Final Project

Future of Agriculture Curriculum for Teaching Sustainability

Name: _____ Hour_____Date: _____

Date Packet is due:_____ Why late? _____Score: _____

Day of Week Date If your project was late, describe why

Overview: In this project, students will demonstrate their understanding of key concepts related to sustainable crop production.

Main Questions

- What factors determine the whether a garden's crop production will be productive, long-term, and sustainable?
- How can these factors affect the design, implementation, and maintenance of a garden?

Week 1 Tentative Schedule

Monday: Gardening 101 (*starting seedlings for transplant*)
Tuesday: Intro Activity: Garden Critique
Wednesday: Garden & Field Critique Presentation & Revision
Thursday: Preliminary Garden Design – What factors are necessary to ensure plant productivity in gardens and fields?
Friday: Career & Community Connections

Week 2 Tentative Schedule

Monday: Garden Design Group Critiques & Revisions
Tuesday: Presentation Work Time
Wednesday: Garden Design Presentations
Thursday: Garden Design Planning & Implementation
Friday: Career & Community Connections

Week 3 Tentative Schedule

Monday: Garden Design Planning & Implementation
Tuesday: Garden Work Time
Wednesday: Garden Work Time
Thursday: Progress Report
Friday: Career & Community Connections

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Semester Schedule

Week 1: Introduction & Lab Safety

Sustainable Soils
Week 2: Sustainable Ag
Week 3: Soil Science
Week 4: BMPs
Week 5: Unit Project

Plant Physiology
Week 6: Roots
Week 7: Stems
Week 8: Leaves
Week 9: Plant Systems
Week 10: Unit Project

Plant Environments
Week 11: Light
Week 12: Temperature
Week 13: Water
Week 14: Biodiversity
Week 15: Unit Project

Gardening
Week 16: Gardening 101
Week 17: Final Project
Week 18: Final Exam

Day 1: Gardening 101

Introduction & Directions: In this activity, your instructor will help you to start some seedlings for your own personal gardens. What you decide to plant is completely up to you and your instructor. There are a couple of purposes for this activity. The first is to help you get a head-start on your own gardens so that you have some items ready for planting as quickly as possible. The second is to help you think about the individual factors that affect the capacity for plants to make food, grow, and function. Again, the overall goal of this project is for you to design a personal garden that will produce as much food over the long-term as sustainably as possible. As you start your seedlings, your instructor will provide tips, strategies, and ideas. These will be helpful as you develop your own explanatory models for how different factors affect plant growth and performance.

Day 2-3: Garden Critique

Introduction: In this activity, you will consider a hypothetical gardening example and assess the capacity for this system to sustainably support long-term crop production.

Directions: *Read the first description of Philip's garden below. Next, complete the questions on the following page.*

Philip's Garden Description: Philip has a backyard garden in a partly-sunny part of his suburban backyard. Philip has invested a lot of money and time creating and maintaining his garden. As such, he has high expectations for his crop productivity. To meet these expectations, Philip depends on a number of strategies. First, Philip uses large amounts of fertilizer to maximize plant growth and performance. Philip has found it is easier to use synthetic fertilizers such as ammonium phosphate. Alternative options such as manure and compost were just too difficult and time-intensive for his schedule and set-up.

Philip usually purchases his plants as seedlings rather than start them from seed. Unfortunately, this is a little more expensive and requires more trips by car, but he feels that the extra expense is worth the amount of time that it saves him (especially with his busy schedule). Philip also thinks that this option makes more sense because the local home improvement stores all have greenhouses but he does not (and he's not aware of any alternatives to a full-sized greenhouse that would work for his own garden).

Philip concludes each growing season by packing up all previous plant material (like dead stems, leaves, and roots) into paper bags for curbside trash pick-up. In spring, he uses his rototiller (a gas-powered appliance with rotating tines) to work up the soil. Philip likes how "fluffy" this makes his soil at the start of each growing season. He feels that this is necessary to make sure that plant roots can grow as much as possible. Philip has noticed that it seems like his soil settles a little lower in his garden beds each year after using his rototiller, but assumes that some soil loss is unavoidable.

Philip uses large amounts of water to grow his garden because he knows that this is a key aspect of plant productivity. Philip primarily uses his outdoor garden hose for this purpose. Philip has noticed that over time, it seems like the surface of the soil is getting a crust that prevents the water from sinking into the soil. This has caused an increased need for water. This also results in higher utility bills. It also seems like his plants are not absorbing this water as well as they used to – his tomatoes in particular seem like they get a little shorter and more stunted each year.

Philip also depends on regular synthetic pesticide applications. This is partly due to the fact that he minimizes wasted space by placing his vegetable plants as close together as possible; he also re-plants his crops as soon as he has harvested the previous crops. It seems like his regular applications of pesticide are becoming less and less effective. Philip is worried that maybe the pesticide company has changed their formula. Philip's neighbor suggests that he should change where he plants each crop. Philip thinks that this is a silly suggestion given that all the same crops are still being planted inside his garden perimeter. He also likes not having to re-design his garden layout each year. Philip has also had a problem with animal predators (especially woodchucks), but has found that poisoning them is a quick way to solve the problem.

While it's a lot of work, Philip finds satisfaction in producing his own food, which he argues is the more sustainable option. He also hopes that he's saving money by producing his own food rather than buying it from the store.

Questions

1. Given his current methods and set-up, would you argue that Philip's garden could continue to support sustainable long-term crop productivity? Briefly summarize your ideas and reasoning (in small groups if possible). Be prepared to share your ideas during a whole-class discussion.

2. Over the course of the semester, you have covered a number of topics. Each weekly unit is summarized below. Critique Philip's garden using content specific to each weekly unit in a separate document. You should go back to your written notes and also possibly review these materials online (https://www.factsnsf.org/facts-horticulture.html). You should collaborate in groups if possible through a Google doc, whiteboard, or other collaborative option. If time is limited, your instructor may assign specific weekly units to individuals or groups.

   Unit 1. Sustainable Agriculture: to what extent can different agricultural methods support growing human populations while maintaining biodiversity and ecosystem services?
   Unit 2. Soil Science: what factors that affect the capacity for soils to support plant growth and productivity?
   Unit 3. Best Management Practices: how can Best Management Practices (BMPs) be used to improve soil health and productivity?
   Unit 4. Roots: how do plants acquire water and minerals from the soil and distribute these substances to each cell in the plant?
   Unit 5. Plant Growth & Function: How do plants make food, grow, and function?
   Unit 6. Plants and Their Environment: What environmental factors affect the capacity for plants to make food, grow, and function? (*Not formally covered this year due to the disruption in classes*)

3. If possible, your group will summarize your unit-by-unit critique of Philip's garden for the entire class. While other groups are presenting, you should take notes and record any considerations that you might have missed or misunderstood. These additional considerations are likely to be helpful for future aspects of this project.

Day 4: Preliminary Garden Design

Introduction & Directions: In this activity, you will be starting your design for your home garden. To do so, you will need to take into account a wide range of factors that you have learned over the course of this semester. You will start by developing an explanatory model that connects all of the key factors necessary for plant growth and performance. You will then use this model to design and revise your home garden in order to optimize its capacity for long-term sustainable food production.

Explanatory Model Development: begin by working individually. In the space below, write down ten of the most important factors that affect *sustainable* plant growth and performance in a garden. Briefly summarize the role that each factor plays in supporting and/or limiting food production as precisely as possible.

Factor: _____ Role it plays: _____

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Factor: _____ Role it plays: _____

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Factor: _____ Role it plays: _____

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Factor: _____ Role it plays: _____

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Factor: _____ Role it plays: _____

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Factor: _____ Role it plays: _____

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Factor: _____ Role it plays: _____

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Factor: _____ Role it plays: _____

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Factor: _____ Role it plays: _____

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Factor: _____ Role it plays: _____

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Factor: _____ Role it plays: _____

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Explanatory Model Revision: if possible, share and discuss your ideas within a small group. Either use the space below or use a separate document to record any additional considerations, make updates/corrections to your original ideas, or add any other ideas or details that might help you as you plan your garden. Be prepared to share your discussion with the class.

Preliminary Garden Design: At this point, you should have some basic ideas as to what you intend to create for your personal garden. Remember, this can vary in size from an entire field to a small windowsill garden. Regardless of size and scope, you should design your garden using principles from this course in order to ensure long-term sustainable plant productivity. To help get you started, please provide your current intentions for your garden with regard to each of the considerations below.

Location: where will you put your garden? _____

Is this an existing garden, or will this be a new garden? Existing / New Do you need additional soil? Y / N

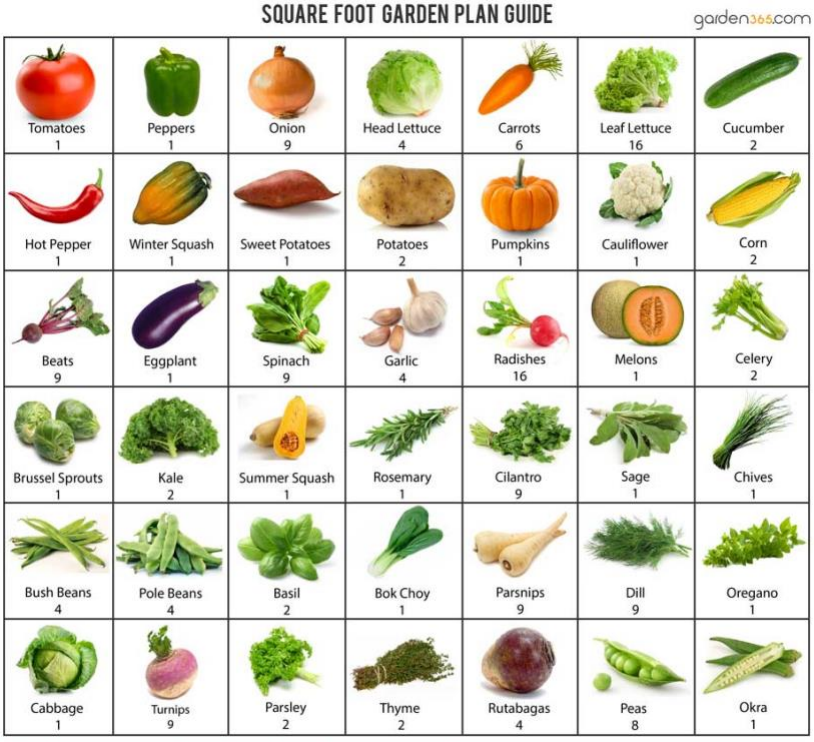
Size: what will be the length and width? Length: _____ Width: _____

Content: what crop(s) do you intend to grow? _____

List any additional supplies that you will need in addition to seeds and soil: _____

Garden Layout: using the grid on the next page, provide a tentative layout for your garden. Be sure to include all of the following:

- The length and width of your garden(s) – be sure to specify the units you are using (e.g. feet or meters).
- The crops you will plant (you can either write the name each plant where you intend to plant it or represent each crop with a symbol that you explain in a key next to the layout).
    - Be sure to properly space your plants! See the table on the next page.
- Cardinal Directions (north, south, east, west).
- Any other key items (such as water sources, fences, compost piles, etc.)



*Numbers represent the number of plantings per square foot *Source: http://www.garden365.com*

Plant Symbols & Meaning

Sustainable Plant Productivity: For each factor, briefly describe how this consideration could be optimized to sustainably enhance plant growth and performance in your own gardens. Keep in mind that sustainability is key! For example, using large amounts of tap water could improve plant performance; however, if every home in a neighborhood utilized this approach, it would potentially lead to water shortages and expensive utility bills!

Factor: _____ How to optimize: _____

_____

Factor: _____ How to optimize: _____

_____

Factor: _____ How to optimize: _____

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Factor: _____ How to optimize: _____

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Factor: _____ How to optimize: _____

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Factor: _____ How to optimize: _____

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Factor: _____ How to optimize: _____

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Factor: _____ How to optimize: _____

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Factor: _____ How to optimize: _____

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Factor: _____ How to optimize: _____

_____

Best Management Practices: For each of the following BMPs, explain how it will be incorporated into your garden design. If it is not feasible to incorporate a particular BMP, explain why. You may want to review this content at: https://www.factsnsf.org/uploads/1/4/0/9/14095127/2019-10-1_factsh_bmps__questions_.pdf

1) Conservation Tillage: _____

2) Cover Crops: _____

3) Crop Rotation: _____

4) Nutrient Management: _____

5) Conservation Buffers: _____

Soil Health Principles: For each of the following, explain how it will be addressed in your garden design. If it is not feasible to address a given principle in your garden, explain why.

1) Minimize disturbances: _____

2) Maximize soil cover: _____

3) Maximize biodiversity: _____

4) Maximize presence of living roots: _____

5) What other considerations will you purposefully address in your garden's soils? (examples include soil composition, soil structure, organic matter, pH, etc.). Explain your plans for each consideration.

Day 5: Career & Community Connections

Directions: Use this day for connecting course content to local community-based considerations (such as through guest speakers, field trips, virtual tours, etc.). Alternatively, this day can be postponed if needed.

Week 2, Day 1-2: Garden Critiques & Revision

Directions: If possible, work with a partner or small group to critique each of your garden designs. Assess the ecological, social, and economic sustainability of each of your plans. In the space below, highlight aspects of your garden's design that are particularly noteworthy in regards to their level of sustainability, as well as any areas of concern and how they will be addressed. You may want to review the sustainability unit content at: https://www.factsnsf.org/uploads/1/4/0/9/14095127/2019-9-20_factsh_sustainable_agriculture.pdf

Aspects that are particularly sustainable: _____

_____

_____

_____

Area of concern: _____

How it will be addressed: _____

_____

Area of concern: _____

How it will be addressed: _____

_____

Area of concern: _____

How it will be addressed: _____

_____

Area of concern: _____

How it will be addressed: _____

_____

Use the time that remains to identify any other aspects of your garden designs that need improvement and to make revisions to your plans. You should also take some time to prepare to present your garden plans to either your instructor and/or the class as a whole. See the next page for more details.

Week 2, Day 3: Garden Design Presentations

Directions: In this activity, you will be presenting your plans to your instructor individually, to the class as a whole, or as part of a small group. Your instructor will decide which of these options is most appropriate and feasible. This is meant to be a final check to make sure that your plans are sufficient to achieve your goals and expectations for your garden.

Your presentation should include all of the following:

- A layout of your garden showing:
  - The dimensions of your garden(s).
  - The crops you intend to grow and how these crops will be spaced.
  - Cardinal directions (this is an important consideration, particularly with regard to sunlight)
  - Any other key items (such as water sources, fences, compost piles, etc.)
- How you will optimize the factors that most affect long-term sustainable crop production.
- How you will incorporate Best Management Practices and/or why some BMPs may not be feasible.
- How you will utilize BMPs to support soil health.
- How your garden supports long-term ecological, social, and economic sustainability.

Your grade will be determined using the following considerations:

Item	*Plus (100%)*	*Check (70-90%)*	*Redo (0%)*
Accuracy	No errors were detected in this work	This work contained a few errors, but overall was very accurate.	This work contained considerable errors.
Thoroughness	No important information was omitted.	A few more details would have enhance this work.	Major topics were omitted that should have been included.
Applicability	This work could be used in real life without any expectation of problems.	This is acceptable work for high school students but there is a chance that this would not be completely suitable for real life.	This work is not applicable to a real-world situation and falls below the expectations for a high school student in this class.
Professionalism	This work is completely free of errors in regards to spelling, grammar, word use, vocabulary, plagiarism, etc.	While this is acceptable work, there were at least a couple errors in regards to spelling, grammar, word use, vocabulary, plagiarism, etc.	Repeated errors were found errors in regards to spelling, grammar, word use, vocabulary, plagiarism, etc.
Effort	Effort exceeds what would be expected of a high school student.	Effort is acceptable for a high school student but room exists for improvement.	Level of effort could have been much greater than what was presented.

Your instructor may opt for one of three outcomes based on your presentation:

- **Approval**: you can begin creating your garden; no additional revision is necessary.
- **Approval w/ Revisions**: your presentation needs minor corrections, but you can begin implementation.
- **Needs Revising**: significant problems are likely and your plans need changes before implementation.

Ongoing: Garden Design Implementation

Directions: Once you have received approval from your instructor, you can begin the work of creating your garden. Your instructor may decide to provide some additional specific instruction to guide you as you start creating your gardens. This may involve topics such as preparing the soil, transplanting, disease prevention, pest management, etc. Be sure to pay close attention to weather forecasts (particularly if there is a risk of severe weather). Dress appropriately as you work outside.

Ongoing: Garden Design Progress Report

Directions: As you create and develop your gardens, you are likely to make observations that expand, challenge, or reverse your initial ideas about the factors that affect sustainable long-term crop production. Periodically, your instructor should facilitate group discussion and whole-class discussion about your individual observations. Use the questions below to support your group- and whole-class discussion.

Discussion Questions:

1. What observations have you made that support your initial ideas about sustainable long-term crop production?
2. What observations have you made that challenge or have reversed your initial ideas about sustainable long-term crop production?
3. What difficulties have occurred as you have implemented your garden designs? What questions do you have as a result of these challenges?
4. What strategies seem particularly effective in your own gardens for enabling long-term sustainable crop production?
5. What aspects of long-term sustainable crop production seem unfeasible in your current garden layout? How might you change your garden design in the future as a result?

Ongoing: Career & Community Connections

Directions: Use this day for connecting course content to local community-based considerations (such as through guest speakers, field trips, virtual tours, etc.). Alternatively, this day can be used if extra time is needed.

Appendix: Gardening 101

Summary: This activity is meant to help students start seedlings as soon as possible while also engaging them in developing explanatory models for the factors that affect long-term sustainable crop production.

Directions: There are two key purposes of this activity. The first is to provide students with a sufficient amount of time to start some of their seedlings. The crops that students plant, and how they prepare them (e.g. in seedling starter trays, egg cartons, directly in the ground, etc.) is entirely up to the instructor and student based on their abilities and limitations (click here to see an example). The second purpose is to have students start recognizing their initial ideas about the factors that affect long-term sustainable plant development and growth.

During or after students have planted their seeds, it would be ideal to engage them in verbalizing their ideas about plant growth and development. This can be achieved in multiple ways. One option is to model science and engineering practices such as questioning and evidence-based reasoning while demonstrating how to plant seeds. An example of this might include asking students to imagine how different kinds of soil texture might affect seed germination as a result of cause-and-effect patterns with other considerations such as moisture and dispersal of oxygen and carbon dioxide. Another example might be connecting prior explanatory models to pragmatic considerations in gardening; for example, you could help students to recognize that the addition of organic matter and/or vermiculite (a soil amendment that improves soil aeration) would improve soil porespace and may enhance soil microbe biodiversity.

This would be a particularly appropriate opportunity to have students engage in discussions in small groups (if feasible) during or after starting their seedlings. Group- and whole-class discussions can be optimized using the Nine Talk Moves:

1. **Time to Think**: Partner Talk Writing as Think Time/Wait Time

2. **Say More**: “Can you say more about that?” “What do you mean by that?” “Can you give an example?”

3. **So, Are You Saying…?:** “So, let me see if I’ve got what you’re saying. Are you saying…?” (always leaving space for the original student to agree or disagree and say more)
Goal: Students listen carefully to one another

4. **Who Can Rephrase or Repeat**? “Who can repeat what Javon just said or put it into their own words?” (After a partner talk) “What did your partner say?”
Goal: Students deepen their reasoning

5. **Asking for Evidence or Reasoning**: “Why do you think that?” “What’s your evidence?” “How did you arrive at that conclusion?” “Is there anything in the text that made you think that?”

6. **Challenge or Counterexample**: “Does it always work that way?” “How does that idea square with Sonia’s example?” “What if it had been a ____ instead?”
Goal: Students think with others

7. **Agree/Disagree and Why?**: “Do you agree/disagree? (And why?)” “Are you saying the same thing as Jelya or something different, and if it’s different, how is it different?” “What do people think about what Vannia said?” “Does anyone want to respond to that idea?”

8. **Add On**: “Who can add onto the idea that Jamal is building?” “Can anyone take that suggestion and push it a little further?”

9. **Explaining What Someone Else Means**: “Who can explain what Aisha means when she says that?” “Who thinks they could explain in their words why Simon came up with that answer?” “Why do you think he said that?”

Appendix: Garden Critique

Summary: This activity is meant to help students develop their initial explanatory models for the factors that affect long-term sustainable crop production by critiquing a highly unsustainable gardening hypothetical.

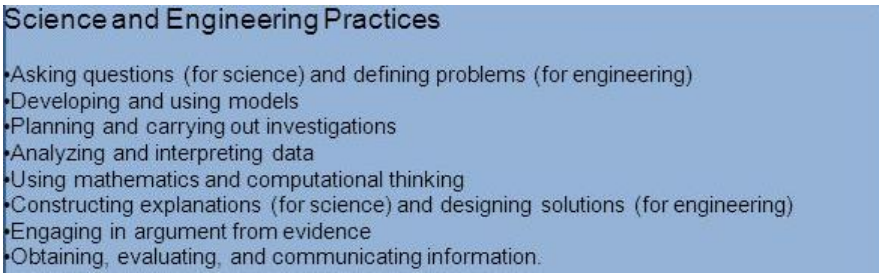
Directions: This hypothetical story contains a large number of explicit examples of unsustainable crop production. The purpose of this activity is to help students make explicit connections to content and explanatory models that they encountered and/or developed over the course of this semester. This should help to remind students of what they already know and help them to appreciate connections across different units that they encountered this year.

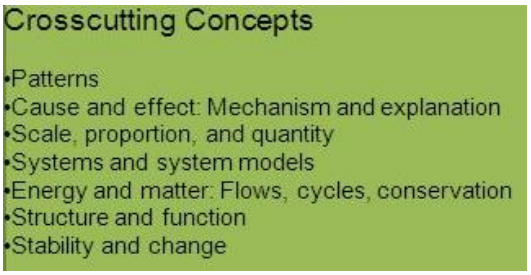
The manner in which you implement this activity is entirely up to you as the instructor. You should consider your constraints to teaching, the abilities of your students, and their level of engagement when making this decision. If feasible, have students transition from individual critiques to group discussion to a whole class discussion. The goal is to have students eventually reach a consensus about the sustainability of Philip's garden.

It is important that students record their ideas in writing in some way. Options include using notebook/scratch paper, small whiteboards, collaborative online options (such as Google docs), etc. This activity might be particularly well-suited for a gallery walk (either in-person or digitally).

After students have summarized their initial ideas about Philip's garden, you should facilitate discussion that has students connect their critiques of this garden to specific units in the curriculum. You may choose to assign specific units to specific groups of students to reduce the amount of time needed for this activity. If so, you should have groups report their ideas to the rest of the class and provide feedback to help students recognize anything they missed and/or to help improve the precision, accuracy, and depth of their responses. This would be an ideal opportunity to model specific Science and Engineering Practices for students as they apply to this consideration. You should also explicitly highlight how Crosscutting Concepts relate to these considerations.

This activity should conclude by having students reaching a preliminary consensus (if possible) about their ideas about sustainable long-term crop production. Note that as students move forward in this activity, their ideas should change, grow, and improve over time.





Appendix: Preliminary Garden Design

Summary: This activity is meant to help students apply their explanatory models for long-term sustainable crop production to an actual garden design that they will implement at school, their own homes, or in a community setting.

Directions: This lesson consists of a sequence of activities that are meant to support students as they develop explanatory models and apply them to their garden designs. A variety of interconnected factors affect crop performance and sustainability, and these activities are meant to elicit student reasoning and sense-making in a manner that enables students to better apply sustainable knowledge and practice to the real-world considerations of their own gardens. Each of these activities are described in more detail below.

- *Explanatory Model Development & Revision*: in this activity, students identify what they consider to be the ten most important factors for sustainable long-term plant growth and performance. There are no right or wrong answers per se; the aim is for students to make connections across the knowledge and practice they addressed over the course of this semester and to think from a systems-level perspective about sustainable crop production. Students should initially work independently; if possible, students should then work in small groups to discuss their ideas and make additions, revisions, and corrections to their original ideas. If possible, group discussion should be followed by whole class discourse in which groups share their ideas and engage in evidence-based argumentation in order reach a consensus as to which factors are the most important considerations. You should encourage students to be as precise and specific as possible – for example, most students are likely to identify "soils" as a key factor, but within this category are a large variety of considerations such as soil texture, porespace, organic matter, biodiversity, etc. It may be necessary for you as the instructor to model the level of specificity and precision that will be needed through a "think-aloud" performance (in which you verbally explain to students how you might write your answer to one of these prompts).

- *Preliminary Garden Design & Layout:* This activity is meant to help students identify some of the more pragmatic considerations for their garden design. This is also meant to guide the planning process for the student and help you to identify potential areas of concern. For example, if a student needs materials that are not available (or available in large enough quantities), this is meant to help you work with that student to make alternate arrangements before they begin any actual work. Students are likely to need assistance with creating their tentative layouts. It may be helpful for you to share an example of your own garden (real or hypothetical) and model your reasoning and planning through a "think-aloud" performance (e.g. "I chose to adopt this size because… I chose this site because… I am planting these crops because… I spaced my crops this far apart because… I have this area reserved for compost and this area for collecting rainwater… I will prevent pest problems by… etc.").

- *Sustainable Plant Productivity*: At this point, students should have had sufficient time and engagement to develop a preliminary explanatory model regarding the factors that affect long-term sustainable plant growth and performance. This activity is meant to connect their models to specific considerations in their own gardens. Students are likely to struggle with this step, and it would be helpful to have them work in small groups followed by whole-class discussion if possible. It would also be helpful for you to

model their expected performances through another "think aloud" performance. For example, you might observe that all students agreed that adequate sunlight was key; to optimize sunlight in your own garden, you might explain that you will ensure that the southern border of the garden is unobstructed by trees and that tall plants should be kept on the northern side of each garden. At this point, students should also be thinking more explicitly about sustainability (economic, social, and ecological). Some considerations may vary between emphasizing crop productivity or sustainability or both (e.g. monitoring soil nutrient levels both improves crop performance and helps to reduce nutrient runoff into surface water).

- *Best Management Practices*: This is meant to further refine student garden plans as well as their explanatory models by having students connect specific Best Management Practices to their own gardens. Students may have to revise or update their plans to accommodate some of these practices. Some of these practices may not be feasible or may have to be reimagined (e.g. it may not be feasible for a student to conduct a soil nutrient test this year; this might have to be something they intend to adopt in a later year and/or they may opt to use non-synthetic options like manure or compost to minimize the risks of over-applying nutrients). In particular, students may struggle with the Conservation Buffers practice – you may need to encourage students to think broadly about what this practice is and why it is necessary (i.e. if their gardens are surrounded by their own lawns, they may already have a conservation buffer in place; if the terrain of the property causes runoff to occasionally move through their garden after heavy precipitation, they may need to adopt additional strategies to prevent nutrients from entering their local waterways). This is another activity that (if feasible) is best suited for group work followed by whole-class discussion.

- *Soil Health Principles*: This section is very similar to the previous section. While the *Best Management Practices* activity focuses on particular management decisions, the *Soil Health Principles* activity focuses on desired outcomes from those management decisions. It may be a good idea to clarify this for students, as this might seem like same activity has been repeated. In this activity, students should focus on summarizing how their choice of management practices will help to enable these outcomes. In the last question (5), students should identify any other soil health considerations that they haven't already addressed on that page that are necessary for crop productivity. Student answers are likely to vary, and group- and whole-class discourse will be valuable if feasible to help students expand their initial responses.

Appendix: Career & Community Connections

Summary: This activity is meant to help students connect their classroom-based instruction to broader considerations specific to their local communities.

Directions: Improving student decision-making in authentic contexts can be enhanced through direct connections between the classroom and the surrounding community. This activity is meant to support this kind of engagement while also providing opportunities for students during days in which they may not able to work outside in their gardens (due to weather, shortened schedules, or other considerations). This also provides for additional flexibility in your schedule; e.g. you may choose to postpone this day if extra time is needed, or you might opt to work with struggling students individually while non-struggling students are engaged in this activity. How you choose to utilize this option is entirely up to you as the instructor. Potential options include:

- *Guest Speakers*: providing students with an opportunity to meet with a local agricultural professional, extension agent, agricultural scientist, ecologist, etc. can serve as a powerful catalyst to help students appreciate the considerations that these individuals use make decisions within their own professional contexts.
- *Field Trips*: providing opportunities for students to visit local farms, greenhouses, nurseries, universities, research farms, or other relevant venues can make the knowledge and practice addressed in the course gain additional relevance and impact.
- *Virtual Tours*: while not as impactful, arranging for virtual tours of the options listed above can provide a more feasible alternative to visiting the sites in person. You can also opt to use this option in addition to in-person field trips to increase student exposure to community-based contexts. Be sure to make arrangements with the field trip site personnel well in advance and if possible, complete a trial run of the tour using the program you intend to utilize (e.g. Zoom, Webex, etc.). You can also opt to pre-record the tour and follow it up with a live Q&A with the personnel from that site as a way to avoid problems that might occur with internet connectivity.
- *Adopt a Farmer*: These days can be ideal opportunities to facilitate planning between an extension agent and a farmer who is interested in adopting more Best Management Practices into their own operation. These individuals could be invited into your classroom to share their conversation about this process, or this conversation could be conducted virtually. Alternatively, you could host a roundtable discussion between farmers who have adopted BMPs, extension agents, and/or agricultural scientists.
- *Career & Personal Connections*: Periodically, it would be valuable to have students connect the knowledge and practice addressed in this course to decisions they intend to make as adults. These decisions could range between professional contexts (e.g. among students who will work in agriculture, food, and natural resources) to personal scenarios (e.g. decisions made at a grocery store or voting booth). This activity could be conducted in a variety of ways, including small groups, gallery walks, fishbowl discussions, etc.
- *Supervised Agricultural Experiences*: this can be an ideal opportunity to engage students in reflecting on what they have learned as a result of their SAEs and how these experiences connect to knowledge and practice they have gained through participation in this course. It may be particularly valuable to help students reconcile discrepancies they might encounter between classroom content and their SAEs (e.g. if a professional they are shadowing suggests that a particular BMP is not feasible or worthwhile).
- *Miscellaneous*: As the instructor, you have complete flexibility in how you opt to use this activity.

Appendix: Garden Critiques & Revision

Summary: Students will critique each other's garden designs for their overall sustainability.

Directions: This lesson is a continuation of the previous lessons, and is meant to lead to a culmination in students' development of explanatory models for the factors that enable long-term sustainable crop production. If possible, students should work in pairs or small groups to assess each other's designs, identifying aspects that seem particularly sustainable and determining which aspects of the designs are potential concerns.

Students should also be using this time to prepare a presentation (see below for more details).

Appendix: Garden Design Presentations

Summary: Students will present their garden designs and defend their ideas and plans using evidence and reasoning.

Directions: This presentation is intended to position students to address a wide range of knowledge and practice that they have addressed over the course of the semester in an authentic context. This is also meant to serve as a final checkpoint for both you and your students before they begin any kind of significant work on their personal gardens. This should provide an opportunity to identify any remaining red flags that might lead to potential problems.

The content that students should address in their presentations is provided in the lesson. You may choose to meet with students individually, in small groups, or have them present for the entire class (small group presentations may provide a balance between providing an opportunity for students to hear a range of ideas while also staggering student presentations based on abilities and prior experience in a manner that may be helpful for classroom management considerations).

A rubric is provided to help students self-assess their work prior to presenting. You may want to have students conduct a peer review prior to their formal presentation. Ultimately, you will be determining whether students can move forward as planned (*Approval*), whether minor revisions will be needed (*Approval w/ Revisions*), or if students need to make changes and present a second time (*Needs Revising*). This form of assessment is meant to reflect the kinds of feedback individuals are likely to get in a professional setting. How you choose to apply these standards is entirely up to you as the instructor.

Note that once students have approval to begin their projects, there are a number of ongoing lessons to guide, scaffold, and support student engagement. These lessons are optional – you as the instructor have discretion to incorporate these and/or other forms of instruction as needed. It would be prudent to have check-in sessions on a regular basis to make sure that students are on task and on target for your school's semester deadlines.