The NORTH FARM

Michigan State University

FOOD, AGRICULTURE, & NATURAL RESOURCES CURRICULUM FOR SECONDARY TEACHERS

15 LESSON PLANS

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Soil Food Web

The soil food web is the community of organisms that live all or part of their lives in the soil, and their interactions form the basis for terrestrial life and energy transfer. Human civilization itself depends on soil for food. The importance of soil life – including how human practices affect soil health and crop productivity – becomes more concrete when students see these often overlooked organisms and their interactions. This activity introduces students to one family of major players in the soil food web and invites them to investigate the connection between organic matter, disturbance, and compaction in relation to plant health.

Arthropods are a large group of invertebrates with jointed (arthros) legs (podos). Some types are large enough to see with the naked eye, but many more are visible using a microscope. Arthropods include insects like springtails, ants, and beetles, crustaceans like sowbugs, arachnids like spiders and mites, and myriapods like centipedes and millipedes.

Arthropods are an integral part of the agricultural soil food web: millipedes shred leaves so that smaller creatures can eat them, which are in turn eaten by microbes. They are predators that control pest populations, they improve the movement of water through soil because their burrows and castings improve soil structure, and these same channels create a good environment for roots and protect the area from erosion. Most arthropods live in the top centimeters of the soil in numbers that are staggering to imagine: a single square yard of soil may contain a half million individual arthropods of tens or hundreds of different species (USDA).

There are various ways to observe soil invertebrates. A light-colored tray, a pitfall trap, and a Berlese (pronounced "bur LAY zee") funnel are methods that can be used to collect arthropods for observation. Collect samples from two different environments to compare the relationship between the number and variety of arthropods and the overall diversity and health of the ecosystem. For instance, samples taken from a field lane, driveway, or construction area (soils with low organic matter and indiscriminate human impact) and a garden, compost pile, or field (soils with high organic matter and carefully controlled human impact) will likely yield different numbers and varieties of arthropods.

Activity adapted from Soil Biology Primer co-authored by Dr. Elaine Ingham [online]. Available: http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/biology/ [1 June 2017] and Soil Biology Classroom #3: What Lives in Your Soil? and Cornell Composting: Composting in Schools [online]. Available http://compost.css.cornell.edu/monitor/macroinvertebrates.html [1 June 2017].

Standards
MCCTE
AFNRE Cluster I.C.2a
01.0000 IIB.1

MI Biology
B3.p2
B4.4a

Resources
Lowenfels, Jeff and Wayne Lewis. *Teaming with Microbes.* http://www.timberpress.com/books/teaming_microbes/lowenfels/9781604691139

Soil Biology Primer: https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/biology/

Selected invertebrates of the soil food web: https://www.youtube.com/watch?v=XqRLVUtAAV8

Soil Critters: Life in the Great Underneath: https://www.youtube.com/watch?v=mRiylsNjdzw

Activity 1: Tray of Compost – Samples can be observed immediately

Objective
Students may identify organisms, estimate numbers, and compare populations across different samples. Students should be able to determine the locations from which the samples were taken based on their observations.

Materials
Light-colored trays or pans
Tweezers, spoons, or tongue depressors
Flashlight
Magnifying glass
Identification Key

Procedure
1. Spread each sample in a large tray or pan, preferably light in color for maximum contrast and observe each sample.
2. Students can use wooden tongue depressors, plastic spoons, or other instruments to gently sort through the sample. Flashlights and magnifying lenses can be used to observe small organisms.
3. To get a closer look, place samples of the compost in petri dishes or watch glasses and observe them under a dissecting microscope.
4. Identify the main groups of arthropods in each sample. A simple identification key is at http://ei.cornell.edu/teacher/pdf/D%26R/D%26R_Soil_Invert_ID.pdf or a more detailed one is at http://www.caryinstitute.org/sites/default/files/public/downloads/curriculum-project/Invertebrate%20Guide.pdf

Activity 2: Pitfall Trap – Allow one week after set up to collect samples

Objective
Students may identify organisms, estimate numbers, and compare populations across different samples. Students should be able to determine the locations from which the samples were taken based on their observations.

Materials
1-to-4 cup sized container (a large yogurt container)
Trowel
Preservative (ethanol or 50:50 ethanol/water mix)
Identification Key

Procedure
1. Set up the trap. Choose a location that will not be disturbed for a week. Dig a hole as large as the container. Set the container into the hole so that the rim is exactly even with the soil surface. If it is a bit higher, organisms will walk around the edge and will not fall in. Smooth the soil up to the rim of the container.
2. Enhancements: If desired, you can fashion a roof over the cup to keep out the rain and animals that might eat the arthropods. You may add a preservative (e.g. ½ of an inch of non-hazardous antifreeze or ethanol) to preserve the organisms and prevent them from eating one another.
3. Collect the arthropods. Leave the trap in place for one week, but check it daily, especially if you did not use a preservative.
5. Identify the main groups of arthropods in each sample. A simple identification key is at http://ei.cornell.edu/teacher/pdf/D%26R/D%26R_Soil_Invert_ID.pdf or a more detailed one is at http://www.caryinstitute.org/sites/default/files/public/downloads/curriculum-project/Invertebrate%20Guide.pdf

Activity 3: Berlese Funnel – Allow one week after set up to collect samples

Objective
Students may identify organisms, estimate numbers, and compare populations across different samples. Students should be able to determine the locations from which the samples were taken based on their observations.

Materials
Trowel and plastic bags for gathering soil.
Large funnel (2-liter bottle, or plastic milk jug)
2 mm mesh screening
Jar or cup
Preservative (ethanol or 50:50 ethanol/water mix)
Incandescent, 60W light bulb and fixture
Dissecting microscope
Identification Key

Procedure

1. Gather soil samples. Arthropods are easiest to find in soil that is rarely disturbed by tillage, not compacted by traffic, not treated with pesticides, not periodically flooded or dried out, and that has several different kinds of plants growing. Push away the surface litter and dig up about 1 liter of soil from the top few centimeters of the soil. (In another experiment, plant litter can be used in place of soil in a Berlese funnel.) Refrigerate sample if you will not use it right away.
2. Set up the Berlese funnel. Cut off the bottom of the bottle or milk jug to make a funnel. Cut and place the screen in the bottom of the funnel to hold the soil. It may help to tape the edges of the screen to the funnel. Half fill the funnel with soil. Set the funnel above a jar or cup with a bit of ethyl alcohol in the bottom. (Glycerol can be added to reduce evaporation.) Set up a desk lamp or hang a light bulb so the bare 60W bulb is about 4 inches over the soil.
3. Collect the organisms. Leave the light bulb on for 3-7 days to dry out the soil. As the soil dries, organisms will move deeper into the soil and eventually fall into the alcohol. Avoid disturbing the setup and knocking soil into the alcohol.
4. Examine each sample. Pour the alcohol solution into a petri dish and examine under a microscope. Put black paper and white paper behind the sample to highlight different organisms.
6. Identify the main groups of arthropods in each sample. A simple identification key is at http://ei.cornell.edu/teacher/pdf/D%26R/D%26R_Soil_Invert_ID.pdf or a more detailed one is at http://www.caryinstitute.org/sites/default/files/public/downloads/curriculum-project/Invertebrate%20Guide.pdf

Results
The instructor should make a two-column list on the board. Ask students to come up and write the type and number of arthropods discovered in each sample. The instructor should reveal the locations of the different samples. Students should be able to determine which sample came from an area intended for growing food, and which one came from soil highly impacted by human movement.

Questions

- Why do we find more arthropods in some places than others?
- What role might each organism play in the soil environment? How does that affect plant life living in the soil?
- How is the success of these organisms linked to that of humans?
- How can humans affect the biodiversity of the soil?
- After watching the videos, what kinds of interactions occur between soil invertebrates and plants?

Composting with Worms

Composting worms can turn kitchen scraps into worm castings, a nitrogen-rich soil amendment, thereby removing organic matter from the waste stream and putting it to good use. *Eisenia foetida*, commonly known as the Red Wiggler, is a worm that can tolerate moist conditions and lives happily in a plastic tote full of shredded newspaper and lunch scraps under the sink or in an entryway at 55-70^{oF}, making them an ideal candidate for class pet. Properly maintained worm bins do not smell. The worm bin can be a focal point for future lessons on soil ecosystems, waste stream reduction, invasive species, the energy cycle, trophic levels, decomposers, plant nutrient requirements, and many other activities.

However, worms of this type are not native to North America and pose a significant threat to northern hardwood ecosystems – maple saplings, trilliums, and morels all depend on a deep layer of leaf litter duff which decays slowly. Red wigglers (which like the slippery layers of leaves) and nightcrawlers (which burrow) change this soil ecosystem radically and quickly by ingesting the leaf litter and compacting the soil. If you decide to do a worm bin, you must have a plan for killing the worms and cocoons prior to using the castings outdoors. This can be accomplished by leaving the bin in an exposed area outdoors in the winter in subzero temperatures for two weeks to a month and checking in the spring to be sure that worms have been killed (Great Lakes Worm Watch).

Having a few worm bins so that there is one available for use as the other is being treated with freezing temperatures can provide a full year of worm bins for your veggie scraps.

Standards
MCCTE
AFNRE Cluster I.C.2a:
01.0 Technical II.B.2:

MI Biology
B3.p2
B4.L3.p4a
B2.3a-c

Resources
Great Lakes Worm Watch:
http://greatlakeswormwatch.org/

The Worm Guide: A Vermicomposting Guide for Teachers
http://www.calrecycle.ca.gov/publications/Documents/Schools/56001007.pdf

NOTE: RED WIGGLERS ARE A NON-NATIVE SPECIES AND ALL WORM BINS MUST BE TREATED WITH EXTENDED FREEZING TEMPERATURES TO KILL WORMS PRIOR TO USE OF CASTINGS.

Activity 4: DIY Indoor Worm Bin

Objective

By building a worm bin and using it in the classroom, students will observe the role of decomposers in their ecosystem and energy transfer.

Materials for Worm Bin

2 – 19 gallon plastic totes with lids (opaque, flexible-plastic totes are less likely to shatter or photodegrade)
Drill with 1/8" bit
4 spacers – 2" blocks of wood, foam, or 2" slices of PVC
Bedding material for the worms – 50-75 sheets of newspaper, shredded office paper, or a garbage bag of leaves
2 cups garden soil
2 cups water
1 pound of veggie scraps (a large yogurt container or so)
1 pound *Eisenia foetida* or Red Wiggler worms (many sources online)

Anticipated Outcomes

Have students hypothesize how long it will take for 1 pound of worms to digest 1 pound of food.

Procedure

1. Divide students into 4 groups; depending on the number of worm bins being constructed, the students can rotate through the tasks:
   A. Drill 15-20 holes in the bottom and a series of holes around the top edge of one tote using hand drill or power drill with supervision.
   B. Look up what kinds of food scraps can and cannot go in the worm bin; make a two column list on the board.
   C. Prepare worm bedding by shredding newspaper into ½" inch strips.
   D. Look up facts about the life cycles of worms (how long they live, temperature requirements, how much they eat, how often they reproduce).
2. Give the two research groups time to report what they have found out.
3. Assemble the worm bin by placing the spacers in the bottom of the solid tote and nesting the tote with holes so it rests on top of the spacers.
4. Fill the top tote with bedding material and wet it to the consistency of a wrung-out sponge. Add soil and worms.
5. Feed the worms their first meal by burying 1 pound of veggie scraps completely in a clump at one side of the bin.
6. Make a sign for the top of the bin that describes what can and cannot be fed to the worms. For this experiment, don't feed them again until the first meal has "disappeared."
7. Observe the bin once a day until there are no more veggie scraps and make a note on the calendar.

Ongoing Care

After the first meal has been completely eaten, feed worms in another section of the bin; continue this process weekly, adding bedding and draining liquid from the bottom of the bin, until enough worm castings have accumulated for a harvest or the bin is full. Remove the worms that you want to use to start a new bin by selective feeding in one location or screening, and place in a new bin. Put the old bin outside and freeze for at least 2 weeks, then use castings as an ingredient in transplant media.

Results

When there are no more scraps from the first meal, compare this to the initial facts learned about worms. Discuss the factors that could contribute to worm bin performance, such as temperature or other disturbances system.

Questions

- What would this ecosystem look like in equilibrium?
- How many pounds of food could a bin of worms digest in a week, assuming that the population remains stable?
- At what point would the first new generation of worms emerge from their cocoons and begin eating?

- What is the relation of the worm bin and its decomposers to other trophic levels?
- Would worms be a good solution for the school lunch room food waste? (See Worms and Food Waste below).

Activity 5: Food Waste

Objective

By observing the amount of food waste the school produces in one day and comparing the time that waste spends in the landfill to how long it takes that same waste to decompose in an accelerated composting system, students will learn the pros and cons of different methods of organic waste disposal.

Materials

5 gallon bucket (s) for food scraps

What goes in the bin sign – printed and laminated

Log sheet and pen

Procedure

1. Ask students to research the waste stream. 31% of food in the US is thrown away, according to USDA findings. Or use this for an introduction: https://www.flickr.com/photos/usdagov/15032644782/sizes/l/
2. Ask students to research the Zero Waste movement. Compare it to the Closed Loop System concept in manufacturing.
3. Seek permission from lunch staff to set up a collection bucket for pre-consumer non-meat, non-dairy scraps from the kitchen that are generated during food preparation. Explain what is acceptable for the bucket (vegetables, fruits, peels, ends, pasta, bread, eggshells, coffee and tea bags) and what is not (meat, dairy).
4. Collect the bucket at the end of an agreed-upon time frame (1 prep, 1 day, 1 week – the time frame depends on the size of the lunch service).
5. Weigh the bucket at the end the period and record the information.
6. Dispose of the scraps.
7. Ask your students to use the weight of the bucket and span of time to calculate how many pounds of food waste are disposed of each day, week, month; figure the average amount of waste per student.
8. Compare these findings to how long it takes 1# of worms to digest 1# of food.

Results

Students will be able to estimate how much food waste is produced in the school, and can extrapolate the size of a composting operation needed to turn all that food waste into a usable product.

Questions

1. Is it feasible to build a worm composting operation that would take care of the school's lunch waste?
2. How could the castings be used? Example: school garden, fundraiser to by selling it to community garden or beautification committee, traded to a local farm in exchange for produce

Planting a Salad Bar

Standards
MCCTE
01.0601: Cluster I.C.2
01.0001: Career Ready Practices I.A.11

MI Biology
B3.p1a, 2a, 2b, 4a

Resources
Fortiner, JM.
http://www.themarketgardener.com/

Bartholemew, Mel.
http://squarefootgardening.org/

Jeavons, John.
http://www.growbiointensive.org/

La culture maraîchère:
http://www.cote2boeuf.fr/le-blog/les-maraichers-parisiens-du-19e-siecle/

Organic Agriculture Working Group:
http://organic.kysu.edu/CompanionSpacing.shtml

Plants have distinct spacing recommendations based on the size of the plant, the stage at which it will be harvested, and soil quality. Lettuce can be direct seeded in bands of several seeds per inch, or transplanted at three weeks of age at 12" apart. The question for farmers and gardeners is: how do I make the most of the space I have?

Many minds have been at work on this and there are many manuals. *Square Foot Gardening* is a method of crop planning by Mel Bartholemew designed to make the most efficient use of space and basic gardening principles in an easily executed package. This approach is a "home gardener" scale take on the dense interplanting and succession planting developed make the most of small spaces that can be traced back to French market gardens or the *culture maraîchère* from the 1700s through the turn of the last century, and made famously profitable in the 21st century by JM Fortiner's *The Market Gardener*. John Jeavons' *Grow More Vegetables* offers "master worksheets" that are a convenient cheat sheet for vegetable spacings.

Market gardeners and CSA farms use similar methods to plan their crops – how many tomatoes will fit in a 100 foot row? – and thus to predict yield and profitability. School gardens can use these techniques, with a dose of the history of gardening or an entrepreneurial eye, to create a high volume of food production from a small space. Crop planning in a hoop house for a school salad bar links theory to a real-world outcome in the school. Students can observe the outcomes associated with crop planning.

The precision and attention to detail required for this kind of planting can be difficult to maintain in a group setting out in the garden, however, when it is hard to see what has already been planted and wet hands waste small seeds. Activity 10 uses a paper towel to represent a square foot of planting space, allowing students to learn spacings that they can use in the hoop house or garden for successive plantings.

Activity 6: How's the Salad Bar?

Objective

After interviewing foodservice staff and classmates, students will be able to rank crops for a crop plan.

Materials

Fact Finding for Planting Interview Questions
Poster board
Markers
Sticky Dots

Procedure

1. Ask students to research the history of the national school lunch program and nutrition science. Research that is applied and becomes policy is part of how science interacts with society. What changes have been made to school lunch programs in light of new evidence? How can a school garden contribute to satisfying new requirements?
2. Assign one team of students to use Fact Finding for Planting to interview foodservice staff about the type, quality, volume, and price of currently sourced fresh produce.
3. Assign another team of students to collect data on current student perceptions of school lunch, such as by asking about favorite vegetables on the menu vs. favorite vegetables of all time, or favorite item on the salad bar using a sticky dot survey set up in the lunch room.
4. Both teams should present their findings to the class.

Questions

- Based on the data, is there a student demand for more or higher quality produce?
- Based on the interviews, which crops that are currently purchased could be grown on school grounds? What volume would be required?

Activity 7: Calculate Growing Space

Objective

Based on measurements of the beds, students will calculate the amount of growing space available in their hoop house, its production capacity, and determine which crops the school garden might feasibly provide to the lunch room.

Materials

Tape measure
Johnny's Plant Specs

Procedure

1. Introduce terms: **population, community, ecosystem** as concentric circles; place a tomato plant, a soil microbe, and a student in the concentric circles. What is the **ecological relationship** between these three organisms? And what about the **human impact** on this ecosystem?
2. Drawing on the dot survey data, propose that they plan the hoop house planting to continue to supply (and improve) the salad bar.
3. Measure area of entire garden and individual beds.
4. Calculate garden growing space on the board to determine available growing space and percentage of hoop house currently in use.

Total area – paths
OR
Bed size * # of beds

For instance:
48X30 garden or hoop house = 1440 ft2
But is that all growing space? No. How big are the beds? 3X40 = 120 ft2
How many beds are there? 6X120=720 ft2
How much of the hoop house is being used for growing space? 720 is 50% of the space
What about vertical space? Are there options for growing in hanging baskets?

5. What do you want to grow? Cold-hardy examples: Spinach, lettuce, carrots, tomato, radish, peas. Walk through a few of the cold-hardy plants from the Johnny's Plant Specs and talk about their growing requirements. Introduce terms such as **soil temperatures** required for germination, **number of days to maturity**, **successive planting**, and **vertical growing**.

Questions

- How can growing space in the garden be maximized? Entertain smaller paths, increased soil fertility, vertical growing, or short-season crops.

Activity 8: Crop Planning I

Objective

By learning about seeding density, days to maturity, students will be able to determine which foods can be grown during the school year. In addition, they will use a spreadsheet to plan the seeding and projected harvest dates for multiple varieties of greens.

Materials
Johnny's Plant Specs
Crop Planning Spreadsheet Example
Johnny's Succession Planting
Julian Date Calendar
Seed packets or plant variety information
Crop planning worksheets tailored to dimensions of school hoop house

Procedure

1. Look at the Crop Planning Spreadsheet Example. The spreadsheet on the front page demonstrates how much of the year can be productive with careful planning and season extension.
2. Follow one line of the spreadsheet – one row of the hoop house – from spring to fall. What happens in that space over time?
3. Point out that there are THREE PLANTINGS to maximize the season extension potential of a hoop house, but that is sometimes hard to accomplish north of the 45th parallel. Each year is different. For the fall, schools will want to start planting salad greens in August for October final harvests. For the spring, schools will want to start planting salad greens ASAP in late February/early March for May final harvests.
4. Define a crop plan.

A crop plan allows you to map out both space and time:
WHERE plants go
WHEN to plant them / **HOW LONG** they will take to grow / **WHEN** you can harvest them

5. Go through radishes as an example step-by-step together. Use the radishes as an example of staggered planting that allows the farmer to control volume, so that only as much radishes as can be sold in a week are planted at a time.
6. Chart the seed and harvest of RADISH at 28 days together using Julian Date Calendar by utilizing the data provided on the back of the Crop Planning Spreadsheet Example.

7. Divide into 5 groups and assign each of the 5 groups each 1 row and 1-2 crops. Answer questions in small groups, and come together as a class to review your progress at the end.

Questions

- For each variety, when to plant? How to plant – direct seed or transplant? How long to maturity? For how many weeks can the crop be harvested? Is there time to plant something else?

Activity 9: Crop Planning II

Objective

Participants are able to project how much of the salad bar will come from the hoop house, and make recommendations to food service. With a visit from a farmer, they may see diversified farming with season extension components as a potential career path

Materials

Lexicon of Food's Crop Rent Calculator: https://www.lexiconoffood.com/images/information-artwork-crop-rent-calculator

Procedure

1. Contact a local farmer who does diversified vegetables and ask them to come and look at your crop plan.
2. Look at a few student examples of the crop plan. Ask students to read a line of their crop plan out loud, and input the data to an Excel spreadsheet.
3. Look over the entire plan: what are the advantages and disadvantages?
4. Choose one crop and follow it from seed to harvest to calculate yield and market value.
   How much will your space yield (food and money)?
   W seeds covers X area = Y # of food = Z$
   SPINACH: 1000 seeds sows 100' = 100# of spinach @ $1.25 per bunch or $5.00 per pound = $500
   The entire Hoop House could produce 720# of spinach…just once. Which would go rotten in the cooler before it could be eaten. If you can charge $6/# for baby spinach, how much money is that? $4,320 – which might help to illustrate the hoop house's potential to offset school lunch costs.
5. Look at Johnny's Succession Planting Sheet. How would one successive plant for about 20# per harvest of lettuce and spinach?
   Lettuce = .25# per ft. sq. means that you should plant 80 ft. sq. every two weeks, or an 8X10 bed
   Spinach = 1 per ft. sq. means that you should plant 20 ft. sq. every two weeks, or a 2X10 bed
   Carrots = (750 seeds sows 25', so 25X12 = 300 inches / 2 inches = 150 carrot seeds, with an 80% germination rate = 120, so 25' = 120 carrots) 120 carrots = 18-20 # of carrots
6. Use the crop plan to come up with a mock product list for the lunch room.

Questions

- What are the limits of the school's current growing space in terms of total food production?
- Which are the most valuable, cost-saving crops to produce – those that are expensive for the lunch room, or those that are plentiful and could replace the largest quantity of food purchased?

Activity 10: Paper Towel Garden

Objective
Given the spacings for various vegetables, students can use interplanting and dense plantings to create a crop plan that makes efficient use of garden space.

Materials
Seeds – for instance, chard, carrots, spinach, kale, lettuce, cilantro, collards, basil
Paper towels
Elmer's glue
Pencil
Vegetable spacing chart, such as

Anticipated Outcomes
Ask students how many pounds of produce or dollars a square foot of soil could produce.

Procedure

1. Show some photographs of the French intensive method http://www.cote2boeuf.fr/le-blog/les-maraichers-parisiens-du-19e-siecle/ and compare this to a photo of an acre of corn http://agfax.com/2017/05/09/ohio-corn-management-practices-for-later-planting-changes-to-consider/ Have a conversation about what is different about these two approaches. What assumptions or principles are at play in each? Discuss tools, yield, inputs, fuel, transportation, scale. Note: during heyday of French Intensive gardening, the city of Paris was horse-powered – think of all the manure for fertility! After discussing the advantages and disadvantages, consider which system would be most appropriate for the school garden.
2. Make a list of the crops you will be planting on the board. Invite students to think about the size of each plant when it is mature.
3. Hand out plant spacing chart and go over how to read it. Which of these could be planted together? Interplanting examples for 1 square foot: 1 tomato, 6 beets; 1 broccoli, 4 leaf lettuces; 1 tomato, 4 basil; 1 pepper, 8 bush beans; 1 cucumber, 16 radishes
4. Determine total square footage of garden and write it on the board. Then, determine the area that is path vs. the area that is to be planted. Write that square footage on the board.
5. Choose a "favorite" vegetable as a class and determine how many of those will be planted. For instance, a garden might have 100 radishes, or 10 bunches at $3.50 per bunch, or $35.00. Note: a short season crop like lettuce or radish which matures at 28 days allows the same group of students who plant the seed to see the results. Use crop rent calculator slide to project yield and dollar value of this crop.
6. Divide students into groups or allow them to work individually; assign number of "squares" to each and distribute paper towel accordingly.
7. Using seeds and plant spacing chard, glue seeds to paper towel. Cover with a second sheet of paper towel.
8. Label paper towels using a pencil; e.g. 1 Tomato, 16 Carrots
9. Paper towels can be "planted" and watered in that day, or at a later time.
10. Throughout the growing season, keep a record of how many pounds/bunches are harvested from the selected plants.

Results
Students will be able to project yields based on their crop plan and compare those yields to actual harvest. A conversation about watering, soil fertility, germination rates, or harvest practices can follow.

Questions

- Did the crop perform according to projections? Why or why not?
- If the school lunch room utilized just that crop, how much money could be saved?

Fact Finding for Crop Planning: Salad Bar

Foodservice Staff Name:

Interviewer Name:

Date:

How many students are at your school?

How many lunches are served daily?

Is there currently a salad bar at the school? What does it look like? Bowls with tongs? A cart with cold wells?

If you do have a salad bar, what quantities of which items does the food service director order for it on a weekly or monthly basis? Number of cases? How many heads or pounds are in a case? What is the cost per case?

Do students and staff like the salad bar? How popular is it? What would make it more appealing?

Example

Tony

Fact Finding for Crop Planning: Salad Bar

What are the dimensions of your hoop house structure? 48' x 30'

What are the dimensions of the beds in your hoop house? How many are there? This is used to calculate total growing space. 6 beds approx. 3' x 40' plus hanging pots 25→30 and a hanging trough 1' x 40'

T How many students are at your school? 358

T How many lunches are served daily? 230

T Is there currently a salad bar at the school? What does it look like? Bowls with tongs? A cart with cold wells? I have one large bowl of tossed salad w/ tomatos, cucumber, peppers mixed. I also have bowls of cucumber, Brocolli, baby carrots and sometimes cherry tomatos.

T If you do have a salad bar, what quantities of which items does the food service director order for it on a weekly or monthly basis? Number of cases? How many heads or pounds are in a case? What is the cost per case?

wk - 20 lbs of mixed Lettuce (Head lettuce carrots - cabbage Romaine) $23.07

wk - 15 lbs cucumbers $17.13

10 per wk - 20 lbs Brocolli $17.20

10 per wk - 20 lbs Baby carrots $32.09

5 per wk - 10 lbs green peppers $8.50

- onion -

- wk - Tomato $19.09

Crop Planning Basics

A **crop plan** for a hoop house has three main components:

A **planting schedule** is a calendar for the year:
- Get several rounds by succession planting of fast-maturing crops
- Anticipate how much seed you'll need – order the right amount

Start your transplants indoors at the right time

A **crop map** lets you see location of plantings:
- Choose vegetable varieties
- Manage crop rotations for disease and pest control, soil structure improvement, and nutrient density
- Order seeds

Good **records** determine future decisions:
- Log the variety of each vegetable, seeding dates, and transplant dates
- Weigh what you harvest
- Analyze crop profitability

HH 1	March				April				May				June				July				August				September				October				November				December			
Row #	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	DS	Guardsmen Scallion						H	H	H	50		TP	Bianca Pepper								H	H	H	65	DS	Salad Mix		H	H	28									
1	DS	Deep Purple Scallion							H	H	H	60	TP	Islander Pepper							H	H	H	60		DS	Salad Mix		H	H	28									
2	DS	Zena Fino Fennel									H	80	TP	Jalepeno/Hot Wax Pepper							H	H	H	63		DS	Salad Mix		H	H	28									
3			DS	Black Summer Pac Choi						H	H	50	TP	Cal Wonder								H	H	H	65	DS	Spinach			H	H	H	H	40						
4		DS	Radish		H	H	21						TP	Habenero Pepper											H	H	91	DS	Spinach				H	H	H	H	40			
4				DS	Radish		H	H	21				TP	Fish Pepper										H	H	H	80	DS	Spinach				H	H	H	H	40			
4						DS	Radish		H	H	21		TP	Cayenne Pepper									H	H	H	75		DS	Spinach				H	H	H	H	40			
5			DS	Bulls Blood Beets				H	H	H	40		TP	King of N Pepper									H	H	H	75		DS	Spinach				H	H	H	H	40			

Examples courtesy of Rock River Farm, LLC.

Example Hoop House Planting Schedule

Abbreviations: **DS** = Direct Seed / **G** = Germination / **H** = Harvest / **T** = Transplant

	Jan		Feb		March		April		May		June		July		Aug		Sept		Oct		Nov		Dec	
Bed 1																								
Bed 2																								
Bed 3																								
Bed 4																								
Bed 5																								
Bed 6																								

Cucumber Lemon	Cherry Tomato Sungold F1	Radish Easter Egg	Spinach Space F1	Lettuce Black Seeded Simpson	Pea Sugar Ann	Carrot Purple 68 F1
Germination:7-30 days	Germination: 7-10 days	Germination: 7 days	Germination: 7-10 days	Germination: 7-14 days	Germination: 4-10 days	Germination: 7-21 days
Maturity: 65 days	Maturity: 50 days	Maturity: 30 days	Maturity: 39 days	Maturity: 28 days	Maturity: 52 days	Maturity: 75 days
Harvest: 21 days	Harvest: 28 days	Harvest: 14 days	Harvest: 28 days	Harvest: 14 days	Harvest: 14 days	Harvest: 7 days
Transplant Start transplants 3-4 weeks before 30 seeds sows 15’ Needs soil temps of 85 F to germinate	Transplant Start transplants 5-6 weeks before 85% germination rate 1000 seeds makes 850 plants	Direct Seed 250 seeds sows 7’ Sow in 3” wide bands, seeds about 1” apart	Direct Seed 1000 seeds sows 100’ Sow every 7 days for a continuous supply	Direct Seed for baby 1000 seeds sows 16’ Grows best at soil temps of 60-65 F	Direct Seed 250 seeds sows 8’ Can be grown with or without trellis	Direct Seed 750 seeds sows 25’ Needs soil temps of 75

Julian Date Calendar – Non-Leap Year

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	32	60	91	121	152	182	213	244	274	305	335
2	2	33	61	92	122	153	183	214	245	275	306	336
3	3	34	62	93	123	154	184	215	246	276	307	337
4	4	35	63	94	124	155	185	216	247	277	308	338
5	5	36	64	95	125	156	186	217	248	278	309	339
6	6	37	65	96	126	157	187	218	249	279	310	340
7	7	38	66	97	127	158	188	219	250	280	311	341
8	8	39	67	98	128	159	189	220	251	281	312	342
9	9	40	68	99	129	160	190	221	252	282	313	343
10	10	41	69	100	130	161	191	222	253	283	314	344
11	11	42	70	101	131	162	192	223	254	284	315	345
12	12	43	71	102	132	163	193	224	255	285	316	346
13	13	44	72	103	133	164	194	225	256	286	317	347
14	14	45	73	104	134	165	195	226	257	287	318	348
15	15	46	74	105	135	166	196	227	258	288	319	349
16	16	47	75	106	136	167	197	228	259	289	320	350
17	17	48	76	107	137	168	198	229	260	290	321	351
18	18	49	77	108	138	169	199	230	261	291	322	352
19	19	50	78	109	139	170	200	231	262	292	323	353
20	20	51	79	110	140	171	201	232	263	293	324	354
21	21	52	80	111	141	172	202	233	264	294	325	355
22	22	53	81	112	142	173	203	234	265	295	326	356
23	23	54	82	113	143	174	204	235	266	296	327	357
24	24	55	83	114	144	175	205	236	267	297	328	358
25	25	56	84	115	145	176	206	237	268	298	329	359
26	26	57	85	116	146	177	207	238	269	299	330	360
27	27	58	86	117	147	178	208	239	270	300	331	361
28	28	59	87	118	148	179	209	240	271	301	332	362
29	29		88	119	149	180	210	241	272	302	333	363
30	30		89	120	150	181	211	242	273	303	334	364
31	31		90		151		212	243		304		365

Recommended Crops for Succession Planting

Vegetables

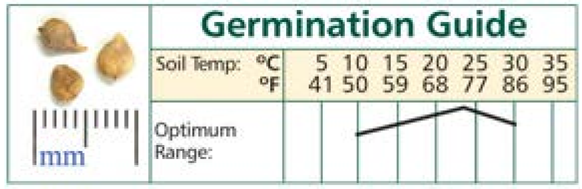
One of Johnny's Selected Seeds' experienced staff members, who is also a longtime market gardener, offers these succession planting guidelines for vegetables based on his experience in Maine:

- **Green beans**: Plant every 10 days
- **Beets**: Plant every 14 days
- **Cucumbers**: Plant every 3 weeks
- **Kale/Collards**: Plant every 3 weeks
- **Lettuce**: Plant full size every 10–14 days; plant salad mix every 7–10 days and harvest regrowth
- **Melons**: Plant every 3 weeks and multiple varieties
- **Radish**: Plant every 7 days
- **Spinach**: Plant every 7 days and harvest regrowth
- **Summer Squash**: Plant every 6 weeks (or more frequently if vine borers are prevalent)
- **Sweet Corn**: Plant every 10 days and multiple varieties with different maturity dates
- **Carrots**: In cooler climates, carrots are often planted in early May for summer harvest, and in early July for fall harvest. Non-storage types can be planted every 2–3 weeks for summer and fall crops. In warmer climates, carrots may be sown in late fall through winter, for late-winter to early-spring harvests.
- **Cabbage**: In cold climates, cabbage is usually transplanted early in May for summer and transplanted again in early July for fall harvest. In mild climates, these dates may be extended to earlier in spring and later in fall and, in very mild climates, year-round.
- **Cauliflower**: In cold climates, cauliflower is usually transplanted in early May for summer and transplanted again in early July for fall harvest. In mild climates, these dates may be extended to earlier in spring and later in fall and, in very mild climates, year-round.
- **Broccoli**: In cold climates, broccoli is usually transplanted in early May for summer and transplanted again in early July for fall harvest. In mild climates, these dates may be extended to earlier in spring and later in fall and, in very mild climates, year-round.
- **Turnips**: Plant every 7 days.

The following handouts are adapted from information from Johnny's Selected Seeds: www.johnnyseeds.com

SPINACH – SPACE F1

Tried and true variety. Medium dark green leaves are upright and smooth to slightly savoyed. Resistant to downy mildew races 1, 2, 3, 5, 6, 8, 11, and 12. Intermediate resistance to *cladosporium* leaf spot. Avg. 41,600 seeds/lb. Packet: 1,000 seeds.



DAYS TO MATURITY: 39

CULTURE: Spinach grows in a wide range of soils if moist and fertile, but is sensitive to acidity; pH should be at least 6.0, preferably 6.5-7.5.

SOWING DATES: Spinach germinates best in cool soil. Begin sowing in early spring as soon as the ground can be worked. Summer sowing in soil over 85°F (30°C) risks low or erratic germination. Sow in mid to late summer for a fall harvest. Spinach can also be planted from late summer until freeze-up in protected structures for fall, winter, and spring harvest. Using floating row covers offers additional winter protection.

PLANTING AND HARVEST: For bunching and full size: Sow 10 seeds/ft., 1/2" deep, rows 12-18" apart. Harvest spinach full size but before bolting, cutting just below root attachment for "rooted spinach", or cut higher for "clipped spinach". For baby leaf: Sow in a 2-4" wide band, 3/4" apart, about 40 seeds/ft. Clip small leaves in 3-5 weeks, depending on time of year and speed of growth. Triple-rinse leaves, sort out cut and broken leaves, and package. For a continuous supply, sow every 7 days.

STORAGE: Store at 32°F (0°C) and 95% relative humidity 10-14 days.

AVG. DIRECT SEEDING RATE: For full-size leaves: 10M/1,000', 290M/acre at 10 seeds/ft. in rows 12-18" apart. For baby leaf: 1M/25', 25M/125', 1,200M/acre at 40 seeds/ft. in rows 18" apart.

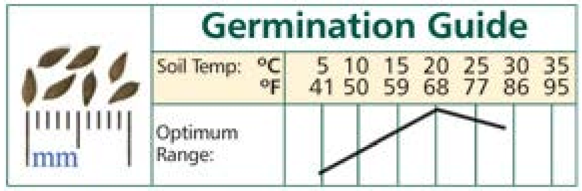
SIZED SEEDS: Standard except where noted.

SEED SPECS: SEEDS/OZ.: (for Size 6-8 seeds, which are usually supplied) 1,875-3,375 (avg. 2,600).
SEEDS/LB.: 30,000-54,000 (avg. 41,500).

PACKET: 1,000 seeds sows 100'.

LETTUCE – BLACK SEEDED SIMPSON

Standard light green baby leaf. An early producer of light green, curled, tender leaves. Packet: 500 seeds.



CULTURE: Lettuce is hardy and can be planted as early as the soil can be worked. It is a cool weather crop and grows best at temperatures of 60-65°F (15.5-18.3°C). Careful variety selection is important for hot weather plantings. Sow every 3 weeks for a continuous supply of fresh lettuce.

DAYS TO MATURITY: 28

THERMAL DORMANCY: Lettuce seed can enter thermal dormancy when exposed to high temperatures. Optimum germination results at soil temperatures of 60°-68°F (15.5-20°C). The priming process in pelleted lettuce seeds broadens the temperature range in which the seeds will germinate, overcoming some of their thermal dormancy.

TRANSPLANTING: Sow in flats, 4 seeds/in., or in 3/4" plug trays, barely covering seeds with fine vermiculite, 3-4 weeks before transplanting outdoors. Shade the flats on sunny, warm days if necessary to keep the soil surface cool, below 75°F (24°C), until germination. If sowing into flats, transplant 1-2" apart into flats, pots, or cell-type containers about 2 weeks later. Harden seedlings by reducing water and temperature for 2-3 days before planting outdoors. Properly hardened transplants can survive temperatures as low as 20°F (-6°C).Transplant iceberg and romaine lettuce 10-12" apart, in rows 18" apart. Other types 8-10" apart in rows 12-18" apart for full size heads or 6" apart for mini heads.

DIRECT SEEDING: Seeds germinate even at low, 40°F (4°C), soil temperature, but poorly above 75°F (24°C) depending on the variety and seed lot. Sow seeds 1" apart, rows 12-18" apart. Cover seed lightly, about 1/8", and firm soil gently. Thin iceberg and romaine lettuce to one plant ever 10-12", other types 8-10" for full size heads or 6" for mini heads. Dry soil must be watered to ensure coolness and moisture, and for uniform germination.

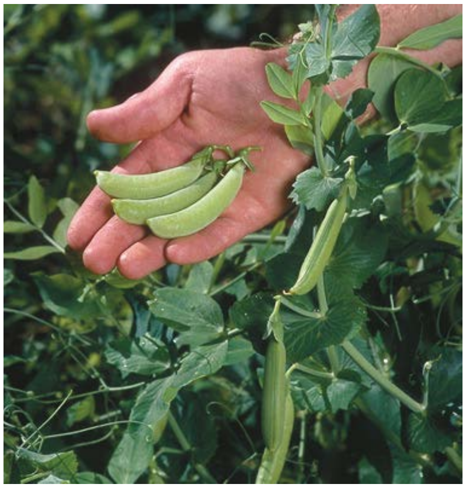
SALAD MIX/BABY LEAF: Sow in a 2-4" wide band, about 60 seeds/ft.

DAYS TO MATURITY: For full-size heads in mild temperatures from direct seeding; subtract 10-14 days if transplanting. Note: Maturity can be 3 or more weeks later in cool weather, and up to 1 week earlier in hot weather.

AVG. DIRECT SEEDING RATE: For full-size heads (precision seeded): 220'/1,000 seeds, 5,300'/oz., 5.5 oz./acre 2.5" apart in rows 18" apart. For baby leaf: 16'/1,000 seeds, 400'/oz., 6,400'/lb. at 60 seeds/ft.

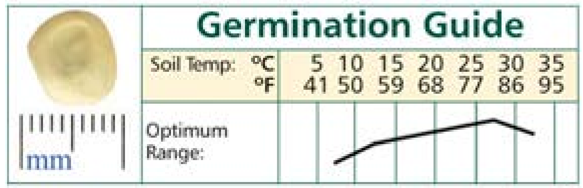
TRANSPLANTS: Avg. 20,000 plants/oz.

SEED SPECS: SEEDS/OZ.: 20,000-30,000 (avg. 24,000).



PEAS – SUGAR ANN

Earliest snap pea! Sweet, crisp, 2½" pods mature extra early. Can be grown with or without support. Remove string from pods before cooking. AAS winner. **Order 559G (Organic), 559 (Nonorganic), 559BG (Organic Natural II), or 559B (Nonorganic Natural II).** Avg. 2,100 seeds/lb. Packet: 250 seeds.



DAYS TO MATURITY: 52

CULTURE: Peas are a cool weather crop. Midsummer pickings are not as prolific as earlier harvests. For best yields ensure adequate fertility and a pH of 6.0-7.5. Adjust pH with ground limestone or wood ashes before planting. Plant the first sowing in early spring as soon as the soil can be worked. In well-drained soil, sow 1-1 1/2" apart in a 3" band (25 seeds/ft.), 1/2-1" deep. Do not thin. Varieties under 3' tall can be sown without support in rows 12"-18" apart. For taller varieties use a trellis net or chicken wire to keep vines upright, easy to pick and off the ground where they are less likely to rot if rainy weather coincides with harvest. Suspend the bottom of the trellis net or chicken wire just above the young plants. The best time to install a trellis is at planting time. Normal row spacing is 4-6' for trellised peas. Harvest when peas enlarge in the pods.

FALL CROP: Choose powdery mildew resistant varieties. Sow about 2 months before frost. Keep seeds well watered to encourage good germination.

INOCULANT: Inoculate peas to encourage formation of nitrogen producing nodules on the plant roots. This enriches the soil, results in larger plants, and increases yield. (see index).

TREATED SEEDS: Some varieties are offered UNTREATED, NATURAL ll treated (B) and TREATED (T). Untreated seeds are more susceptible to rotting in prolonged cold, wet weather.

DISEASES: The most common disease is probably pea root rot (Fusarium sp. or Aphanomyces euteiches) which causes browning and drying of the foliage from the ground up. The best control is to ensure well-drained soil and to rotate crops out of legumes for at least three years. Powdery mildew causes white, powdery mold on the leaves, stems, and pods in hot weather. Choose resistant varieties.

FREEZING: All our peas are good for freezing and canning.

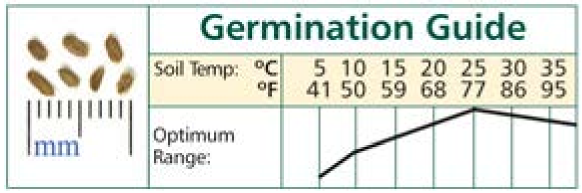
AVG. SEEDING RATE: 80'/lb., 13 lb./1,000', 272 lb./acre at 25 seeds/ft., in rows 24" apart.

SEED SPECS: SEEDS/LB.: 1,500-2,700 (avg. 2,000).

PACKET: 250 seeds sows 8'.

CARROT – PURPLE 68 F1

Uniform deep purple roots. Excellent flavor raw or cooked. Intended for midsummer sowings and fall harvests as it will bolt under increasingly warm temperatures and/or during long-day-length periods. High yields of attractive roots. Intermediate resistance to Alternaria. Avg. 246,000 seeds/lb. Packet: 750 seeds.



CULTURE: Carrots require well-drained soils, with a pH range of 6.0-6.8. Deep, loose, and fertile sandy loams and peat soils with good moisture-holding capacity grow the straightest and smoothest roots.

DAYS TO MATURITY: 75

PLANTING: Sow from early spring to mid-summer, 3/4-1" apart (about 30 seeds/ft.), 1/4- 1/2" deep, in 2" wide band, or single rows 16-24" apart. For minimum soil compaction, use raised beds with 2 or 3 rows 16-24" apart, beds 5-6' on center. Sprinkle the soil surface to keep moist. Don't allow soil to crust before the emergence of seedlings which takes 1-3 weeks, depending on temperature and moisture. If soil moisture during germination is an issue, we recommend using pelleted seed. If necessary, thin young seedlings to 3/4-2" apart, depending on root size desired. Keep weed-free by tine weeding and shallow hoeing. To prevent greening, cover exposed crowns.

DISEASES: Blights can reduce yield and quality. *Alternaria* blight shows as brown-black lesions edged with yellow on leaf margins beginning on oldest leaves. Leaflets may shrivel and die. *Cercospora* blight first appears as small dark spots with yellow margins on the younger leaves and stems. To prevent blights, practice a 3-year crop rotation. Copper fungicides (see Index) can be employed as a preventive measure or control.

INSECT PESTS: Carrot rust flies and wireworms. Provide fertile growing conditions and avoid ground recently in sod if possible. Exclude adult insects with fabric row covers (see Index.)

HARVEST: Carrots may be dug any time after they reach a good orange color (bright, not pale), at which stage flavor develops. Generally the best harvest period lasts about 3 weeks (longer in cool, fall weather), after which time the roots may crack or the taste and appearance may decline. Make a few sowings at 3 week intervals for a continuous supply of tender carrots at their prime.

STORAGE: Plant carrots intended for winter storage about 100 days before expected fall frost. Carrots store best at 32°F (0°C) and 95% relative humidity.

AVG. SEEDING RATE: 1M/33', 5M/166', 25M/830', 720M/acre at 30 seeds/ft. in rows 24" apart.

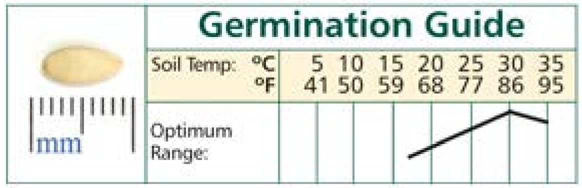
SIZED SEEDS: Standard except where noted.

SEED SPECS: SEEDS/LB.: 175,000-600,000 (avg. 288,000).

PACKET: 750 seeds sows 25'.

CUCUMBER – LEMON

Small, round, pale yellow cucumbers. Pick at 1 1/2-2 1/2" diameter. This versatile cucumber is sweet and flavorful, and doesn't have much of the chemical that makes other cucumbers bitter and hard to digest. Though it's often served raw, it's also a good pickling cucumber. Specialty market salad item. NOTE: Very late to begin bearing. Avg. 16,800 seeds/lb. Packet: 30 seeds.



DAYS TO MATURITY: 65

CULTURE: Requires warm, well-drained soil high in fertility, with a pH of 6.8-7.2. Consistent, adequate irrigation is needed to produce an abundant crop. Cucumbers are very sensitive to cold. Make sure both soil and air temperatures have warmed prior to planting. The use of poly mulch and row covers will greatly enhance the vigor and potential yields of cucumbers by providing warmth and insect protection. For greenhouse or high tunnel production the use of gynoecious and parthenocarpic varieties are highly recommended.

TRANSPLANTING: Sow indoors in 50-cell plug trays, 1-2 seeds/cell, 3-4 weeks before transplanting. Keep temperature above 70°F (21°C) day and 60°F (16°C) night. Transplant 12" apart in rows 5-6' apart. Do not disturb roots when transplanting.

DIRECT SEEDING: Wait until soil is warm, at least 70°F (21°C). Cucumber seeds will not germinate at a soil temperature below 50°F (10°C). Sow 2 seeds/ft., 1/2" deep, in rows 6' apart. Thin to 12" apart.

DISEASES: Practice crop rotation, residue sanitation, and choose disease-resistant varieties. Control insect pests to prevent bacterial wilt.

INSECT PESTS: Exclude cucumber beetles with row covers at planting, or control with pyrethrin or azadarachtin.

HARVEST: Once fruit bearing begins, pick daily.

STORAGE: Hold cucumbers at 45-50°F (7-10°C) and 90% relative humidity for up to 2 weeks.

DAYS TO MATURITY: From direct seeding; subtract about 10 days if transplanting.

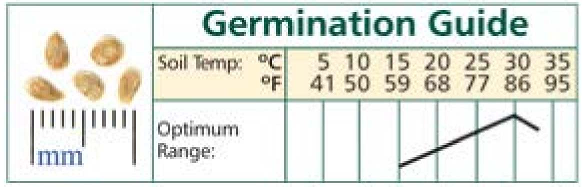
AVG. DIRECT SEEDING RATE: 30 seeds sows 15', 100 seeds/50', 250 seeds/125', 500 seeds/250', 1,000 seeds/500', 15M/acre at 2 seeds/ft. in rows 6' apart.

TRANSPLANTS: Avg. 85 plants/100 seeds.

SEED SPECS: SEEDS/LB.: 16,000-21,000 (avg. 18,000).

CHERRY TOMATO – SUNGOLD F1

Intense, fruity flavor. Exceptionally sweet, bright tangerine-orange cherry tomatoes leave customers begging for more. Vigorous plants start yielding early and bear right through the season. Tendency to split precludes shipping, making these an exclusively fresh-market treat. The taste can't be beat. 15-20 gm. fruits. Indeterminate. Avg. 12,850 seeds/oz. Packet: 40 seeds.



DAYS TO MATURITY: 57 (from transplants, which take 50 days)

INDETERMINATE: (climbing) varieties should be staked, trellised, or caged, and pruned for best results; fruit ripens over an extended period. Call for additional cultural tips.

CULTURE: GROWING SEEDLINGS: Don't start too early! Root-bound, leggy plants that have open flowers or fruit when planted out may remain stunted and produce poorly. Sow in flats, using a soilless peat-based mix (NOT potting soil), 5-6 weeks before plants can be transplanted out after frost danger. Keep temperature of the starting mix at 75-90°F (24-32°C); tomato seeds germinate very slowly in cooler soil. When first true leaves develop, transplant into plug trays or 3-4" pots for large, stocky 7-8 week transplants for earliest crops. Grow seedlings at 60-70°F (16-21°C). Water only enough to keep the mix from drying. Fertilize with fish emulsion or a soluble, complete fertilizer.

TRANSPLANTING OUTDOORS: Transplant into medium-rich garden or field soil varieties at 14-20" for staking. Water seedlings with a high-phosphate fertilizer solution. For earliest crops, set plants out around the last frost date under floating row covers which will protect from frost to about 28°F (-2°C). If possible, avoid setting out unprotected plants until night temperatures are over 45°F (7°C). Frost will cause severe damage!

FERTILIZER: Abundant soil phosphorus is important for early high yields. Too much nitrogen causes rampant growth and soft fruits susceptible to rot.

DISEASES: Learn the common tomato diseases in your area. Select resistant varieties. For prevention, use young, healthy transplants, avoid overhead irrigation, plow in tomato plant refuse in the fall, rotate crops, and do not handle tobacco or smoke before handling plants. Fungicides can reduce certain diseases when properly selected and applied. Prevent Blossom End Rot by providing abundant soil calcium and an even supply of soil moisture.

INSECT PESTS: Use row covers to protect young seedlings from flea beetles. Tomato hornworms can be controlled with bacillus thuringiensis. Use spinosad for potato beetle larvae and adults.

HARVEST: Fully vine-ripen fruit only for local retailing or use. To deliver sound fruit, pick fruit less ripe the further the distance and the longer the time between the field and the customer.

STORAGE: Store firm, ripe fruit 45-60°F (7-16°C) for 4-7 days.

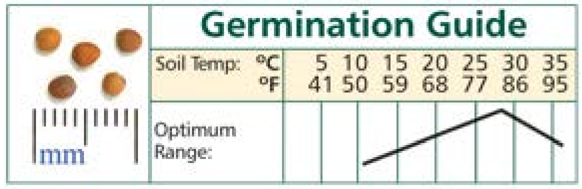
TRANSPLANTS: Avg. 850 plants/1,000 seeds, 7,450 plants/oz., 119,000 plants/lb.

AVG. PLANTING RATE: Avg. 785 seeds to produce 667 plants needed to plant 1,000 ft. of row. Avg. 8,540 seeds, approx. 1 oz., to produce 1 acre of transplants, 18" between plants in rows 4' apart (7,260 plants needed).

SEED SPECS: SEEDS/OZ. (varies): 6,875-15,625 (avg. 8,750).

RADISH – EASTER EGG

Make beautiful bunches with this mix of red, purple, and white round radishes. Maturing over an extended period of time, they stay crisp and mild even when large. Great fun for children and adults alike. Easter Egg II blend. Packet: 250 seeds.



CULTURE: Radishes require friable, well drained soils with a pH range of 5.8-6.8. Sow at any time during the season, beginning in early spring. Use 2-3" wide bands, seeds about 3/4-1" apart (about 35 seeds/ft. except 10 seeds/ft. for 624 Red Meat and 616 Nero Tondo), 1/2" deep, rows 1' apart, or any row or bedding scheme that will eliminate unplanted ground to discourage weeds. Radishes are adversely affected by hot, dry weather. They remain in prime condition only a few days and should be grown rapidly with plenty of moisture to be mild, tender, and attractive. If growth is checked, roots may become tough, pithy, and too spicy.

DAYS TO MATURITY: 30

INSECT PESTS: Use floating row covers at time of planting to control flea beetles and cabbage root maggots (see index).

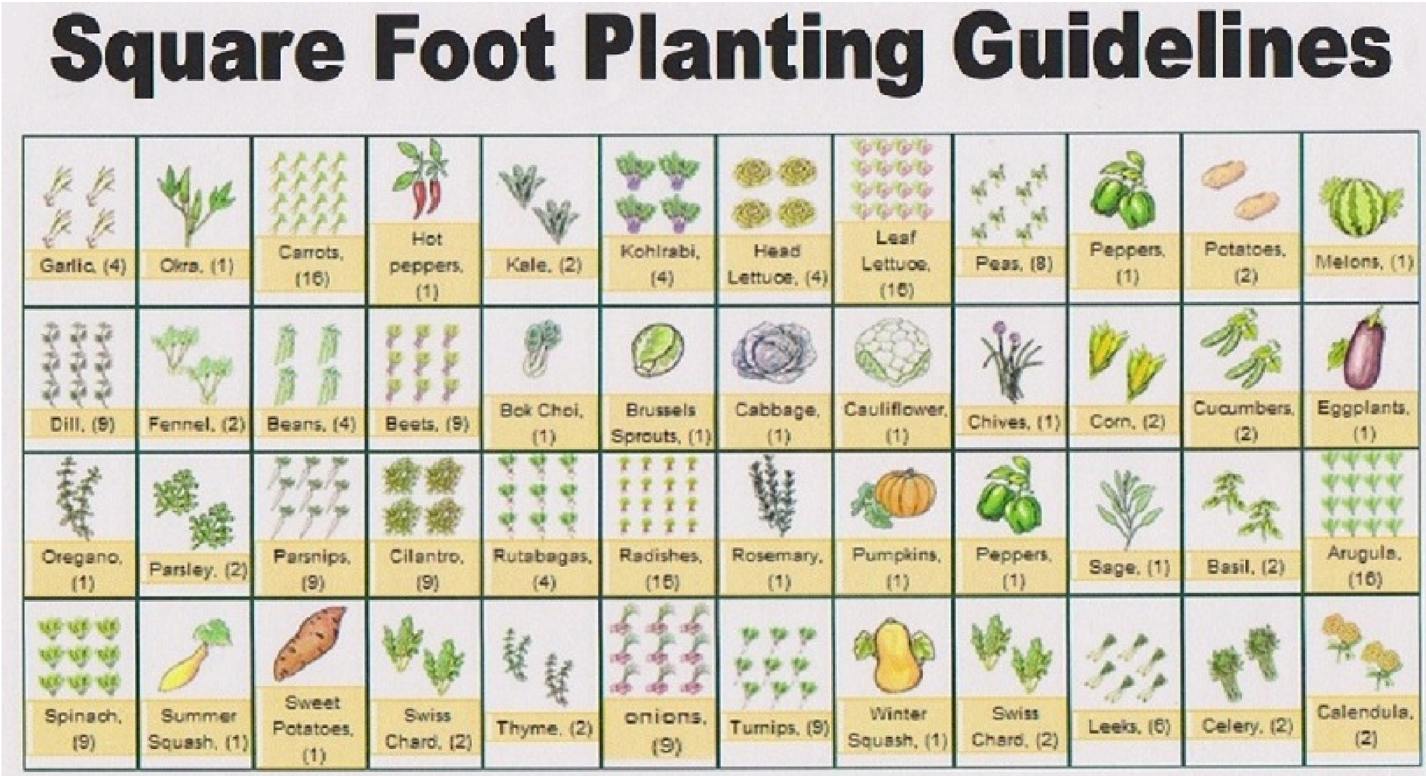
HARVEST AND STORAGE: Harvest on time, beginning at about 3-4 weeks when roots are the size of a large marble. Bunch or top, hydrocool, and refrigerate. Topped radishes will keep 3-4 weeks in good, crisp condition if kept at 32°F (0°C), 95% relative humidity, and in breathable packaging.

AVG. DIRECT SEEDING RATE: 70'/oz., 14 oz./1,000', 21 lb./acre at 35 seeds/ft. in rows 18" apart, or 31 lb./acre in rows 12" apart.

SEED SPECS: SEEDS/LB.: 40,000-56,000 (avg. 49,000).

PACKET: 250 seeds sows 7'.

Johnny's Selected Seeds
An employee-owned company



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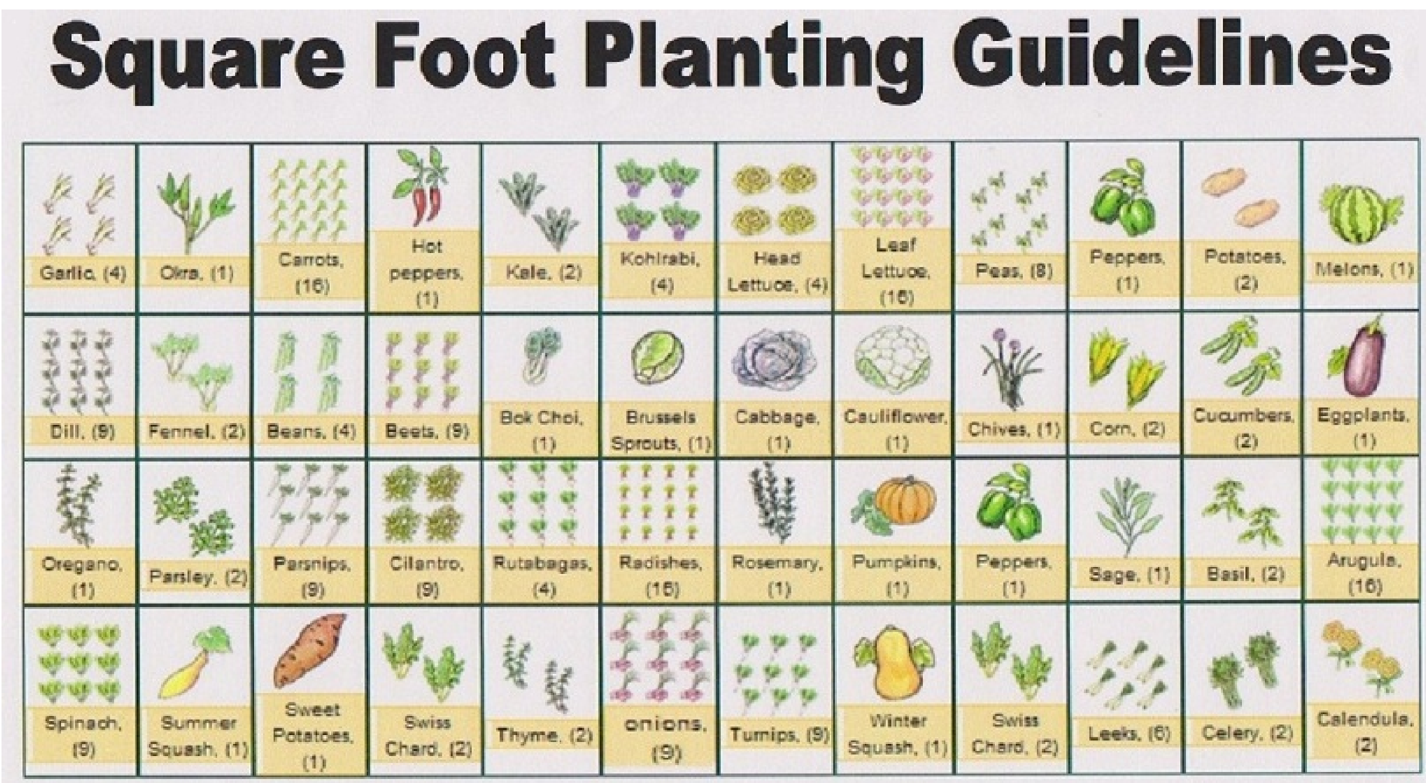

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Investing in Soil Blocks

Soil block makers produce transplants using a specialized tool. The benefits of using soil blocks over plastic trays include the elimination of disposable plastic, decreased root binding as plant roots air prune, and decreased transplant shock.

The tool to make soil blocks, however, has an up-front investment – up to around $200 – and it takes more time to make soil blocks than it does to fill cell trays. The following activity introduces the concept of Return on Investment (ROI) in a small business context. ROI is a measure of the investment's gains against its cost; it is a profitability ratio that calculates the profits of an investment as a percentage of the original cost. As a performance measure, ROI is used to evaluate the efficiency of an investment or to compare the efficiencies of several different investments. Though there are multiple ways to calculate ROI, this activity is designed to operate at a very basic level.

Activity 11: Soil Block Maker vs. Plug Flats Race

Objective
Given a small farm scenario and data regarding soil blockers and plastic trays, students will determine the ROI on each investment and make a logical decision based on the scenario that incorporates context. As part of their research, they will use tool each in order to get hands-on practice in commonly utilized transplant production techniques.

Materials
Soil Blockers (available from MSU North Farm Tool Library)
1020 Trays
Plug Flats
1 3.8 ft3 bag potting mix
Access to water
2 large plastic totes or containers (available from MSU North Farm Tool Library)
Mask if necessary

Standards
MCCTE
01.0601 Technical I.C.1.4
01.0601 Pathway I.C.7.c, I.C.8.a,b

MI Biology
B3.L3.p4A
B1.1f

Resources
Michigan Farmers Market Association: https://www.youtube.com/watch?v=B0Y6Dlafv7s

Montri, Adam. Michigan Farmers Market Association. "Soil Blocks for Transplant Production." http://mifma.org/wp-content/uploads/2014/07/MIFMA-Soil-Blocking-Field-Guide-2015.pdf

Thompson, Collin. MSU Extension. "Transplant Production Tools and Techniques." http://msue.anr.msu.edu/news/transplant_production_tools_and_techniques

Anticipated Outcomes
Ask students to define "efficiency" in the context of a diversified farm business. Possible types of efficiency include time to create soil blocks or fill flats, transplant survival rates, and cleaning/storage of tools.

Procedure
1. Fill one container with potting mix and break up clumps, using a mask if necessary.
2. Fill one container with potting mix and break up clumps, using a mask if necessary, then add water slowly while mixing until potting mix is the consistency of peanut butter.
3. Demonstrate to students the use of each method or show videos listed above. Allow students to practice with soil blocker.
4. Divide students into teams to compete for the specific task of filling 5 trays using each method. Ask students to time one another.
5. Come back together as a group and compare the times.
6. Discuss the experience of using each tool. Ask students to rate each method according to the types of efficiency identified earlier, such as time to create soil blocks or fill flats, transplant survival rates, and cleaning/storage of tools.
7. Consider this activity with seed starting for the school hoop house or a plant sale fundraiser, in which case the flats and blocks can be seeded out after step 5.

Results
Using the soil blocker takes 2X or more longer; times can be improved with practice.

Questions
- How long would it take to fill 100 flats?
- Which method did you prefer? Why?

Activity 12: Comparing Soil Block Maker vs. Plug Flats ROI

Scenario
A diversified farm produces 100 flats of transplants to increase early season sales at the farmers market. Seeds are started in flats, then transplanted to another container for sale. How does each tool fare over 10 years?

Actual Labor Cost: use number gained from activity filling 5 flats and extrapolate to 100 flats @ $15.00/hr

- Trays
  Cost of trays: 100 trays @ $124 x 5 = $620
  Estimated Labor Cost: 3.33 hours @ $15.00 = $50 x 10 = $500
  Actual Labor Cost:
  Lifespan: 2 years (annual depreciation 62%)
  Gross annual income: $7,200 ($72,000 over 10 years)

- Blocker
  Cost of blocker: 1 blocker @ $199 = $199
  Estimated Labor Cost: 5 hours @ $15.00 = $75 x 10 = $750
  Actual Labor Cost:
  Lifespan: 10 years (annual depreciation 19%)
  Gross annual income: $7,200 ($72,000 over 10 years)

Price of plug flats: http://www.greenhousemegastore.com/product/plug-flats-100-cs/flats-trays-inserts
Price of Soil Block Makers: http://www.johnnyseeds.com/tools-supplies/seed-starting-supplies/soil-block-makers/stand-up-20-soil-blocker-9352.html#q=soil%2Bblock%2Bmakers&lang=en_US&start=1

Anticipated Outcomes
Ask students to consider the pros and cons of each tool, based on their experience with it, independent of price. Without knowing how the tools compare on price, which one would they choose? Take a class vote.

Procedure

1. Describe scenario and write numbers on board.
2. Demonstrate ROI equation using numbers provided in scenario.
3. The return on investment formula is calculated by subtracting the cost from the total income and dividing it by the total cost. This formula is simplistic and broadly defined; revenue and costs are not specified and could mean different things to different individuals.

Return on Investment

$$\text{ROI} = \frac{\text{Investment Revenue} - \text{Investment Cost}}{\text{Investment Cost}}$$

credit: http://www.myaccountingcourse.com/financial-ratios/return-on-investment

4. For this situation, use: Gross Income – (Cost of tool over 10 years + Labor over 10 years) / (Cost of tool over 10 years + Labor over 10 years) = ROI
5. Take a class vote again, based on ROI data. Did this change anyone's mind? Why or why not?

Results
The blocker has a higher ROI, even if labor costs are counted.

Questions

- What is not accounted for in this ROI calculation?
- How could ROI be a versatile tool for small farm decision making?
- What if labor was not included? What if depreciation were not included? What are the dangers of using just ROI to make a decision?

Harvesting Safely

Food safety is a topic associated with kitchens and restaurants, but it is a consideration beginning where the food is grown. One of the significant risk factors associated with students harvesting food from school gardens is foodborne illness. Luckily, this is one of the risk factors can be addressed with training.

This lesson proposes a scenario in which someone who received school lunch has a foodborne illness and students take the role of a health inspector to investigate the source of the outbreak. This mock-audit tests the effectiveness of a school garden traceability plan, which should identify who harvested produce and who received the produce in a complicated community setting.

A traceability plan means that records are kept around the garden that allow for "one step forward, one step back" in the supply chain. For instance, once step forward is to the foodservice staff or the food pantry; one step back is to the specific individual or classroom that harvested the food. Traceability is a concept integral to Good Agricultural Practices certification and Organic Certification.

Standards
MCCTE
Horticulture 01.0601 I.C.8.

MI Biology
B2.3d-f

Resources
USDA's Food Safety Tips for School Gardens:
http://nfsmi.org/documentlibraryfiles/PDF/20110822025700.pdf

Activity 13: Don't Pick When You're Sick

Objective

By constructing a timeline for events (research) and practicing constructing hypotheses, students will be able to determine whether the school garden was the source of a foodborne illness outbreak.

Materials

Sample Log Book Sheet
Roles Note Cards

Anticipated Outcomes

Ask students how foodborne illness travels. What are the main ways that the microbes that cause biologically transmitted foodborne illness are transmitted?

Procedure

1. There are 9 roles. Roles can be combined, depending on the number of people in the group.
2. Set the scene: There have been five people hospitalized with an extremely contagious foodborne illness starting on June 3. An Investigator has been called to see whether this illness may be connected to the school garden. The Investigator's role will be to try to identify the sequence of events using clues from different characters and materials to determine the source of the foodborne illness.
3. Hand out roles – ask individuals to keep the details of their role secret until they are asked by the Investigator.
4. Give the Hoop House Log to the person with the Teacher role.
5. Those who did not accept roles will play the Investigators.
6. Investigators need to determine the order of events by interviewing those with specific roles. Investigators may ask questions and ask to see documents.
7. Periodically pause and ask investigators to form a hypothesis based on the information they currently have. Write these on the board.
8. After an order of events has been established, ask individuals to sit down as they are ruled out as Patient X. Eventually, everyone will be sitting down, as none of these individuals were in the right place at the right time to have caused the outbreak.
9. Define "traceability" as a feature of the food system that allows of recalls of potentially dangerous produce. Think of national examples and relate the process that has just been completed to the procedure for investigating foodborne illness outbreaks at a larger scale.
10. Return to the various hypotheses written on the board and discuss the ways in which new information coming to light (research) changed the working hypothesis.
11. This ought not turn into a witch hunt or an Inquisition. A degree of drama and humor are great additions to this activity, which entertains ideas that can be scary to consider (that a garden with good intentions might inadvertently poison the community) and threatening (no one wants to be the one who made someone else sick) – but quite possible. Keeping the activity light-hearted provides a memorable experience for participants, who will hopefully take the responsibilities that come with growing food to heart.

Results

The squash from the lunchroom is NOT the culprit – indeed, it's likely that none of these individuals are the source of the foodborne illness.

Questions

- What risks to food safety at this school were identified in the process of this investigation?
- What could be done to lessen the risks that have been identified? For instance, should there be a lock on the hoop house? Should the janitor get pesticide training?
- Does your school have a log book for the garden? What does the log book accomplish in this activity?
- Are there any food safety risks at our school that need to be addressed?

Foodservice Staff Accepted squash from school garden May 30, none of the foodservice staff have been sick	**Student 1** Took tomatoes and lettuce as a donation to food pantry on May 30, then went home early due to illness	**Student 2** Took squash to Foodservice Staff on May 30, has not been sick
Teacher Supervised harvest and distribution of food on May 30 at 9:30 am. Student 1, Student 2, and Student 3 were with Teacher in the hoop house working.	**College Student** Walked into the school hoop house by accident on his way home from a party and urinated on May 30 at 11:30 pm	**Student 4** Came down with the stomach flu on June 3 after eating squash served in the cafeteria; then, the entire family got sick
Janitor Sprayed for hornets near hoop house without reading herbicide label June 2	**Volunteer** Lost an earring in the garden on June 1	**Student 3** Harvested tomatoes, lettuce, and squash on May 30, has not been sick

School Hoop House Daily Log

Date May 30th, 2017

Time 8:30 am

Weather Sunny Temperature Inside 75°F Outside 62°F Humidity 55%

Crop Planting and Observations

BED	CROP	VARIETY	GERM RATE/NOTES
2	Pea	Sugar Snax	Germ rate 70%
4	Carrot	Danvers	No germ yet

Crop Harvest

Produce	Weight	Unit	Where did it go?	Who harvested it?	Who delivered it?	Garden Leader
Tomatoes	5	Pounds	Food Pantry	Student 3	Student 1	Teacher
Lettuce	2	Pounds	Food Pantry	Student 3	Student 1	Teacher
Squash	45	Pounds	School Foodservice	Student 3	Student 2	Teacher
Totals:	52					

Chores Accomplished Harvest, wash, and deliver produce, weed, germination rates

Chores to Complete First round of peas are almost ready to harvest!

Visitors Volunteer came by to help with weeding

Scouting for Pests Bird that was trapped in the hoop was gone, must've flown out.

Maintenance Concerns Door doesn't close properly – need new handle?

Observations It's a sunny day after all that rain!

Workers	In	Out	Combined Hours
Teacher	8:30	10:00	9
Student 1	8:30	10:00	
Student 2	8:30	10:00	
Student 3	8:30	10:00	
Volunteer	8:30	12:30	

Activity 14: Food Safe Harvest Game

This activity uses a sequencing game to put activities in the right order, and then puts the game in practice by harvesting together. This is a great activity for teaching food safety at your garden – especially the first time a new group comes out to harvest.

Start with the basic rules, which should be printed and posted in the garden, hoop house, or somewhere connected to the garden.

- Food safety isn't just in the kitchen – it starts in the garden
- Don't pick when you're sick, give it 48 hours
- Wash your hands or use gloves
- Wash/rinse/sanitize harvest containers and tools
- Be aware of contamination: glass, animals burying scat or perching overhead, unsafe water
- Keep harvest records: use the Log Book

Print the Food Safe Harvest Game Cards and hand out to students who volunteer. Allow a few minutes for these students to put themselves in order, then let the rest of the class adjust the order. This activity can also be done in small groups.

Wash and sanitize harvest container, knives, scissors	**Harvest salad greens**
Wash hands	**Wash squash**
Go to the bathroom	**Wash tomatoes**
Get the stomach flu	**Wash lettuce**
Harvest tomatoes	**Wait 48 hours before going to the garden**
Harvest squash	**Refrigerate produce as if it is found refrigerated in the grocery store**

Food, Science, & Culture

Tracing the history of tomatoes back to their introduction to European culture through Romie Scott's article for *Atlas Obscura* reveals that food is a ripe topic for studying the beliefs that surround – and obscure – what we eat.

Michael Pollan's notion that domestication is a nuanced relationship in which plants have benefited from being attractive to humans can be introduced in relation to the tomato: "We learn about the mutually beneficial relationship between honeybees and flowers. To make their honey, the bees collect the flowers' nectar and in the process spread pollen, which enables the flowers to reproduce. *The Botany of Desire* proposes that people and domesticated plants formed a similarly reciprocal relationship. 'We don't give nearly enough credit to plants,' says Pollan. "They've been working on *us* – they've been using us – for their own purposes'" (*Botany of Desire*).

The tomato plant can be analyzed through multiple lenses in order to have a conversation about how scientific beliefs are embedded in the culture of its thinkers: the social history of the Americas and Europe, colonization and food culture, and biologically as a plant with radical differences across its thousands of varieties. From its unlikely Latin name – *Lypersicum*, literally "wolf peach" – to its origins, it has been the subject of many misunderstandings.

Standards
MCCTE
01.000 Cluster AFNRE
I.A.6,8,12

MI Biology
B1.1B
B1.1F
B3.p2A

Resources
Botany of Desire:
http://www.pbs.org/thebotanyofdesire/viewers-guide.php

Activity adapted from Romie Scott's article in Atlas Obscura, October 24, 2016 http://www.atlasobscura.com/articles/when-tomatoes-were-blamed-for-witchcraft-and-werewolves [1 June 2017]

Activity 15: When Tomatoes Were Blamed for Witchcraft and Werewolves

Objective

Students will evaluate the validity of historically-credited "scientific conclusions" about tomatoes to identify the incorrect assumptions upon which these once-believed-true conclusions were based.

Materials

Find Romie Scott's "When Tomatoes Were Blamed for Witchcraft and Werewolves" at
http://www.atlasobscura.com/articles/when-tomatoes-were-blamed-for-witchcraft-and-werewolves
Cherry tomatoes to snack on

Procedure

1. Ask students if what we believe to be true now will always be true. What are examples of scientifically supported "truths" that have been proven wrong? A neutral example of this kind of scientific shift would be the rapidly changing science on weight loss and research on low-fat food items.
2. Offer cherry tomatoes for a snack.
3. Present Scott's article to students on a projector and summarize or ask students to read on their own.
4. In conversation, list three untrue facts about tomatoes that were believed to be scientifically sound at the time.
5. Ask students to write these facts down, then research the underlying assumptions that led to people believing this interpretation of the tomato.
6. Students share their research findings at the next class period.

Results

Students can have an analytical conversation about how science and society have interacted to form the historical, political, economic, and social perspectives that led to people believing that tomatoes were dangerous.

Questions

- Why has the tomato persisted, though it went through a phase of unpopularity?
- How did the colonization of the Americas influence the movement of – and attitudes toward – the tomato?
- What kind of scientific and cultural attitudes do we still have around the tomato? For instance, what is the marketing value of lycopene to the ketchup industry?

growing the next generation of farmers in the heart of michigan's upper peninsula

EXPLORE A NORTHERN FOOD SYSTEM

Want to find ways to incorporate a school garden, visits to local farms, or seed saving into your classes? These lesson plans are part of the North Farm's Teacher Training Institutes at the Michigan State University Upper Peninsula Research and Extension Center.

These lessons are designed to empower educators to carry out project-based agriculture, food and natural resources education (AFNRE) in the classroom tackling the challenging upper Michigan climate.

Each lesson is cross-walked with Michigan Center for Career and Technical Education's Agriculture standards and Horticulture clusters (2013), and the Michigan Department of Education Biology standards.

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