NUTRIENTS FOR LIFE FOUNDATION

KANSAS CORN STEM

Grow Your NPK Knowledge

This breakout is made possible with the support and content contributions of the Nutrients for Life Foundation and the Kansas Corn Commission.

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KANSAS CORN COMMISSION

Grow Your NPK Knowledge

Grade Level: High School

Overview

There are many things that impact growing healthy plants, like corn. Essential elements are vital to sustaining life on our planet. Plants require 17 essential elements. These essential elements can be found in air, water, and soil. Soil is continuously being formed by geological and biological processes. The organisms that live in the soil create a unique ecosystem in which its inhabitants depend upon and interact with one another. Missing essential elements and poor soil can both cause plant health to be affected.

Learning Objectives

- Students will understand the nitrogen cycle.
- Students will assess different soil horizons, columns, and the texture triangle.
- Students will understand more about organic and commercial fertilizers.

Next Generation Science Standards (NGSS)

High School Science

- **HS-ESS3-3.** Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity
- **HS-ESS2-2.** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
- **HS-LS2-7.** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Breakout Edu Tips

If this is your first time using a Breakout Edu box, you are in for a treat. Once you've done one breakout box, your students will be ready for the next time.

- You can use breakout boxes as a whole class in addition to small groups.
- You can give students hints. Every box comes with at least two hint cards. If you have a higher performing group, you may want to challenge them with fewer hints while a different hour may need more.
- Having a visual timer for students while they are working is helpful. It allows them to budget their time and decide when they may want to use their hints.
- As the teacher, you have the discretion to hide things wherever they best fit in your room. Feel free to make adjustments. Just make sure the clues for the locks don't change. Otherwise, students may not be able to get in.
- Do note, when programming the locks, there is a starter ring that has mini teeth. This ring needs to come first.

Background

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Introduction
We are fortunate to live in a society with abundant food, but the challenge for the future is simple. We must feed a population that grows by 80 million people each year, using the same amount of farmland and depleting natural resources. Clearly, the farming practices of the past are not going to be able to sustain us in the future. Our response to this challenge involves making difficult decisions about land use, fertilizers, pesticides, and genetic engineering, among others. As a society, we will have to decide how agriculture can economically feed our growing population while at the same time help us protect our environment.

Soil Triangle
During soil formation, inorganic material is broken down by weathering into particles of various sizes. Soil texture refers to the relative proportions of different-sized particles found in the soil. Scientists classify soil particles into three categories: clay, silt, and sand. Because soils vary in their proportions of these, soil scientists classify different soil types using the soil triangle. Each side of the soil triangle represents the amount of a particle of a certain size—clay, silt, or sand. The relative amounts of these three soil components intersect within the triangle and determine what type of soil those proportions correspond.

Nourishing Crops with Fertilizers
Fertilizer is essentially "plant food." It is added to replenish nutrients that people indirectly extract from the soil by harvesting plants. In non-agricultural ecosystems, the nutrients removed by plants are returned to the soil after the plants die and decompose. On farms, some of these nutrients are removed in the form of harvested crops, so it is often necessary to replace them with fertilizers. The essential components of most fertilizers are nitrogen, phosphorus, and potassium, which are macronutrients. All three of these elements play essential roles in allowing plants to access the free energy of the sun through photosynthesis and must be present in adequate amounts to ensure healthy crop growth.

Organic and Commercial Fertilizers
Farmers who fertilize their crops have the choice of using either organic or commercial fertilizers, or a combination of the two types. As the name suggests, organic fertilizers come from once-living material, such as plants or animal manure. Commercial fertilizers consist of natural ingredients that have been subjected to a chemical process to make a fertilizer with increased and uniform nutrient content. Commercial fertilizers come either from natural mineral deposits or, in the case of nitrogen, from the Earth's atmosphere. Chemically, there is no difference between the nitrogen atoms that come from fertilizer, animal manure, a compost pile, or the atmosphere. Provided they are in the same form (e.g., ammonium, nitrate, or urea), they are the same as far as the plants are concerned. Yet, there are differences in the rate at which the nitrogen from each of these sources is made available to plants and in the ratio of nitrogen to other elements such as phosphorus.

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Meeting Crops' Nutrient Needs

Fertilizers can be applied as liquids, solids or, as in the case of anhydrous ammonia, a pressurized gas that is injected into the soil. Bagged fertilizers are sold in a wide variety of mixtures. It is easy to read their contents from the fertilizer label. The percentage by weight of the three macronutrients—nitrogen, phosphorus, and potassium—is listed as the fertilizer's NPK ratio. For example, a label with an NPK ratio of 26-6-6 means that the fertilizer contains 26 percent nitrogen, 6 percent phosphorus, and 6 percent potassium. Some fertilizers also contain micronutrients, which are nutrients needed in smaller amounts for plant health and growth. Fertilizer labels also indicate the amounts of micronutrients as well as any inert ingredients, such as sand, that are included to provide bulk and make the fertilizer easier to apply.

Farmers use scientific methods to determine the appropriate nutrient balance for their crops. Because every farm field is different, farmers need to be able to select best management practices (BMPs) that are suited to their growing conditions. Factors that may influence BMP selection include soil, climate, topography, and crop nutrient requirements. Often, farmers work with a certified crop adviser, a trained nutrient management professional, to assess growing and environmental conditions and develop a nutrient management plan based on soil needs determined by soil tests.

Free Educational Resources

Science and proper soil nutrition will be critical to helping with not only feeding our world but doing so sustainably. This background information serves as a basic understanding to this complex subject. Free Nourishing the Planet in the 21st Century high school curriculum is available for teachers to use. Teaching the curriculum prior to teaching the breakout box will provide the background information needed for the students to be successful at the lesson. To view other free educational resources, visit www.nutrientsforlife.org and www.kansascornstem.com.

Materials

- Organic and Commercial Fertilizer Bags
- Fertilizer Bags Sort Cards
- Nitrogen Cycle Image
- Nitrogen Cycle Pieces
- Nitrogen Cycle Hint Card
- Soil Column Log Info
- Soil Horizons Definitions
- Soil Horizons Image
- Texture Triangle and Pieces
- Soil Column Cards
- Certificate (Optional)

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Breakout Activity

Game Name
Grow Your NPK Knowledge

Game Designer
Kansas Corn Commission, Nutrients for Life Foundation, and Jessica Sadler

Content Areas
STEM, Agriculture, Nutrients, Corn, Science

Recommended Ages
K-Adult

Ideal Group Size
Can be used in small groups or whole class

Suggested Time
30-40 minutes

Story
With your 16th birthday around the corner, all you have been thinking about lately is getting a car. Sitting in class, you hear your teacher talking about nitrogen and it catches your interest. Raising your hand, you ask, "Isn't nitrous oxide a part of the nitrogen family?" Your teacher confirms you're correct. They even pull up a diagram of the nitrogen cycle. Seeing this piques your curiosity about nitrogen. Who knew soil and plants could produce something used during surgeries, but more importantly could make a new car go faster? You begin thinking you want to learn a little more about soil as well as plant and human interactions.

Lock Combinations
The following codes will open the locks on the Box:

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3-Digit Lock - 3 numbers
2, 6, 7

4-Digit Lock - 4 numbers
3, 7, 1, 9

Letter Lock- 5 letters
R, E, A, B, C

5-Digit Lock- 5 different numbers
2, 3, 4, 3, 2

Key Lock
Teacher Administered

Setup Instructions

Steps

1. Students will need the nitrogen cycle image and nitrogen cycle pieces to solve the 5-digit lock on the main box. These pieces can be hidden around the room or laid out in a pile together. Students will need to place the five pieces back into the correct place in the cycle. When the pieces are ordered, students will put the numbers into the lock.
2. To solve the letter lock that is on the main box, students will need to use soil horizon image and soil horizon definition stripes. When students have matched the definitions to the correct soil horizon, they will know what order to enter the letters into the lock.
3. Students will need to use the soil column cards and the soil column log info page to help solve the key lock on the small box. You may give all groups or students the opportunity to complete this page or have one copy available for work. Students will need to complete the five different columns of information for the four cards on the log info page. After completion, they will show the sheet to the teacher who can check it against the answer key. If it is completed to satisfaction, the students will receive the key to unlock the small black box.
4. Students will need to use the organic and commercial fertilizer bags and fertilizer sort cards to solve the 3-digit lock on the main box. The fertilizer sort cards will need to be locked in the small box. The organic and commercial fertilizer bags can be left outside of the small box anywhere the teacher would prefer. Once students have unlocked the small box, they will be able to sort the pieces into the correct bags. The number on the clue card will go first. When students are done sorting the cards, the number of cards in each bag represents the last two numbers.
5. To remove the 4-digit lock from the main box, students will need to reassemble the texture triangle. There is

a clue card telling them to begin by placing clay. Clay is also the first number they will want to input in the lock. This should cue them to enter the numbers starting from the top and moving downward. The other shapes and symbols have been added to create an additional challenge.

6. It is also possible to include materials or information in the large black box to lead into other Nutrients for Life or Kansas Corn STEM lessons. Certificate can also be used.

Additional Requirements

To access the full labs visit nutrientsforlife.org and kansascornstem.com.

Reflection and Conclusion

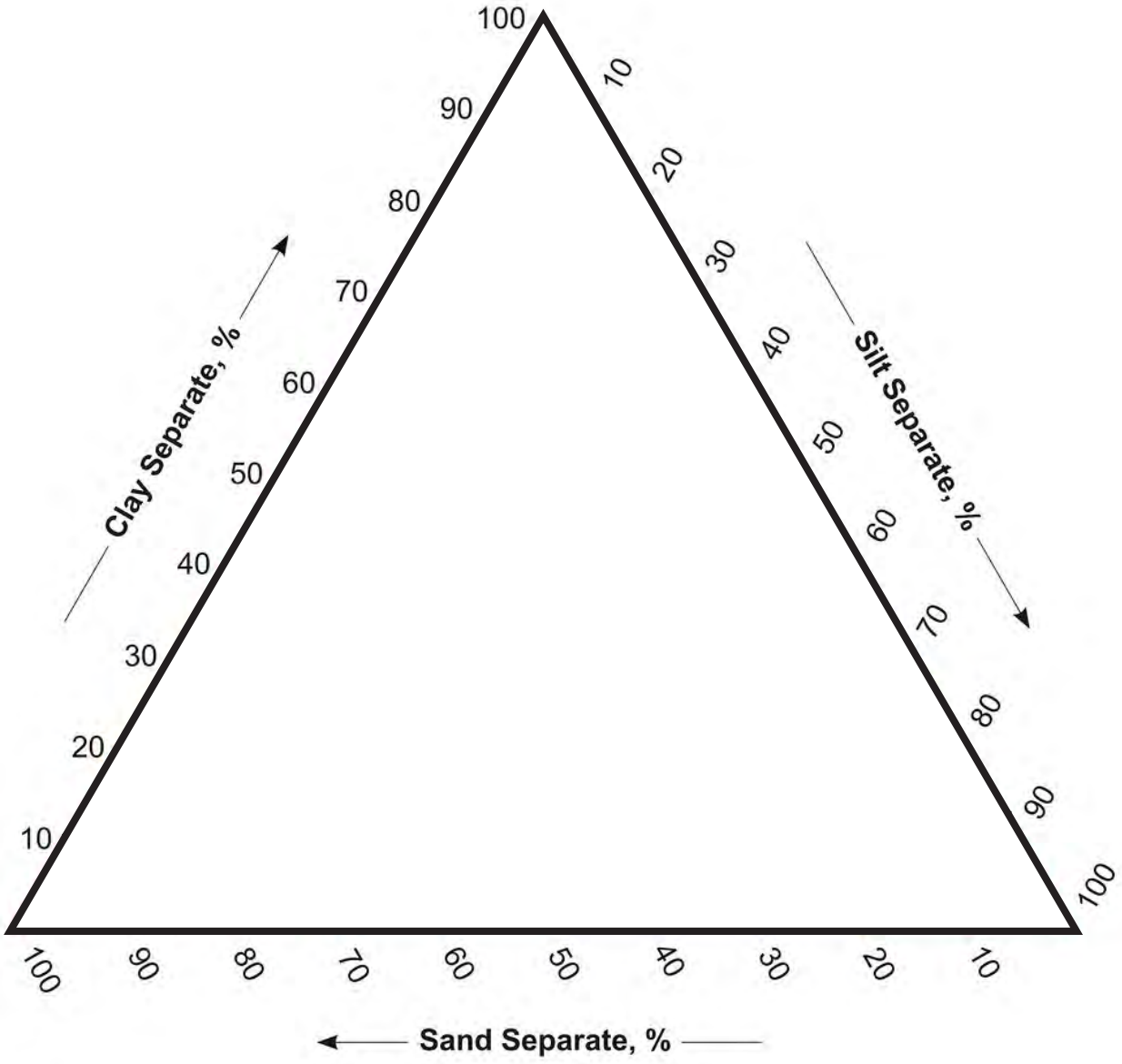
At the completion of this breakout, your students should have a better understanding of the nitrogen cycle, organic and commercial fertilizers, and soil columns/textures/horizons. Feel free to give students the following questions as an exit ticket or knowledge check at the end of the breakout. If you have groups that do not breakout, it is always nice to go over the information or clues that would have led to the last locks coming off.

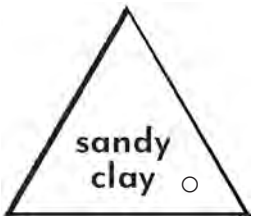
1. In the nitrogen cycle, what is responsible for converting most of the nitrogen used by plants into a usable? Answer: Bacteria
2. What can you learn about soil properties from a soil core sample? Answers will vary. Possible answers: Color, density, porosity, type of soil, water content, rock and mineral content and sizes, presence of pollutants or contaminants, etc.
3. What is the oldest layer in a soil horizon? Answer: Bedrock
4. What are some of the advantages and disadvantages of organic and commercial fertilizers? Answer: Student responses will vary.

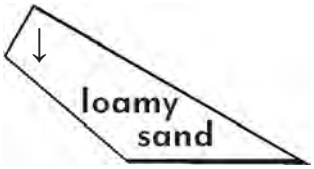
Nutrients for Life

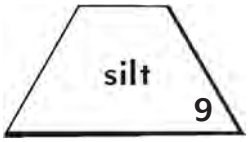
With your 16th birthday around the corner, all you have been thinking about lately is getting a car. Sitting in class, you hear your teacher talking about nitrogen and it catches your interest. Raising your hand, you ask, “Isn’t nitrous oxide a part of the nitrogen family?” Your teacher confirms you’re correct. They even pull up a diagram of the nitrogen cycle. Seeing this piques your curiosity about nitrogen. Who knew soil and plants could produce something used during surgeries, but more importantly could make a new car go faster? You begin thinking you want to learn a little more about soil as well as plant and human interactions.

Soil Texture Triangle

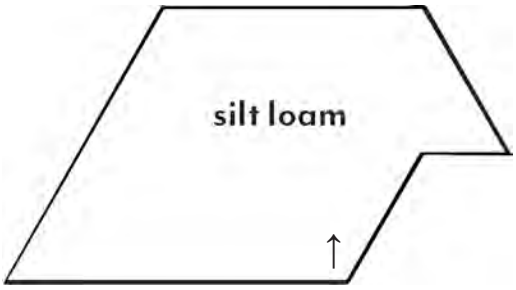



sandy
clay
○

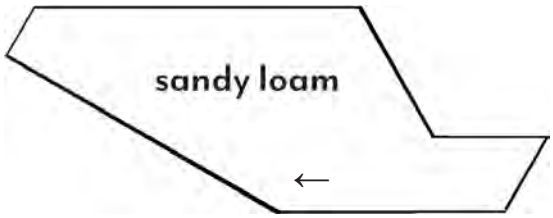

↓
loamy
sand

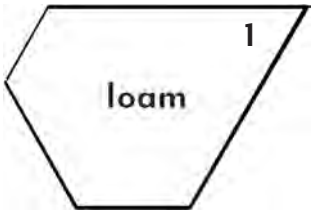

silt
9


clay loam
□


silt loam
↑


silty
clay
→

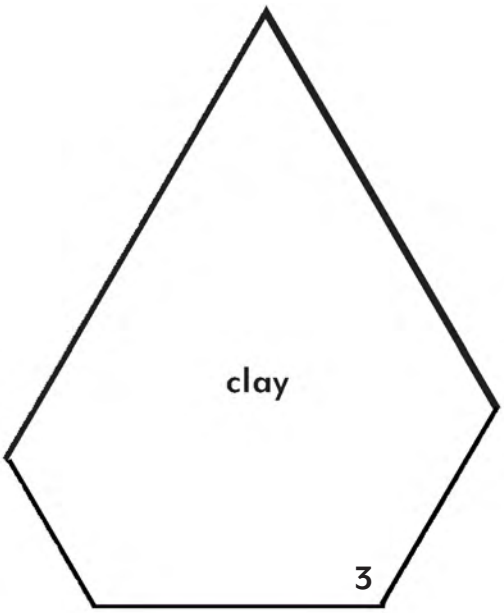

sandy loam
←


1
loam


sandy clay loam
7


silty
clay loam
↓


△
sand


clay
3

Soil Horizon Image and Definition Strips

A mass of rock such as granite, basalt, quartite, limestone or sandstone that forms the parent material for some soils - if the bedrock is close enough to the surface to weather. This is not soil and is located under the C horizon.

1

The deposit at Earth's surface from which the soil developed.

5

Rich in minerals that leached (moved down) from the A or E horizons and accumulated here.

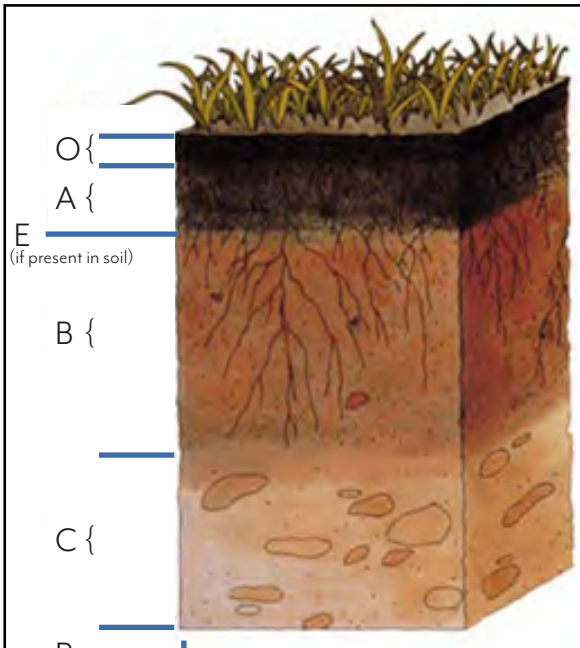
4

Leached of clay, minerals, and organic matter, leaving a concentration of sandy and silt particles of quartz or other resistant materials - missing in some soils but often found in older soils and forest soils.

2

Mostly minerals from parent material with organic matter incorporated. A good materials for plants and other organisms to live.

3



Soil Column Log Info

Depth (Measure depth of layer from top)	**Graph** (Draw layers here)	**Fraction of Sample** (Calculate %)	**Color Description**	**Grain Description**

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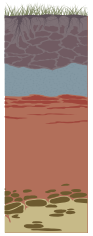
ANSWER KEY KANSAS CORN STEM

Soil Column Log Info

Depth (Measure depth of layer from top)	**Graph** (Draw layers here)	**Fraction of Sample** (Calculate %)	**Color Description**	**Grain Description**
L1: 0-2 in L2: 2-3 in L3: 3-6.5 in L4: 6.5-8 in		L1: 25% L2: 12.5% L3: 43.75% L4: 18.75%	L1 is a dark grayish purple. L2 is a medium blue. L3 is a rust red/orange. L4 is light tan with dark brown patches.	L1: L2: L3: L4: L5: Student response with vary
L1: 0-.75 in L2: .75-1.25 in L3: 1.25 - 2.5 in L4: 2.5-5.25 in L5: 5.25-8 in		L1: 9.375% L2: 6.25% L3: 15.625% L4: 34.375% L5: 34.375%	L1 is mossy green. L2 is white/grey. L3 is peachy. L4 is sea foam green with darker green particles. L5 is a rust red/orange.	L1: L2: L3: L4: L5: Student response with vary
L1: 0-3 in L2: 3-6 in L3: 6-8 in		L1: 37.5% L2: 37.5% L3: 25%	L1 is a rust red/orange with darker red particles. L2 is cobalt blue. L3 is a lighter blue with a few colbalt splotches.	L1: L2: L3: L4: L5: Student response with vary
L1: 0-.75 in L2: .75-2.25 in L3: 2.25-4.75 in L4: 4.75-7.25 in L5; 7.25-8 in		L1: 9.375% L2: 18.75% L3: 31.25% L4: 31.25% L5: 9.375%	L1 is tan. L2 is white/grey. L3 is hunter green. L4 is a light brown. L5 is dark brown. L6 is mostely orange chunks with a little red.	L1: L2: L3: L4: L5: Student response with vary

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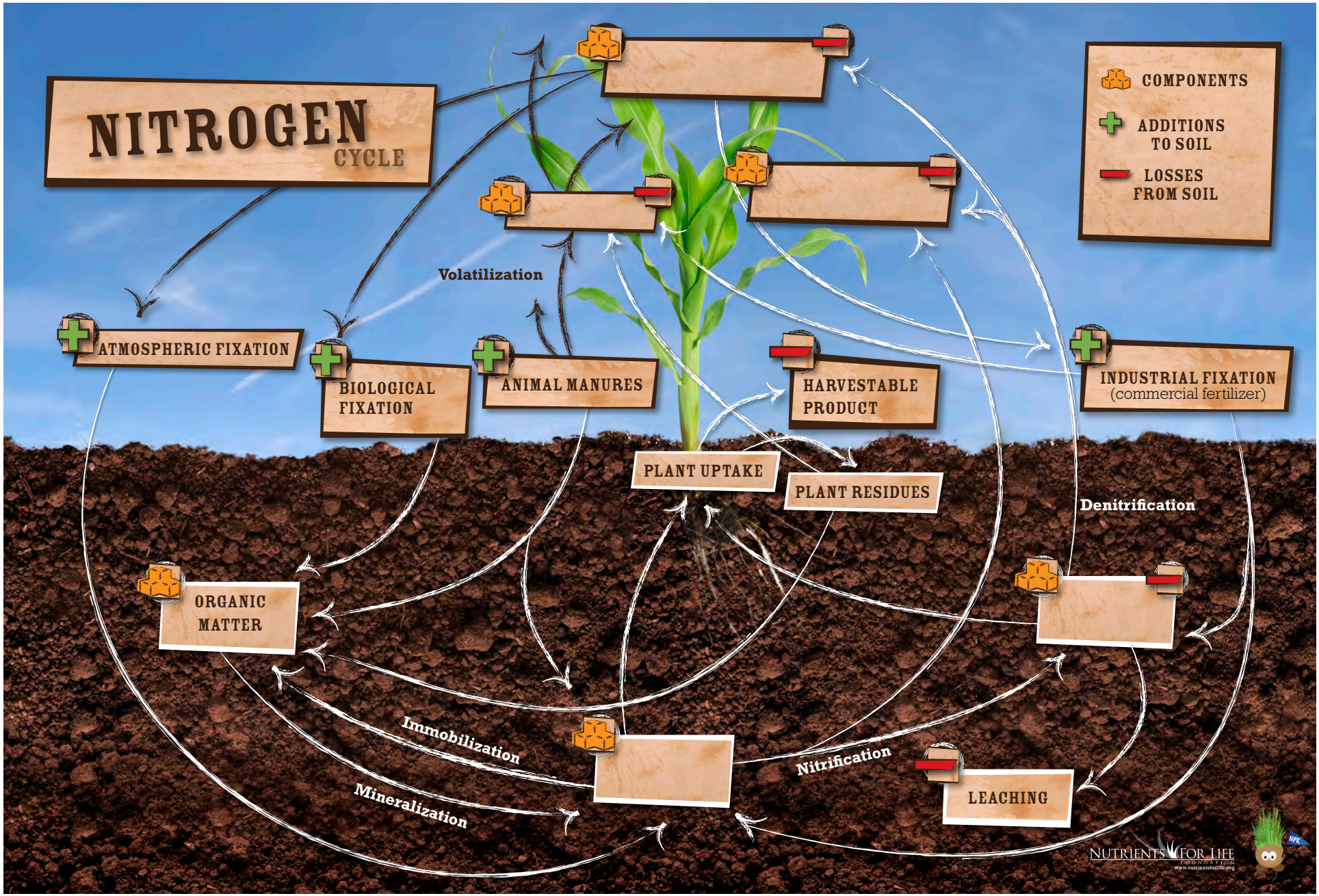


Nitrogen Cycle Pieces and Hint Card

Start with the component closest to the top. Then read them left and around to open the 5 digit lock.

Nitrate NO_3

Ammonia NH_3

Ammonium NH_4+

Nitrous Oxide N_2O

Atmospheric Nitrogen N_2


ORGANIC


CONVENTIONAL

Usually contain little or no synthetic material.

Lower and unpredictable amounts of nutrients.

Farmers may need to use larger amounts of these to meet the needs of crops.

Can be less expensive but may produce lower crop yields.

Requires best management practices to raise healthy crops while protecting the environment.

Encourages the use of local natural resources.

Most nutrients are released slowly as microbes in the soil break down the organic material into forms the plant roots can absorb.

Made usable to plants through industrial processes.

The precise amount of each nutrient is known

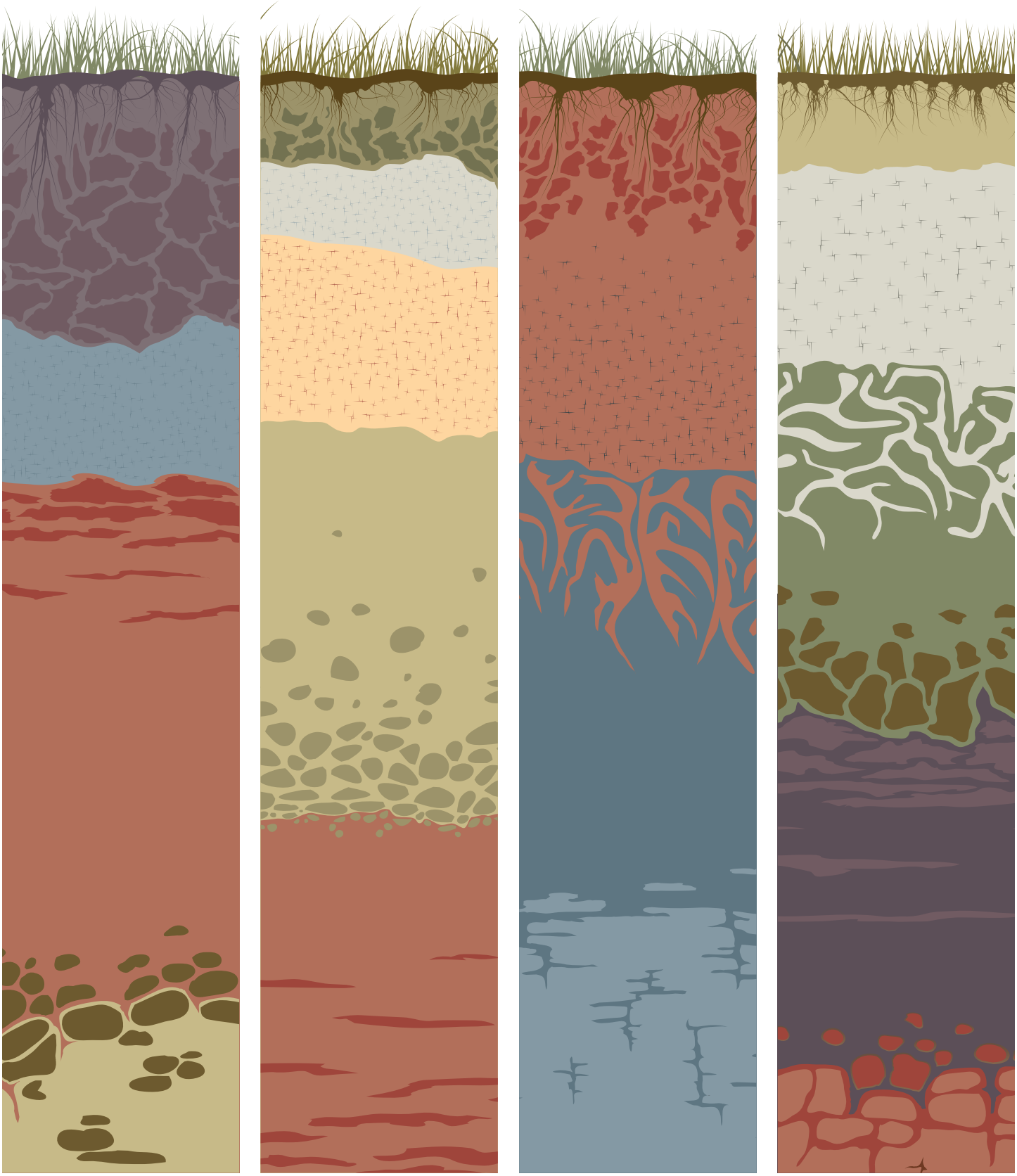
The components come from natural mineral deposits or the air.

Bags are labeled with the amounts of nitrogen, phosphorus, and potassium.

Requires best management practices to raise healthy crops while protecting the environment.

Fertilizer overuse is more likely to occur.

Alphabetize your bags before sorting through, the 2 types of fertilizers you see before you.



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Congratulations!

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