Seed Banks

Overview: Students will learn about the mission of seed banks and the importance of carefully and intentionally preserving the genetic information from a diversity of plant species.

Grade Level/Range: 4th – 8th Grade

Objective:
Students will explore:

- The importance of genetic diversity for plants, especial food crops.
- The science behind seed saving.
- The important work of seed banks.

Time: Advance Preparation, 1-3 months; Exploration, 1 week.

Materials:
Paper towels
Sealable plastic bags (sandwich size)
Pre-treated seeds (select seeds with a short germination time of a few days to a week, such as wheat or beans)
Water
Paper and pencil

Background Information

Have you ever considered the importance of saving seeds? A seed represents the promise of life -- a new plant in a ready-to-grow package. It also contains that species' genetic code that will manifest as traits the plant has evolved to help ensure its survival over the long haul.

Over time, both through natural selection and human intervention (i.e. plant breeding and genetic engineering), the genetic information of our most commonly grown seeds has changed. Insects and diseases, urban development, agricultural practices, climate change — even our taste preferences — affect which types of plants we choose to grow and thus the seeds that we save.

Globally, approximately 150 crops make up the majority of the food grown and consumed by humans. Through centuries (and for some crops, millennia) of selective seed-saving, combined with scientific advancements, we have increased the beneficial traits in these crops, such as tolerance to drought, frost resistance, enhanced nutritional content, and toughness to withstand mechanical harvesting. In general, to make large-scale agriculture more predictable, the number of crop varieties grown has decreased and the uniformity of their traits has increased. The upside of this process? An efficient system that feeds millions and keeps food prices low. The downside? Crops with less variation or biodiversity could be highly vulnerable to diseases that are inadvertently introduced or evolve to be particularly destructive. Biologists are concerned about the lack of genetic resources within these crops that would allow them to breed varieties that can withstand such diseases.

Already three-quarters of the biodiversity in crops have been lost in the last century, according to the Food and Agriculture Organization. Biodiversity is the degree of variation within a given ecosystem or biome. It is often an indicator of the health of the ecosystem because greater biodiversity implies greater health. Biodiversity can also refer to the genetic variations among plants within a species, such as a particular crop.

Saving a wide variety of seeds (not just the ones most commonly grown) can increase our ability to overcome diseases and environmental challenges in the future. Making sure that there is a diversity of genetic information available so scientists can find plants with the right traits at the right time is critical. Keeping seeds viable (able to grow) over time is no small job. Specialized seed banks or gene banks are designed to provide the ideal storage conditions to guarantee the safekeeping of this valuable genetic material.

Seed banks serve as an insurance policy for the future of agriculture and plant science. Disasters, such as war, hurricanes, and other destructive events, will happen and when they do, entire crops of food and fiber may be eliminated. If seed banks aren't available to help provide new seeds and plants for these locations, human populations may suffer from devastating conditions, including famines and economic collapse.

The purpose of a seed bank is to:

- Conserve the diversity of plant species.
- Offer resources for breeding of stronger crop varieties.
- Provide food solutions in times of disaster.
- Safeguard food supplies for future generations.

How They Work

In a seed bank, seeds are kept in a cool (generally frozen), dry condition so that they do not sprout or rot. Periodically, the seeds are used to grow new plants, which will in turn produce fresh seeds for the seed bank. This rotational system keeps the seed viable over time since most seed cannot be kept indefinitely.

Seed banks may contain more than just seeds. Some plants require even more sophisticated methods of gene-banking as they are most commonly grown from tubers, rhizomes, cuttings, and tissue culture. For example, crops such as potatoes, yams, and cassava are grown from tubers or rhizomes. They do not produce true seed, for when they do, they shuffle their genes so that the potatoes or yams that grow from the seed are not genetically identical to the plants that produced them. The particular qualities of that variety are lost unless the tubers themselves are stored. They are easily stored for a short time, but must be regenerated (replanted) much more often than most seeds.

Other plants pose even greater difficulties. Many cultivated bananas and plantains produce no seed at all — they are sterile, and they don't produce any storage organs (tubers or rhizomes) either. They are propagated exclusively by cuttings. Seed banks use new technology to store the cells of these plants by growing them on a gel and feeding them nutrients and hormones to grow entirely new plants. They also store these cells through a special form of freezing called cryopreservation (-196° C).

In their Genebank Standards Guide, the Food and Agriculture Organization (FAO) lists that there are about 1,750 individual seed banks worldwide. One of the largest and most important seed banks is the Global Seed Vault near Longyearbyen, Norway. The Norwegian island of Svalbard houses this vault, built in 2008. The vault sits halfway up a mountain overlooking the main airport and fjord near the island's capital. Descending almost 500' under the permafrost, the entrance tunnel to the seed vault is designed to withstand bomb blasts and earthquakes. An automated digital monitoring system controls temperature and provides security akin to Fort Knox. No one person has all the codes for entrance. Although there are many seed banks, few are as high-tech or secure as the Global Seed Vault. The security of the vault is important for all nations because it now contains samples from one-third of the world's most important food crop varieties.

The seed vault functions like a safe deposit box in a bank. Like a bank owning the building, the Government of Norway owns the vault and other seed banks make deposits with the seeds they send. The seed samples that are stored in the vault are copies of samples stored in other banks. The vault is simply a way to keep specific samples safe and secure. No one has access to anyone else's seeds inside the seed vault. There are many organizations that help operate the vault. They care for the seeds, coordinate shipments, and record valuable information.

The Global Vault is part of a broad effort to gather and record information about plants and their genes. A system of plant banks could be crucial in responding to climate crisis since it could identify genetic material and plant strains better able to cope with a changed environment.

Laying the Groundwork:

Begin your discussion of the importance of saving seeds by providing an example of when what can happen when there is a lack of diversity in plant species. The Irish Potato Famine of the 1800s provides a prime example.

Potatoes are generally not grown from seed, but rather from "starts" or "eyes" in the tuber itself. (The small potato pieces commonly planted are sometimes referred to as "seed potatoes". These starts are genetically identical to the parent plant. During the late 17th century, the potato became the widespread dietary staple in Ireland. Many people were poor and had small farms. They relied on the potato because it grew in the relatively cool climate and provided sufficient calories to sustain the population. Because few, if any, potatoes were grown from seed in this region, the plants had very little variation. This genetic uniformity left the potatoes — and the people that depended upon them for sustenance, — vulnerable to a pest or disease outbreak because each plant was equally susceptible.

It is unclear where the fungus that caused the potato blight originated — perhaps on a ship from Baltimore or New York — but in 1845, a rot disease caused by *Phytophthora infestans* hit Ireland, turning non-resistant potatoes into inedible slime. In just a few months it spread throughout Ireland, destroying more than one-third of the potato crop. By the following year (and for the next seven years), three-quarters of the crop was lost to potato blight. Little seed had been saved because few felt that it was necessary when the plant could be grown from the tuber. Because Ireland was so dependent on the potato as the major source of calories and nutrients, especially among the poor, the Great Famine, as it came to be known, resulted in an estimated one million deaths from starvation. It also resulted in a mass exodus as millions of residents relocated to other countries (many to the United States) as a means of survival.

Today, we understand that relying on crops with low genetic variation can lead to disaster. The Great Famine had a number of causes, but the disaster would not likely have been so severe if either the potatoes had more genetic diversity or more seed were available to strengthen the variety available. Some potatoes would have carried the right genes to survive infection by the fungus, and more of the resistant varieties could have been planted in the years following the first epidemic.

Introduce seed banks to your students and explain how they can play a critical role in finding these types of solutions. As a class, ask students to list some of the most important crops in our food system. You will likely be surprised how just a few, like corn, wheat, and rice, make up the bulk of our diet. Discuss the potential for the changes in their diet that would occur if wheat, rice, or corn could no longer be grown in the United States. Would there also be global repercussions from such an event? Tell the students that there are over 100,000 varieties of rice and its relatives stored in seed banks. Why would this be an important fact to the global community?

Advance Preparation:

For the Exploration section of this lesson, students will test germination rates of seeds that had previous been saved in cold storage. Choose seeds with short germination times, such as wheat or beans. To prepare, place a class set of seeds in the freezer three months before the Exploration. Place another set in the freezer two months before the Exploration and a third set one month before the Exploration.

Exploration:

1. Ask the students to describe the purpose of a vault or safe. What kinds of things belong in a vault or a safe? Explain to the students the importance of keeping seeds safe. Ask them to brainstorm ways that seeds could be saved. In the short-term, seeds can be kept in dry, cool locations and need to be protected from rodents and other insects that may try to eat them. Use the Background Information to explain some of the complexities involved with long-term storage.

2. Explain to students that you have pre-treated a selection of seeds and that you plan to test to see if the treatment has impacted germination rates.

3. Divide students into at least four teams, with each team trying to germinate seeds that experienced a different pre-treatment, (If you pre-treated more than one type of seed then you may need more teams.) Team 1 will try to germinate seeds that were in the freezer for three months. Team 2 will try to germinate seeds that were in the freezer for two months. Team 3 will try to germinate seeds that were in the freezer for one month. And Team 4 will try to germinate seeds that were never placed in a freezer. Have teams place the seeds on wet paper towels in sealed plastic bags and keep them at room temperature.

4. Have students carefully observe the seeds every day and track the number of seeds that have germinated. At the end of one week, have them calculate the germination rate of the seeds: Divide the number of seeds that germinated by the total number of seeds and multiply by 100.

Example: If 15 out of 20 seeds germinated: 15 divided by 20 equals .75, multiplied times 100 = 75. So the germination rate was 75%.

5. Ask, did cold storage have an impact on our seeds? What do you think would have happened if they had been left in cold storage longer?

Making Connections:

Use this video from The Crop Trust to further explain the importance of crop diversity and to introduce the Global Seed Vault: https://www.youtube.com/watch?v=UGAMn4LALIs.

Locate the Svalbard Islands on a map. Why was this location chosen? Unfortunately, even this site is not immune to disaster. In 2017, the Vault experienced flooding due to Arctic ice melting

Ask students to consider what this might mean for our society. What are some other solutions available to us to help preserve diversity? Ask them, how can we use our home and school gardens to help?

Extension

As a class, determine a few plants from your garden that you could save seeds from. List the steps and form a plan for harvesting, preparing, and preserving those seeds. Discuss the advantages and disadvantages of saving seeds from year to year.

Check out the Seed Savers Exchange (https://www.seedsavers.org/), a nonprofit who mission is to help preserve diversity in our food crops. Schools are eligible to apply for community seed donations at: https://www.seedsavers.org/seed-donation-program.

In addition to seed banks, many botanical gardens and arboreta are working to preserve plant species. There are also substantial rare plant and seed collections in botanical gardens around the world. It is estimated that botanical gardens grow over 80,000 plant species (approximately one-third of all known plant species). If possible, schedule a class trip to a local botanical garden to learn more about their collections.