Farmers may fail to submit satisfactory samples because they sample only one bag or too few bags or too few places in each bag; their samples may be too small for a complete test; samples of bins of seed often are taken from the place most easily reached, instead of from different places and depths in the bin.

Farmers often do not identify samples properly as to lot number or other designation when they send them to the laboratory.

So the sample is all-important. It should be drawn by a trained person using good equipment and procedures. It should be subsequently subdivided with the best mechanical divider available and with utmost care. Commercial samplers and official inspectors should always be warned that the sampler of seed has someone's reputation and well-being in his two hands.

A. S. Carter, Director of Seed Control and State Chemist Services, Biochemistry Department, Purdue University, is concerned with the administration of the Indiana seed, feed, and fertilizer laws. He has conducted research in seed technology, including the sampling of seeds.

The scientist who is called on to analyze seeds may have to determine the purity of a sample of seeds, examine it for seeds of noxious weeds, find out its origin, and ascertain the varietal purity of the seed stock.

The person who submits the seeds to the laboratory for test usually specifies the services he desires.

The purity test determines what proportion of the sample is pure crop seed and what proportion is seeds of weeds, seeds of other crops, and inert matter.

Assuming that the sample he receives is of adequate size and is representative of the seed lot, the seed analyst or technician reduces the bulk sample he receives to a smaller sample on which the test is to be made, usually referred to as the working sample.

Most kinds of seeds are mixed and divided by means of a mechanical divider, a device that mixes and divides the sample into two parts. The dividing process is repeated until the desired size of sample is obtained. Samples of seeds that are not free flowing, such as cotton and certain chaffy grasses, must be divided by hand. The seed is poured into a pile on the table, mixed thoroughly, and halved repeatedly until the amount is right.

The minimum weights to be used for working samples of agricultural seeds, vegetable seeds, and certain herb seeds are prescribed in the Rules for Testing Seeds, formulated by the Association of Official Seed Analysts, and the rules and regulations under the Federal Seed Act.
The amount varies with the size and nature of the seed to be tested. Seeds as small as redtop (Agrostis alba), which averages about 11 thousand seeds per gram, require 0.5 of a gram; Kentucky bluegrass (Poa pratensis), averaging about 4,800 seeds per gram, requires 1 gram; hairy vetch (Vicia villosa), with approximately 36 seeds per gram, requires 100 grams; field pea (Pisum sativum), with only about 4 seeds per gram, requires 500 grams.

To avoid errors due to any hand manipulation, the bulk sample is reduced to the nearest minimum weight specified in the rules. The working sample may exceed the prescribed weight but should never be less.

After the bulk sample has been reduced to the prescribed size, the working sample is weighed and taken to a workboard, where it is examined for trueness to name. The sample is then separated into its four components: Pure seed, other crop seeds, weed seeds, and inert matter.

Because of the small size of the units that make up most seed samples, the separation must usually be made under magnification. A hand lens of 6 X or 7 X magnification is suitable for most samples. The lower magnification of an ordinary reading glass is adequate for large seeds. The technician must be able to identify correctly every particle in the sample.

The component parts are weighed on an analytical balance that can weigh accurately to three or four decimal places. The less sensitive torsion balance may be used for large seeds, such as beans or peas. The percentage of each component is calculated on the total combined weight, and the kind and number of other crop seeds and weed seeds are recorded.

As a check against possible loss of material in the process of making the separation, the combined weights of the components and the original weight of the sample are compared. Another test is made if there is an appreciable difference between the two weights.

The evaluation of damaged or undeveloped seeds may present difficulties. Seeds of crops and weeds may be broken or otherwise injured, or the seed unit may be of such nature that it is difficult to determine visually whether a grain or embryo is present. The technician must determine whether they should be classified as "good" seeds or as inert matter. The standards for evaluating crop and weed seeds of this nature differ in some important respects. To assure uniformity in interpretation among seed technicians, the rules give specific instructions for the classification of questionable units.

A damaged crop seed, such as a broken alfalfa seed, obviously should not be counted as two seeds instead of one. In such cases, the rules provide that pieces of crop seeds larger than one-half the original size are to be classified as pure seed; pieces one-half the original size or less are classified as inert matter.

The broken part that is classified as pure seed may or may not produce a plant. Its planting value will be determined later in the germination test. The determination of potential germinability of agricultural seeds is not considered a function of the purity test.

The rules provide that diseased agricultural seeds shall be classified as pure seed. Those whose contents are replaced by fungus bodies—such as ergot or other sclerotia, smut balls, or nematode galls—however, are classified as inert matter.

Damaged weed seeds require a somewhat different interpretation. Because weed seeds are not tested for germination, as agricultural seeds are, the seed sample is not penalized by classifying as "good" weed seeds the seeds that are too damaged or undeveloped to grow.

The rules specify the conditions under which a weed-seed unit shall be classified as inert matter.

The following examples illustrate a few cases of damaged weed seeds or seedlike structures that would be clas-
sified as inert matter: Hulled dock (Rumex), more than half of whose embryo is missing; seeds of dodder (Cuscuta) that contain no embryo; bulblets of wild onion (Allium) that show damage at the basal end or are devoid of husk and pass through a ½-inch round-hole sieve; immature florets of quackgrass (Agropyron repens), in which the caryopsis (grain) is less than one-third the length of the palea; empty hulls of seeds (achenes), such as the sunflower (Helianthus) or the docks (Rumex).

The absence of embryo or endosperm may have to be determined by dissection or by examination over a diaphanoscope. A diaphanoscope is a device in which a strong beam of light is directed upward against a pane of clear glass, over which the seeds are examined with a hand lens. A light intensity of about 200 foot-candles is usually strong enough to penetrate the hull or seedcoat of most kinds of seeds.

Special techniques sometimes are used to establish trueness to name of the sample.

We do not attempt to distinguish individual seeds of perennial ryegrass (Lolium perenne) and Italian ryegrass (L. multiflorum). The possible diagnostic structures, such as awns and pubescence, usually are removed or damaged in harvesting and cleaning to such an extent that the seeds are indistinguishable. The fluorescence test is used exclusively to detect seeds of Italian ryegrass and hybrids in lots of perennial ryegrass or to determine perennial ryegrass in Italian ryegrass.

The fluorescence test involves a germination test. Four hundred seeds are taken from the pure seed fraction of the purity test and germinated on filter paper. The seedlings are examined under ultraviolet light, and the percentage of fluorescence and nonfluorescence is determined.

The results are then subjected to either of two formulas to calculate the proportion of each kind in the sample. The first is: The percentage of perennial ryegrass is 1.0526 times the percentage of nonfluorescence times the percentage of pure ryegrass divided by the percentage of germination.

The second formula is: The percentage of pure ryegrass or hybrids, or both, equals the percentage of pure ryegrass times the percentage of fluorescence minus the sum of 0.0526 times the percentage of nonfluorescence divided by the percentage of germination.

The formulas take into consideration a small percentage of short-lived perennial plants that may normally be present in perennial ryegrass.

We have no way to tell individual seeds of white-blossom sweetclover (Melilotus alba) from yellow-blossom sweetclover (M. officinalis). Yellow-blossom sweetclover produces a variable proportion of seeds that are spotted—often faintly—with purple. They are referred to as mottled seeds. As far as we know, the varieties of white-blossom sweetclover grown in the United States do not produce mottled seeds. When mottled seeds are observed in a sample labeled “white-
blossom sweetclover,” it can be assumed that seeds of yellow-blossom sweetclover are present. Most samples from plantings in fields and greenhouses have indicated that about four times as many yellow-blossom plants will be produced as there are mottled seeds. We conclude therefore that each 1 percent of mottled seed represents 4 percent of yellow-blossom sweetclover.

If a sample is submitted as white-blossom sweetclover, a mottled-seed test is made to determine the possible presence of yellow-blossom sweetclover. A minimum of 400 seeds, taken from the pure seed fraction of the purity test, is examined. The entire 5-gram working sample is examined in some laboratories. A hand lens or a higher magnification may be necessary to detect the fainter markings.

The rules provide the following formula for the determination of percentage of yellow-blossom sweetclover in a sample of white-blossom sweetclover: Weight of mottled seeds (in grams) times 4 times percent of pure sweetclover.

Several new varieties of yellow-blossom sweetclover have been introduced. Some of them show great variation in content of mottled seed. There is strong evidence that the area and year of production strongly influence the percentage of mottled seed. These findings indicate that our formula for determining the extent of an admixture should be considered only an estimate rather than an accurate analysis. A field or greenhouse test should be made when an accurate determination is required.

Pelleted, or coated, seed may contain single seeds or several seeds each. The pellets are designed to make small or irregular seed units easier to plant. The coating material may be inert material or it may contain some fertilizer or fungicide.

The rules do not prescribe specific procedures for purity tests for pelleted seed. Since the coating material is not a part of the true seed or its accessory structures, it is interpreted that the inert coating material should be removed and added to other inert matter that may be present in the sample. The sample accordingly is reduced to the prescribed working-sample size and weighed. The coating is removed by soaking for a few minutes. The seed is then blotted dry and weighed again. The difference between this weight and the original weight is added to the total inert matter in the sample.

Testing seeds of poorly cleaned samples or seeds of chaffy grasses takes work and time. Several helpful devices are available. A set of graduated sieves is useful for separating samples that consist of particles of various sizes into size groups. The groups must still be examined under magnification, but the grading of the particles saves a great deal of handpicking.

The grain of many kinds of grasses is enclosed in a pair of chaffy or hardened scales (lemma and palea), which usually are opaque. The technician must examine every seed unit in the sample to determine if it contains a grain or if the structure is empty. This may be done by light pressure with forceps or by examination over strong light—a time-consuming procedure, especially for the small-seeded kinds, such as bluegrass.

Two mechanical aids are available for testing chaffy grasses—the vertical airblast seed blower or separator and a diaphanoscope.

Several types of seed blowers have been developed. A simple form consists of a uniform flow of air (up to about 6 pounds) with a valve to regulate the amount of pressure. The airflow is directed upward into a tube of specified diameter, which contains the sample. Two traps near the top of the tube catch the lightweight material as it is blown upward.

By carefully controlling the air pressure, one can make several blowings, which separate the empty and light-
weight units from the heavy seeds. The first blowing usually consists entirely of empty florets. The second and third

blowings may consist in part of the heavier empty florets and the florets that contain small or poorly developed grains. The residue in the tube usually consists of the heavy, filled florets. The separate blowings are then examined under magnification to remove all empty florets from the filled florets. This is done on the workboard by light pressure with forceps or by examination over a diaphanoscope.

The florets of grasses are produced in clusters, called spikelets, which may have many flowers as in ryegrass, or may be single flowered, as in redtop.

Not all of the florets of the many-flowered spikelets may contain grains. The mature spikelets in some species break apart readily, and the empty florets are removed in processing. In other species, the spikelets do not break apart easily, and the seed sample may contain a variable proportion of spikelets that contain both filled and empty florets. These are referred to as multiple units.

The rules enumerate certain species in which the presence of the attached empty florets is negligible and the multiple units need not be separated in the purity test. These include bluegrass (Poa), rhodesgrass (Chloris gayana), bluestem (Andropogon), gramagrass (Bouteloua), and oats (Avena).

The separation of multiple units for the purity test may be exceedingly tedious in the following species: Creeping red fescue (Festuca rubra), chewings fescue (F. rubra var. commutata), crested wheatgrass (Agropyron desertorum), orchardgrass (Dactylis glomerata), and intermediate wheatgrass (Agropyron intermedium).

A modified procedure has been adopted in the rules for testing them. All multiple units that contain one or more grains are weighed with the pure-seed single florets. Then they are removed and weighed separately. If the weight of the multiple units is less than 5 percent of the total pure seed, the empty florets are removed manually and added to the other inert matter in the sample; if greater than 5 percent, the florets are not separated, but a prescribed portion of their weight is added to the percent of pure seed and the remainder is added to the inert matter. The specific factor that is applied is determined by the percentage of single florets present in the sample, as well as the kind of seed under consideration.

For example: A sample of orchardgrass was composed of 60 percent of fertile single florets, 30 percent of multiple units, and 7.5 percent of inert matter. The factor for 60 percent of single florets in orchardgrass is 81 percent.

Thus, 81 percent of 30 would be added to the pure seed fraction \((60 + 24.3)\), a total of 84.3 percent of pure seed. The remainder of the multiple units
would be added to the inert fraction (7.5 + 5.7), a total of 13.2 percent of inert matter.

The classification of incidental "other crop" seeds in a purity test often poses a problem. Because of the wide diversity of climate, soils, topography, and prevailing cultural practices, a plant that is a valuable economic crop in one situation may be a weed elsewhere. The disposition of such seeds in a purity test may depend somewhat on the use for which the seed lot is intended. A plant that may be valuable in pastures may be objectionable in a lawn—perennial ryegrass (*Lolium perenne*) and black medic (*Medicago lupulina*), for example. Sweetclover, once considered a weed, now is classified generally as a crop seed.

The rules under the Federal Seed Act list the kinds of agricultural and vegetable seeds that are to be classified as weed seeds when occurring incidentally in imported samples of agricultural and vegetable seeds. In determining whether a certain kind of seed should be classified as a crop or a weed, the technician must be guided by the accepted practice in the State where the seed is to be sold.

The term "weed seeds" includes seeds of all plants generally recognized as weeds.

From an agricultural viewpoint, weeds fall into two categories: Relatively harmless plants, usually annuals, that are easily controlled by ordinary cultural methods and are objectionable only as they occur in quantity; and weeds that are objectionable or detrimental to the land. The latter are noxious weeds. Noxious weeds not only produce seed but also spread by underground roots or stems, which, when well established, are highly destructive and difficult to eradicate or control by ordinary good cultural methods.

Each State seed law contains a list of noxious-weed seeds, a combined total of about 150 species. The Federal Seed Act recognizes these kinds as noxious weeds in interstate commerce. A separate list of noxious-weed seeds is recognized under the Federal Seed Act for imported seed. The lists are subject to change as conditions warrant.

The test for seeds of noxious weeds is made on a larger amount of seed than that prescribed for the purity test. The reason is plain. Seeds of a noxious weed, such as dodder, might be present in a lot of red clover, but fail to appear in the small 5-gram working sample of the purity test.

The rules specify the minimum amount to be examined for the noxious-weed test for the different kinds of agricultural seeds. The quantity varies with the relative size and nature of the seed from 25 grams for the very small-seeded kinds up to 500 grams for large seeds. The laboratory sample is reduced to the prescribed size by means of a mechanical mixer and divider.

The test consists of removing the noxious-weed seeds only. The seeds are counted, and the number of each kind per unit weight (grams) of the sample examined is recorded. Federal seed laws and those of most States require that the number of each kind per pound be stated.

The following conversion table is convenient for converting from the gram basis to pound or ounce.

<table>
<thead>
<tr>
<th>Size of sample examined (grams)</th>
<th>Factor to be used for number of seeds per pound</th>
<th>Factor to be used for number of seeds per ounce</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>18.0</td>
<td>1.14</td>
</tr>
<tr>
<td>35</td>
<td>13.0</td>
<td>0.81</td>
</tr>
<tr>
<td>50</td>
<td>9.0</td>
<td>0.57</td>
</tr>
<tr>
<td>100</td>
<td>4.5</td>
<td>0.29</td>
</tr>
</tbody>
</table>

Thus, if two seeds of dodder were found in a sample of 50 grams, 18 seeds per pound would be reported.

The seed technician making the noxious-weed test is guided by the list published in the laws or regulations of the State where the seed is to be sold.

The test consists of the removal of seeds of the kinds specified for that particular State only. The individual requesting the test usually specifies the
State or States for which the information is desired, or he may request a test for noxious weeds for all States. In the latter instance, all seeds designated as noxious would be removed from the sample.

If a noxious-weed test is desired for export purposes, the exporter would request an examination for certain weeds only, such as dodder.

The importance of the origin of agricultural seeds is recognized in State and Federal seed laws that require the origin of specified seeds to be stated on the label attached to the seed. The Federal Seed Act requires that imported seed of alfalfa and red clover be stained in certain proportions with colors that indicate the origin or general adaptation of the seed in the United States.

The place of origin of seeds of forest trees may affect the form, rate of growth, and even survival after planting. A transfer of altitude of 500 feet or more is known to be unfavorable to some kinds. We know of no method of determining the origin by an inspection of the seed. Some States have enacted laws regulating the labeling and sale of tree seeds with regard to geographic origin.

Some agricultural crops produced in one locality have characteristics that are a result of temperature, rainfall, and altitude. Some varieties are grown to the exclusion of other varieties because of their adaptation—such as winter hardiness—to local conditions. Sometimes plants grown from seed produced in one region may be susceptible to a disease that is prevalent in another region, and certain areas may have diseases that would be harmful if introduced into another region. It is important therefore to know the origin of certain crop seeds.

An experienced seed technician often can determine the origin of agricultural seeds by carefully examining extraneous material, such as weed seeds and other crop seeds, that may be present in the sample.

The size of the sample to be examined for origin cannot be specified definitely. The usual practice is to continue the examination until conclusive evidence is found—maybe in a small amount of seed or maybe in the entire sample submitted. If no evidence is found in about a pound of such seed as alfalfa or red clover, however, it would appear that little or no useful purpose would be served by further search.

The correct evaluation of the impurities in a sample requires a wide knowledge of plant distribution and good judgment on the part of the seed technician. An illustration: A lot of alfalfa seed offered for sale in the North as a winter-hardy variety was tested for origin. Examination of the seed disclosed the presence of a few seeds of silversheath knotweed (*Polygonum argyrocoleon*), a plant that is not known to occur in the northern latitudes. Its presence, together with other evidence, established the fact that the alfalfa seed was of southwestern origin.
and not the winter-hardy variety it was claimed to be.

Varietal identification by seed characters has certain possibilities, the limits of which the skilled technician learns to recognize.

The problem can be considered in three parts.

First are the varieties that can be identified accurately both in the bulk and as individual seeds. This can be illustrated by Kentucky bluegrass (*Poa pratensis*) and Merion Kentucky bluegrass (*P. pratensis* var. Merion). Size and color are not reliable criteria because of the variation that may be evident in Kentucky bluegrass from different areas of production. The outstanding distinguishing features are shape of seed (floret), as it appears in outline in lateral view, and texture and nerves of the lemma.

Another example is Highland bentgrass (*Agrostis tenuis* var. Highland bent). This minute seed is distinguishable from Colonial bentgrass and Astoria bentgrass, both of which are varieties of *Agrostis tenuis*. In this case, the main distinguishing features are shape of seed in dorsal view and the character of the apex of the palea.

Striate lespedeza (*Lespedeza striata*) and Kobe lespedeza (*L. striata* var. Kobe) can be distinguished by size and color.

Second are varieties that are distinguishable in the bulk, although not all of the individual seeds can be recognized with certainty. Such separations are useful as indicators of a mixture of varieties and may produce sufficient evidence to detect a mislabeled sample. Certain varieties of oats, soybeans, sorghums, and others are among them. Such groups have many agronomic varieties when considered on a countrywide basis. Many laboratories work with only a few local varieties, however, and it is often possible to identify the individual seeds accurately.

Third are varieties that appear to have no diagnostic features of the seeds, either in bulk or as individual seeds. Among them are varieties of such plants as alfalfa, red clover, certain varieties of oats, and soybeans. A growing test should be made if varietal identification is required.

The seed technician must become familiar with the possibilities and limitations of variety identification of the kinds with which he works in order to know the extent to which such separations should be attempted.

The science of seed identification, which is such an essential part of purity analysis, is a specialized field of botany. It has been developed over the past 50 years to meet the needs for correct labeling of seeds in commercial channels in order to assure the consumer of high-quality seeds.

Seeds do not vary greatly as a result of environment, and the characteristic morphological features remain fairly constant. It has been possible to illustrate the seeds and prepare seed keys for the identification of species in all of the more important genera of crop and field-weed plants. The distinguishing features between the species of a genus may be fairly similar. The differences often are minute or obscure. A widefield stereoscopic microscope equipped to give magnifications of about 20 X and 40 X is essential for viewing the finer structures.

Most agricultural plants belong to one of two families—the grass family (Gramineae) and the legume family (Leguminosae). A representative genus of each family has been selected to illustrate the technique of seed identification by means of a seed key and illustrations of the seeds.

In the grass family, the grain is classified botanically as a fruit, which is called a caryopsis. The embryo lies on the outside of the endosperm in an oval area toward the base of the seed. The root-shoot axis of the embryo, often protected by only a thin membrane, appears as a raised line, or ridge, down the middle of the oval area. The caryopsis is enclosed by two bracts, the lemma and palea. The
bracts may be thin and chaffy, as in bluegrass, or they may be thick and hardened, as in the millets (Setaria).

The so-called seeds that compose a grass-seed sample may consist entirely of the mature florets (caryopses within their lemmas and paleas) or of the hulled caryopses. Some samples may be a mixture of both. The seed technician must become familiar with the morphological features that are characteristic of both forms.

The bluegrass genus (Poa) comprises about 20 species that are used for lawn, pasture, hay, and range purposes. About half of this number are in commercial production, and three or four species may appear incidentally in other crop-seed samples.

An abbreviated seed key, classifying five species and one variety of the more widely distributed species of bluegrass, will serve as an example for the identification of grass seeds. (Page 426.)

The illustrations show the seed types that may occur in a single spikelet.

THE LEGUME FAMILY includes such crops as alfalfa (Medicago sativa), the true clovers (Trifolium), sweetclovers (Melilotus), vetches (Vicia), soybeans (Glycine max), peanuts (Arachis hypogaea), and many others.

The seeds vary widely in size, shape, and color, but they have certain structural features that immediately place them in the legume family.

With the exception of the peanut, the seedcoat tends to be hard and brittle and often impervious to water. Such seeds are sometimes damaged by cracking or chipping of the seedcoat in processing.

The embryo fills the entire cavity and consists of two large, thick cotyledons, with the radicle (root) bent back against them.

The hilum (seed scar) is evident on the seed surface near the tip of the radicle. It is usually an oval, circular, or oblong area with a longitudinal groove or slit down the middle. The area may be minute, as in some of the clovers, or it may be large and conspicuous, as in vetch and soybean. In some species, the slit in the hilum is obscured by a persisting layer of corky tissue, as in cowpeas (Vigna sinensis) and beans. The size, shape, and position of the hilum are important diagnostic features.

A small, dark-colored elevation, the chalaza, may be evident on the surface of many legume seeds. Its prominence and its position in relation to the hilum are also important diagnostic features.

A seed key and illustrations of the seeds of the vetches (Vicia) illustrate the identification of seeds of one genus of the legume family. Eighteen species of vetch are of interest in our agriculture. Eight of these species are cultivated crops in this country. Ten species may occur incidentally in other vetch samples or with other crops, and these are usually classified as weed seeds.

PLANT GENERA that include valuable agricultural species may also contain one or more species that are recognized as noxious weeds.
A. Seed of clover in longitudinal section: (a) The radicle; (b) cotyledons; (c) seedcoat; (d) position of hilum and (e) chalaza. B. Hilar area showing the longitudinal groove of the hilum and (a) the micropyle, (b) chalaza, (c) the raphe.

The seed technician must assume the responsibility for distinguishing the seeds of the noxious-weed species from those that may be crop species of similar appearance. This can be illustrated by the wheatgrass genus (*Agropyron*).

**Thirteen species of wheatgrasses appear in our agriculture.** Ten of the species are valuable forage, hay, or range grasses. Two of the species are classified as weeds that appear occasionally in cultivated fields. One species, quackgrass (*Agropyron repens*), is classified as a noxious weed in almost all States.

A comparison of the seeds (florets) of quackgrass (*Agropyron repens*) and two common crop species, western wheatgrass (*A. smithii*) and slender wheatgrass (*A. trachycaulum*), shows that superficially they appear to be closely similar. A close examination of the morphological structures, however, reveals differences whereby they may be distinguished.

Often some of the structures, such as awns and pubescence, are removed or damaged in harvesting and cleaning. Such seeds will not show all the diagnostic features and the seed technician must learn to make an identification on fragmentary evidence. It requires study and practice on the part of the technician to develop the skill and proficiency necessary for accurate work.

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**POA, BLUEGRASS**

**A SEED KEY**

1a. Intermediate nerves of lemma distinct to the base; lemma pointed, the apex folded.

2a. Pubescence on midnerve and marginal nerves only, the pubescence long and dense; lemma 5–6½ mm. long. Hairs on keels of palea short on upper half, long and dense on lower half.

*Poa arachnifera*, Texas bluegrass (figure 6).

2b. Pubescence on all nerves; lemma 2½–3 mm. long.

3a. Pubescence long and dense; hairs on keels of palea long, dense, do not extend to tip of palea... *P. annua*, annual bluegrass (figure 5).

3b. Pubescence on nerves shorter, confined to lower half of nerves.

4a. Lemma evenly brownish straw-color, close-fitting on the grain, the intermediate and marginal nerves distinct to the tip; hairs
Figure 1. *Poa pratensis.*
FIGURE 4. *Poa compressa*.

FIGURE 5. *Poa annua*.

FIGURE 6. *Poa arachnifera*. 
on keels of palea very fine, short, close-spaced, extend to tip of palea. . . . . . . . . . . \textit{P. trivialis}, rough-stalked bluegrass (figure 3).

4b. Lemma light to dark straw-color, darker brown toward the base, smooth fitting on the grain; hairs on keels of palea coarse, short, wide-spaced, do not extend to tip of palea.

\textit{P. pratensis}, Kentucky bluegrass (figure 1).

1b. Intermediate nerves of lemma lacking or obscure.

5a. Lemma broad, short-pointed, the apex expanded, light straw-color, loose-fitting on the grain.

6a. Hairs on keels of palea short, fine, close-spaced, or longer about midway, extend to tip of palea; length 2–2½ mm. \textit{P. compressa}, Canada bluegrass (figure 4).

6b. Hairs on keels of palea short, coarse, wide-spaced, do not extend to tip of palea; length 2¼–3 mm. \textit{P. pratensis} var. Merion Kentucky bluegrass (figure 2).

5b. Lemma pointed, slender, delicate, loose-fitting on the grain, light straw-color, often gold-tipped or purplish; rachilla long, slender; hairs on keels of palea short, or longer about midway, close-spaced, extend to tip of palea; length 2–2½ mm. . . . . . . . . . . \textit{P. palustris}, fowl bluegrass.

\textbf{VICIA, VETCH}

\textbf{A SEED KEY}

1a. Chalaza on the back, opposite the hilum.

2a. Hilum about 2 mm. long, flush with surface of the seed or nearly so.

3a. Hilum narrowly oblong, \(\frac{1}{2}\) to \(\frac{3}{4}\) mm. wide; seed 4–4\(\frac{1}{2}\) mm. long. \textit{V. pannonica}, Hungarian vetch (figure H).

3b. Hilum short-oval, about \(1\frac{3}{4}\) mm. wide; seed 5 mm. long. \textit{V. hybrida}, no common name (figure J).

2b. Hilum about 4 mm. long, oblong.

4a. Hilum narrow (\(\frac{1}{2}\) to \(\frac{3}{4}\) mm.), slightly depressed at the margins; seed 6–6\(\frac{1}{2}\) mm. long, may be variously compressed. \textit{V. lutea}, yellow vetch (figure I).

4b. Hilum wide (1 mm. or more), flush with surface of seed or nearly so; seed 4\(\frac{1}{2}\) to 5 mm. long. \textit{V. melanops}, no common name (figure K).

1b. Chalaza near one end of the hilum.

5a. Hilum linear, obscured by a persisting whitish, frill-like tissue; seeds 3–4 mm. long.

6a. Hilum about two-thirds the length of the circumference; seed lens-shaped, brownish and faintly mottled. \textit{V. grandiflora}, showy vetch (figure C).

6b. Hilum 1–3 mm. long; seed slightly flattened but not lens-shaped.

7a. Hilum 2½ to 3 mm. long; seed dull black. \textit{V. bengalensis}, purple vetch (figure B). \textit{(V. atropurpurea)}.

7b. Hilum about 1 mm. long; seed brownish, faintly mottled. \textit{V. monantha}, Bard vetch (not illustrated).

5b. Hilum not obscured by persisting tissue.

8a. Seeds relatively small, length 1½–2 or 3 mm.

9a. Seed with knoblike protuberances, minutely stippled, appears 4-sided in outline. Hilum dark reddish brown, short-oval, length
Seeds of vetch, *Vicia* spp., greatly enlarged.
A. *V. hirsuta*, tiny vetch
B. *V. bengalensis*, purple vetch (*V. atropurpurea*)
C. *V. grandiflora*, showy vetch
D. *V. tetrasperma*, fourseed vetch
E. *V. cracca*, cow vetch
F. *V. angustifolia*, narrowleaf vetch
G. *V. angustifolia*, narrowleaf vetch
1 mm., width $\frac{1}{2}$ mm.; seed light grayish brown with a prominent chalaza near end of hilum, length 2 mm.

*V. lathroides*, low pea vetch (not illustrated).

9b. Seed smooth, mostly spherical.

10a. Hilum oblong, length $1\frac{1}{4}$ mm., width $\frac{1}{2}$ mm. or less; seed reddish brown and finely mottled, length 2–2$\frac{1}{2}$ mm.

*V. tetrasperma*, fourseed vetch (figure D).

10b. Hilum markedly longer, 2–3 or $3\frac{1}{4}$ mm.

11a. Hilum linear-oblong, width $\frac{1}{2}$ mm. or less.

12a. Seed glossy, yellowish or brownish, copiously mottled with purple; hilum 2–2$\frac{1}{2}$ mm. long, commonly with a stalklike appendage loosely persisting........*V. hirsuta*, tiny vetch (figure A).

12b. Seed dull, black or lighter and mottled; hilum 2$\frac{1}{2}$ to 3 mm. long...*V. cracca*, cow vetch (figure E).

11b. Hilum linear-ovate, width at broader end about $\frac{3}{4}$ mm.

13a. Hilum about 2 mm. long, slightly raised along the groove down the middle; seed spherical, black and lustrous or dull greenish with dark mottling.

*V. angustifolia*, narrowleaf vetch (figures F and G).

13b. Hilum about $3\frac{1}{2}$ mm. long, flat, grayish and scurfy; seeds slightly flattened, dark brown with obscure mottling.

*V. americana*, American vetch (not illustrated).

8b. Seeds relatively large, length 4–5 or 6 mm., up to 14 mm. in *faba*.

14a. Chalaza 2$\frac{1}{2}$–3 mm. from end of hilum; hilum about 1 mm. long, $\frac{3}{4}$ mm. wide. Seed dull, pale brownish and usually mottled with dark green, the side opposite the chalaza flattened at right angles to the hilum so that seed appears triangular in outline..........*V. ervilia*, bitter vetch (not illustrated).

14b. Chalaza 1 mm. or less from end of hilum.

15a. Seed spherical or slightly flattened.

16a. Hilum flush with seed surface, smooth and flat, color black or reddish, length about 2 mm., width 1 mm., seeds black or obscurely mottled.

*V. villosa*, hairy vetch (figure M).

*V. villosa* var. *glabrescens*, smooth vetch.

16b. Hilum depressed at the margins.

17a. Hilum linear-oval, flat, the surface slightly granular and scurfy with a light-colored strip along the groove down the center, length about 2 mm., width $\frac{3}{4}$ mm. or less; seed dull black or obscurely mottled.

*V. dasycarpa*, woollypod vetch (figure N).

17b. Hilum linear-ovate, raised down the middle along the groove, length 2–2$\frac{1}{2}$ mm., width $\frac{3}{4}$ mm.; seed color variable, commonly reddish brown and obscurely mottled. A variable species.

*V. sativa*, common vetch (figure L).

15b. Seed broadly oblong or oval, thick, flattened, reddish brown, length 13–14 mm., width 8–9 mm., hilum lies along the narrower end, length 5–6 mm., width 1–1$\frac{1}{2}$ mm.

*V. faba*, horsebean (not illustrated).
Seeds of vetch, *Vicia* spp., greatly enlarged.

H. *V. pannonica*, Hungarian vetch
I. *V. lutea*, yellow vetch
J. *V. hybrida*, no common name
K. *V. melanops*, no common name
L. *V. sativa*, common vetch
M. *V. villosa*, hairy vetch
N. *V. dasycarpa*, woollypod vetch