INVESTIGATION

How Does Nature Grow Food?
Principles of Soil Health and Land Management

Time Required: 40 to 60 minutes

Grade Levels: Adaptable to any age: Kindergarten through Adults

Summary: Participants work together to figure out how natural ecosystems regulate water cycles and grow healthy plants and animals so effectively These group insights form the basis of a list of soil-health and land-management principles (which can later be tested and applied to agriculture, conservation, and other land management.) The group's list is compared to lists of soil health principles that the Natural Resource Conservation Service (NRCS) Soil Health Team, the Soil Carbon Coalition, and other groups have been working on, and see if they have come up with anything new to add to this effort.

Materials:

- ✓ A whiteboard with markers, or some other way to take notes that everyone can see.
- ✓ (optional) slide projector and screen
- ✓ (optional) slides or printed images of various natural versus agricultural landscapes (rainforests, prairies or savannahs with large herds of grazing animals, ranches, and agricultural fields) in order to notice principles at work in different landscapes.

EDUCATIONAL STANDARDS

Next Generation Science Standards

Performance Expectations:

HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Science and Engineering Practices:

Engaging in Argument from Evidence; Obtaining, Evaluating, and Communicating Information; Constructing Explanations and Designing Solutions; Asking Questions and Defining Problems

Disciplinary Core Ideas:

LS1.A Structure and Function; **LS1.C** Organization of Matter and Energy Flow in Organisms; **LS2.A** Interdependent Relationships in Ecosystems; **LS2.B** Cycles of Matter and Energy Transfer in Ecosystems; **LS2.C** Ecosystem Dynamics, Functioning and Resilience; **LS2.D** Social Interactions and Group Behavior; **LS4.C** Adaptation; **LS4.D** Biodiversity and Humans

ESS2.A Earth Materials and Systems; **ESS2.**C The Role of Water in Earth's Surface Processes;

ESS3.A Natural Resources; **ESS3.C** Human Impacts on Earth Systems

ETS1.A Defining and Delimiting an Engineering Problem; **ETS1.B** Developing Possible Solutions; **ETS1.C** Optimizing the Design Solution

Crosscutting Concepts:

Patterns; Cause and Effect; Systems and System Models; Energy and Matter: Flows, Cycles, and Conservation; Stability and Change

Common Core State Standards

SL 9-10 and 11-12.1

Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades appropriate topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

SL 9-10 and 11-12.4

Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

Activity

1. Introduction

Depending on the group, you may want to start with some version of this introduction:

A loosely organized group of people—many of them connected to the Burleigh County Soil Conservation District in North Dakota—have been working to understand the overall principles that allow natural ecosystems to grow healthy plants and animals so effectively.

We call these principles ***soil health principles*** *(or, as one farmer, Gabe Brown, says: 'Nature's Way.') Many of these principles turn out to be a radical departure from the way we were taught to manage land, even though they can be observed all around us in the natural world. This has been a humbling experience for scientists, farmers, and other land managers, but also a very exciting one. Because of the work on soil health principles, farming has become a much more creative and exciting venture. Innovative people are applying these principles to farming and ranching, with excellent results: plants and animals get healthier, more resistant to diseases, and higher in nutrients; the land is less vulnerable to drought, flooding, erosion and runoff; pest management is easier; and in many cases farm profits are increasing.*

There is no single definitive list of these principles, nor should there be. People explain them and express them in a variety of ways. We are just at the beginning of understanding them, and we are still adding new insights.

Today we'll see how many of these principles we can figure out on our own, and maybe we will come up with some new ones to add to the list.

We are going to think out loud together about how natural ecosystems grow healthy plants, animals, and people—and how that compares to the way that food is grown in most agricultural systems.

2. Engaging Question:

› *What are the most productive types of* ***natural*** *landscapes you can think of? (i.e. not farms or ranches.)*

Participants may say some or all of the following:

Rainforests
Temperate forests
Boreal forests
Grasslands (also called prairies, savannahs, steppes, pampas, velds, rangelands depending on the region)
Wetlands and Marshes

› *Let's look at a tropical rainforest: do you think a rainforest produces more or less total* ***biomass*** *(weight of living things: plants, animals, insects, fungi, microbes) both above and below ground, compared to a typical farm in that same climate?*

› *How about a natural grassland or prairie (before human intervention) vs. a typical farm in Oklahoma or Kansas?*

› *How about a temperate forest vs. a dairy or vegetable farm in New England?*

Explain that right now you are just going to estimate (a lot more, a lot less, a little more, a little less) but you could do a project where you calculate the biomass, or look up research others have done to calculate that biomass.

If you include everything, natural ecosystems will generally be far more productive in total biomass than farming systems. They will also generally provide far more ecosystem services in terms of water, carbon, and nutrient cycling.

As humans, we can't necessarily use all of that biomass, but everything that is produced in those systems is used by something else. Ultimately we benefit from this, even if we aren't using those products directly, because we are part of the whole system that cycles carbon, water, and nutrients through the landscape and atmosphere. Natural systems have evolved intelligent ways to hold and filter water, build carbon stores in soils and trees; balance predation by insects and animals; and regulate atmospheric carbon, temperature, and moisture.

Agricultural land, on the other hand, has tended to lose its carbon stocks (through deforestation, erosion and loss of soil microbial communities), lose the natural water storage, water filtration, evapotranspiration, and rain cycling effects, and lose the balancing and regulating effects of complex ecosystem function. Because of that, agricultural land systems tend to become drier, compacted, more disease-prone, and less profitable over time, as well as increasingly dependent on technological fixes, with increasing costs for fertilizer, irrigation, pesticides, and disease control.

› *Is there anything we can learn from nature about how to grow large quantities of food that we can apply to farming and ranching?*

3. Thinking out loud about natural vs. human processes of land management
Challenge participants to come up with all the things that nature does to grow food—and to notice how those practices are similar to, or different from, current agricultural practices. Prepare to make a list on the board, with **Standard Practices in Nature** on one side, and **Standard Practices in Farming and Ranching** on the other side.

› *What would be some questions we could ask each other in order to compare human vs. natural systems for growing large quantities of foods?*

Write the group's questions on the board.

If you have a group that needs more prompting, here are some examples of questions you can add, that may help spark the discussion:

› *How do seeds get spread?*

› *How do seeds get into the ground?*

› *How are the plants arranged?*

› *Is the soil structure and ecology disturbed or left alone?*

› *Is the soil left bare or covered?*

› *How does water get to plants?*

› *How does water get to animals?*

› *What natural processes drive the water cycle?*

› *What species participate in the water cycle?*

› *Who spreads water over the landscape?*

› *Do natural systems tend more to monocultures or diversity of plant life? How about farms?*

› *How are nutrients returned to the soil?*

› *How are nutrients moved uphill?*

› *How does nature make sure falling rain seeps slowly into the ground rather than compacting it or eroding it?*

› *Who makes sure water gets down deep into the ground for deep rooted plants?*

› *How does nature prevent insects from eating plants?*

› *How does standard agriculture prevent insects from eating plants?*

› *How does nature (or agriculture) keep animals healthy?*

› *How does nature (or agriculture) make sure that the right food grows for the inhabitants who live in the area?*

› *How are soil temperatures modulated?*

› *How are ambient air temperatures modulated?*

› *Does anything cost money? What are those things? How much do they cost?*

› *Who pays for the cost of supplies?*

› *Does anything get damaged?*

› *Who pays for the cost of damages?*

› *What ecosystem services does each system provide?*

4. What are the principles you see at work in healthy natural landscapes?
Write the group's answers on the board.
Here's a short version of the soil health principles adapted from the NRCS Soil Health Team:

- Keep living roots in the ground year round.
- Keep soil covered year round.
- Use diverse species of plants.
- Minimize physical, chemical and biological stresses.
- Integrate animals.
- Get to know the context of the land.

Is there anything you would add to this list? These natural processes for growing food developed in nature through millions of years of adaptation. Why do you think nature chooses to do things that way? What advantages are there?

Here is my version of those principles, with a bit more explanation of why I think they work:

- Soil life needs protection from heat, pounding rain, and wind. **Keep soil covered year round.**
- Much of soil life is fed by liquid carbon produced by photosynthesis, exuded through living plant roots. **Keep living roots in the ground as long as possible.**
- Soil life is hard at work building underground structures we depend on for water, carbon and nutrient cycling; and for structural stability for our own infrastructure. **Try not to disturb those underground structures with tillage.**
- Like any other living system, soil ecology will succumb to overwhelming stresses. **Minimize chemical, physical, and biological stresses.**
- A diverse system is more resilient than a monoculture. **Use plant diversity to increase diversity in soil microorganisms, beneficial insects, and other**

species.

- A healthy landscape stores and filters water, cools the surrounding atmosphere, creates mist and clouds, and prevents flooding and drought. Complex systems involving all kingdoms of life are responsible for the water cycle on land. **Plan with the whole water cycle in mind.**
- Nature never farms without animals. Animals move nutrients, create small and large pores in soil, manage flows of water, pollinate crops, balance predator/prey relationships, and replenish soil microbes. **Plan to integrate and welcome a diversity of animals, birds, and insects into the system.**
- Every place has unique strengths and vulnerabilities. **Get to know the context of the land.**

What would you add to this list?

Please send us any ideas you have. Didi's email is: landlisteners@gmail.com