

The Science of Seeds

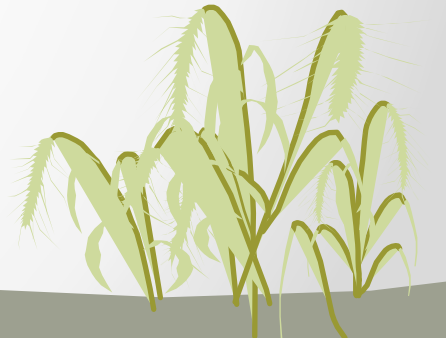
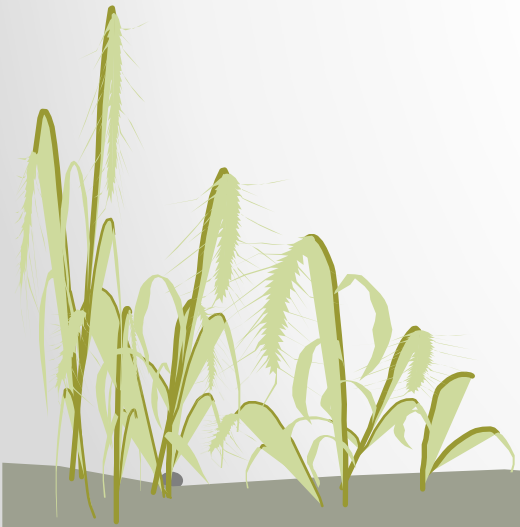
Hybrid, Heirloom, Organic, GMO, & Beyond

By Kaydie McCormick, Residential Horticulture Agent &
Master Gardener Volunteer Coordinator
UF/IFAS Extension Seminole County



What We'll Learn

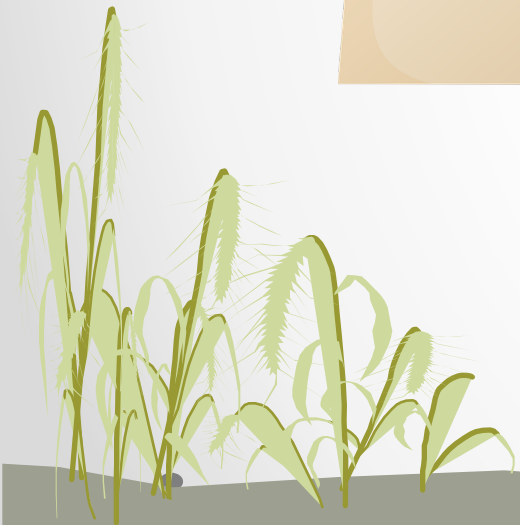
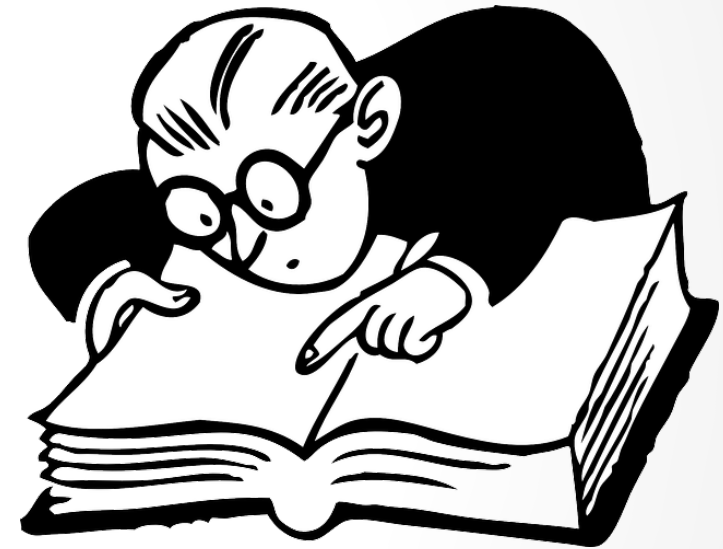
- Definitions of seed related words
- Proper storage of seeds
- How to plant seeds
- Common problems with seeds



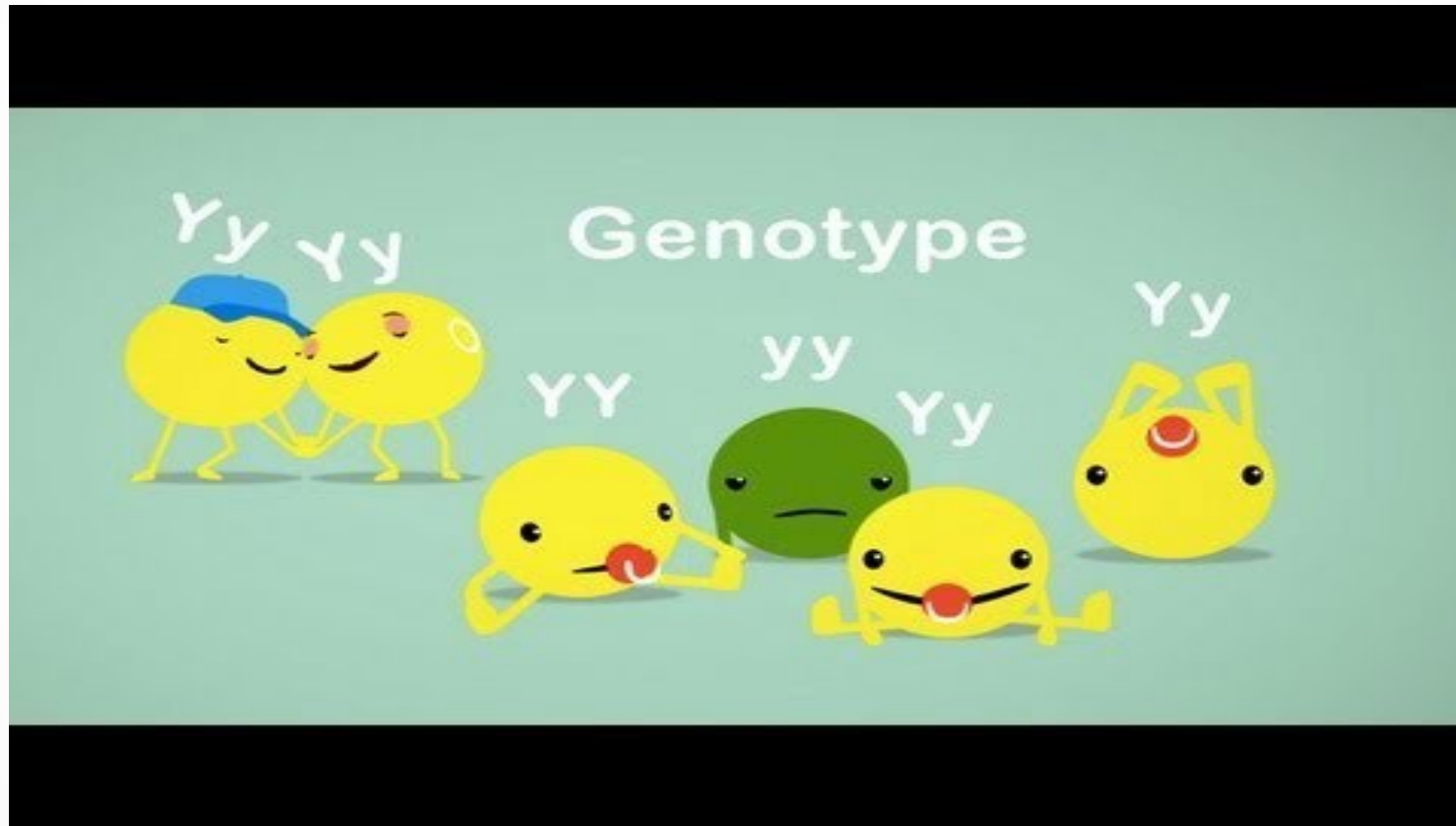
What Do These Words Mean?



1. Hybrid
2. Open Pollinated
3. Heirloom
4. Organic
5. GMO
6. CRISPR
7. Stratification
8. Scarification
9. Leaching

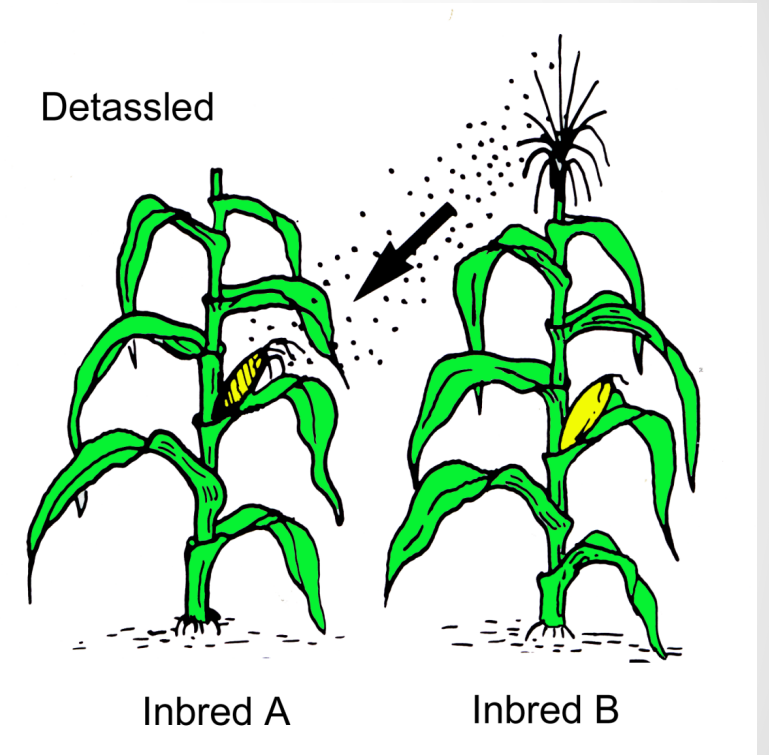


Hybridization Overview



HYBRID

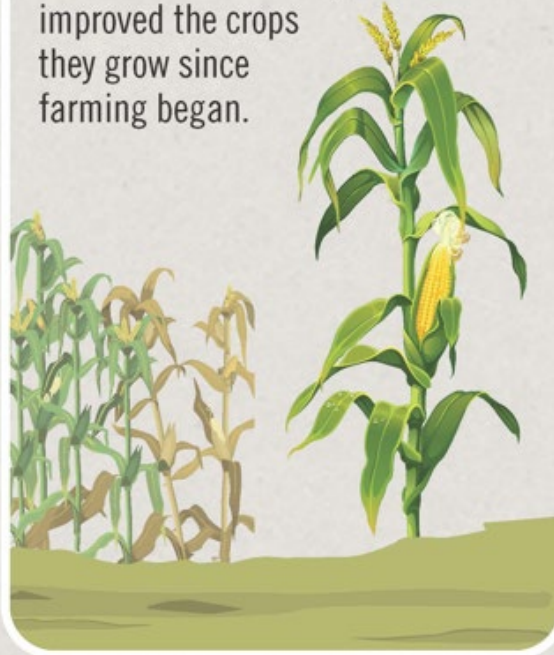
- Crossing specific parent plants produces a hybrid seed (plant) by means of controlled pollination.
- F1 Hybrid:
- “F1-hybrid seedlings are the result of crosses between two or more inbred lines. An inbred line is produced from a homozygous parent that has been self-pollinated a number of times to fix the genetic traits of the plant.”





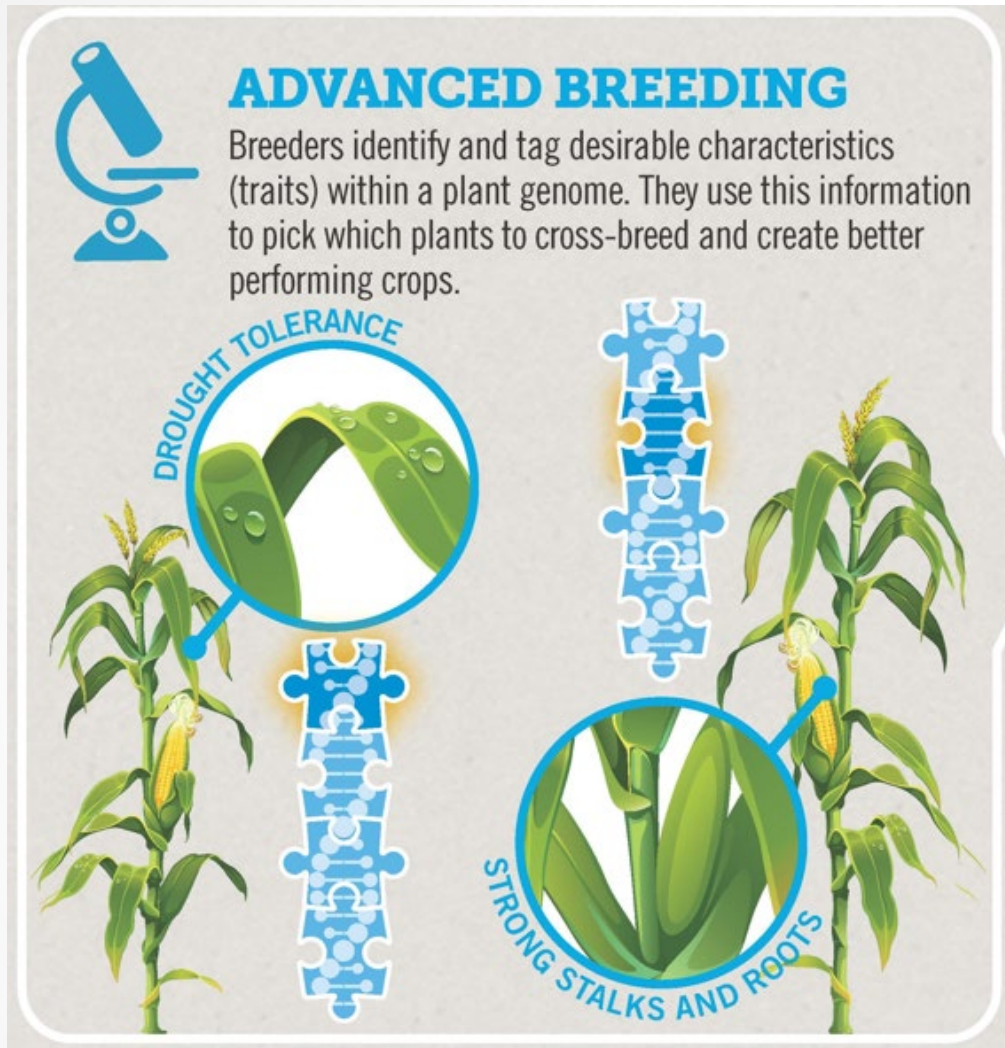
SELECTIVE BREEDING

Plant breeders look for, select and cross-breed the best performing plants in the field, similar to how farmers have naturally improved the crops they grow since farming began.



Hybrid: Traditional Breeding Technique

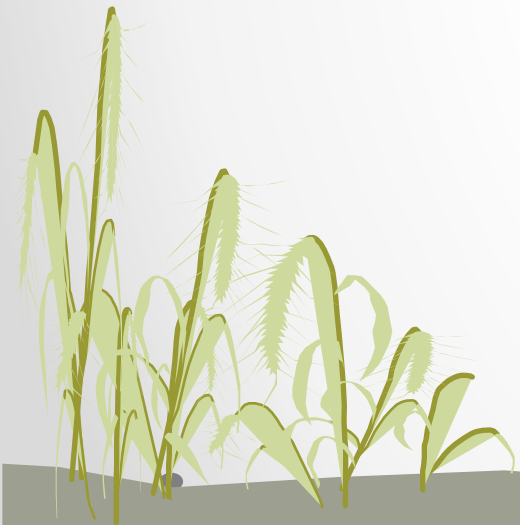
Traditionally, breeders would look for certain traits in a plant and use that plant in their breeding program.



Hybrid: Advanced Breeding Technique

Breeders can now use plant genomic testing to pick which ones to continue crossing!

IFAS Strawberry Hybridization



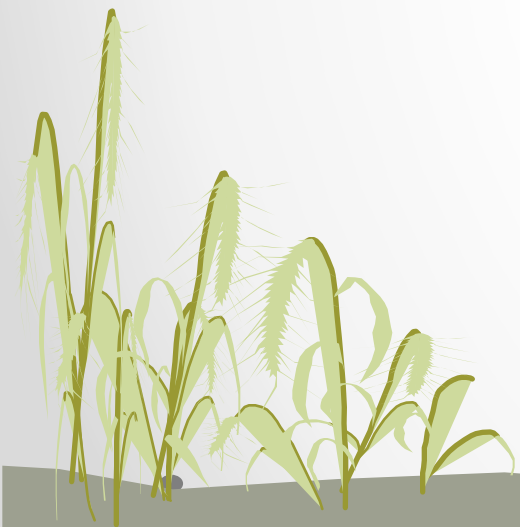
Hybrid Seed Pros & Cons

PROS

- Hybrid Vigor
- Exactly as Advertised
- Often Bred for Certain Traits
 - Ie. Disease resistance, color, flavor

CONS

- Second Generation Seeds Inferior
 - Must be purchased each year
- Can Promote Unsustainable Monocultures



OPEN POLLINATED

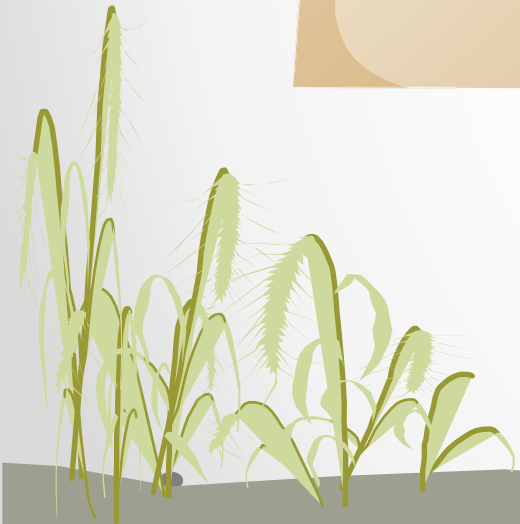
- Varieties with stable traits from one generation to the next
- Genetic drift is possible
- Cross pollination possible
- Can be heirloom



HEIRLOOM



- Open Pollinated plants +
- No firm definition but:
 - May have historical/family connections
 - 50+ years as a variety (so pre 1974)
 - Some say pre-1940s to count



Open Pollination Considerations

- Self-pollinating plants:

- Beans
- Peas
- Peanuts
- Lettuce
- Eggplant
- Peppers
- Tomatoes



- To reduce chance of accidental crosses, plant with 10ft between varieties.

- Wind or insect pollinated plants need to be isolated

- Onions
- Cucumbers
- Corn
- Pumpkins
- Squash
- Broccoli
- Beets
- Carrots
- Cabbage
- Cauliflower
- Melons
- Radishes
- Spinach
- Swiss Chard
- Turnips





ORGANIC

- Renewable resources
- May only use approved inputs
 - Naturally available nutrients
 - Naturally derived pesticides
- Most synthetic pesticides, nutrients, and other practices prohibited
- Approved certifier
- Handlers and processors must be certified



Organic Continued

- So... what does this mean for seeds?
 - “Certified “organic” seeds come from certified organic plants and go through processing equipment that is also certified for organic production. The facilities where organic “stuff” is processed also requires certification to organic standards.” – Hannah Wooten, Extension Agent, Commercial Horticulture
- So... what does that mean for consumers?
 - The amount of non-organic pesticide in a non-organic seed is negligible
 - Organic seed is more expensive
 - You may be supporting organic farms/farming practices



What is GMO?

- Cutting a desirable gene from one organism and adding it to the DNA of another
- Done with a single cell that is then grown in the lab



GMO RESEARCH, REVIEW AND REGULATION | How Does a GMO Get to Market?

On average, GMOs take **13 years** and **\$130 million** of R&D **BEFORE** coming to market

The **regulatory process** alone can take **5 to 7 years**

REGULATORY SCIENCE

75+ different studies¹ are conducted to demonstrate each new GMO is:

Safe to grow

- Crop grows the same as non-GM varieties
- Crop exhibits expected characteristics (e.g., insect resistance)



Safe for the environment and beneficial insects



Safe to eat

- Same nutrients as non-GM crops
- No new dietary allergens



REGULATORY REVIEW

More than **30 government bodies²** globally review and approve GMOs. In many countries, multiple agencies are involved in the regulation of GMOs.

GMOs have been grown or imported by more than **75 countries³** since 1996.



U.S. REGULATORY AGENCY REVIEWS



Safe to grow



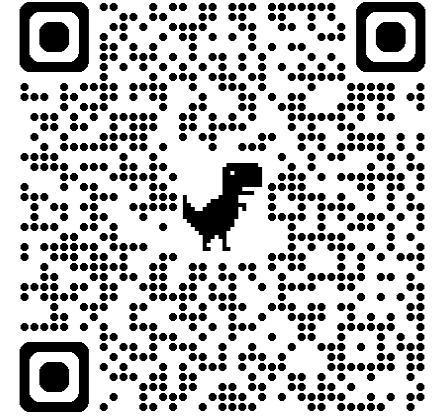
Safe for the environment



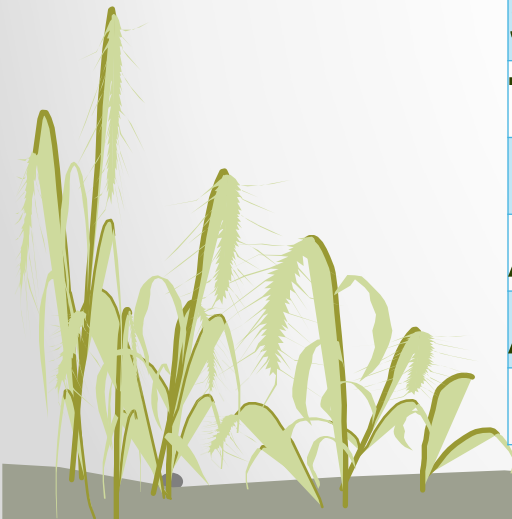
Safe to eat



GM Seeds Approved for Use by USDA:



| | | | |
|------------------|-----------|---------------------------|----------|
| Corn | 58 | Sugar Beet | 3 |
| Potato | 40 | Cantaloupe | 2 |
| Cotton | 28 | Papaya | 2 |
| Canola | 23 | Squash | 2 |
| Soybean | 22 | Sugarcane | 2 |
| Tomato | 8 | Wheat | 2 |
| Rice | 4 | Creeping Bentgrass | 1 |
| Alfalfa | 3 | Flax | 1 |
| Apple | 3 | Pineapple | 1 |
| Radicchio | 3 | Plum | 1 |



GENETIC TRAITS EXPRESSED IN GMOs IN THE U.S.

APPLE

Genetic Traits

Non-browning

Uses: Food



POTATO

Genetic Traits

Reduced Bruising
and Black Spot

Non-browning

Low Acrylamide

Blight Resistance

Uses: Food



FIELD CORN

Genetic Traits

Insect Resistance

Herbicide Tolerance

Drought Tolerance

Uses:

- Livestock and poultry feed
- Fuel ethanol
- High-fructose corn syrup and other sweeteners
- Corn oil
- Starch
- Cereal and other food ingredients
- Alcohol
- Industrial uses



CANOLA

Genetic Traits

Herbicide Tolerance

Uses: Cooking oil,
Animal feed



ALFALFA

Genetic Traits

Herbicide Tolerance

Uses: Animal feed



SOYBEAN

Genetic Traits

Insect Resistance

Herbicide Tolerance

Uses:

- Livestock and poultry feed
- Aquaculture
- Soybean oil (vegetable oil)
- High oleic acid (monounsaturated fatty acid)
- Biodiesel fuel
- Soymilk, soy sauce, tofu, other food uses
- Lecithin
- Pet food
- Adhesives and building materials
- Printing ink
- Other industrial uses



RAINBOW PAPAYA

Genetic Traits

Disease Resistance

Uses: Table fruit



COTTON

Genetic Traits

Insect Resistance

Herbicide Tolerance

Uses: Fiber, Animal feed,
Cottonseed oil



SUGAR BEET

Genetic Traits

Herbicide Tolerance

Uses: Sugar, Animal feed



SWEET CORN

Genetic Traits

Insect Resistance

Herbicide Tolerance

Uses: Food



SUMMER SQUASH

Genetic Traits

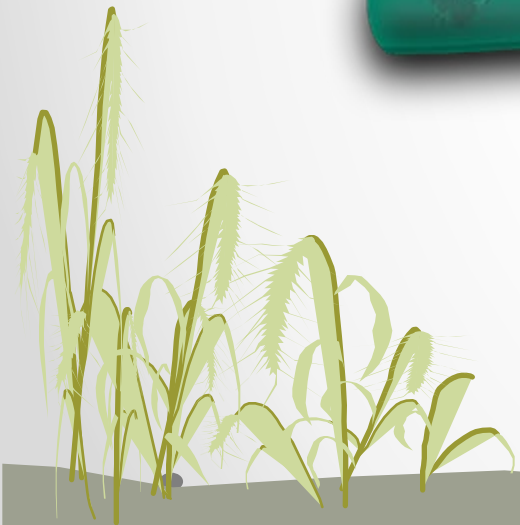
Disease Resistance

Uses: Food



CRISPR

- New gene technology: Clustered Regularly Interspaced Short Palindromic Repeats
- Instead of adding, careful editing or subtraction of existing genes



CRISPR Video





Gene Editing with CRISPR-Cas9

Using Native Characteristics to Improve
Crops to Benefit People and the Planet

CRISPR-Cas9 Method

Clustered Regularly Interspaced Short Palindromic Repeats

Cas9 (the most widely utilized system) is a special enzyme that can be guided by a short piece of RNA to find the target sequence of DNA and carry out the editing function



Cas9 **edits, deletes or replaces** the targeted gene sequence to create specific results



Benefits for Crop Breeding

Faster crop improvement
Precise traits
Inexpensive



Benefits for Farmers and Consumers

Defense against pests
Drought tolerance
Larger harvests
Better nutrition
Longer shelf life



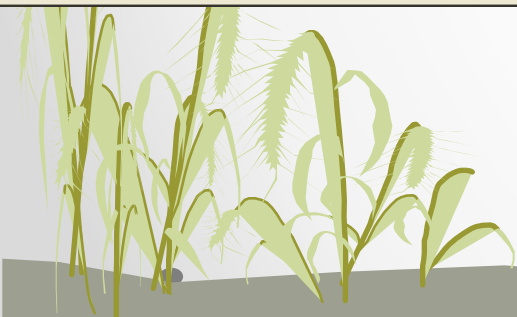
DONALD DANFORTH
PLANT SCIENCE CENTER

danforthcenter.org

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How CRISPR Works

- An enzyme makes a precise cut in the DNA sequence.
- It is programmed to:
 - Turn on a trait in the plant DNA
 - Turn off a trait in the plant DNA
 - Replace a trait in the plant DNA



The background of the image is a vast field of yellow mustard flowers, slightly out of focus. In the foreground on the left, a single flower stalk is in sharp focus, showing several bright yellow flowers and some buds. The text 'Seed Care & Use' is overlaid on the right side of the image in a dark green, bold, sans-serif font.

Seed Care & Use

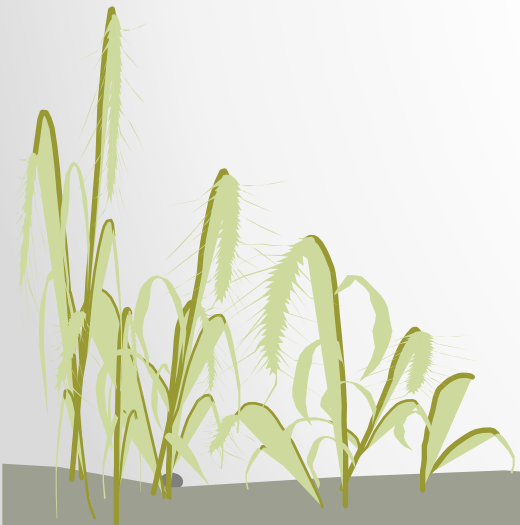
Prepping Seeds for Storage

- Collect & Dry
 - 100 degrees for 6 hours
 - In oven with door kept open



Proper Storage of Seeds

- 1 year: at room temp
- >1 year: in fridge
- Keep DRY
- Sealable container better than plastic bag



How to Plant Seeds

We'll Be Covering:

- Stratification
- Scarification
- Soaking/Leaching
- Light
- Depth
- Care



Stratification

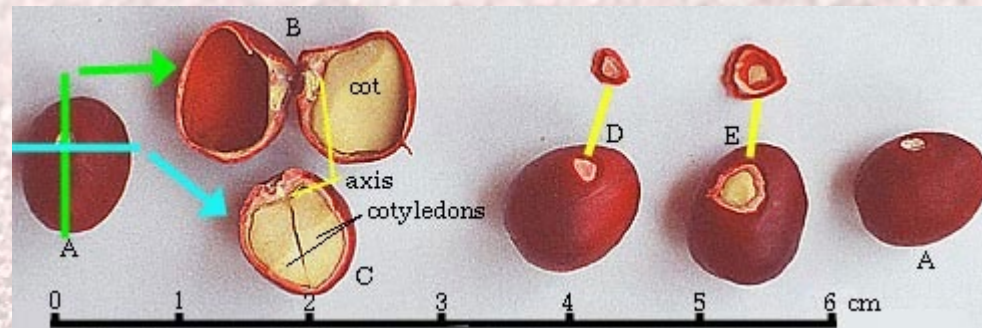
- Storing the seeds in a cold, moist environment to meet their requirements for sprouting.



**Tell your loved ones that this isn't
taco meat! [Millie Burrell](#)**

Scarification

- The process of penetrating or cracking the seed coat barrier.



Just Right

Too Deep

Soaking/Leaching

- Seeds may contain chemicals that inhibit germination





Light

- Not all seeds have the same light requirements.
 - But all seedlings require sunlight.
- Need to germinate in dark: *Allium* spp.
- Need to germinate in light: *Begonia*, *Coleus*



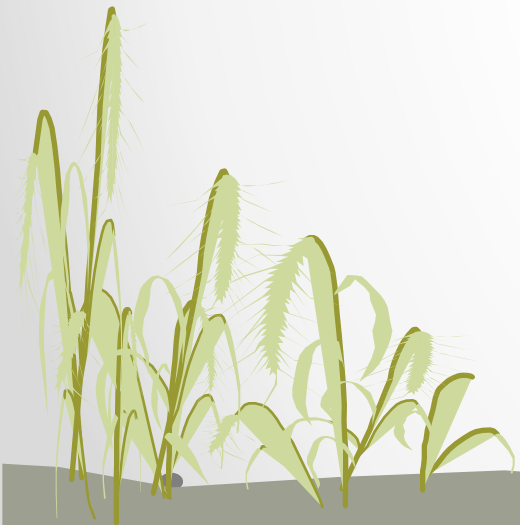
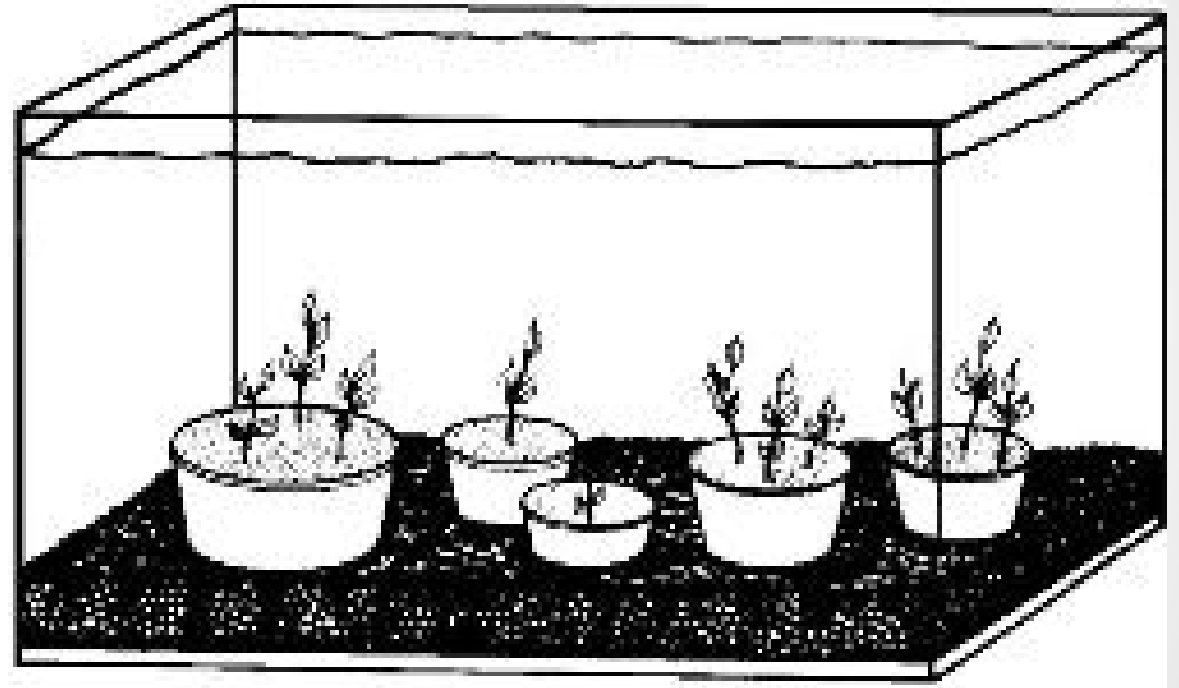
A close-up photograph of a shovel's metal head digging into dark, rich soil. The shovel is positioned vertically, with its handle extending upwards. The background is a blurred outdoor scene with green foliage and a wooden fence, suggesting a garden or farm setting. The lighting is bright, creating a soft glow around the shovel and the soil.

Depth

- Seed should be planted no deeper than 1 to 2 times their diameter.

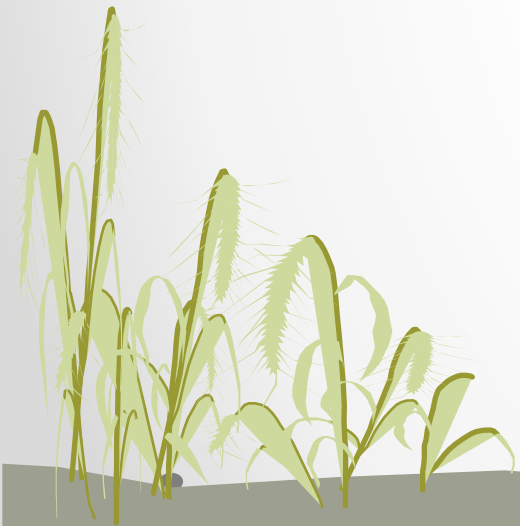
Care

- Keep moist
 - relative humidity near 100 percent
- Moderate temperatures
 - between 70°F to 80°F for most seeds



Common Problems with Seeds

- Poor or Erratic Germination
- Tall, Spindly Growth
- Collapse and Death of Seedlings
- Discolored Seedlings



Poor or Erratic Germination

- Weak Seeds
- Poor Conditions
- Fungus, Bugs, or Animals
- Seed Coat
- Allelopathy

The background of the slide is a photograph of several young seedlings growing in a tray. The seedlings have very long, thin, white stems that are leaning over, which is a sign of etiolation or 'spindly growth'. They have small, green, rounded leaves at the top. The soil in the tray is dark brown and appears moist. The overall lighting is soft and slightly diffused, highlighting the pale color of the stems.

Tall, Spindly Growth

- Tall, spindly growth is a common problem when growing transplants indoors. Poor (insufficient) light, excessive watering, high temperatures, excessive fertilization, and crowded conditions are factors that contribute to spindly growth.

Collapse and Death of Seedlings

- “Damping Off”: The fungi, *Rhizoctonia* spp. and *Fusarium* spp., along with the water mold *Pythium* spp. are the most common pathogens responsible for damping off



Discolored Seedlings

- A nutrient deficiency is likely responsible for the sickly yellow-green or purple color.



QUESTIONS?

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