

Hawaii Heritage Seed Project: Classroom Lessons- Overview

These lessons were designed as part of a Master's degree project which seeks to identify and record the stories of heritage (heirloom) varieties of food and medicine plants that were brought to the Hawaiian Islands during the plantation era.

The first lesson introduces students to basic pollination biology, including flower morphology, self-pollination, cross-pollination and the differences between hybrid and open-pollinated plants.

In the second lesson, students will examine the importance of varietal diversity in our food systems and look at the decline of this diversity.

Students who participate in both lessons are invited to participate in a community project where they survey their family and community to find "Seed Keepers", individuals who grow and maintain old varieties of food and medicine plants..

These lessons were developed for Middle School students, but may be adapted for other grades. You are welcome to modify and use these lessons in your class as desired.

For any additional questions or information, please contact me at istout@hawaii.edu or see the information at www.gofundme.com/HawaiiHeritageSeed.

Mahalo!

Ilana Stout

Lesson 1: Plant Reproduction

Materials:

8"x11" white paper (or regular classroom notebooks)

Scissors

Paper plates

Hand lenses

Toothpicks

A selection of flowers (at least 1 per student) that have both male and female parts (Hibiscus, beans and other legumes are easy to find examples)

White board

Projector or printouts of flower images from attached PowerPoint file

If available:

For Huli Prep demonstration:

Kalo plant, with corm attached (it does not need to be large),

Sharp knife,

Cutting board

For Seed Saving demonstration:

Fully mature (dried on the plant) green beans for seed saving

Very ripe tomato for seed saving

Glass jar

Water

Introduction

(Optional) Students create notebooks to use for the two lessons

<https://www.youtube.com/watch?v=QC3e80HFEOI>

Q: What are your favorite foods that include plants?

Students may not know that flour, chocolate, sugar, etc. come from plants; trace these items back to their plant origins. This is also a good time to emphasize that, because animals eat plants, ALL of the energy in our food was originally harvested by plants via through photosynthesis. For this reason, the study of plants is very important to the survival of humankind.

Think-pair-share

Q: What do you know about plant reproduction?

Students brainstorm in their notebooks, discuss with a partner, and share to the larger group. Record answers on the board and encourage students to add to their individual lists.

Solicit:

(Plants reproduce in different ways)

(Some plants can reproduce via clones, cuttings, slips, huli.)

This is called **Vegetative Reproduction**

(Some plants reproduce via seeds.) This is called **Sexual Reproduction.**

Sexual reproduction is important because it means that genetic recombination occurs, and the offspring are not identical to the parent plants.

(Flowers are the part of plant used in sexual reproduction, seeds are baby plants.)

(Flowers have male and female parts.)

The names of specific reproductive structures will be covered later in the lesson, so it is not necessary to go over them now unless students offer them

(Pollination is the process by which plants produce seeds.)

Vegetative Reproduction

Introduce Kalo (*if living plant is not available , you can use a drawing on the board or the illustration attached at the end of this lesson*)

Q: What is this plant?

(Kalo/ Taro/Colocasia esculenta)

Q: What foods do we make from it?

(Poi, laulau, luau, kulolo)

Q: How's it planted?

(Cuttings called **huli**)

Demonstrate how to prepare huli for planting

Clean off feeder roots, outermost lau. Cut at just below the kohina, cut off top of lau. Do not cut unfurled lau. (See the following for more information :

<https://www.youtube.com/watch?v=-fUxr7SAKSI> -huli prep starts at approximately 3:20)

Draw Kalo on board & label parts, students record/draw in notebooks

See illustration at end of lesson

-lau/luau

-piko

-hā

-kohina

-oha

-kalo

-huli

Brainstorm other vegetatively propagated food plants

(eg .turmeric, ginger, sweet potato, banana, pineapple)

Discuss limitations of vegetative propagation:

Keiki plants are genetically identical to the mother plant.

This leads to decreased **genetic diversity**...

(Genetic diversity= # of different genes in a population)

... which leads to decreased **agricultural diversity** (*Agricultural diversity=diversity of different types of foods*).

This can create problems for our food systems (*as we will discuss in Lesson 2*)

Sexual Reproduction-Flowers

Q: How else do plants reproduce?

(Most plants also reproduce sexually, many via flowers)

Q: What are some of the parts of a flower?

(Answers will vary depending upon the skill level of the class)

Perfect flowers

It is not necessary for students to memorize the individual terms for the reproductive parts, but they should understand their basic function. Use your discretion as to level of detail that is appropriate for your class.

Draw flower on board and & label parts (*see attached illustration*)

Students copy illustration into notes/notebooks

Petals: (*attract insects/protect reproductive parts*)

Sepals: (*protection of developing flower*)

Anther/stamen/pollen: Male parts ♂ (*label as a group*)

Stigma/style/ovary/egg: Female parts ♀ (*label as a group*)

Illustrate the process of pollination:

A pollen grain, containing 2 sperm cells, travels from the **stamen** (*via wind or a pollinator*) to the sticky **stigma**. It forms a long tube down the style to the **ovary**, where one of the two sperm merge with an egg to form an **embryo**, which will become the baby plant (*students may recognize this from having looked at the inside of a peanut or avocado.*). The second sperm cell becomes the **endosperm**, the bulk of the seed, which is food for the embryo. The ovary develops into the fruit.

Flower dissection

In pairs, students use hand lenses to dissect **perfect flowers** (*eg. hibiscus, beans*) with toothpicks on paper plates and draw/label the parts in their notebooks.

Imperfect flowers

Q: There are also “**imperfect flowers**” ! What do you think these look like?

What do you think makes them "imperfect"?

(Imperfect flowers have only male or only female parts)

Draw "monoecious" flower (*see attached illustration*) .

I generally introduce the scientific terms for types of flowers until later in the lesson, so do not label it as monoecious at this point.

Go over parts again but do not relabel with botanical terminology

Just identify what are (male) ♂/ (female) ♀ parts

Students copy illustration into notes.

Share pictures of monoecious flowers and list of examples (eg. corn, squash)
(see ppt attachment)

Q: Can you think of any other ways that flower parts might be arranged?

(Sometimes the male and female flowers are located on separate plants)

Draw dioecious flower on board (see attached illustration)

Point out reproductive parts, but do not label.

Share pictures of dioecious flowers (see ppt) and discuss examples.

Date palms are one of the best examples. They are wind pollinated and people who grow dates have to ensure that they plant the female plants downwind from the males so that pollination can occur. NOTE: Cannabis is also dioecious, some students will bring this up, saying that is the reason that growers kill the males, to prevent seeds from forming.

Share image and story of "Methuselah" (see ppt for image).

In 2003, researchers in the middle east found the 2000-year old seeds of a now-extinct variety of date palm. They were able to get one of the seeds to germinate and grow into an adult plant. This was considered a huge success, both for the preservation of genetic diversity and cultural history. But there was a problem. Methuselah is a male and date palms have separate female and male plants. So we haven't been able to produce new seeds from this species.. Yet.

Extension: Read Stories about Methuselah from National Geographic:

<http://news.nationalgeographic.com/news/051122-old-plant-seed-food/>

<http://news.nationalgeographic.com/2015/03/150324-ancient-methuselah-date-palm-sprout-science/>

Introduce botanical terminology

Write the Latin terms and their meanings on the board next to each illustration.

Imperfect Flowers:

-**Dioecious** = "two house"
male and female flowers on separate plants

-**Monoecious** = "one house"
male and female flowers on the same plant

Perfect Flowers:

-**Monoclinous**= "one bed"
male & female parts in the same flower

These types of flowers are also called **hermaphrodite**.

Flower structure affects agriculture

Q: Why do farmers/gardeners care about any of this ?

Hint: Genetics

(Flower structure is important for keeping different crop varieties distinct -eg hot vs sweet peppers)

Q: There is a man in Hilo who has been keeping the same special variety of Kabocha Squash for 75 years. Squash are have imperfect flowers. What could happen if his neighbor grows some different pumpkins?

(They could cross, the seeds of the next generation would be a combination of the two parents, and he would lose his special variety) .

Because of this farmers/gardeners use special techniques to save seed .

This is a good time to review a simple punnet square if you have time

Intro to seed saving

Perfect flowers = **Self-pollinating** = “selfers”= easiest to save seeds

Imperfect flowers = **Cross-pollinating** = “outcrossers” = harder to save seeds

Offspring of outcrossers can be genetic recombinations. they won't look/taste like parent plants UNLESS special steps are taken to prevent cross pollination between different varieties.

If you have time:

Demonstrate how to clean green bean seed for planting:

<https://www.youtube.com/watch?v=AuHc2kQMXkQ>

and set up tomato seed fermentation (see Lesson 2)

<https://www.youtube.com/watch?v=FEkVep0PnLo>

Exit pass:

Why does the flower structure matter to farmers?

Collect mini-note books.

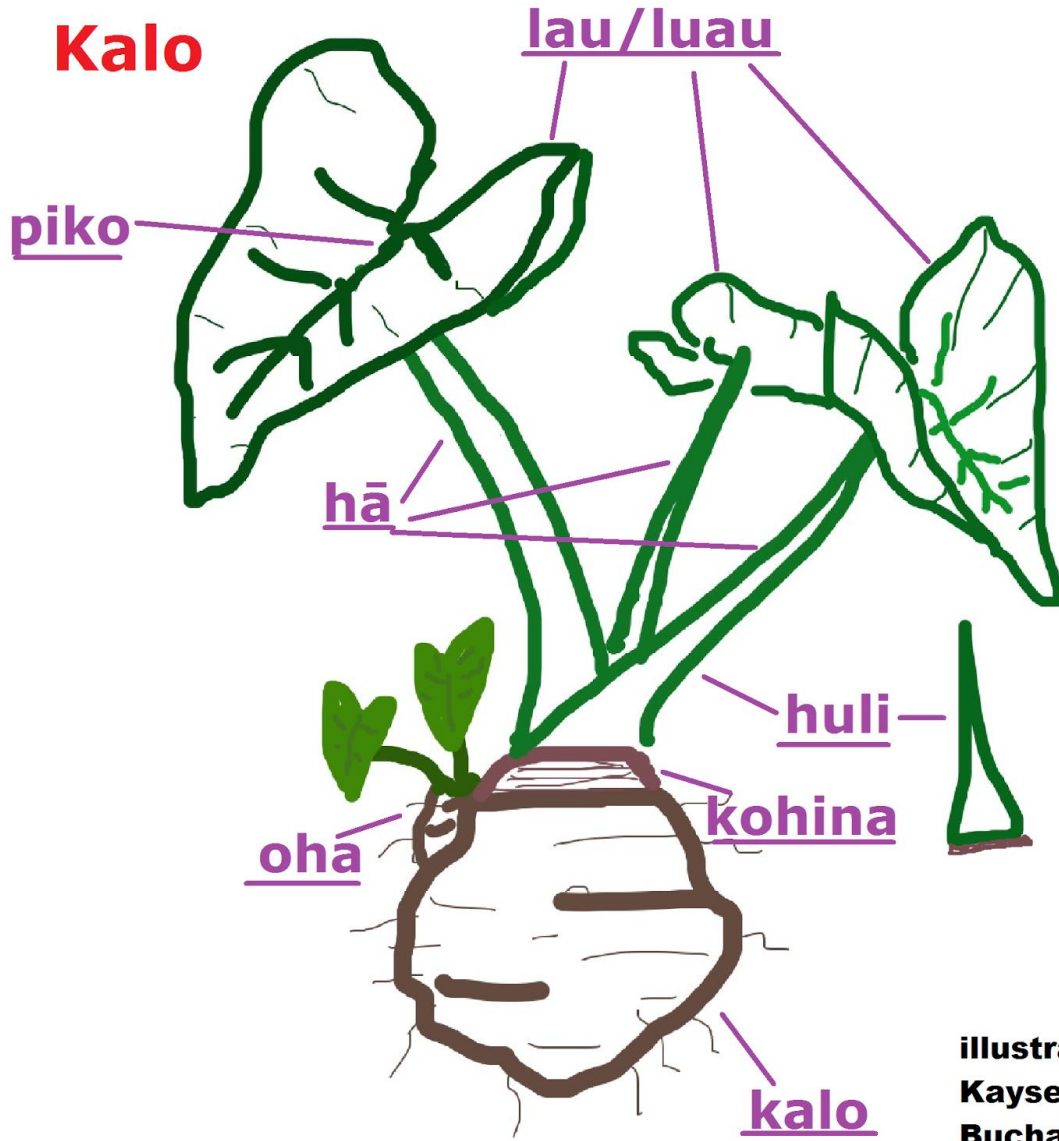
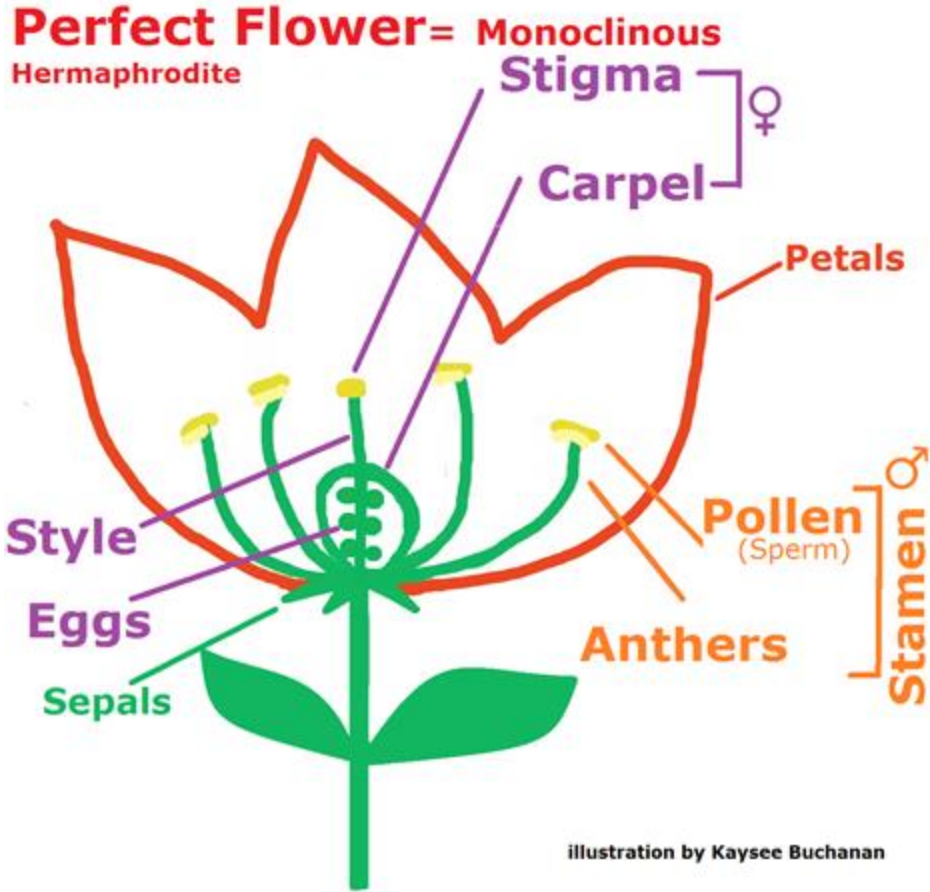
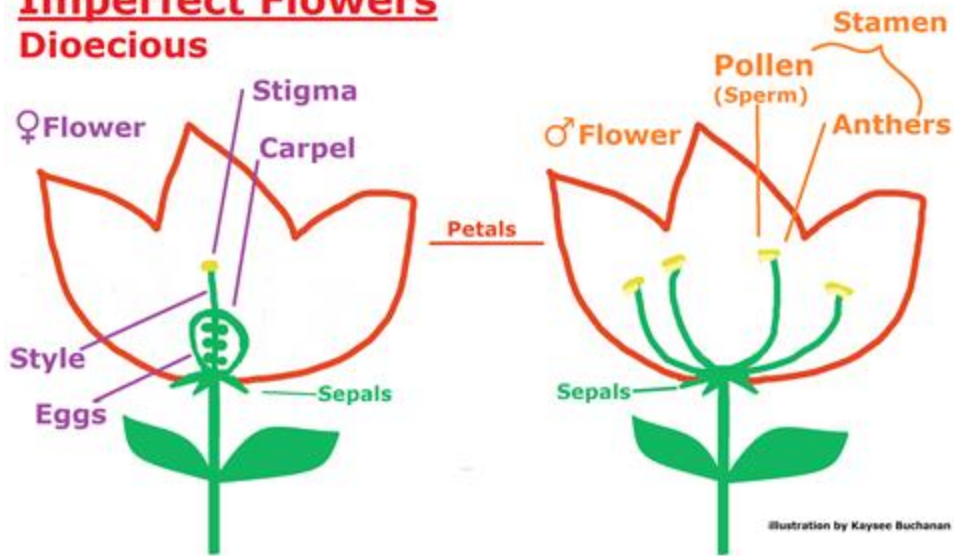


illustration by:
Kaysee
Buchanan



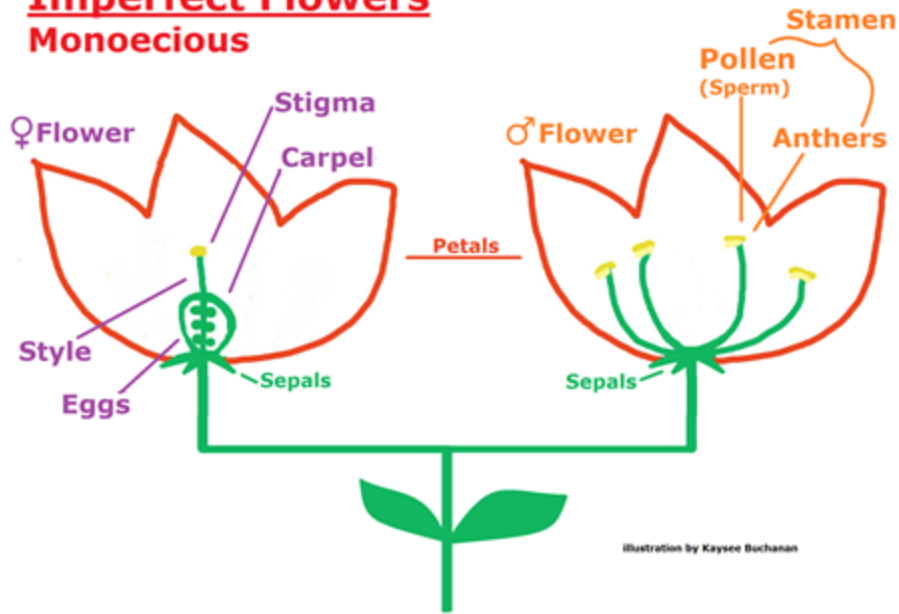
Imperfect Flowers

Dioecious



Imperfect Flowers

Monoecious



Seed Lesson 2: Varieties & Diversity

Materials:

Perfect & Imperfect Flower Illustrations

Samples of known seed varieties, if possible ones that you have personal experience growing
If you need help identifying varieties for activity, please contact me (istout@hawaii.edu)

Computer access or print copies of http://evolution.berkeley.edu/evolibrary/article/agriculture_02

Seed Catalogs

*Having a variety of seed catalogs from different companies can help with differentiation, as some catalogs contain more pictures, while others have more detailed descriptions.
If you need help finding seed catalogs, please contact me (istout@hawaii.edu)*

Review: Pollination Biology

- Q: Why does flower biology matter to seed savers?
(To keep varieties pure/avoid cross-pollination)
- Q: What is a perfect flower?
(**Perfect** flowers have female ♀ and male ♂ parts on the same flower.)
Share illustration from Lesson 1
- Q: What is an imperfect flower?
(**Imperfect** flowers have female and male parts are on separate flowers or plants.)
(Share illustration from Lesson 1)
- Q: Is it easier to save seed from plants with perfect flowers or imperfect flowers?
(Perfect)
- Q: Why?
(Plants with perfect flowers are usually self-pollinating, these are easy to save because the offspring are always identical to the parent plants, they are called "**Selfers**")
Examples: tomatoes, beans, lettuce
- Q: What can happen if you save seed from plants with imperfect flowers?
(Plants with Imperfect flowers can be cross-pollinated by other plants/varieties. This means that sometimes the offspring are not the same as the parent plants. Because of this, special techniques are needed to save seed. Plants with imperfect flowers are called "**Outcrossers**")
Examples: melons, corn, squash

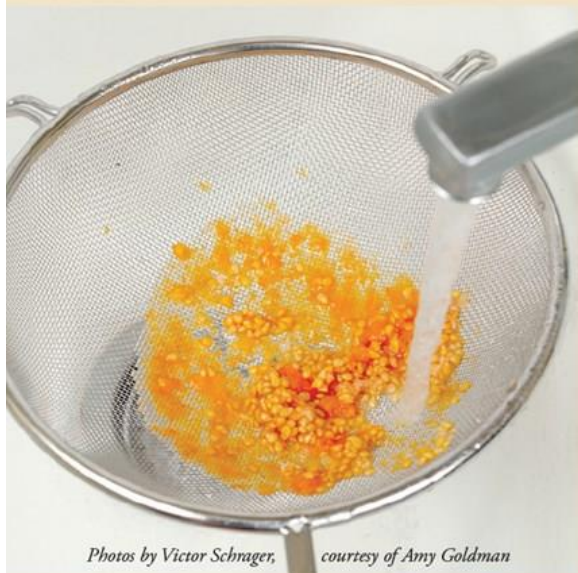
Seed Saving:

If you have set up tomato seeds fermentation, demonstrate how to clean them for saving (

HOW TO SAVE TOMATO SEEDS



1 Cut tomatoes open—one variety at a time—and squeeze the pulp, juice, and seeds into a glass or plastic container.



Photos by Victor Schrage, courtesy of Amy Goldman

3 Viable tomato seeds will sink to the bottom of the container. Pour off pulpy mixture on top, and then pour the remaining liquid and seeds into a kitchen strainer and wash thoroughly under the faucet until clean.

2 Set the containers aside to ferment, this breaks down the gelatinous coating on the seed that prevents it from germinating. Fermentation can happen in 24 hours to 4 days, during this time a layer of mold may form across the top.



4 Spread the seeds out thinly on surface to dry. Any substrate to help them dry as quickly as possible will work: coffee filter, paper plates, paper towel, or wax paper. It is best to dry seeds out of direct sunlight—drying could take up to 4 weeks.



Introduction: Seeds in Hand Activity:

Pass out a sample of one seed to each student

Using multiple varieties can help maintain student interest, if possible, choose varieties with interesting stories/ histories/ traits..

Q: What can you tell me about these seeds?
(Solicit physical qualities)

Q: Can you tell me the type of plant?
(Some will be able to do this)

Q: Can you tell the variety?
(Most will not be able to do this)

Q: Can you tell if it grows well in wet/dry conditions?
(No)

Q:Can you tell if it is tasty?
(No)

Q:Can you tell if it is Genetically Modified?
(No)

Q:Can you tell if it is alive?
(No)

This is because physical seeds alone are not enough, the story is very important!

Share stories of the seeds you shared with the students

Alternative Introduction Activity:

Play the following SeedBroadcast story by Jim Veteto and have students illustrate the story while listening, then discuss as a class why seed stories are important

(<https://soundcloud.com/seedbroadcast/jim-veteto-talks-about-the-seeds-that-have-influenced-his-life-and-work-as-a-cultural-anthropologist>)

Seed Diversity:

Pass out Seed Catalogs to pairs of students:

Assign one vegetable crop to each pair (eg. *lettuce, tomato, beans, eggplant, squash*)

For their assigned crop, each pair should answer the following questions:

How many varieties are available?

Which is the most interesting looking variety? Why?

Which variety has the most unusual name?

Can you tell where any of the varieties originally came from?

Do any varieties grow in unusual conditions?

Are there codes (letters/abbreviations) associated with any of the varieties?

Discuss results as a whole class, highlight the following:

- There is greater diversity in some crops than others
- Not all catalogs offer the same varieties, this is in part because some varieties are considered **intellectual property** of the breeder or seed company.
- Many old varieties are from one specific area or farmer/gardener.
- Sometimes names tell you a bit about the variety (Earl girl , Big Boy, Lazy Wife)
- Some varieties are adapted for early or late season growing, disease/pest resistance, heat, cold, moist, dry or saline conditions.

- Common Abbreviations :
 - **OG= Organically grown** seed (likely to perform better for organic growers because it is adapted to **low input** conditions)
 - **OP: Open –Pollinated** (these seeds will grow true to type, can be saved)
 - **F1: Hybrid** (these seeds are special crosses that have been produced by the seed company to increase vigor or performance, because they are crosses of 2 parent lines, seed that is saved from hybrid plants will not be like the parent lines)

Students take notes (or illustrate) the following:

- Over the past 10,000 years, countless generations of people have saved seed from the very best plants that they grew and created thousands of varieties of food plants.
There are over 40,000 varieties of beans alone!
- In Hawai'i alone there were ~300 named varieties of Kalo before European contact, there are now only 86 varieties remaining.

Q : How might this variety diversity be helpful to farmers/ gardeners? Why don't we all just grow one kind of taro?

(Different kinds grow better in different places, different kinds have different uses/flavors/ textures, some are able to withstand drought, disease or pests better)

Variety Diversity & History: the Irish Potato Famine

Students view online (or distribute in hard copy) :

http://evolution.berkeley.edu/evolibrary/article/agriculture_02

Students read article in groups and answer the following guiding questions:

What was the main crop grown in Ireland in the 1800's?

Why was this crop at risk of disease?

There were approximately 8 million people living in Ireland during the 1840's. How many people died due to starvation during the famine?

What are some of the things that would have made the famine less severe?

Where else in the world are many potatoes grown? Why did these areas not experience crop failure?

Based on the article, would you say that modern agriculture has learned much from the lesson of the Irish Potato Famine? Why or why not? How could we do things differently?

The title of this article includes the word **Monoculture**. Based on the article, what do you think this word means? (Hint: Mono means 1)

Extension: Although the scientific causes of the crop failure was lack of genetic diversity and late blight (*Phytophthora infestans*); inequality and the policies of the English government towards Ireland significantly increased the severity of the famine. The famine in turn had major sociopolitical impacts, both in Ireland and abroad. The following resources can help you to discuss these topics with your students:

<http://kids.britannica.com/comptons/art-184523/The-Irish-Potato-Famine-devastated-Irelands-population>

<https://www.youtube.com/watch?v=45Uvpv0z9w>

<https://zinnedproject.org/2012/03/the-real-irish-american-story-not-taught-in-schools/>

https://www.youtube.com/watch?v=QAkW_i0bDpQ

The Value of Agricultural Diversity

Q: What are some of the reasons that it is important to keep many varieties of plants in our farms and gardens?

Record on board/students take notes or illustrate

- **Disease/pest resistance**
 - eg. Irish Potato Famine
- Adaptation to **changing environmental conditions**
 - Such as **climate change, sea level rise**. Some varieties are more **drought resistant** , or **salt tolerant**. For example, varieties of taro and other crops that can tolerate high levels of salt may be able to help pacific islanders that are faced with rising sea levels and saltier soils.
- **Culture**
 - Old varieties are called **Heirloom varieties** or **Heritage varieties** because they have been kept around and passed down by many generations of people. These plants are valuable because they have special flavors, textures, appearances, and cultural uses. Keeping these varieties alive is an important part of preserving and protecting our cultural heritage

What is Happening to Heirloom Varieties?

Share Our Dwindling Food Variety image (*see attached*)

Help students interpret image:

- Width of each colored bar at the top represents how many seed varieties were offered in seed catalogs in 1903
- Width of bar at the bottom represents how many of these same varieties still existed in 1983.
- This study found that over 90% of the varieties of food plants grown at the turn of the century have been lost.

What has happened to these varieties?

Students take notes (or illustrate):

There are a number of reasons that so many varieties have been lost:

- **Hybrid Varieties:**

- Since the 1950's, farmers have been encouraged to switch over to hybrid varieties, which are intentional crosses between two parent lines of plants. However, seed from hybrid plants is unpredictable and will not grow "true to type". Plants grown from this seed will be like one of the parent types or some combination of the two. For this reason, farmers can not save seed from hybrid plants.

A great animation that defines Hybrid seeds:

<https://www.youtube.com/watch?v=wSOsekBtSYw>

Same animation, comparing Heirloom vs Hybrid vs GMO seed

<https://www.youtube.com/watch?v=qzXstf9xTNI>

A short video where a homesteader describes what happened when she planted hybrid seed she had saved:

<https://www.youtube.com/watch?v=dSFgK-njmtI>

- **Global Food Market:**

- 100 years ago, most people relied on food (especially fruits and veggies) that were grown locally. Now most of the food we eat was grown in other places. This global food market is the reason that we can eat fruits and veggies that won't grow in Hawai'i or aren't in season. But it also means that farmers now have to make sure that produce will last much longer during transportation and processing. This means that size, appearance and shelf life are emphasized in planting decisions, while varieties that are valued for flavor, cultural importance and diversity have become less economically important.

- **Seed Industry Consolidation:**

- There used to be 100s of small independent seed companies, which offered varieties that were unique and specific to one area. In the past 50 years, the majority of these companies have been purchased by a few large corporations. These 'seed giants' now own the varieties that were once held by the smaller companies. Sometimes they want to encourage the public to buy specific modern or hybrid varieties, and will not make older varieties available for sale.

An image that depicts seed industry consolidation in the past 30 years :
<https://msu.edu/~howardp/seedindustry.html>

What can we do to help with this problem?: The Hawai'i Heritage Seed Project

Pass out and read Looking for Seeds with Stories!

This is where students can help with my graduate research!

*I am identifying seed keepers who keep varieties of food and medicine plants that came to the islands during the **plantation era** and am collecting the stories of these plants. They can be plants that are grown from seed or plants that are grown from cuttings.*

*Students can help with this project by talking to people in their families and communities and asking if any of them know seed keepers who might be interested in participating. I will interview seed keepers about their specific varieties. If they are interested they can also donate seed to be grown out by a local seed farmer o school garden in order to increase the amount of seed available (many seedkeepers are elderly and it may be challenging for them to grow out their seeds as often as they would like). The main goal of this project is to collect **oral history**, not seed samples, so seed donation is not required to participate.*

Students view online survey form (or distribute in hard copy) :

<https://goo.gl/forms/DnUCnYNZP0FKOoQO2>

Discuss survey questions & brainstorm people in the community who students can ask.

Some teachers assign this survey as a homework assignment. But it is not likely that all students will be able to find seed keepers. One way to use the survey as an assignment is to ask students to bring in a list of three people whom they have talked to about the project and showed the survey –even if they are unable to find a seed keeper. Another strategy is to have students work in small groups to ask people in the community (at library, community center, church etc.) about seed savers.

Exit Pass:

List of 3 people/places to share the survey and ask about seed savers

Extension:

There are many people and organizations that are working on conserving agricultural biodiversity. Assign small groups of students the following videos and ask them to summarize what each organization is doing to protect heritage varieties.

Overview of seed conservation work at Native Seeds/SEARCH :

<https://www.youtube.com/watch?v=nFkPdZ7e6p0>

More information on Native Seed /SEARCH- Facebook live tours:

Seed Conservation Farm: <https://www.youtube.com/watch?v=pYphMjVT2AE>

Seed Collection/ Seed Vault : <https://www.youtube.com/watch?v=cFgDbCM5M68>

Overview of Pima County Public Seed Library:

https://www.youtube.com/watch?v=OTGVs_Eqz0s

Overview of seed conservation work at Seed Savers Exchange:

https://www.youtube.com/watch?v=vxVROu_kwOE

Ted Talk by Cary Fowler, developer of the Svalbard Global Seed Vault:

https://www.ted.com/talks/cary_fowler_one_seed_at_a_time_protecting_the_future_of_food

The Great American Seed Up : <https://www.youtube.com/watch?v=vwuf-TQ7Wjk>

Overview of the Seed Broadcast mobile journalism unit :

<https://www.youtube.com/watch?v=nVpYU1AeXlc>

Additional Seedy Resources:

Hawaii Heritage Seed Project Facebook Page

Hawaii Island Seed Stewards Facebook Page

Hawaii Public Seed Initiative

Home: <http://kohalacenter.org/hpsi>

Resources: <http://kohalacenter.org/hpsi/resources>

Seed Variety Selection Tool for the Hawaiian Islands: <http://kohalacenter.org/hpsi/svst>

A Handful of Seeds: Seed saving and seed study for educators: Lessons by the Occidental Arts and Ecology Center :

<https://www.oaec.org/wp-content/uploads/2014/10/A-Handful-of-Seeds.pdf>

From Generation to Generation : a Seed Saving Activity guide by Fedco Seeds

<http://www.slideshare.net/S7w4X/zwv51>

Free Seed Saving Guide by Organic Seed Alliance

https://seedalliance.org/index.php?mact=DocumentStore,cntnt01,download_form,0&cntnt01pid=12&cntnt01returnid=139

SeedBroadcast “agri-Culture” journalism project :

<http://seedbroadcast.org/SeedBroadcast/SeedBroadcast.html>

Regenerations International Botanical Garden and Kauai Community Seed Bank:

<http://ribg.org/>

Hawaii Island Native Seed Bank:

<http://www.mahaloaina.org/homepage/projects/hawaii-island-native-seed-bank-cooperative/>

And last of all, here is a fun animation illustrating the process of pollination:

http://68.media.tumblr.com/5e0747dd8b96fa6656e5041cfa81285b/tumblr_o9cks0fPHr1sk2szio1_540.gif

Mahalo nui loa for your help with this project, if you have any questions please contact me.

Ilana

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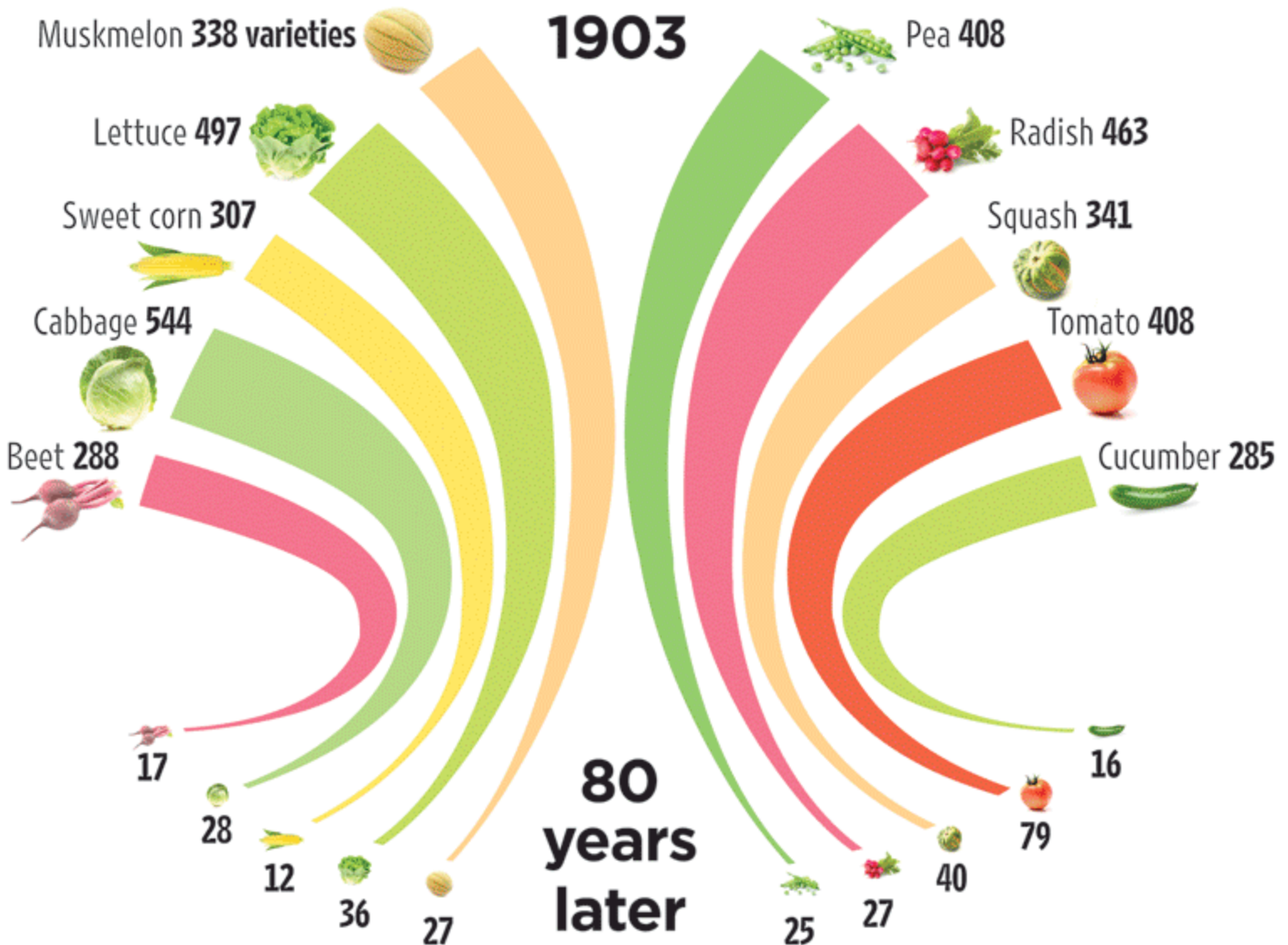
Stout

UH Hilo TCBES

January 2017

Our dwindling food variety

A little over a century ago, U.S. commercial seed houses offered hundreds of varieties, as shown in this sampling of ten crops.



Few of those varieties were found in the National Seed Storage Laboratory (*now called the Center for Genetic Resources Preservation*).

SOURCES: *National Geographic*; Rural Advancement Foundation International; iStock

Looking for Seeds with Stories!

Aloha!

My name is Ilana Stout, I am a graduate student in the Tropical Conservation Biology and Environmental Science Program at the University of Hawai'i at Hilo. For my master's degree research, I am studying heritage varieties of food and medicine plants that were brought to the Hawaiian Islands by immigrants during the plantation era and recording their stories to preserve them for future generations.

If you know a person who keeps and saves these old kinds of seeds who would like to talk about them, please contact me. Mahalo nui loa!



Ilana Stout
896-3237

istout@hawaii.edu

For more information about this project, please visit:

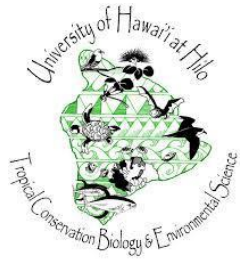
<https://www.gofundme.com/HawaiiHeritageSeed>

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For more information about this project, please visit:

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