



Growing Grain In Your School Garden



Northeast Agricultural Education Foundation, Inc.
Growing ideas. Feeding minds.

~
This guide is dedicated to Arnie Voerainger 1937-2011,
for his love for and wealth of information about growing
small grains in ecological farming systems,
and his generosity of sharing what he knew.
~

Massachusetts Agriculture in the Classroom 2015.
All text and photos by Alice Posner unless otherwise noted.

Cover Images: Barley and Heritage Flour Corn

Table of Contents

- ❖ Introduction4
- ❖ Linking Grain Growing and the Curriculum Standards.....5-6
- ❖ Whole Grain Science and Nutrition7
- ❖ Grain Growing Calendar8
- ❖ Types of Grain to Grow9
- ❖ Finding Seed11-12
- ❖ Prepare Your Planting Area.....13
- ❖ Tools and Supplies.....14
- ❖ Planting Day15-16
- ❖ Maintenance17
- ❖ Timing Your Harvest..... 18
- ❖ Post-Harvest Processing19
- ❖ Other Grains To Plan.....20
- ❖ Grain Glossary21
- ❖ Milling and Recipes22
- ❖ Sources and Resources23



Image: Illinois Wheat Weavers (see resources)



Introduction

Most every culture around the world has its defining grain. Whether it is Jewish rye bread, Japanese rice, Andean quinoa or Ethiopian teff, grain is the backbone and “life bread” of cuisines and communities. Barley, flax, and Einkorn wheat were grown as far back as 9000 B.C.E, and were among the earliest crops cultivated by humans in a region of the Middle East known as the “Fertile Crescent.” Grains continue to be an essential food crop for much of the planet, and are central to issues like world hunger, agricultural policy and world trade. All this and more makes grains a great entry point for learning about the global current events and world history for students.

In the U.S, each wave of immigrants brought with them their particular bread or grain. Corn, a grain of huge importance around the world today, is native to the Americas and was cultivated and selectively bred by the indigenous communities of the Americas for thousands of years before European settlement. Using grain in the classroom can involve many hands on activities such as bread baking and tortilla pressing. Students can literally get a taste of history.

Many STEM connections can be made and questions stimulated in the activities associated with growing grain. Determining yield, timing and planting space involves mathematical thinking and problem solving. For example, sunflowers are perfect examples of fibonacci numbers. In earth, space and life science, grain plants are a great way to study life cycles, parts of a plant, pollination and soil. The uniform nature of grain makes it perfect for testing different conditions in a garden and the effects of these conditions on plant growth. In engineering and physics, students can study the machines developed over human agricultural history for growing and processing grain, and design their own simple machines to use in the garden.

Grains are low maintenance and easy crops to grow in the school garden. They are also a relatively shelf stable food, and not as time-sensitive to take from harvest to plate as most vegetables. In the short term grains do not need refrigeration. Therefore, a grain project can be divided up into small tasks over several days or weeks, and this is especially helpful if you only have students for short periods of time. Harvesting and processing of grain crops have historically been cooperative social activities, and so perfect for large groups in a school community. This guide hopes to help you find your own ways to integrate grain activities into your classroom and school year.



Curriculum Standards

The techniques and information in this guide can be adapted to any grade level. Some of the activities have either elementary or middle school students in mind. Grain growing can be integrated into many curriculum areas because it connects well to both state standards and STEM guidelines. Below are examples of curriculum connections for grades 1-4, followed by middle school connections.

Grades 1 & 2	Grades 3 & 4	Sample Activities
<p>Earth and Space Science: 4. Recognize that the sun supplies heat and light ... and is necessary for life.</p>	<p>Earth and Space Science: 4. Explain and give examples of the ways in which soil is formed. 5. Recognize and discuss the different properties of soil...</p>	<p>Test three garden beds - one that was left bare over the winter, one that was covered with straw, and a third that had a cover crop. In the spring, look at the properties of the soil in each bed.</p>
<p>Life Science: 1. Recognize that animals and plants are living things that grow, reproduce, and need food, air and water. 3. Recognize that plants and animals have life cycles...</p>	<p>Life Science: 2. Identify the structures in plants that are responsible for food production, structural support, reproduction etc. 9. Recognize plant behaviors. Change the direction or height of the light source in indoor seed starting. Observe the way the plants move, or stretch upwards towards the light. 11. Describe how energy derived from the sun is used by plants to produce sugars...and is transferred within a food chain...</p>	<p>Study the effects of weather, soil and sunlight on crops. Create small square plots of grain plants and cultivate each differently. Monitor the growth rate, grain size and weight of a crop. Try:</p> <ol style="list-style-type: none"> 1. One crop planted with regular direct sunlight, one crop planted in a shady area. 2. One crop planted in heavy, clay soil, the other planted in sandy soil. 3. One crop watered weekly, one crop watered only in dry spells.
<p>History and Social Studies: 1.9 Explain that Americans have a variety of different religious, community and family celebrations and customs. 2.8 ...give examples of traditions or customs from other countries that can be found in America today.</p>	<p>History and Social Studies: 3.2 Identify the Wampanoags and ...describe their way of life. 3.4 Explain how the Puritans and Pilgrims differed... describe the daily life, education and work of the Puritans in the Massachusetts Bay Colony.</p>	<p>Look at different grain-based holiday foods from different cultures. Try making some. Plant a corn, beans and squash garden. Plant a Puritan garden to give students the experience of the hard work of making bread in preindustrial times.</p>
<p>Math: Measurement and Data. 1. Work with time and money. 7.</p>	<p>Math: Geometric measurement 5, 6, 7</p>	<p>Chart out days from germination to harvest for a grain crop. Measure out garden beds. Figure out how much yield of a particular crop you can get from a given area.</p>
<p>English and Language Arts: 2. Write informative/explanatory texts</p>	<p>English and Language Arts: 7. Participate in shared research writing projects.</p>	<p>Write a step-by-step grain growing guide for next years class. Write an article about your grain crop. Make a garden newsletter.</p>

Grade 6	Grade 7	Sample Activities
<p>6.MS-LS1-1. Provide evidence that all organisms (unicellular and multicellular) are made of cells.</p>	<p>17.MS-LS1-4. Construct an explanation based on evidence for how characteristic animal behaviors and specialized plant structures increase the probability of successful reproduction of animals and plants.</p>	<p>Do a seed saving activity with your grain plants. Examine how the grain reproduces and what the plant does to ensure the success of its seeds.</p>
<p>6.MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution. Include potential impacts on people and the natural environment that may limit possible solutions.</p> <p>6.MS-ETS1-5(MA). Create visual representations of solutions to a design problem. Accurately interpret and apply scale and proportion to visual representations.</p>	<p>7.MS-ETS1-2. Evaluate competing solutions to a given design problem using a decision matrix to determine how well each meets the criteria and constraints of the problem. Use a model of each solution to evaluate how variations in one or more design features, including size, shape, weight, or cost, may affect the function or effectiveness of the solution</p>	<p>Design a sketched or 3D model of a planting machine for planting grain in your garden beds accurately.</p>
<p>6.MS-ETS2-3(MA). Choose and safely use appropriate measuring tools, hand tools, fasteners, and common hand-held power tools used to construct a prototype.</p>	<p>Geometry. Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.</p>	<p>Build raised beds for your school garden using common hand held tools. Determine surface area and amount of soil needed to fill them.</p>
<p>History and Geography 3. Interpret geographic information from a graph or chart and construct a graph or chart that conveys geographic information (e.g., about rainfall, temperature, or population size data). (G)</p>	<p>Human Origins 7.4 Explain the importance of the invention of metallurgy and agriculture (the growing of crops and the domestication of animals). (H)</p> <p>7.5 Describe how the invention of agriculture related to settlement, population growth, and the emergence of civilization. (H)</p>	<p>Learn about the history of grain around the world and how it shaped human settlement.</p>
<p>English and Language Arts: 2. Write informative/explanatory texts</p>	<p>English and Language Arts: Conduct research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.</p>	<p>Write a step by step grain growing guide for next years class. Write an article about your grain crop and how it relates to agriculture in the U.S. today.</p>

Whole Grain Science and Nutrition

Cereal grains are grasses, members of the Monocot family, known as Gramineae. Whole grains are full of vitamins, minerals and phytochemicals. Growing whole grains at school can help familiarize students with the idea of introducing whole grains to their diet.

Did you know? People who switch to eating whole (unrefined) grains from more commonly eaten grain products such as white bread reduce their risk of:

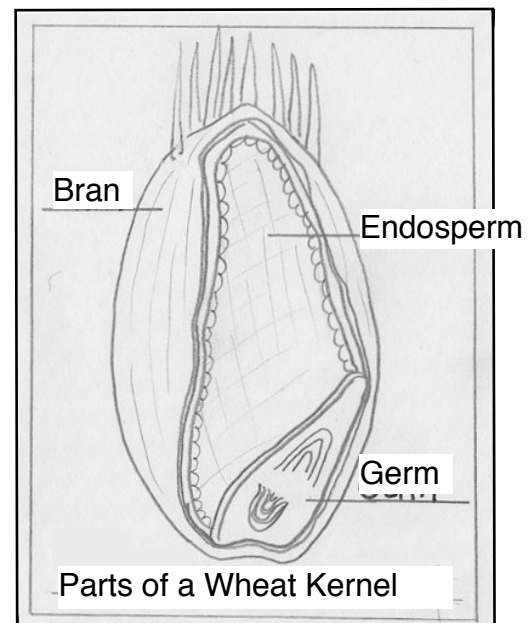
- Heart disease up to 35%
- Stroke up to 37%
- Type 2 diabetes up to 27 %
- Cancer of the digestive system up to 43%
- hormone related cancer by up to 40%

(University of Minnesota Dept. of Health)

A whole grain kernel is made up of three things: the **bran**, the **endosperm**, and the **germ**.

1. The **bran** is the hard outer layer of the kernel and protects the inside of the seed. The bran contains fiber, antioxidants, B vitamins, phytochemicals and up to 80% of the minerals in grain, including iron, copper and magnesium. The bran is made up of several parts: the *pericarp*, the *seed coat* and the *aleurone layer*.
 - a. The outer layer of the pericarp is called the epidermis. The inner layers are called the hypodermis, cross layer, and tube layer.
 - b. The seed coat, also called the testa, controls the movement of water into the seed.
 - c. The aleurone layer stores many oils and minerals used by the developing seed and contains much nutrition, including phosphorus, potassium and folate.

2. The **endosperm** is the largest part of the seed, at about 83%. It contains mostly carbohydrates and protein and small amounts of some B vitamins. This part of the seed provides energy for the germinating plant. It is the only part of the grain you are getting when you eat refined, white flour products.
3. The **germ** is the embryo of the seed, and contains the genetic material from which the new plant will grow. The germ is made up of the *scutellum*- which secretes enzymes and absorbs nutrition from the endosperm during germination. It also holds the beginnings of the leaves and roots. Wheat germ has high levels of oil, and quickly turns rancid. It is often removed to lengthen shelf life of grain foods. It is best to mill whole grain flours yourself or buy them fresh. Wheat germ includes many healthy fats, B vitamins, phytochemicals and antioxidants like vitamin E.



Garden Grain Growing Calendar for Massachusetts

The chart below is intended to give you a sense of how growing grain might fit into your school garden year. Grains that have a planting day and also a harvest day during the school year include flour corn, popcorn, sunflowers and Amaranth. Other grains such as wheat, rye or barley can be planted during the regular school year, but will need to be harvested during the summer by you or a summer program. The harvested stalks may be easily bundled, stored in a dry place and processed by students in the fall or winter term.

The speed of grain growth relies a lot on temperature. Maturity dates may vary due to the climate in your area, seasonal variations, and the micro-climate of your site. You also have to time planting and harvesting based on a stretch of dry weather. Doing frequent garden walks to observe, and talking with other gardeners and farmers in your area is the best way to figure out when to plant and harvest. See the “Timing your Harvest” section for more detailed information on this.

Grain Planting and Harvest Calendar

April	May	June	July	August	Sept	Oct	Nov
		Flour Corn and Popcorn					
	Barley						
Oats							
		Sunflowers					
		Amaranth					
						Winter Wheat, spelt, Emmer	
							Rye

Each block represents the time that a particular grain would be in the garden. The left hand end of the block, where the grain name is written, is roughly the time period in which to plant. The right hand end of the block is the beginning of the approximate time to harvest.

Note: It is suggested here that rye and wheat are planted in the fall, and harvested in the spring.

WHEAT

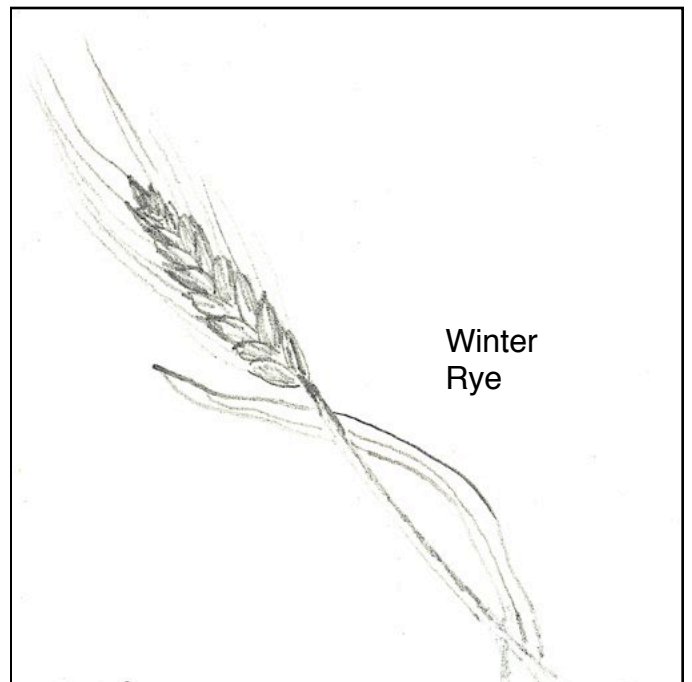
Botanical (Latin) name	<i>Triticum aestivum</i>
Days to harvest	140
When to plant and harvest	Wheat can either be planted in the early spring or in the fall, depending on the variety. I recommend choosing a variety that can be planted in the fall, usually called “Winter” or “Cool Season.”
Types of wheat	Wheat varieties are divided into two groups: Hard and soft. These groups then break into color: Red or white, and planting time: spring or fall.
Varieties to try	Try fall-planted “Warthog” or “Expedition.” Try spring-planted “Glen” or “Red Fife.”
Notes	Wheat relatives include Einkorn (which is the ancestor of all wheats), and Kamut. Durum wheat (a traditional pasta wheat) is a different species (<i>T.durum</i>), as are Emmer farro (<i>T.dicoccum</i>), and Spelt (<i>T.spelta</i>). Triticale is a cross between Rye and Wheat. All of these can be grown in much the same way as wheat.

RYE

Botanical (Latin) Name	<i>Secale cereale</i>
Days to harvest	120
When to plant	Late fall
When to harvest	40-50 days after temps reach the 40s in the spring. Approx. the end of June.
Varieties to try	Be sure to get cereal rye, (<i>Secale cereale</i>) not rye grass (<i>Lolium perenne</i>).
Notes	Rye also makes a great winter cover crop.



Image: CIMMYT (International Wheat and Maize Improvement Centre) showing diversity of Turkish wheat landraces collected in 2012. (A. Morgounov/CIMMYT.)



OATS



BARLEY

Botanical (Latin) name	<i>Hordeum vulgare</i>
Days to harvest	60-70
When to plant	Spring
When to harvest	Summer
Varieties to try	Find hull-less varieties- e.g. Himalaya, Burbank.
Notes	Barley falls into either two-row or six-row types, based upon how many rows of kernels each head has. Six-row is more nutritious.



Image: Prof. Dr. Otto Wilhelm Thomé *Flora von Deutschland, Österreich und der Schweiz* 1885: biolib.de

Botanical (Latin) names	<i>Avena sativa</i> , <i>A. byzantina</i> or <i>A.nuda</i> .
Days to harvest	100-120
When to plant and harvest	Plant as soon as the soil is dry enough to work in the spring.
Types of oats	Oats are divided into “white” spring oats, grown in the north and “red” winter oats grown in the south (not winter hardy here). Finally, there are “ hull-less ”oats. These are the ones to grow in your garden. The other kinds need processing equipment.
Varieties to try	Streaker hull-less

Finding Seed

Finding grain seed can be somewhat challenging. You usually cannot just walk into your local hardware store and pick up a packet of grain seed. Luckily, with a little advanced planning, getting small amounts grain seed for your garden is getting easier as more people become interested in growing grain at home for themselves or their animals.

Understanding Seed

Seed can be treated or untreated, open pollinated (sometimes called heirloom), hybrid (F1) or genetically modified (GMO).

Open pollinated seed can be saved and planted again the next year. It will come back much the same as the plant from the last year. Hybrid seed has been bred in a lab using traditional plant reproduction techniques. If you save and plant hybrid seed, you may get random characteristics from the parent plants that were bred. Genetically modified seeds are the product of a gene splicing technique. Plant, animal, bacteria or virus genes that would not be able to combine on their own in nature are combined. GMO seeds cannot usually legally be saved, and often produce sterile seeds.



Rye seed saved from last years crop

When looking for seed, check for the following things:

1. **Is your seed treated?** When students will hand sow, avoid treated seed. The seed treatment, while not be a problem in a tractor system, might cause irritation to skin or eyes.
2. **Is your seed open pollinated?** Open pollinated seed is a nice thing in a school garden, because it allows you to save your own seed for the following year. Open pollinated seeds also often require more days from planting to harvest, which is often an asset for growing during the school year.
3. **Is the seed variety the one you want?** Be sure to buy an edible variety suited to your area. The best way to do this is to buy from a local or regional seed company, or ask a local farmer.

Seed Sources:

- **Your local farm and garden supply** - if you have one, will often sell you a small amount of grain such as winter rye or buckwheat. They may also sell some small grains intended to be used as a cover crop. Ask in advance and they may be able to special order what you want.
- **Local farms** may be willing to sell you a small amount of cover crop, chicken or grain seed. Most Massachusetts farms do not grow grain for eating, so be sure you are getting the seed you want.
- **Farmers markets** - Look for grain sold for eating and ask what the variety is.

Your favorite seed company - Many garden seed catalogues are starting to include garden amounts of small grains in their inventory. Johnny's and Fedco are examples. Look for the heading "Farm Seed."

Save your own! - Once you have grown a grain crop to maturity you can set aside some of the seed to use next year. If you intend to use your grain only as a cover crop, consider letting a few plants at the edge of the bed grow to maturity for this purpose. "Breeding" locally adapted seeds in this way is a wonderful way to promote plant vigor.

How much seed will I need?

Look at the information given with each seed variety in this guide to determine how much seed you will need to buy based on the space you have available. A safe estimate is about 1/2 lb for each 100 square feet of garden space. You may not be able to buy seed in amounts less than 1lb, but small hands often drop a lot by mistake. Also, if you buy extra, you can send the rest home with students to plant at home, do an indoor classroom growing project, or make catgrass pots! (These are usually oat grass, but any grain will do).

Important note about grain categories:

This guide includes corn and sunflowers because these are usually classified as grains. They have different requirements for planting, harvesting and processing than small grains like wheat and rye. Many of these techniques are simpler and closer to growing vegetables. These instructions appear later in the guide. The directions on planting and harvesting that follow should be assumed to be for the other grains.



Winter Rye Raised Bed

Prepare Your Planting Area

Grain can be incorporated into an existing gardening system. You could interplant into your existing veggie beds, or till up a new in-ground area, or even plant in containers. What size growing area you choose will affect how much grain you are able to grow and use, as well as how many people can be involved and what kinds of tools you might need.

This guide focuses on small hand-scale techniques, but this does not mean you could not be ambitious and enlist a local farmer to help to plant a whole retired sports field in grain. A hands-on harvest could become a major yearly event for your school!

If you are going to till with a rototiller or fork over your garden to bury the weeds, try to do this a few weeks in advance of your planting day. This will give the green plants a chance to break down in the soil without creating a too high carbon effect that could adversely affect your grain. If you plan on hand-tilling, sifting and removing weeds by hand (recommended as fun for students who can also look for worms!), you can do this right before hand or a few days in advance to save time on planting day.



In-Ground Corn Bed

Most grain crops prefer full sun, but they may do ok in a partially shaded, protected area.

Raised beds

Prepare raised beds much the same as you would for any crop. Fork up the soil, remove all weeds, roots and crop residues and add compost in advance of the day you are planning to plant. Rake the bed free of lumps and then level the seed bed.

Interplanting

If you are short on space or just want to get started with just a few grain plants, you can plant some seeds in among your vegetables. Give the veggies a little space. Some grains like rye emit a chemical that discourages growth of other things near them. Six inches should be fine.

In-ground beds

Prepare a weed-free, clearly defined area with fertile soil and good drainage. Follow instructions for raised beds. Consider putting a small fence or stakes around your bed so people know it is there. Small grains can look like grass!

Larger area

When planting a larger area, consider marking out pathways so that students can have easy access to the plants without stepping on them.

A field

While planting and harvesting can be done by hand in a field setting, you will probably want to consider hiring a farmer to have the field plowed and harrowed each year before planting.

Tools and supplies

Since human beings have been growing, processing and eating grain, they have been inventing different tools to help with the task. In a school setting it is fun to do many of these tasks by hand. It is inexpensive, fun and connects us with the work of our ancestors!

A “*” indicates an optional tool or supply. Review the technique you are going to use to determine what you need on this list.

Planting and maintenance

- seed
- rake
- stakes and string to mark out the area
- a watering can or spray hose attachment
- *a board or grass roller*
- straw or grass clippings
- *a push or crank seeder*

Harvest

- scissors or hand scythe
- string
- basket or tarp

Threshing

- tarp
- something to hit the grain with, e.g. a wooden spoon or a flail

Winnowing and cleaning

- two large containers, e.g. buckets
- * a fan
- a large bowl or tray to hand clean

Processing for Eating

- * hand or electric mill
- * rice cooker
- * hot air popcorn popper



A traditional winnowing basket and two types of flails. Grain is thrown into the air in a forward circular motion and the chaff is carried off by the breeze.

~

For contrast, here is a description of the steps and tools used to grow grain on a farm scale. (Exact methods vary based on scale, organic or non-organic practices, regional cultural practices and soil type as well as personal preference and how the grain fits into a farm system):

- The field is prepared using a tractor-pulled plow, disk and harrow to create a seed bed. The grain is then planted using a seed drill, an implement that creates furrows, drops seed, then covers up the seed all in one pass.
- Before sprout emergence, the field might be sprayed with herbicide to kill weeds, or lightly cultivated with a spring wire tine to kill any germinating weeds. Once the plants have emerged the field might be cultivated between plants for larger plants like corn.
- Once the grain plants are mature, the grain will be harvested using a self-propelled combine that has its own engine or by a combine pulled behind a tractor. The combine machine “combines” the separate tasks of cutting down the grain, threshing and winnowing.
- Once the grain is brought back to the barn or grain processing center, it is dried if necessary, then the seed is cleaned again and bagged, or sent to food processors.

Planting Day

1. **Gather your supplies.**
2. **Make a seed bed if you have not already.** Remove all crop residue and roots from your bed by hand or with hand tools, rake it free of lumps, then make the bed level using a rake.
3. **Mark out where you are going to plant.** A recommendation for large groups of students, is to divide your bed into a grid. Whether you are broadcasting or planting in rows, this allows each student or group of students to have an area of their own to plant into.
4. **Plant the seed** as evenly as possible. This can be done in a few different ways:

Broadcasting. (For medium large areas) Get students to hold a handful of seed in a fist palm up, and to make circular horizontal motions with their hand while making a small opening in the front of their fist to scatter the seed. This traditional method helps avoid all of the seed landing in a clump in one corner of the bed! (See illustration)

Hand planting. (For small areas) Plant in the same way as you would vegetable seeds. Scrape small trenches or furrows about 1" deep, a couple of inches apart. Drop your grain seed 1-2" apart into the furrow.

Mechanical seeding. (For larger areas): Use a Seedway or other push planter, or a crank seeder. (see tools for descriptions)

5. **Cover the seeds** with about 1 inch of soil. If planting in furrows, simply fill them in. If you broadcast the seeds, put aside a bucket of soil beforehand, or bring in compost, and cover the area as evenly as possible at least 1" thick.

6. **Tamp all over the bed** with the back of a hoe or with your hands to ensure good soil to seed contact. You can also do this by laying a wide board or plank on top of your bed and gently pressing. If you have access to a lawn roller, this can also be used.
7. **Cover the area thinly** with loose straw or grass clippings to help prevent the soil from drying out before the plants germinate. You should be able to see the soil in between the covering to be sure the seeds will get the light they need to germinate. Do not use hay with seeds as these will germinate and compete with your grain.
8. **Water well** using watering cans, cups with holes in the bottom, or a shower hose attachment. Continue to water often during the critical germination period of your seeds to prevent the seed bed from drying out. (Important)

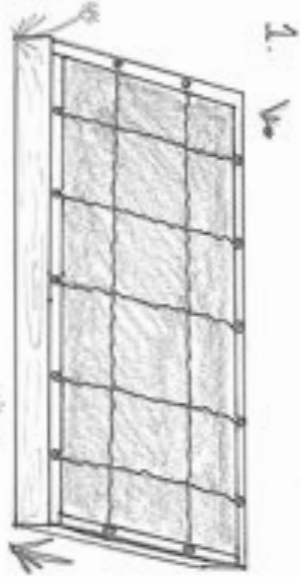


Wheat sowing. Detail from the calendar page for October from the Belles Heures of Jean de France, Duc de Berry, 1405–1408/1409. The Metropolitan Museum of Art, New York, The Cloisters Collection.

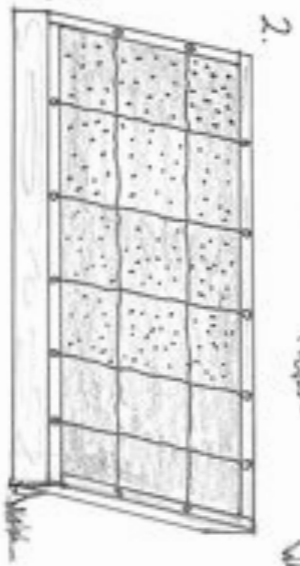
Planting Your Grain

First prepare your seed bed by removing weeds, roots, rocks and breaking up clumps.

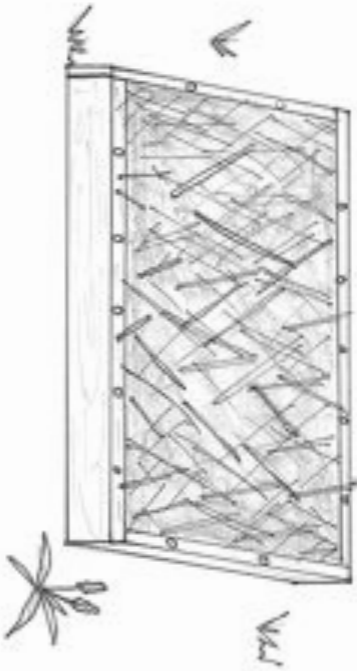
Grid out your bed or planting area with screws or staples and string



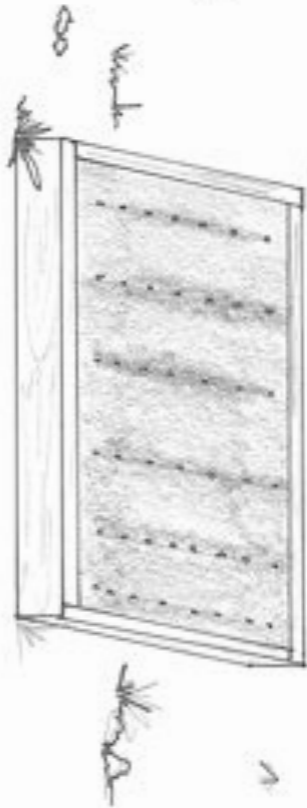
Broadcast seed evenly in each square then cover with 1" of soil or compost.



Tamp in, then cover planting area thinly with straw and water in well.



alternatively, instead of broadcasting, you can plant in rows as you would veg.



Maintenance

Grain crops are fairly low maintenance. However, some key things will greatly increase your yield and chances of success:

1. **Keep your bed moist** during the first few weeks before your grain seeds sprout and when they are very small. Do not let your bed dry out! Your grain may not germinate, or may die after germination during the tender first days.
2. **Pull out weeds** as they emerge. Hopefully there will be very few if you prepared your bed properly and used weed free compost and seed free straw.
3. **Water your grain during droughts** right up until a few weeks before harvest. (*See the harvest section for how to tell when your grain is ready.*)



(Photo courtesy of River Side Farm)

Cover Crop or Food Crop? Your Choice!

Growing a bed of winter cereal grain is also a good way to protect your garden soil for the winter as a cover crop. Cover crops protect soil from winter erosion, add organic matter and improve soil texture. For more detailed information, including non-edible cover crops, see our “Cover Crops Guide” (*See Resources*).

To use grains as a cover crop:

1. **Timing is key.** Unless you are growing perennial cover crops as fallows (taking your bed out of production for a while to increase soil health), annual crops should be removed, turned in, mowed, or crushed before they go to seed. The nutrients they fix and bring up from deeper soils, and the organic matter they provide become available after they decompose.
2. **Till your plants under** when they are soft, green, and about a foot tall. You can till them under using a spade or hoe and chop them up as you go. Keep in mind you will want to do this three to four weeks before you intend to use the garden bed to give them a chance to decompose.
3. Or **put them in your compost.** If your plants are over a foot tall, or your bed is very small, you may want to remove, chop up and compost the grain plants, and get their nutrients this way.
4. Or **use them as a mulch.** Tall plants, can be pulled up by the roots before their seeds mature then layed down as mulch, either chopped up or whole. The pulled-up cover crop will decompose on the surface of the soil. Then you can transplant vegetable plants directly into what has become compost.

Timing Your Harvest

If you choose to harvest your grain for food, wait until their harvest time (*see Calendar*). Make sure the grains in the seed head are hard and fully mature.

Grain goes through several stages:

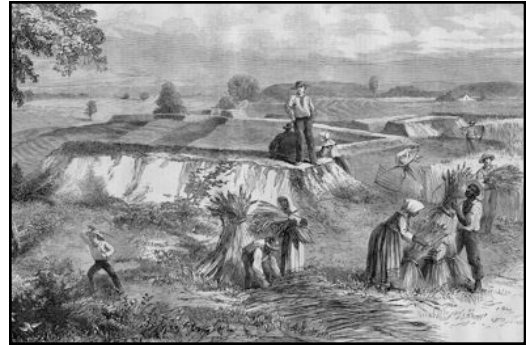
- The **milk** stage. The seeds are full of a milky liquid. They will be soft and easily flattened when squeezed between your fingers and the liquid may leak out.
- The **dough** stage. As the milk hardens, the grain is easy to dent with a fingernail and the leaves on the plant start to turn brown or yellow.
- The **mature** stage. The seeds are hard. They are not easy to dent with your fingernail. The leaves will be fully gold/brown. The grain is ready to harvest.

If your school has no summer program, you will have to visit your grain in the summer and cut down the plants for processing with children in the fall. Otherwise, your grain may drop or be eaten by birds.



Harvesting sheaves of grain (fresco), Italian School, (15th century) / Castello del Buonconsiglio, Torre dell'Aquila, Italy / The Bridgeman Art Library

Harvest Day



“Harvest on Historic Fields - A Scene at the South”:
Harpers Weekly, 1857.

You will need:

- A basket or tarp to collect your grain.
- Your cutting implements of choice: Scissors are great!

1. **Cut down the stalks** near the base with scissors or a hand scythe.

2. **Prepare the grain for drying:**

The traditional hand method is to bundle the grain into “sheaves.” Gather the cut grains into bundles 10-20 plants thick, and tie just under the seed heads with string. Then balance these “shocks” upright and leave to dry. (*See illustration*) This should be done indoors if there is any chance of rain.

You can also cut off the individual seed heads at the end of the stalks and spread them out to dry in a basket or on a screen, such as a window screen.

3. **Transition your garden.** That day, or at a later date, cut off any remaining stalks and save for mulch. Turn the roots into the garden with a fork or pull them out depending on your management plan (*see the Cover Crop section*).

Post-Harvest

Once you have harvested, and sure your grain is dry, you are ready for the fun of processing your grain to get the seeds!

1. **Threshing** means separating the grain kernel from the seed heads and straw (chaff). Place your grain heads inside a pillow case, with the heads at the front and the stems sticking out the side, and hit the bag against a wall. You can also bash them while loose on a large tarp. Traditionally a flail is used, which is two sticks with holes drilled in the ends so they can be tied together. You can also use a plastic baseball bat or the back side of a shovel.
2. **Winnowing** is separating the grain from the chaff. On a breezy day, or in front of a fan, pour your grain/chaff mixture from one container such as a bucket to another. Hold your first container up high and then carefully pour into the second in front of the fan, or in the breeze. The chaff should blow away, and your clean grain kernels should drop into the second container or bucket. (*See the photograph*)
3. **Hand clean.** If you are planning on eating your grain, you may want to pick through it in a large bowl, or on a tray to remove chaff or other things that did not get winnowed away. This is especially important with rye. Here, pick out elongated black kernels that have a fungus.
4. **Enjoy your harvest!** You have many options for enjoying the fruits of your labor.

Save for seed. Package your grain carefully, store in a cool, dark and dry place and replant it in the fall for next year.

Feed to animals. If you are lucky enough to have animals at your school, find out which grains can be used as animal or bird feed.

Use in arts and crafts. Many traditional crafts use grains. Look into grain braiding for ornaments and artwork, straw hat making, seed mosaics etc! (*See the illustration in the table of contents.*)

Cook and eat. You can use your grain right away, and grind it into flour to bake with, cook it like rice, or sprout it. You may want to combine with traditional all purpose flour in your recipes until you get the hang of using your own, fresh school-grown flour! If you store the grain for more than a few weeks, the refrigerator or freezer is best. (*See Recipe section for ideas about cooking grain with students.*)



Tibetan farmer winnowing Barley (Note the chaff blowing away and the grain dropping onto the pile.) Barley is a staple in traditional Tibetan cuisine.

Other Grains To Plant

FLOUR CORN and POPCORN

Botanical (Latin) name	<i>Zea mays</i>
Days to harvest	Between 75-120, depending on variety and use.
When to plant and harvest	Plant in the spring once the soil is warm (60°F). Harvest these dry corns mid to late fall when the kernels are hard and the leaves are all dead.
Types	Flour, Dent, Flint (Popcorn is a type of flint). The main difference between them is how much starch each contains. You can also let sweet corn dry out and grind that to get started.
Varieties to try	“Glass Gem” for its amazing colors and for flour, “Dakota Black” popcorn for its nutty taste.
Notes	Popcorn will need to dry for a few months in your classroom after harvest before it can be popped. All corn varieties can be ground, but flour corn is easiest. Husk and let the cobs dry, then push the kernels off with your thumbs. These can then be cooked or ground.



SUNFLOWERS

Botanical (Latin) Name	<i>Helianthus annuus</i>
Days to harvest	110
When to plant	Spring
When to harvest	Fall
Varieties to try	“Daytona”, “Mammoth”
Notes	Cut flat behind the heads and bring them in when all the seeds are mature to get them before the birds! Dry upright in your classroom, then eat or replant next year.



Grain Glossary

Straw: The grain stem and leaves, cut and dried, without any seeds

Hay: The full grain plant, cut and dried, including the seeds

Scythe: A curved blade on a short or long handle traditionally used for harvesting grain

Flail: Two sticks tied together used for threshing grain

Sheaf: A bundle of grain tied just beneath the seed heads

Shock: An upright pile of several sheaves stacked together to dry

Kernel: The grain seed

Seed head: The top of the grain plant where the seeds are held, often inside of little husks. This is also the part of the plant that flowers but you can rarely see grain flowers. They are tiny and the same color as the rest of the plant

Mill: Using a stone or metal millstone to grind grain into flour



Image: Amaranth- another grain to try growing!
Watertown High School

Milling Grain

You can grow and eat grain without getting a mill, but milling your grain into flour will give you more versatility and is fun.

If you are growing very small amounts, grain can be milled in small amounts using a kitchen blender. Try tipping it slightly. It helps! A hand cranked coffee grinder can also be used. For larger amounts and for a better grind, there are many different types of home mills available. I recommend getting a hand cranked mill to use all that energy your students have! One I have had good luck with is the “Family Grain Mill” which can be found online for about \$250. This mill will grind many kinds of grains, not just wheat like some of the impact mills. It has an optional hand crank attachment, and an adjustable grind. You may have to pass some grains like corn through a couple of times to get a fine grind. There are cheaper mills out there, but they are often so slow that they are really only able to be used as a demonstration and do not produce usable results.



Students test different types of yeast before making pizza

Recipes

A couple of recipes to get you started...

Whole Grain Salad

Cook wheat, rye, spelt, barley or other similar grains as you would rice. In a rice cooker or on the stove top, add one part grain to two parts water. Add salad dressing, your favorite finely cut vegetables and fruits and serve warm or cold. Melon cubes are especially popular with an orange juice sweet dressing.

Whole Wheat Pizza

Mill your wheat or spelt flour. This recipe makes 16 servings. Adjust accordingly. You can make four large, or about 16 individual pizzas.

- 4 packets active dry yeast
 - 5 cups warm water
 - 4 Tbs sugar or honey
 - 2 Tsp salt
 - 1/2 cup oil
 - 12 cups flour (This can be mixed with store bought flour.)
1. Dissolve the sugar or honey in the water in a large bowl. Add the yeast. When mixture bubbles, add the salt and oil. Gradually mix in the flour.
 2. Flop the dough onto a lightly floured surface and divide it up in pieces among students. Let them kneed for about 10 minutes or as long as they can last...
 3. Put the kneaded dough into a large greased bowl. You can also have them put individual sized dough balls of about 1/2 cup in small bowls if you are making personal pizzas.
 4. Allow dough to rise in a warm place if you have time, for about 1/2 hour, or just roll it out on a floured surface into four large (or many small) pizzas.
 5. Preheat your oven to 500°. Add toppings to each pizza from your garden if you can! Thinly chopped veggies and herbs seem to work better for students who usually just eat cheese.
 6. Bake for about 20 minuets or until the crust is browned and the cheese is bubbling. Cool well before serving.

Resources and Sources

Mass. Ag. in the Classroom Guides

Can be found at www.aginclassroom.org under “Classroom Agriculture”

- Agriculture and STEM Education - Debi Hogan, MAC Newsletter
- Cover Crops Guide - Alice Posner for Massachusetts Agriculture in the Classroom 2012
- Choosing the Crops to Grow Guide - Alice Posner for Massachusetts Agriculture in the Classroom 2011
- MAC Composting Guide - Debi Hogan for Massachusetts Agriculture in the Classroom

Books

- Homegrown Whole Grains Sara Pilzer. 2009 Storey Publishing, North Adams MA

Seed Sources

Companies that will sell in small amounts:

- Fedco Seeds: fedcoseeds.com. A Maine based seed cooperative.
- Johnny’s Seeds: johnnyseed.com

A good farm seed company for other varieties in large amounts:

- Lakeview Organic Grain <http://lakevieworganicgrain.com/products.html>

Organizations

- Northern Grain Growers Association: <http://northerngraingrowers.org/>. A resource for northeast regional small grain growers

Cover Image: <https://livingseedcompany.wordpress.com/category/seed-saving/>

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Agriculture in the Classroom 2015*

Other sources used in this guide

- Whole Grain Nutrition Fact Sheet- University of Minnesota: <http://www.health.state.mn.us/divs/hpcd/chp/cdrr/nutrition/docsandpdf/wholegrainfactsheet.pdf>
- <http://www.gardenguides.com/138041-parts-wheat-seed.html>
- USDA National Agricultural Statistics Service
- Corn seed graphic: Pic2fly.com
- The Gleaners- Jean Francois Millet - 1857
- Wheat weaving: Illinois wheat weavers- <http://www.illinoiswheatweavers.org>

All photos and illustrations are by the author unless otherwise noted.

About the Author

Alice Posner has been farming for over ten years, and worked with a grain and bean CSA in Belchertown MA. She taught in school gardens in Holyoke MA public schools and has designed curriculum for summer programs on farms and in gardens for students from elementary to middle school levels. She has been writing garden guides and working in school gardens with MAC since 2012