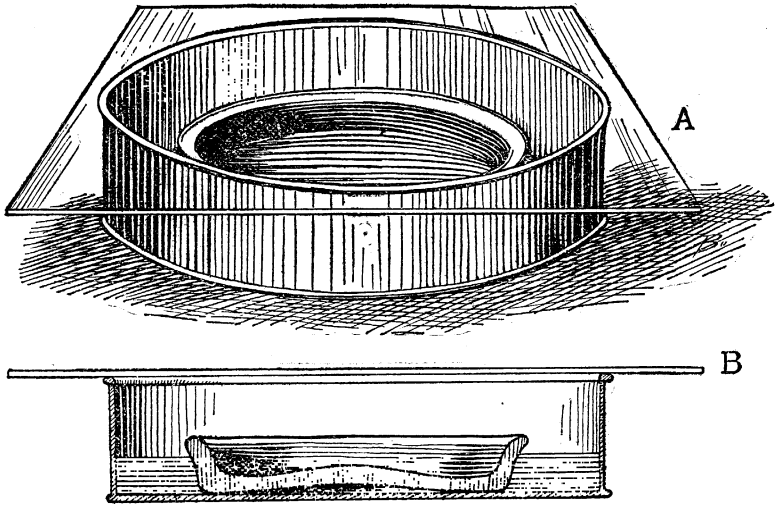


FIG. 24.—Homemade germinating apparatus. A, complete; B, section.

to the seed. Wet the cloth, pressing out the surplus water, leaving it very damp, but not soaked. Place the seeds between the folds of cloth, put in the number of the record, marked in pencil on a piece of paper, with date and number of seeds, and cover with the second plate, inverted. Plenty of air will get in between the plates, and the upper one will prevent too rapid evaporation of moisture. If the tests are to be made during the winter, keep the apparatus in the living room, as the heat of such a room will be sufficient for most seeds. During the night the seeds should be put in a warm place. Instead of the cloth, old newspapers, well soaked, can be used. These need to be moistened more frequently, however. (See fig. 23.)

Another apparatus that will give good results, especially for seeds not larger than wheat, is the one shown in fig. 24. Here the seeds are placed free on the bottom of a porous saucer and the latter put inside of a tin basin. The basin should have at least two coats of

mineral paint to prevent rusting. Water is poured into the basin up to about one-half the height of the saucer. The water will soak through the saucer and supply the seeds. For larger seeds this method is slow, since the seeds do not get water rapidly enough.[1]

A very simple apparatus is a glass or porcelain dish or tin pan with a little water in the bottom, and a handful of cotton batting, soaked, and placed in the dish. Put the seeds on the cotton and cover the dish with a plate of glass.

If it is desired to test a number of samples in the same apparatus, a convenient form is the following: Take a large dripping pan or an ordinary frying pan. Paint it to prevent rusting. Put four supports in the pan (inverted porous saucers are good) and place a tin or wire frame upon them, as shown in fig. 25. The seeds are laid between folds of blotting paper or cloth, which are then placed on the frame. A flap of paper or cloth hangs down into the water, which half fills the tray and keeps the folds moist.

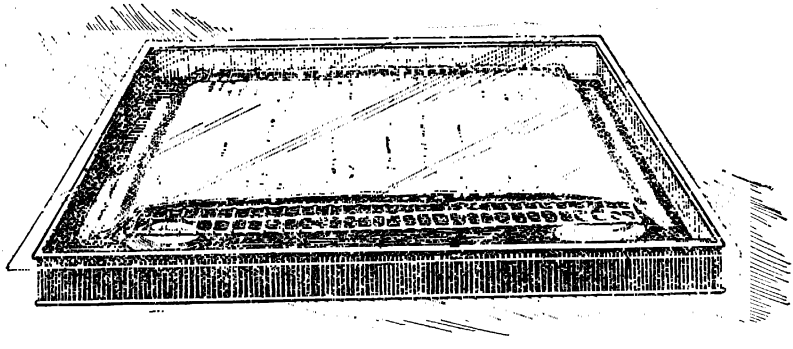

FIG. 25.—Apparatus for germinating several varieties at one time.

If glass can be had to put over the pan, evaporation will not be so rapid; otherwise the water will need replenishing frequently.

The tin or wire tray need not be expensive, and can be replaced by anything the operator may have. It is only necessary that a flap should dip into the water to provide moisture.

In testing seed some trouble will be experienced from the growth of mold. If the cloths and dishes are used many times, this trouble will become worse unless the spores of the fungi are killed. This can easily be done by boiling all cloths and washing the dishes in boiling water after each test.

In testing seeds it is necessary that there should be a standard of germination with which the germination of the sample can be compared. If the percentage of germination falls far below the standard, the seed is not fit for use, and its value decreases for every per cent

[1] An improvement on the above is described in the Yearbook of 1894, p. 405. Here folds of blotting paper or flannel cloth are placed in the porous saucer and the seeds laid between the folds.

of difference between its germination and that required by the standard.

The following table is offered provisionally, having been made up from original data and the most reliable outside sources. A great deal of experimenting will be necessary before a permanent table of germination standards is offered:

*Table of germination standards.*

| Seed. | Per-cent-age. | Seed. | Per-cent-age. | Seed. | Per-cent-age |
|---|---|---|---|---|---|
| VEGETABLE AND GRAIN SEEDS. | | VEGETABLE AND GRAIN SEEDS—continued. | | VEGETABLE AND GRAIN SEEDS—continued. | |
| Asparagus | 90 | Leek | 85 | Turnip | 95 |
| Beet | 150 | Lupin, yellow | 90 | Wheat | 95 |
| Brussels sprouts | 95 | Gherkin | 92 | GRASSES AND FORAGE PLANTS. | |
| Borecole | 95 | Melon, musk | 92 | | |
| Broccoli | 85 | Melon, water | 92 | Rape | 95 |
| Beans, bush | 95 | Mustard | 95 | Sorghum | 90 |
| Beans, lima | 95 | Onion | 85 | Spurry | 90 |
| Buckwheat | 92 | Okra | 85 | Clover, red | 90 |
| Cabbage | 95 | Oats | 95 | Clover, white | 85 |
| Carrot | 85 | Parsley | 75 | Clover, alsike | 85 |
| Celery | 65 | Parsnip | 75 | Clover, scarlet | 90 |
| Celeriac | 65 | Peas | 98 | Grass: | |
| Corn, field | 92.5 | Pepper | 85 | Fowl meadow | 75 |
| Corn, sweet | 92.5 | Pumpkin | 92 | Johnson | 75 |
| Cucumber | 92 | Radish | 95 | Kentucky blue | 50 |
| Collards | 95 | Rhubarb | 85 | Meadow fescue | 80 |
| Cauliflower | 85 | Salsify | 83 | Orchard | 80 |
| Chicory | 85 | Spinach | 89 | Texas blue | 50 |
| Cress | 90 | Squash, winter | 92 | Timothy | 90 |
| Eggplant | 85 | Squash, summer | 92 | Millet: | |
| Endive | 94 | Sunflower | 90 | Common | 85 |
| Kohl-rabi | 90 | Tomato | 90 | Pearl | 85 |
| Lettuce | 90 | Tobacco | 88 | | |

Nothing has been said in this article about testing seeds for purity. This is an important matter, but could not be properly treated in a few pages. Garden and flower seeds ought always to be nearly pure, but those of grasses and forage plants, especially clovers, frequently contain a considerable amount of foreign matter. The seeds of harmful weeds are often found in quantity in clover seed. Farmers should be on their guard against impure seeds.