# Global Farm Metric's Guide For School Gardens

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# How to use this guidebook

This guidebook was created to help educators integrate a holistic understanding of sustainable farming into their children's gardening curriculums and programs. We hope that the ideas found in this booklet will inspire schools, public libraries, community gardening groups, summer programs, forest schools, and anyone involved in childhood education to explore how gardening can deepen a child's understanding of the around them.

The following content is based on the Global Farm Metric Framework, which was designed, in part, as a teaching tool for a common understanding of farm-level sustainability. This is the GFM team's first attempt at adapting the theory behind the framework for a younger audience. To aid in this endeavor, we used The Harmony Project's seven guiding principles to help shape this work. There are twelve categories in the wheel which encapsulate the social, environmental, and economic factors that farmers think about in their everyday decision-making. After engaging with this framework, we hope students will also begin to look at their garden projects through an environmental, social, and economic lens.

The guidebook is laid out by season (Winter, Spring, Summer, Fall). Each category is discussed in at least one season, but some have activities that span multiple seasons. A brief description, along with ways that students can begin to think about and measure sustainability in the context of their school garden projects, is included in each section. To align the project with the Harmony Principles, each category also contains inquiry questions that teachers can use to guide student learning and brief descriptions of how each category is connected to the relevant Harmony Principles. Educators are encouraged to develop their own approaches to teaching each category. However, we hope the overall message of a holistic view of farming is maintained throughout.

# Introduction to Harmony

As mentioned above, this teaching guide also includes elements of the Harmony Project Principles to guide student learning further. The Harmony Project focuses on inquiry-led learning, allowing students to enter a journey of exploration, imagination, and education. Therefore, each category of our wheel will include a list of possible inquiries that can be used to guide children through their path of discovery.

The following page briefly describes each of the seven principles at the heart of the Harmony Curriculum. Each section will also include notes on how each category connects to these seven principles.

The Harmony Project

More information on Harmony can be found at: https://www.theharmonyproject.org.uk/

## 1 Diversity

**Diversity** is found everywhere in Nature and in many different ways. No two things are exactly alike. There are millions of different kinds of animals and plants and habitats. **Diversity** enriches our lives, from the foods we eat to the languages we speak and the plants and animals outside our windows. It is something not just to value but to promote and celebrate. **Diversity** is expressed in natural systems which are healthy and resilient and better able to adapt to change.

## 2 The Cycle

Nature works in **cycles** that are endlessly self-sustaining and self-regulating. Within these cycles, there are times of growth and abundance, and there are times of decline and decay, of regeneration. During periods of restoration, resources are recycled as food or fuel so that the **cycle** can begin again. Nature has no waste. Everything has a value. Nothing is 'thrown away'.

## 3 Geometry

The patterns of Nature are everywhere. They can be seen around us and in us, and in forms beyond this world. They can be seen at a microscopic level and in macro form. They can be seen in patterns of circles and spirals, and in the proportions and symmetries of different living things. Recognizing these patterns allows us to understand that we are nature, not separate from it.

## 4 Adaptation

Nature is in a constant state of change. When there are changes in one population within an ecosystem, others respond. It is this state of change that enables natural forms to survive and evolve in their own environments. When we consider the principle of **Adaptation** in terms of learning, we can look at how we might adapt learning to our local context. This way of learning builds a sense of place for students. When they identify with a place, they are more likely to engage with it, give back to it, value it and the people who are part of it.

## 5 Health

The principle of **Health** reminds us of the need for balance and the link between our own human health and the health of the natural world. When Nature is not well, it is usually due to human activity. The future well-being of our world requires us to put the **health** of our soil, our water, our air, and our ecosystem services at the heart of all we do. The balance and well-being of natural systems is maintained by the dynamic relationships that exist within them.

## 6 Oneness

The principle of **Oneness** can provide a spiritual dimension to this work. It highlights that to appreciate Nature's Principles of Harmony fully, we need to find our own sense of peace, of belonging, of what some would call the divine. This unites all principles, revealing that we are a part of something greater than ourselves.

## 7 Interdependance

Each element within a system supports the wider well-being of its community. When we learn about Nature's **interdependence**, we can see that every element within an ecosystem has a value and a role to play. From an educational perspective, Nature's network of interdependent relationships teaches us how interconnected our world is. It, therefore, makes sense for us to design learning so that it links together and so that the teaching of different subjects contributes to a broader theme or project.

# Timeline

## Winter

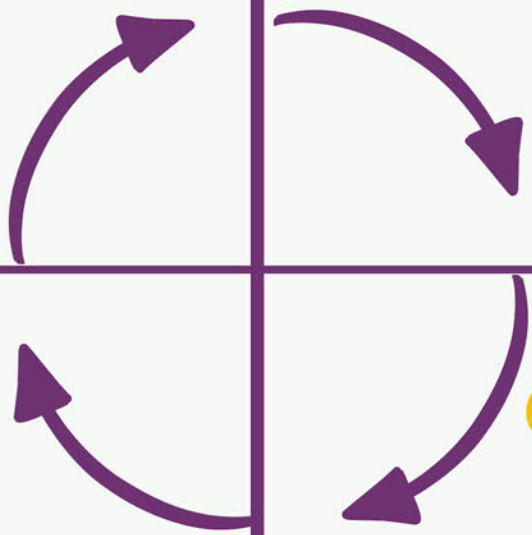
**Planning the Garden**

- Crops and Pasture
- Animals
- Climate (Introduction)

## Spring

**Planning and Preparation**

- Farmers and Workers
- Resources
- Climate (Weather Data)



## Autumn

**Harvest Season and Reflection**

- Resources (revisited)
- Production
- Economics
- Community

## Summer

**Data Collection and Garden Management**

- Climate (Weather Data)
- Nature
- Water
- Soil
- Nutrients

*__A note on the structure:__ We start our lessons in the winter season but depending on your program's specific timeline, we anticipate that you might need to start at different entry points or reformat the layout to fit your schedule. No matter where you begin your journey, the cyclical nature of the guidebook will bring you to each category in turn.

## Introductory Activity

- Show your students the GFM Wheel. Introduce each category by name.
- Explain that as we work in our garden this year, we will be learning about each of these 12 categories more deeply and how they connect to one another to create sustainable gardens.
- Ask them if they can think of any connections already.
    - For example, both **animals** and **crops and pastures** need water.

# Crops and Pasture

- Crops are plants that are grown and harvested for the purpose of feeding humans and or animals. They can include grains and grasses, fruits, vegetables, herbs, and spices. While all plants require water, sunlight, air, and enough nutrients to grow, that doesn't mean that they prefer the same environment or grow in the same way.
- Plants are actually extremely diverse! It's up to us to understand this diversity to make sure that every crop has everything it needs to reach its full potential. We must also choose crops that are adapted to our local environmental conditions.
- Growing lots of different types of species is also very important. Not only will we have lots of different foods to eat and flavors to explore but our garden will also be more resilient and full of biodiversity.

**Questions to guide thinking**

- What plants grow well in our environment?
  - What should we plant in the sun?
  - What grows best in the shade?
  - Do any plants need support like a wall?
- Do any plants grow well side by side?
- How many different plants do you eat in a week?

**Connections to other categories:**

- Growing different plants can also help protect the **soil** from erosion, clean up **water** sources, and build up important **nutrients** in the ground.

- Lessons from this category will be reintroduced in the **Climate** section. Combining our knowledge of what plants need to grow with our local climate conditions will allow us to choose the best plants to grow in our garden.

## Harmony Connections

- **Adaptation:** Plants have all adapted different characteristics to live in their own unique habitats. Look at all the ways and places plants can grow.
- **Diversity**: Planting lots of different kinds of crops is an important part of creating a healthy and resilient environment. It's also delicious! Some of your favorite foods might even have unique varities. Have you every tried a purple carrot or potato?
- **The cycle:** Plants all have their own growth cycles. Some live and die within one year. Some go into periods of dormancy based on the season (think trees)
- **Interdependence:** Not only do the crops we choose provide us with food, but they also act as shelter and habitat for other species. They help the soil from eroding away and are an essential part of the water cycle.
- **Oneness:** Have students look up traditional planting methods of different cultures. Everyone everywehre needs to eat food.

## Key Vocabulary

- annual plant
- perennial plant
- germination
- Resilient

**Measurements**

1. Germination counts: Over time, seeds can get old, and some will no longer germinate. One way farmers test to see if seeds are viable is to do a germination test. You don't want to spend a lot of time and resources planting seeds that won't grow.
    a. You can select a packet of seeds you plan to grow in the garden. Peas and tomatoes are easy ones to use.
    b. Place ten seeds of each kind on a wet paper towel and keep them on the windowsill. Spritzing the towel once it's dry with water to keep them moist.
    c. Have the students check every day for seedlings. (Most plants should germinate within 1 or 2 weeks, but the seed packet will include expected germination times.
    d. At the end of two weeks, count up how many seeds germinated. If it is more than 6, you can be confident that most of your seeds will sprout!

*__Bonus activity__: Watch plant germination time-lapse videos on youtube!

**Activities**

- Learn about plant lifecycles and the difference between annual and perennial lifecycles. For example, many flowers are annuals, but trees are perennial. Have students come up with a list of plants of each type.
- Have the students brainstorm what different plants need to grow. Does every plant need the same amount of sunlight or water?
    - Have students look at the needs of a cactus compared to a tree.
    - Make a list of crops and their different needs. Where would they grow best in our garden?
- Have students research companion plants. Are there any plants that help each other grow better? Ex. Three sisters

## Additional Resources

Companion planting

- https://kidsgardening.org/resources/gardening-basics-companion-planting/
- https://www.theenglishgarden.co.uk/expert-advice/gardeners-tips/companion-planting-beginners-guide/

Plant Lifecycles Books:

- The Amazing Life Cycle of Plants – Kay Barnham & Maddie Frost
- From Seed to Plant – Gail Gibbons

# Animals

- Animals are an important part of the farm. Not only do they provide food and wool to people, but they also help improve the farm ecosystem. They provide nutrients that go back into the soil, help pollinate your crops, keep pests and invasive plants in control, and so much more!
- Farmers are responsible for keeping the livestock in their care happy and healthy. Just like plants, each animal has its own needs, and the farmer must make sure they have everything they need to live a good life. They can do this by helping them when they are sick, giving them nutritious food and good habitat to live in.
- Farms are also home to many wild species of animals too. Sometimes this can be challenging because some wild animals can eat your crops or cause disease. Farmers must think creatively to find solutions to save their crops and livestock without completely destroying other species.

**Questions to guide thinking**

- How can farmers ensure that their animals have a good life? What do different animals need to be healthy?
- What roles/jobs do different animals play on the farm? What do they provide us with?
- How do we balance the needs of wild animals with the needs of our crops and livestock?

**Connections to other categories:**

- Discussions surrounding habitats and biodiversity will also be brought up in the **nature** section.
- Pollinators help in the lifecycles of **crops.** By spreading pollen they help plants to create seeds and therefore new plants.

**Measurements:**

- Calculate how many pollinators are in the garden. Have the students sit out in the garden as quietly as possible and watch a section of flowers for 10 minutes. Have them note down what animals come to visit the flowers.

## Harmony Connections

- **Health:** Just like us, animals need suitable environments to be healthy. They need healthy food and to live in the right habitat. When animals are happy and healthy, they can help keep the whole farm healthy.
- **Adaptation**: Animals have also adapted to specific environmental conditions. Discuss certain traits that animals have that are specific to their habitat.
- **Diversity:** Farms usually have many different kinds of domestic and wild animals. Having lots of animals makes the whole farm work better. Count how many animals you can find in the garden.
- Interdependence: Every animal has a unique role to play on the farm. They both provide us with many things and require things in return. What jobs do the animals on our farm do for us?
- **Cycles:** Animals are a part of the circle of life. They are born, and then eventually, they die. They are important parts of many different natural cycles. Can you list any?

**Key Vocabulary**

- Pollinators
- Habitat
- Pest
- Carnivores
- Herbivores
- Omnivores

## Activities

- Have the students match farm animals to the category they belong in. Hint some animals can be in multiple categories.
  - Possible categories
    - **Helpers**: Animals who help farmers to do their chores. (Horses, cats, dogs, donkeys, llamas, bees)
    - **Habitat engineers:** Animals who help other species to grow better (worms, bees, poultry, cattle)
    - **By-products:** Animals that provide us with food or fabric but don't have to die to do it. (poultry, sheep, alpacas, llamas, cattle, goats)
    - **Products:** Animals that are raised to become our food. (Cattle, pigs, sheep, poultry, fish)
    - **Herbivores:** Animals that eat only plants. (Cattle, sheep, goats, horses)
    - **Carnivores:** Animals that eat only meat. (Cats, dogs)
    - **Omnivores:** Animals that eat plants and meat. (Poultry, fish, pigs)
    - **Pests**: Animals that eat the crops you are trying to grow (insects, rabbits)

- Create a pest management strategy: Some animals that live on your farm might try and damage your crops. First, discuss some ways to deal with these pests while doing the least damage to the rest of the ecosystem. Then, if needed, develop a pest management strategy you can implement later in the summer.
  - Control pests/invasive species: Some farm animals can eat weeds and bugs that might damage your crops. Ducks and chickens eat some species of bugs.
  - Ladybugs eat aphids, a common pest found in gardens.
  - Chemical sprays can be used, but they could end up harming species that also help your crops.
  - Rabbits might eat your lettuce. So what are some solutions to keeping rabbits from eating your vegetables? (Fences, plants that rabbits don't like (onions, garlic, marigolds, lavender, etc.)
- Including animals in your garden in a school setting might be challenging. Some possibilities include a worm farm that works with the compost pile or adding fish if a pond exists.

**Additional Resources:**

- Lesson plans for worm farming:
  - https://schoolgardening.rhs.org.uk/resources/activity/mini-wormery
  - https://compost.css.cornell.edu/worms/steps.html
- Garden Pest Management for Kids Gardening:
  - https://kidsgardening.org/resources/gardening-basics-dealing-with-garden-pests-and-diseases/
  - https://schoolgardening.rhs.org.uk/resources/info-sheet/common-pests-and-diseases

# Climate

- ·The climate surrounding our farm is constantly changing—day by day, month by month, year by year. As farmers/gardeners, we need to understand and notice weather patterns so we can grow our crops and animals in the best way. Farmers also must be prepared for unexpected weather events. Floods, droughts, heat waves, and ice storms can all affect life on our farm.
- Climate and weather patterns depend on different levels of gases in our atmosphere. Adding more of these gases can lead to an overall warming effect and make extreme weather events more likely.

### Key Vocabulary

- Extreme climate events
  - floods, drought, heatwaves, forest fires, etc.
- Weather
- Precipitation
- Humidity
- Greenhouse Gases
- Emissions

### Questions to guide thinking

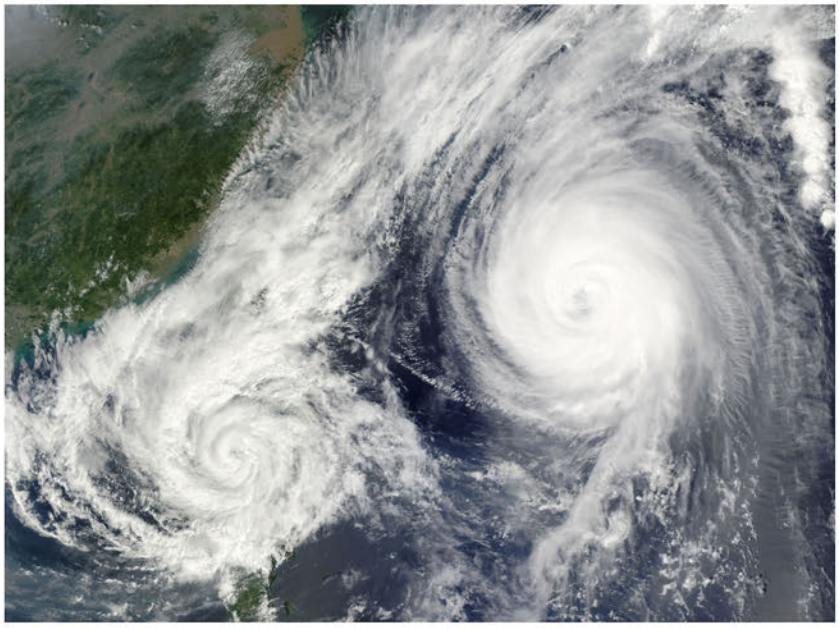
- How can we adapt the school garden for future climate scenarios?
- What plants and animals grow well in our area naturally?
- How is climate change changing our location?

### Connections to other categories:

- Discussions about garden planning also lend themselves well to the **crops and pastures**, and **animal** categories. Students must recognize that many crops are adapted to place. They are designed for specific habitats and climatic conditions.

### Harmony Connections

- **Adaptation:** The climate category is all about place-based measurements. What is going on in our own environment? Different species of crops and animals are naturally fitted to specific places and their specific climate conditions.
- **Cycles**: Different weather patterns occur at different times of year based on the seasons. What weather patterns do you see in every season?
- **Interdependence**: The earth's climate is one big connected system. Greenhouse gases that are emitted in one part of the world affect everyone and can change weather patterns in other parts of the world.



**Measurements**

- These measurements are great for students to gather. The school is encouraged to keep a log of these measurements over time so that patterns can begin to emerge. Students can also calculate monthly averages for each of these measurements which feeds into math lessons.
  - Precipitation level
  - Humidity
  - Daily temperature
  - Soil temperature
  - Windspeed

**Activities**

- Combine what you've learned from the last three categories to create a seasonal garden plan.
  - Select what crops you want to grow and have the students research how much water, sunlight, nutrient levels, and soil type each plant needs.
  - Look at historical weather and climate data, or if this is the project's second year, use the data gathered the summer before to predict what the weather will be like this year.
- Ensure the students consider whether the plants are a good fit for the environment. For example, ask them: Can we grow bananas in the UK? or Would an apple tree grow well in the desert?
- Compile all the weather data collected from the summer and calculate the averages for each. Use this data and compare it to local historical weather records in your area. How has it changed over time? What are the future trends?
- Weather patterns are beginning to change in some regions of the world. Are there crops that we couldn't grow before that now we can?
  - Examine whether grapes will be able to grow in the UK in the future.
- Have a quick discussion about greenhouse gases. Carbon dioxide is a gas that goes into the atmosphere anytime something is burned, either naturally (volcanos) or by human activity (cars, campfires, burning coal, etc.). Once it is in the atmosphere, it traps heat in the atmosphere changing weather patterns and making things hotter on average.

**Additional Resources:**

- Tons of resources about what to plant and when can be found at **https://schoolgardening.rhs.org.uk/home**
- Hardiness Zone Maps
  - USA: https://planthardiness.ars.usda.gov/
  - UK: https://www.rhs.org.uk/plants/pdfs/rhs-hardiness-rating.pdf
- Plant maps and Koppen Climate Classification Maps for various regions
  - https://www.plantmaps.com/index.php

# Farmers and Workers

- Farms are made up of many kinds of workers whom all bring different skills to the table. Everyone has a role to play and deserves to be treated fairly.
- One of the farmers' most essential tasks is to create safe workplaces and to ensure there is proper safety equipment and that everyone knows how to stay safe.
- There are always many different tasks and jobs to complete on a farm. Therefore it is essential that everybody communicates and works together to complete tasks and learn new skills.

**Key Vocabulary:**

- Equipment
- Hazard
- Risk

**Questions to guide thinking:**

- How do we all stay safe in the school garden?
- What does it mean to work collaboratively?
- How do we spread out jobs and tasks fairly?
- What skills can we learn by working in the garden?

**Connections to other categories:**

- Many of the safety concerns found in the garden will have to do with the tools or resources needed to grow the plants. Therefore, this lesson can easily be tied into the **Resources** section, where discussions surrounding different farm tools (rakes, shovels, etc.) will take place.

## Harmony Connections

- **Health**: Everyone who works on the farm needs to stay safe and healthy to take care of all other plants and animals. We also must do an excellent job of taking care of each other. How can we make sure all our classmates are following the safety rules?
- **Interdependence:** Everyone in our class plays a role in our school garden. We all have different skills and talents that we can bring to this work. Working together as a team is the best way to ensure a good harvest.
- **Cycles**: Some tasks and skills are specific to certain times of the year. Tasks are often repeated weekly, monthly, or yearly and often match up with the seasons of the year. What patterns can you find in the jobs we do in the garden?

**Measurements**

- At the beginning of the season ask students to list all the garden skills that they want to learn that year.
- At the end of the year have the students write a paragraph describing all the garden skills they ended up learning.

**Activities**

- This activity can be done during the garden planning process. Discuss with your students about farm safety and work together to create rules to follow in the garden.
- Another activity that can be done is establishing specific garden tasks and creating teams of students so that all the tasks are completed each week.
  - i.e., weeding, watering, harvesting, cleaning up, planting seeds, fertilizing.
  - Ask students how they think they can make sure that job selection is fair.
    - Everyone votes on what they want to do.
    - Weekly rotations so everyone has a chance to do every job at least once.
- Discuss the difference between low-risk and high-risk activities.
  - Not wearing gloves is a low-risk activity. A student might get a small cut
  - A high-risk activity would be treating tools as toys. Explain that doing this could cause them to seriously hurt themselves or other students

**Extra Resources**

- Common tasks for school gardens checklist
  - https://schoolgardening.rhs.org.uk/Resources/Spotter-Guide/Gardening-Task-Cards?returnUrl=%2FResources%2FFind-a-resource%3Fso%3D0%26pi%3D20%26ps%3D10%26f%3D2,12:%26page%3D3
- Garden safety resources
  - https://schoolgardening.rhs.org.uk/resources/info-sheet/health-safety-in-the-garden

# Resources

- To grow food successfully, farmers will need to rely on additional resources to help them perform their day-to-day tasks. These resources can be anything from tools, machines, chemical inputs, fuel, buildings, etc. Therefore, it is important to use resources wisely and take care of the tools and machines used daily to ensure our farm is not creating unnecessary waste.
- Energy is another key focus of this category. Much of the infrastructure and machines needed to farm will require some form of energy, whether via electricity, fuel, or physical labor. This opens the opportunity to discuss the links between energy use and our changing climate.

**Key Vocabulary:**

- Renewable energy
- Infrastructure
- Fossil fuels
- Climate Change

**Questions to guide thinking:**

- What tools do we already have for our garden?What tools do we need in the future?
- How do we take care of our tools to keep using them?
- What rules can we make regarding each tool?
- What kind of energy does each tool require?

**Educator Tips**

- As mentioned above, this lesson can connect to discussions about **farmers and workers. In addition, students** can create rules for tools that help promote safe practices and ensure that the tools are taken care of.
- Discussions about renewable energy and fossil fuels also connect to discussions about changing **climate.**
- Lastly, most resources cost money and can reduce the overall profits a farm makes in a year. Therefore this section also lines up with the content found in the **economics** category.

## Harmony Connections

- **The Cycle:** Teach students to care for the tools used in the garden. Promote the ideas behind Reduce/Reuse/Recycle . Conducting a yearly inventory and assessing the state of resources throughout the year should help foster mindfulness about not wasting resources.
- **Diversity:** Each crop requires different resources and tools to help it grow. The same is true for people using the tools. We are all different; sometimes, we need different equipment and tools than our classmates to help us garden better.

## Activities

- Have students create an inventory of all the tools and materials they have at the beginning of the year. Then after harvest, assess the state of the tools and infrastructure and make a plan to reuse or repair broken things. Throwing things away should be the last option.
- Students can come up with safe practices for different tools. Some examples are included below:
  - Always wear gloves and boots
  - Put everything away at the end of the day
- Ask the students what kind of energy is required for each tool. For example, shovels, rakes, and watering cans all require physical labor, but lightbulbs and small handheld machines require electricity. Or fuel to operate.
- Discuss how using some energy that burns fossil fuels releases carbon dioxide into the air and can affect the global climate.

**Measurements**

- Count how many things require electricity to operate.
- Are there any renewable sources of energy?
  - Solar charger
  - Windmill
- Lifecycle assessment of each tool. How many years has it been used? How many times has it been repaired? Has it been converted into anything else?

## Extra Resources

- Books about energy and climate change
  - Buried Sunlight by Molly Bang and Penny Chisholm
  - Running on Sunshine: How Does Solar Energy Work? by Carolyn Cinami DeCristofano

# Nature

- Farms are a part of nature, not separate from it. They follow the same natural rules that all life follows and rely on the same natural cycles and processes found elsewhere on earth.
- When thoughtfully designed, farms can act as safe havens for all kinds of biodiversity. They provide habitats for all many species, from mammals to birds to microbes in the soil.
- Farms can also help keep our water and air free from pollutants that can cause us and the environment harm.

**Key Vocabulary**

- Habitats
- Threatened species
- Ecosystem Health
- Biodiversity
- Pollution

**Questions to guide thinking**

- How can we find out how many species there are on a farm?
- What forms of life live on a farm?
- What things do species need to have a healthy place to live?
- How many species can we find in our garden?
- How can we create better habitats for species like butterflies and bees?
- How do farms contribute to keeping our air and water clean?

**Connections to other categories:**

- Conversations about how farms can contribute to healthy **water,** air, and **soil** will be further explored in their respective sections.
- Farms help protect shared resources that **communities** rely on. Discussions about why clean water and air are important in nature can also be tied in with why these resources are important for people as well.

## Harmony Connections

- **Diversity:** Choosing a variety of species of plants and animals to grow on your farm helps to promote the diversity of wild species. A diverse natural system is a healthy and resilient natural system.
- **Adaptation:** Over time, species have evolved specific behaviors and patterns to thrive in their habitats. These behaviors help them to co-exist with other species. Farms often mimic these same patterns. For example, including multiple animal species in a pasture reflects what naturally occurs and keeps the field healthy. So how can farmers mimic nature's ways?
- **Cycle**: Nature depends on many different cycles. Many of which we will explore in future sections. Often times these cycles are connected to one another in an even larger cycle. How do the season effect plant life? How does the water cycle influence the nutrient cycle?

## Measurements

- Conduct a biodiversity index on your garden.
  - Count how many living things can be found in your garden. Break it into categories. How many tree species? How many plants? How many animals? How many insects?

## Activities

- Students can create habitats or shelters for local endangered species.
  - Think insect hotels, hedgehog homes, birdhouses, etc.
- Have the students participate in a schoolyard Bioblitz or other local citizen science programs.
  - These citizen activities can help local researchers and students alike to collect data about different species which are visiting your school garden. See additional resources for more information.
- After completing your own biodiversity index, look up the biodiversity indexes of different ecosystem types and compare them together. Ask the students what factors they think to lead to the differences they see.

## Extra Resources

- Bioblitz Activity
  - https://www.nhm.ac.uk/take-part/citizen-science/bioblitz.html
  - https://www.nationalgeographic.org/projects/bioblitz/
- Guide to creating habitat in your school garden:
  - https://schoolgardening.rhs.org.uk/resources/info-sheet/encouraging-wildlife-in-your-school-garden

# Water

- Water is essential for all forms of life. Plants, animals, and humans all need it to grow. The water we need is part of an important cycle that is continually flowing around us.
- Farmers have an important role in the water cycle on their farms. Every farm will have unique natural water-holding capacity and weather patterns that determine when and how a farmer should water their crops.
- Farmers will have to be prepared for times of flood and drought.
- An awareness of how water is a shared resource. The water that is used on the farm could eventually run into rivers, lakes, and oceans or turn into local drinking water supplies. Therefore it is important to make sure that the water that leaves the farm is not polluted.

**Questions to guide thinking**

- Where can we find water on the farm?
- How much rainfall do we have?
- How much water do we use to water our garden?
- What time of day do you water your plants?
- How can we recycle water on our farm?
- Where does the water go after we water our plants?

**Connections to other Categories:**

- Discussions of water can lead back to previous discussions found in **Crops and Pasture**. Selecting plants that are well suited to how much water your farm naturally gets is essential.
- Water is often held in the **Soil.** UnderstandingTherefore, understading the properties of different soil types and how much water they can hold will also determine how often you have to water.
- It can tie into discussions about **Community**. Farmers should only take what they need to grow their crops and have a responsibility to keep the water we all share free from pollutants.

## Harmony Connections

- **The Cycle:** Water moves through the environment in a cycle. When it rains, the water falls onto the soil, where plants will then use their roots to take water up to help them grow. Any water that is not used by plants or animals or is not stored somewhere will eventually evaporate back into the atmosphere. Once this happens, the water will condense and fall as rain again. Have the students explore where the water goes after using it to water their crops.
- **Health:** Healthy farms can help to clean local rivers and ponds if they are nearby. The plants and soil act like a giant filter and can ensure the harmful materials don't end up in the local rivers.
- **Interdependence:** Farms are part of a larger local ecosystem. Features found on the farm, like trees planted near rivers or additions of wetlands, can help control flooding downstream. They can also help store water in the system in times of drought.

**Key Vocabulary**

- Precipitation
- Water- cycle
- Evaporation
- Recycling
- Conservation
- Irrigation

**Activities**

- To begin thinking about storing water in your garden, consider building a rain barrel or rain garden. The areas where water can be collected can help in times of drought. That way, in-between rain showers, we can use it to water our crops.
- Watch videos learning about the water cycle.
- Conduct an evaporation experiment to learn about the time of day that is best to water our plants.
    - Place a jar of water on the window sill and mark the water line.
    - Every hour mark where the water level is. Which period showed the most change? What time of day should we water our plants?

**Measurements**

- How much water do we use to grow every crop?

**Extra Resources**

- Water conservation tips
    - https://schoolgardening.rhs.org.uk/Resources/Info-Sheet/Conserving-water
- Water Cycle Videos on YouTube
    - The Great Aqua Adventure- CrashCourseKids

# Soil

- Healthy soil is the foundation for a healthy school garden. The soil contains all the nutrients and water that plants need to grow.
- Soil can also provide ecosystem services like keeping carbon out of the atmosphere, decomposing biomaterials into nutrients, and preventing erosion. However, to improve and conserve our soils, we must first measure how healthy our soil is now.
- The soil is also home to a great many creatures. Soil biodiversity is critical to soil health.

**Key Vocabulary**

- Ecosystem service
- Decomposition
- Soil compaction

**Questions to guide thinking**

- What types of organisms live in the soil? Are there worms, insects, roots, fungi, etc.?
- What role do these organisms play?
- What is stored in the soil?
- How do different soil properties affect our crops?

**Connections to other categories:**

- Learning about soil will also connect to previous discussions about **Crops and Pasture, Climate, and Water.** Seeing as the soil plays a key role in the global water and carbon cycle.
- The role of **Nutrients** in the soil will be discussed further in the next section.

## Harmony Connections

- **Health:** Healthy soil is living soil. It has different microbes, insects, and fungi that help break down plant materials to create more nutrients to give back to the plants. Healthy soil leads to healthy crops and healthy animals. What roles do organisms play in building healthy soil?
- **Interdependence:** The soil serves many functions. It provides nutrients and water, and habitat for many species. It also stores carbon and
- **The Cycle:** The soil plays a role in many different natural cycles. Plants die, fall to the ground, and are decomposed. This process releases nutrients that help new plants to grow.

**Activities**

- Learn about sand, silt, loam, and clay soils. Understanding what soil type is in our garden will help us plan how much water we will need and what plants will grow the best where.
- Conduct a soil compaction experiment. For plants to grow, the soil must have space for air and water to move. If soil is too compacted, it is hard for air to move through.
  - Fill two clear jars with soil from your garden.
  - Take one jar and have the students push down on the soil or compact it. The other jar should have soil that is still loose.
  - Pour water into the jar and observe what happens. Where does the water pool? What does this mean for plants?

**Measurements**

- Count how many earthworms are present. These help with decomposition.
- How much water is stored in our soil?
  - Take soil from the garden and place it in a plastic bag. Then weigh it.
  - Leave the bag with the soil in the sun for several days. Then weigh the bag again.
  - Subtract the difference between the two, and that is how much water your soil can hold.

Extra Resources

- New York Botanic Gardens soil basics sheet:
  - https://www.nybg.org/learn/schools-teachers/resources/school-gardening-101/school-gardening-101-session-2/
- Soil Texture Test:
  - https://schoolgardening.rhs.org.uk/Resources/Activity/Soil-texture-test?returnUrl=%2FResources%2FFind-a-resource%3Fso%3D0%26pi%3D30%26ps%3D10%26f%3D2%2C1%3A%26page%3D4

# Nutrients

- All life needs specific nutrients to be able to grow. So how do different organisms get the nutrients they need?
- Plants use their roots to get both nutrients and water from the soil. These nutrients are then stored in the plant and can be used by animals and humans for their own nutrient needs or can go back into the soil to provide nutrients for future plants.
- Nutrients move through the world in a complex cycle that involves the atmosphere, soil, plants, animals, and microbes. Disturbing the natural balance of nutrients in a system can lead to a goldilocks effect. Too much in some areas and not enough in others.

**Key Vocabulary**

- Nitrogen
- Potassium
- Phosphorus
- Carbon
- Fertilizer
- Compost

**Questions to guide thinking**

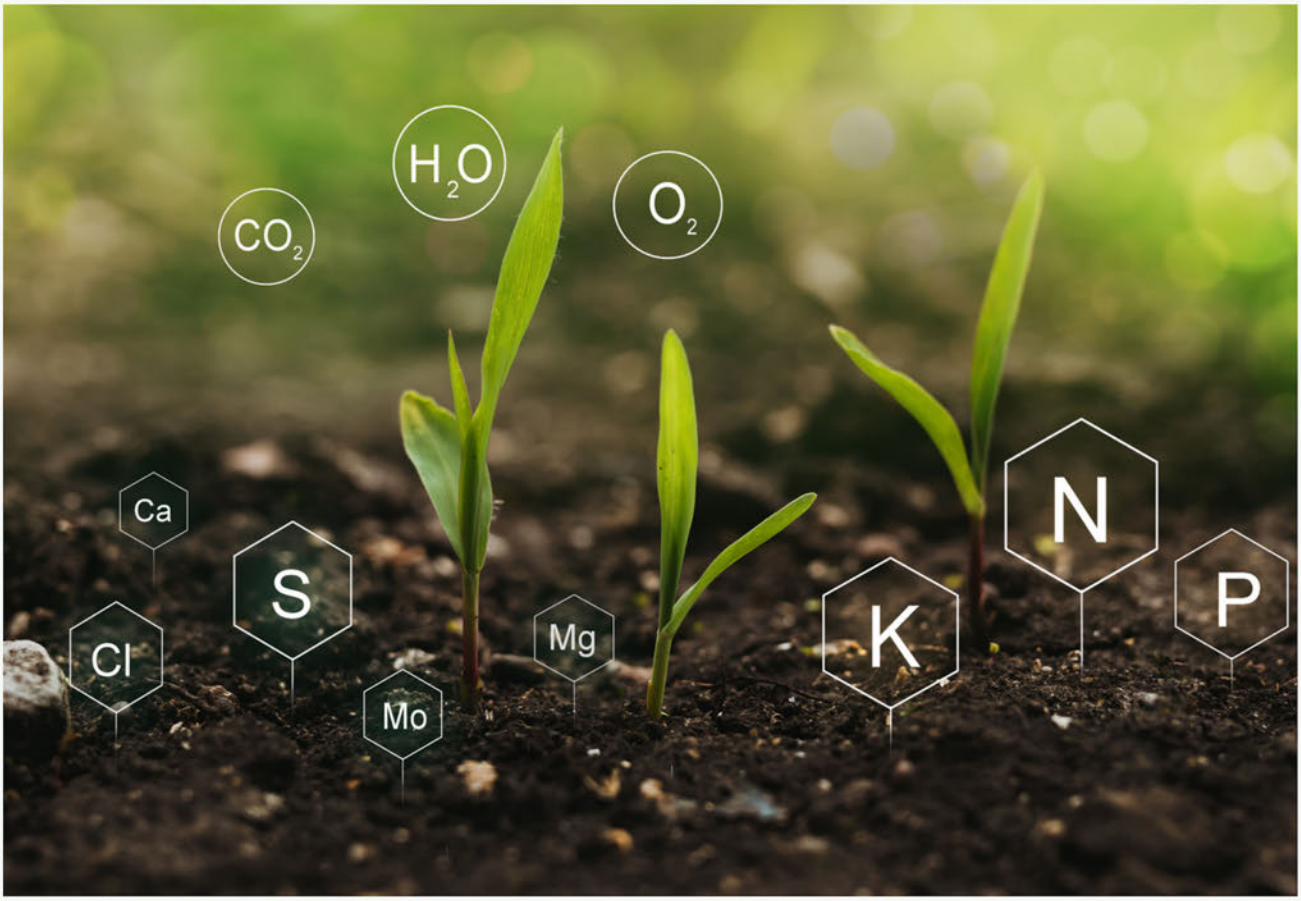
- What is a nutrient?
- Where can we find nutrients in our garden?
- How can we make sure our plants get the nutrients they need to grow strong? Are there any factors that can help or hinder our plants from getting what they need?

**Connections to other categories:**

- The **Soil** plays a vital role in the nutrient cycle. Therefore, these two categories are easy to integrate.
- Adding additional nutrients to the soil in the form of artificial fertilizers can have **Economic** costs and can affect the surrounding **Nature.**

## Harmony Connections

- **The Cycle:** Nutrients move from one living organism to another when not stored in the soil or the atmosphere. Illustrate how nutrients move through the world in a cycle. Nutrients that are no longer needed by one organism can be used to give life to another.
- **Interdependence:** Microbes, plants, animals, the soil and the atmosphere all have a role to play in cycling nutrients in nature.




### Activities

- Explain that nutrients move through the world in a cycle. From the soil to plants to animals and back to the soil again via waste or death. Processes like decomposition can help break down nutrients into usable forms.
- Start a compost pile with all the food waste and plant matter left over to learn more about decomposition.
- Explore when the best time to fertilize plants is. For example, applying nutrients right before heavy rain can cause all the fertilizer to wash away.
- Learn the signs of nutrient deficiencies in plants.
  - Nitrogen: pale green or yellow leaves
  - Phosphorus: Bronze, red or purple color on lower leaves
  - Potassium: Yellow and or curling leaves.

### Measurements

- What color is your soil? Darker soils indicate that there is more carbon and nutrients that plants need to grow.
- How many times did you add fertilizer or compost to your garden?

### Extra Resources

- Composting:
  - https://schoolgardening.rhs.org.uk/Resources/Info-Sheet/Top-tips-for-making-compost?returnUrl=%2FResources%2FFind-a-resource%3Fso%3D0%26pi%3D40%26ps%3D10%26f%3D2,1:%26page%3D5
- Nutrient Deficiencies
  - https://www.rhs.org.uk/prevention-protection/nutrient-deficiencies
- Nutrient Cycles:
  - https://edibleschoolyard.org/resource/introducing-nitrogen
  - https://edibleschoolyard.org/resource/decomposition-cycle

# Production

- Farmers and gardeners are always thinking about how to grow produce efficiently while also thinking of protecting the environment. It takes a lot of time, energy, and resources to grow our food, so it is important that we don't waste it. If we grow more than we can eat, we can donate what's left over, feed some to our animals, or turn it into compost.
- Growing a diverse array of healthy, nutritious food is also a main priority. Good yields depend on healthy soil and water, enough nutrients, thriving biodiversity, and a stable climate.
- Yield is highly dependent on the weather. Planting a diverse field of crops is not only good for nature, but it can also help ensure that a farmer has a good yield. What grows well one year might not the next, so it is always good to have a variety of crops to then sell.

**Key Vocabulary**

- Yield
- Quality
- Nutrition

**Questions to guide thinking**

- How much food were we able to grow?
- What makes food nutritious?

**Connections to other categories:**

- Yields from the year can be celebrated in a **community** event where you create meals based on the foods you've grown.
- This also can reinforce lessons first discussed in the **crops and pastures** section. The more diverse different plants we grow the more different kind of foods we are able to eat.

## Harmony Connections

- **Diversity:** Growing lots of different plants is good for the environment, the farm economy, human health, and local culture. Think of how many recipes we can create when we grow lots of different food!
- **Health:** Lots of plants that are grown lead to lots of different foods that we can eat. If we eat diverse foods, we can ensure that we are getting all of the nutrients we need to be healthy.
- **Interdependence:** Every part of the farming system is important in ensuring a good yield. Every part of the wheel is connected to other parts, and farmers need to think about all of them together to ensure that their farm or garden is working well.

### Activities

- Talk about nutrition! Cooking food that celebrates the yield or harvest of the year.
- Discuss what it means to have high-quality foods. What do you think is important? Is it color? Shape? Size? Taste? How was it grown? Nutrient content?
  - What should students look for when shopping for vegetables with their families?
- Discuss what we should do with the food we cannot eat. For example, we should eliminate food waste in our gardens.
  - Donate it
  - Compost it to be added back to our garden later. This replaces some of the nutrients that we took. So we are giving back as well as taking.
  - Feed it to other animals.

### Measurements

- Count how much food is grown. This is the yield.
  - It can be measured by weight or amount.
- How many different foods did we grow?
- How many different meals can we make with the food we grew?
  - ex. what can we use tomatoes to make?

### Extra Resources

- Nutrition Lessons
  - https://northerngardener.org/nutrition-curriculum-resources-for-school-gardens/

# Economics

- Money is used as a tool that farmers need to continue to improve their farms and provide a good yield every year. Being able to sell lots of different products will protect a farmer in case something goes wrong with one part of the farm.
- Farmers can make money by selling their produce, providing educational opportunities, or protecting the environment.
- While oftentimes farmers grow to produce to make money, that is not the only option. Sometimes farmers will exchange food in their local community for other goods and services that they need to support their farm. Other times food can be grown for your own use and the extra is given away to family, friends, and neighbors.

**Questions to guide thinking**

- What do farmers have to pay for?
- How do farmers make money?
- How many different products can we make with our crops?
- What are the benefits of selling our produce? Of donating it?

**Educator Tips**

- Find ways to engage with the local **Community** to 'sell' or 'donate' your produce.
  - Restaurants
  - Nursing homes/ Food banks
- The **Production** section is closely aligned with this category. The higher yield you have, the more money can be made.
- Farming requires different expertise or tools that you may have to pay for. Everyday expenses can be found in the **Resources, Animal, Crops and Pasture,** and **Nutrients** categories.

**Harmony Connections**

- **Diversity:** The more crops and animals you produce the can lead to more opportunities to create products to sell. There is also great diversity in the different products that can be created with the crops you grow. These different products can then be sold to a variety of people and markets.
- **Cycles:** Just like many natural cycles, the economic cycle of a farm must be balanced. What happens if you spend more money than you make? How does this effect the farm in the future?

**Key Vocabulary**

- Profit
- Cost
- Expenses
- Income
- Ownership
- Economics

## Measurements

- Create basic expense sheets with the students. For example, how much are seeds, tools, water, energy, etc.
  - How much could we sell our produce to ensure we make our money back?
- Another way to approach this without selling anything is to discuss EROI- Energy return on investment. Calculate how many hours of work it took to produce this food and how much energy you gain from it. There are lots of ways to approach this concept.
  - Hours worked/pounds of food produced
  - Hours worked/meals created with your recipes
  -

### Activities

- Students can earn school money or points for hours they work in the garden that can be used to buy veggies from the garden or other prizes.
- Host a fundraiser at the end of the year where you sell the produce to local community members. Or partner with a local restaurant that would purchase some of your produce every week. The money earned can go back into buying materials for the garden every year, like seeds or tools etc.
  - After selling the produce have the students reflect on the experience. How did it make them feel? What did they learn?

### Extra Resources

- School Farmer's Market
  - https://kidsgardening.org/resources/digging-deeper-school-farmers-market/

# Community

- Farms are an integral part of our local and global communities. They work with many different people, including restaurant owners, businesses, banks, vets, and schools, to name a few.
- A farm provides more than just food to a community. They can be a gathering place for the local community, a place of education, and somewhere that safeguards nature's natural beauty.

**Key Vocabulary**

- Community
- Network

**Questions to guide thinking**

- Whom do farmers work with?
- How does food get from the farm to your plate? Who is involved in making that happen?
- How can our school garden help out our local community?
- Why does where our food comes from matter?

**Connections to other categories:**

- Discussions about the community can enhance some of the concepts that were first explored in the **Economics** category. Examine the benefits and drawbacks of selling produce vs. sharing it with the local community.
- Farms can help preserve shared environmental resources found in **Nature.** Sustainable farms can provide many natural benefits to local communities.

**Harmony Connections**

- **Adaptation:** Each local community has its own unique culture and identity. What is unique about our local community?
- **Diversity:** Strong communities are found everywhere, from small towns to city neighborhood blocks. Just as no two communities are alike, neither are the individuals who make up a community. Diversity is what makes them strong.
- **Interconnectedness:** Farmers are a part of their local community. They can help provide healthy, diverse foods and ecosystem services. Farmers also must engage with people in their communities to get the help they need for various projects. Farms can also donate extra food to the people in the community who need it the most.

**Activities**

- Create a simple meal or snack from the foods you grow in the garden and share it with others
  - this could include other classes, your families/neighbors, or local nursing homes/food banks.
  - Have students reflect on these experiences and compare them to what they felt when the produce was sold instead.
- Learn from farmers in your local area.
  - Organize a visit to a local farm to learn from a farmer.
  - Signup your classroom for the Farmer Time program- a weekly facetime call with a farmer.
- Write letters about the farm to family members, pen-pals, and neighboring schools.
- Encourage local community members to help out with the school garden. Get parents or grandparents with a passion for gardening involved with the project. Is there anyone whose family could teach cultural gardening practices?
- Host a harvest day at the end of the year, where you invite families to the garden. Older students act as tour guides to the farm and teach the visitors about what they have learned. Activities can include a mini farmers market and cooking demonstrations with the produce grown.
- Deliver local produce to food banks/shelters or nursing homes. Encourage sharing.

**Measurements**

- How many people helped us grow our food?
- How many people can you tell about our farm?
- Also, how many of the things used to grow the food (including the seeds, etc.) were produced locally?
  - What are the benefits of buying locally?
    - Think environmental costs, convenience, supporting local economies, and building trust.

**Extra Resources**

- Farmer Time Program
  - https://leaf.eco/farmertime/home

# Review/Reflection Activity

To encourage students to make connections between the categories, have them think through what would happen to the whole garden system, all 12 categories if we implemented some kind of change in the upcoming year. Below are a series of possible exploration questions as well as an example of how to guide students through this critical thinking process. This activity can be done as a whole class or in small groups, where each group presents its ideas at the end. There are no right or wrong answers. The goal is to have the students examine the data they have collected over the summer, reflect on what they've learned, and come up with a creative solution. This activity also mirrors some of the decision-making skills that real-life farmers use every day!

## Possible Exploration Questions*

- How do we prepare for a drought year?
- How can we increase the yield of our tomato plants?
- What are the advantages and disadvantages of growing a new crop?
- Should we add fertilizer to the soil next year?
- How can we create a habitat for _____?
- How can we prevent soil erosion in our garden?

*This is just a sample of the kind of questions you can ask. We encourage you to come up with your own

**Example of how to guide discussion**

- Should we add fertilizer to the soil next year?
  - This discussion can help highlight how the **Nutrients** category connects with others.
  - Have the students think back to this summer. Did any of the plants show signs of lacking nutrients? You can also ask them what the potential benefits of adding fertilizer would be.
  - If they decide to add fertilizer, then ask them what kind. Have them go through the advantages and disadvantages of both options. Have them consider how this decision could impact all the categories of the wheel.
    - Artificial Fertilizer
    - Compost
    - Are there other creative options?
  - Possible categories this could intersect with
    - Economics
    - Nature (Biodiversity)
    - Water (What consequences could this have on water sources?)
    - Soil
    - Community (Who do we get this from?)
    - Farmers and Workers/Resources (Who will apply the fertilizer, and do we have the proper equipment to keep them safe?)
    - Production (will this help our yield?)