

Small Grains:

Wheat

Oats

Barley

&

Rye

4-H Crops
and
Soils Project

MJ0110

To the Member

In this book you will learn about the small grain plant, how to grow, harvest, store, and market these crops, how these crops are used, and careers related to these crops. As you work through this project, you can ask for help from other 4-H club members, your 4-H project leader, and your parents. First, check with your own 4-H club to find out what is expected of a 4-H member. The 4-H Crops and Soils Project suggests that you do the following:

- Plan the project with your parents and the 4-H Crops and Soils Project leader, using page 1 of the Crops and Soils Record Sheet.
- Complete at least three exercises in the exercise division that you select.
- Attend meetings related to your project.
- Help your 4-H project leader decide how many Crops and Soils Project meetings your group should have during the year and attend those meetings.
- Help your 4-H project leader and the 4-H project group to carry out their plans.
- Present a talk or demonstration about your project.
- Make a public exhibit of your project.
- Complete the 4-H Crops and Soils Record Sheet. (If you raise less than one acre, you must complete only page 1; if you raise one or more acres of a crop, you must complete pages 1 through 4.)
- Discuss your progress in the project with your parents, project leader, and friends.

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Introduction

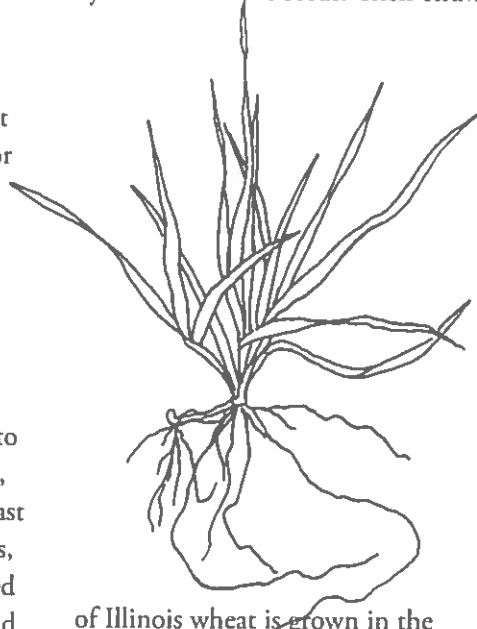
The small grains, also called cereal grains, are all members of the grass family. Like other grasses, they have long, narrow leaves, often multiple stems (tillers) per plant, and large, branching root systems. Because their seeds are especially rich in starch and other nutrients, small grains have long been considered excellent sources of food. We know from ancient records, drawings, and writings that they were important food crops of the world's earliest civilizations, and they are still grown mainly for their edible seeds. Their straw is also used for livestock bedding and

for making products such as paper and cardboard, and their dense root systems make them useful plants for keeping out weeds and preventing erosion.

Wheat

Wheat is the most important food grain produced in this country. As you probably know, it is ground into the flour that is used in bread, cake, cookies, crackers, macaroni, breakfast cereal, pizza dough, ice cream cones, and many other foods. It is also used as feed and pasture for livestock, and its straw is used as livestock bedding, as mulch, and as an ingredient in paper and cardboard.

Although Illinois is not always as cool and dry as wheat prefers and usually corn and soybeans give the farmer better returns, Illinois is still an important wheat producer. Most of the wheat grown here is soft red winter wheat, which is used for cake and cookie flour. About two-thirds



of Illinois wheat is grown in the southern one-third of the state.

Oats

Oats are grown in Illinois for several purposes. They are especially good as feed for horses, breeding animals, and young stock, and they are used as food for humans. In addition, they are often planted with another crop that grows more slowly, usually a legume such as alfalfa – called a companion crop. By controlling weeds and holding moisture in the soil, the oats give the legume seedlings a better chance to establish. Oats may also be cut for

hay or used for pasture or silage. The top oat-producing counties are in the northwest part of Illinois.

Barley

Barley is used as a livestock feed, as a breakfast cereal, and for starchy food. It is one of the ingredients in malted milk and is also used to produce malt for alcoholic beverages. Only a small amount of this grain is planted in Illinois. There are both winter and spring types.

Rye

Rye flour is used with wheat flour to make rye bread. Like barley, rye is also used for breakfast cereals and for the manufacture of alcoholic beverages. In addition, it is often grown as green pasture for livestock in fall, winter, and early spring. It is an excellent winter cover crop and a good green manure crop. (Cover crops are grown to cover the ground and prevent erosion. Green manure crops are grown to be plowed back into the field.)

Rye is usually grown as a cover crop in Illinois, especially on sandy soils such as those in Mason County.

Exercise 1 Visit a Bakery

Visit a local bakery and obtain the following information:

What kind of flour is used? _____

What is the percentage of protein in the flour? _____

How many pounds of flour come from a bushel of grain? _____

Make a list of products made from the same kind of flour. _____

Exercise 2 Explore Uses of Small Grains

Collect various products made from the small grains and make a display of your collection. For each product, find out what part of the grain is used and, if possible, how it is processed (for example, is it ground, soaked, and so on). Include this information in your display. You might also like to have a contest with other members in your group to see who can make the longest list of products.

Exercise 3 Visit a Local Livestock Feed Store

Small grains are used in many kinds of rations for many kinds of livestock. Visit a local livestock feed store and find out the following information:

What small grains are used in the livestock feed in your area? _____

What are the advantages of using a small grain in a livestock ration? _____

What is the cost per pound of protein in a small grain? _____

In soybeans? _____

How can small grains be processed to make them better livestock feeds? _____

Parts of the Plant

The Seed

While the seed is still on the stalk, the tiny plant inside it has already reached a certain stage of growth. When the parent plant dies, this miniature plant also stops growing and moves into a dormant, or inactive, stage. It will stay dormant until the seed either falls onto or is planted in the ground. Then it will break out of its protective covering and grow to a mature plant.

Small grain seeds have three main parts: the pericarp, the embryo, and the endosperm. The pericarp is the protective covering of the seed. As the figure below shows, it has several layers. The embryo is the young plant itself that is still in the dormant stage. It contains the protein, oil, and minerals that it will need to continue growing. The endosperm is the stored food that will supply energy

and nutrients to the embryo when it begins to grow. It is composed mostly of starch.

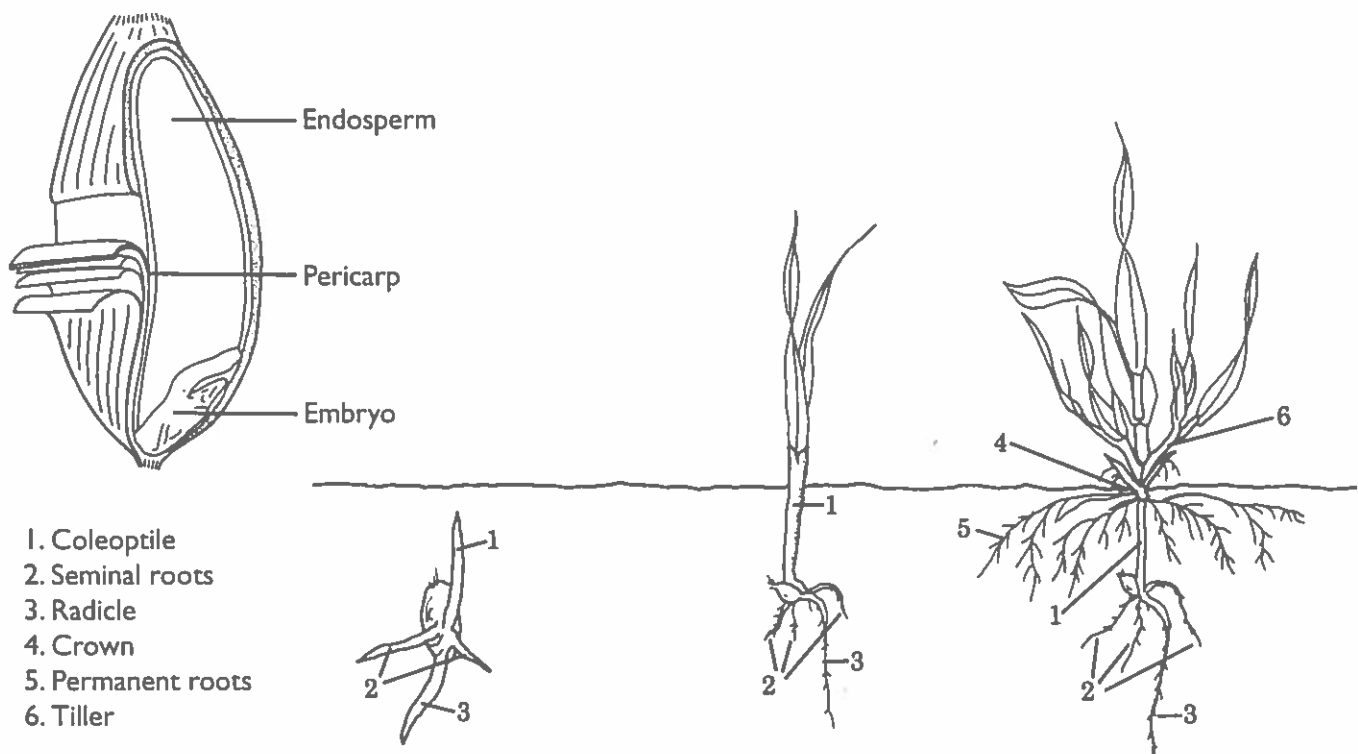
Seeds will germinate, or resume growth, when they have a favorable amount of water and oxygen and the right temperatures. As small grain seeds germinate, they produce three main parts: the coleoptile, the radicle, and the seminal roots. The coleoptile is a sheath that surrounds the first leaves and protects them as they push through the soil. The radicle is the first root. It anchors the seedling in the ground. The seminal roots are the roots that form from the seed just after the radicle and that help the seedling become established in the soil.

The Roots

Cereal plants usually grow about three to eight seminal roots.

Although they make up only a small part of the total root system, they perform useful functions throughout the life of the plant. The main roots, however, are called permanent roots. These branch out from a point called the crown that is $\frac{1}{2}$ to $\frac{3}{4}$ inch below the soil surface, and its distance above the seed is $\frac{1}{4}$ to $\frac{1}{2}$ inch, depending on planting depth. The roots continue to develop until the plant begins to flower. After that they stop growing.

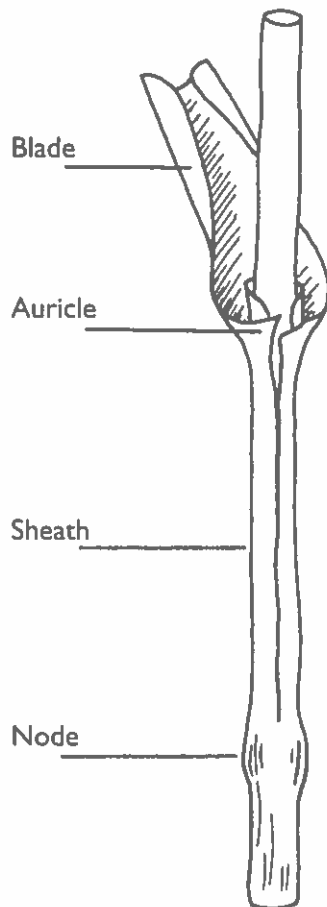
The roots of small grains are fibrous - they branch outward and downward from the base of the plant rather than from a main root, or tap root, as do those of some other plants. Each root is covered with many small root hairs, which absorb water and nutrients from the soil. The roots transport these nutrients up to the plant.



The Stem

The main stem of the small grain plant grows from the coleoptile. The stem is round and usually hollow, except at its joints, or nodes, which are solid. Unlike some other plants, small grain plants are often able to form secondary stems in addition to the main stem. These secondary stems, called tillers, grow from the first nodes at the base of the plant.

Stems serve three main functions: they hold the leaves up to the sunlight and the air, they transport water and nutrients from the roots to the leaves, and they transport manufactured food from the leaves to all parts of the plant.



The Leaves

Cereal plant leaves grow one from each node, alternating from one side of the stem to the other. Lower leaves may die off with shading but each node has a leaf. As the plant grows taller, the nodes, which are the joints of the stem where leaves attach, become easier to see. A leaf is considered fully expanded when the tip of the next leaf is just visible.

Each leaf has two main parts: the sheath and the blade. The sheath encircles the stem like a tube. It is split down one side (the side opposite the blade) and its two edges overlap. The leaf blade is sometimes twisted. Leaf width and shape vary some with variety.

Using light energy from the sun and nutrients from the soil and air, the leaf makes sugar from carbon dioxide and water in a process called photosynthesis. The uppermost leaf, called the flag leaf, makes much of the food that helps the new seeds develop. When the flag leaf sheath begins to bulge open from the developing head inside, the plant has reached the boot stage. The head emerges and flowering soon follows.



Wheat



Oats



Barley



Rye

You can tell the difference between the four small grains most easily by looking at the leaf parts of the young plants. Wheat, barley, and rye have small hooks, or auricles, at the points where the leaves grasp the stem and the shapes of these auricles and other parts also differ.

The Reproductive Parts

Seed is produced on a spike in wheat, barley, and rye, and on a panicle in oats. The entire seed head is made of many spikelets and each spikelet contains several flowers, or florets. In panicles of oats, the uppermost spikelets are the first to flower; in spikes, the middle spikelets

are the first to flower.

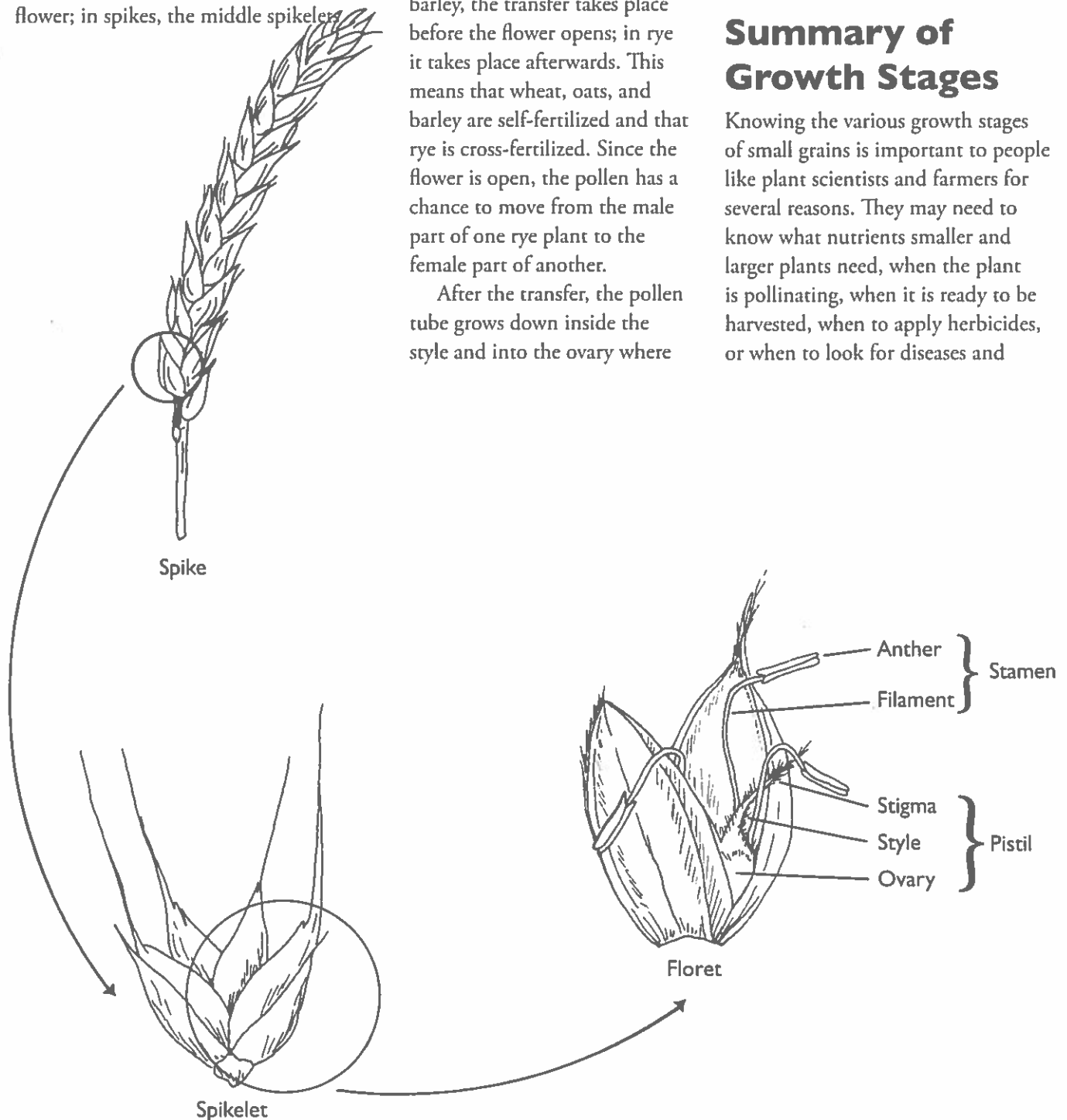
The flowers contain the male and female parts that engage in reproduction. The male part is called the stamen and the female part is called the pistil. To reproduce, pollen must be transferred from the anther of the stamen to the stigma of the pistil. This transfer is pollination. In wheat, oats, and barley, the transfer takes place before the flower opens; in rye it takes place afterwards. This means that wheat, oats, and barley are self-fertilized and that rye is cross-fertilized. Since the flower is open, the pollen has a chance to move from the male part of one rye plant to the female part of another.

After the transfer, the pollen tube grows down inside the style and into the ovary where

it joins with the egg and fertilizes it. The new embryo and endosperm grow rapidly after fertilization and store an abundant supply of food, especially starch. The embryo and endosperm increase in size until they fill the ovary and finally merge with its walls. By the time the seed is mature, the embryo has developed the radicle, the coleoptile, and the beginnings of the first leaves.

Summary of Growth Stages

Knowing the various growth stages of small grains is important to people like plant scientists and farmers for several reasons. They may need to know what nutrients smaller and larger plants need, when the plant is pollinating, when to apply herbicides, or when to look for diseases and



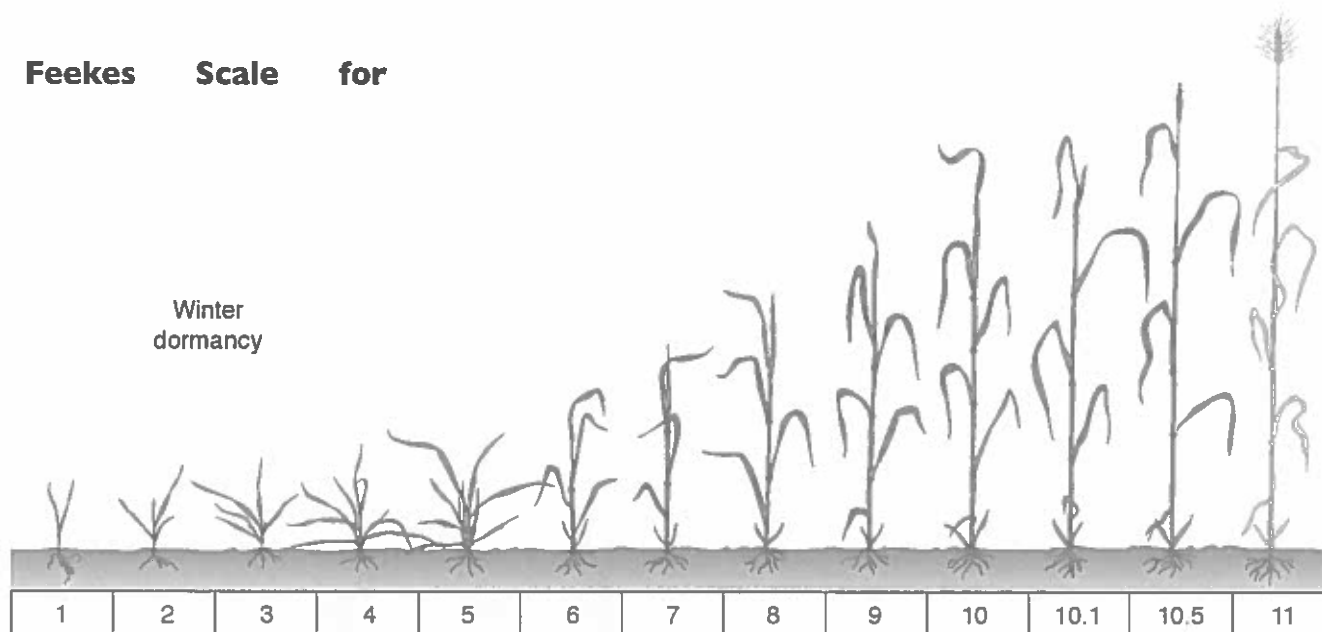
insects. The growth stages of small grains are usually expressed by the following terms:

1. **Seedling** (Feekes stage 1), which occurs from the time the plant emerges until the first tiller appears.
2. **Tillering** (Feekes stages 2-4) begins when the first tiller appears and continues until stem elongation first starts. In unstressed conditions, the first tiller appears as the fourth leaf is expanding.
3. **Jointing** or stem extension occurs from the time the hollow stem is first visible above the crown (Feekes stage 5) until heading begins (Feekes stage 11).
4. **Heading** begins as the spike emerges from the flag leaf sheath (Feekes stage 10.1) and continues until flowering is complete (Feekes 10.5).
5. **Ripening** refers to the development after the grain has reached maximum dry weight. Though the Feekes scale concludes with ripening (Feekes stage 11), another very critical time period exists, which is frequently referred to as grain-filling.
6. **Grain-filling** is the period that occurs from pollination until maximum grain dry weight is obtained. Grain-filling may be

separated into the water, milk, soft dough, and hard dough stages. Each stage can be identified by removing a kernel and squeezing it. If a clear, watery fluid is exuded, it is classified as water stage. Milk stage occurs when a squeezed kernel exudes a liquid, but instead of being clear, it is white like milk.

For crop production practices and information by state for the major crops produced, visit:
<http://www.ipmcenters.org/cropprofiles/docs/okwheat.html>

Feekes Scale for



Exercise 4 Learn the Parts of the Small Grain Plant

Dig up a cereal plant that is in the late boot stage but that is still green. Attach the plant to a sheet of cardboard and label the various parts. Show the parts to your club members and explain their functions.



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Urbana-Champaign, Illinois

MJ0110

December 2006

Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914,
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