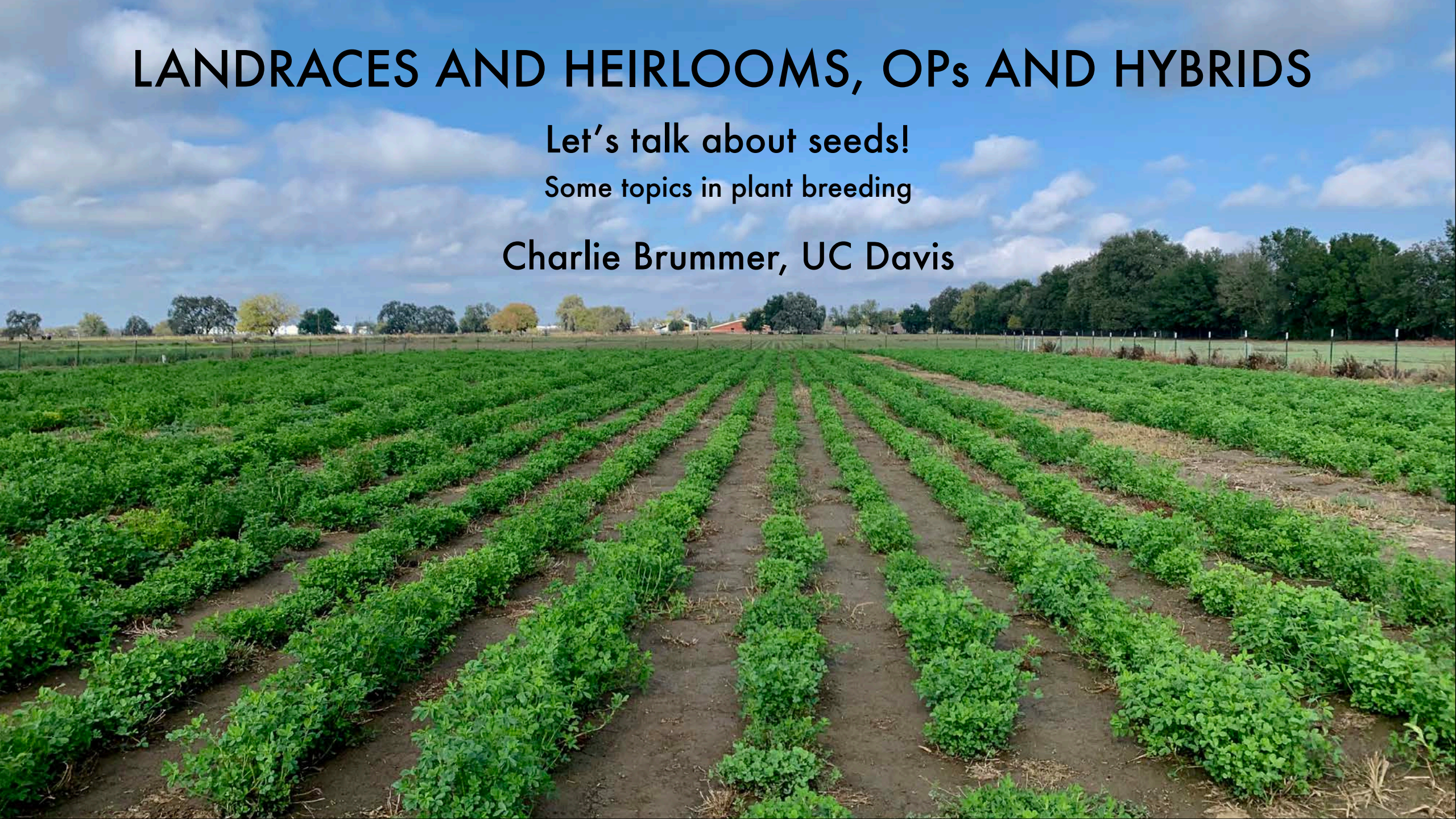
LANDRACES AND HEIRLOOMS, OPs AND HYBRIDS

Let's talk about seeds!

Some topics in plant breeding

Charlie Brummer, UC Davis



DEFINING TERMS

BREEDING PROGRAMS

CULTIVAR TYPES

INTELLECTUAL PROPERTY PROTECTION
....OR NOT

LANDRACES

- Usually found within the center of origin of a species
- Pictures: alfalfa in Turkey, the center of origin
- Small fields growing seed probably harvested from the region
- Natural selection over time
- Often named for the region or possibly for a well-known farmer
- May become “varieties” over time – sold as a known entity outside the local region

VARIETY

TAXONOMIC MEANING – A VARIANT OF A SPECIES WITH A SPECIFIC TRAIT

ALSO COMMONLY USED TO DENOTE "CULTIVAR"

Keys to Subordinate Taxa of *Medicago sativa*

A. Comprehensive key

1. Fruit without gland-tipped trichomes 2
   2. Flowers uniformly violet or blue-violet; some of fruits with at least 1.5 coils (usually more) 3
      3. Calyx (base to tip of longest lobe) usually less than 4.5 mm long;fruit intersuture width usually less than 1.8 mm ..... subsp. *caerulea*
      3. Calyx length usually more than 4.5 mm; midfruit intersuture width usually more than 1.8 m ..... subsp. *sativa*
   2. Flowers yellow or yellow-violet variegated; fruits often with less than 1.5 coils 4
      4. Flowers yellow; fruit with less than 1 coil (usually less than 0.5 coil) ..... subsp. *falcata* var. *falcata*
      4. Flowers variegated yellow-violet and/or fruits with 0.8–1.4 coils ..... subsp. ×*varia*
1. Fruit with at least some gland-tipped trichomes 5
   5. Flowers uniformly yellow; fruit densely covered with gland-tipped trichomes 6
      6. Fruit with less than 1 coil (usually less than 0.5 coil) ..... subsp. *falcata* var. *viscosa*
      6. Fruit with more than 1 coil ..... subsp. *glomerata*
   5. Flowers variegated yellow-violet; fruit lightly to moderately covered with gland-tipped trichomes ..... *M. sativa* subsp. *sativa* × subsp. *glomerata*

FROM E. SMALL, 2011, ALFALFA AND RELATIVES.

Fig. 12-10. *Medicago sativa* subsp. *falcata* var. *viscosa*. **Clockwise from left:** Branch with flowers and some fruit; side view of flower; stipule; leaf attached to stem node. (Based on Berkovskaya 2572, WIR; artist: L. Yuzyk.)

Yellow flowered alfalfa with glandular hairs on leaves and pods = *Medicago sativa* subsp. *falcata* var. *viscosa*

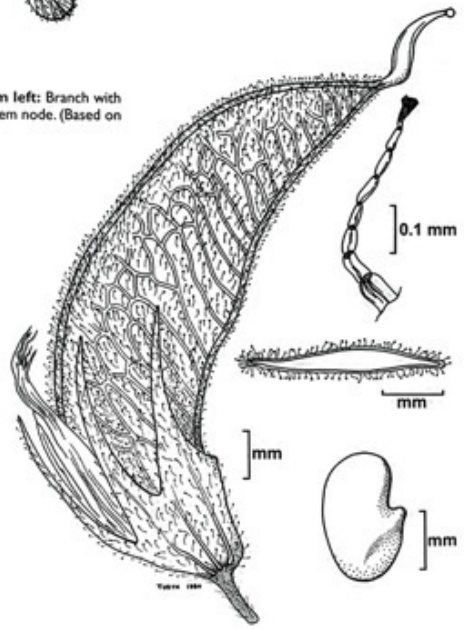
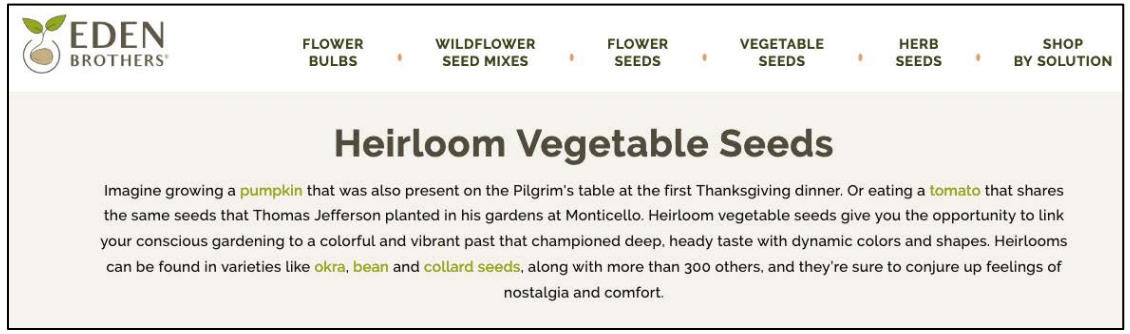


Fig. 12-11. *Medicago sativa* subsp. *falcata* var. *viscosa*. **Clockwise from left:** Fruit; gland-tipped hair; outline of cross section of fruit; seed. (Based on Berkovskaya 2572, WIR; artist: L. Yuzyk.)

CULTIVAR

- Cultivated variety
- Plants selected to have specific traits and to reliably express those traits under production conditions
- Heirloom cultivars (varieties) - some historical context regarding origin and use…somewhat like ‘antiques’



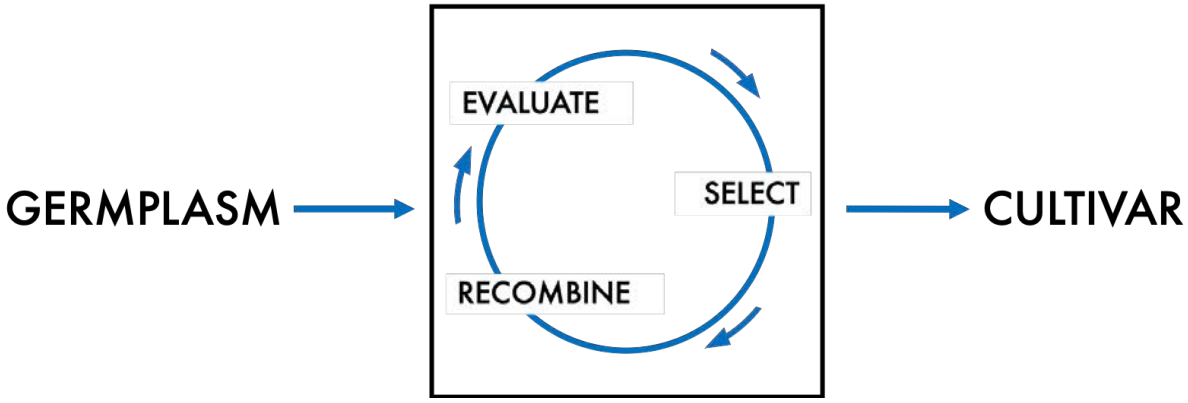
SEED SAVING	HARVESTING SEED TO GROW NEXT YEAR
SELECTING	HARVESTING SEED OF THE BEST PLANTS FROM WITHIN A DIVERSE POPULATION TO GROW NEXT YEAR
BREEDING	ACTIVELY HYBRIDIZING DESIRABLE PLANTS TO GENERATE NEW RECOMBINANTS FOR SELECTION NEXT YEAR

artisan.seeds

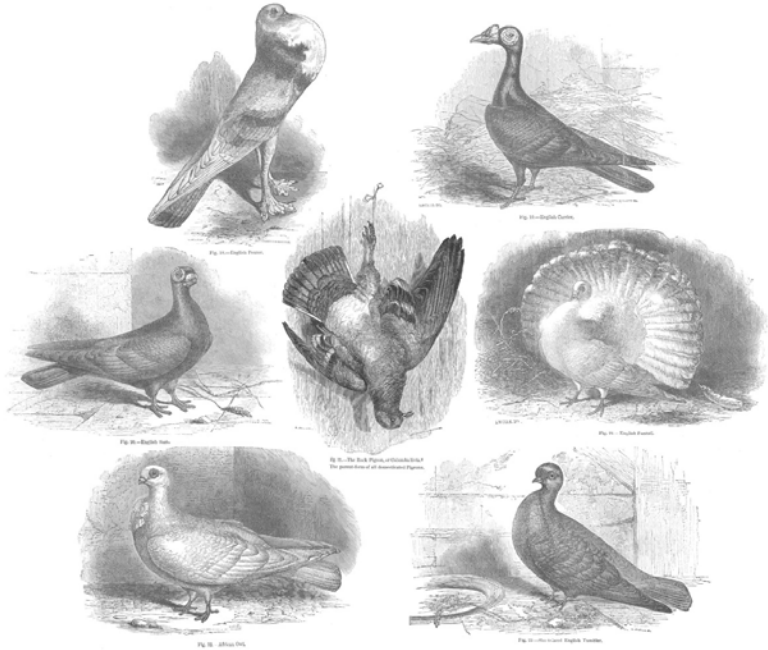
From Instagram – Feb 9, 2022

The ultimate goal of plant breeding is to develop new cultivars that will be useful to whomever wants to grow them.

BREEDING IN BRIEF



"The direct effect of selection is remarkably predictable and precise."
-Bill Tracy



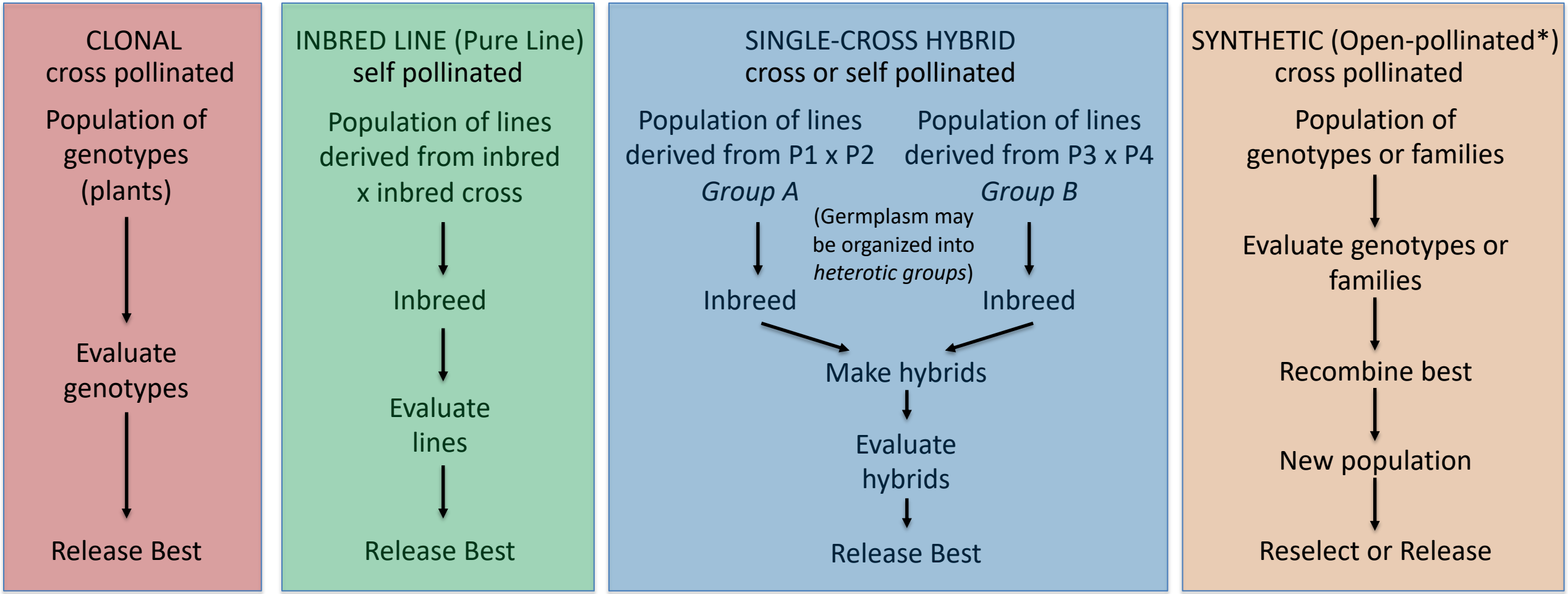
C. Darwin. 1868. Variation in Animals and Plants under Domestication.

(1) Even in the absence of genetic knowledge of the traits under selection, if the traits are heritable and genetic variation is present, selection will be successful.

(2) If you don't select for a trait, you are unlikely to see genetic gain for that trait.

GENERAL BREEDING METHODS

What's the mating system? Can I develop inbred lines? Can I make hybrid seed? Can I isolate my selections from other pollen?



*Confusingly, non-hybrid tomatoes are sometimes referred to as "open-pollinated" but that just means they are inbred lines that will breed true generation to generation.

THE BREEDING PIPELINE

HYBRIDIZE PARENTS and DEVELOP LINES/FAMILIES

1-2 YEARS

EVALUATE *IN TARGET ENV*. and SELECT TOP PERFORMERS

2-5 YEARS

MULTILOCATION TRIALS and RELEASE

3-5 YEARS

SEED (CLONE) INCREASE BEGINS DURING TRIALING

0-3 YEARS

From start to finish: 6 to 15+ years for a new cultivar
Once the pipeline begins flowing, new cultivars produced yearly

Genetic variation – the grist for a breeding program

(UC Davis hemp breeding program, 2020)

Recombination: The KEY Concept in Breeding

Hybridize (cross-pollinate) individual plants or inbred lines
to create <u>new genetic combinations</u>

Common Bean Improvement through Introgression

Backcrossing *Bean Common Mosaic Virus* resistance from an elite commercial cultivar into heirloom cultivars. Part of the SCOPE project.

Journal of Plant Registrations

REGISTRATION

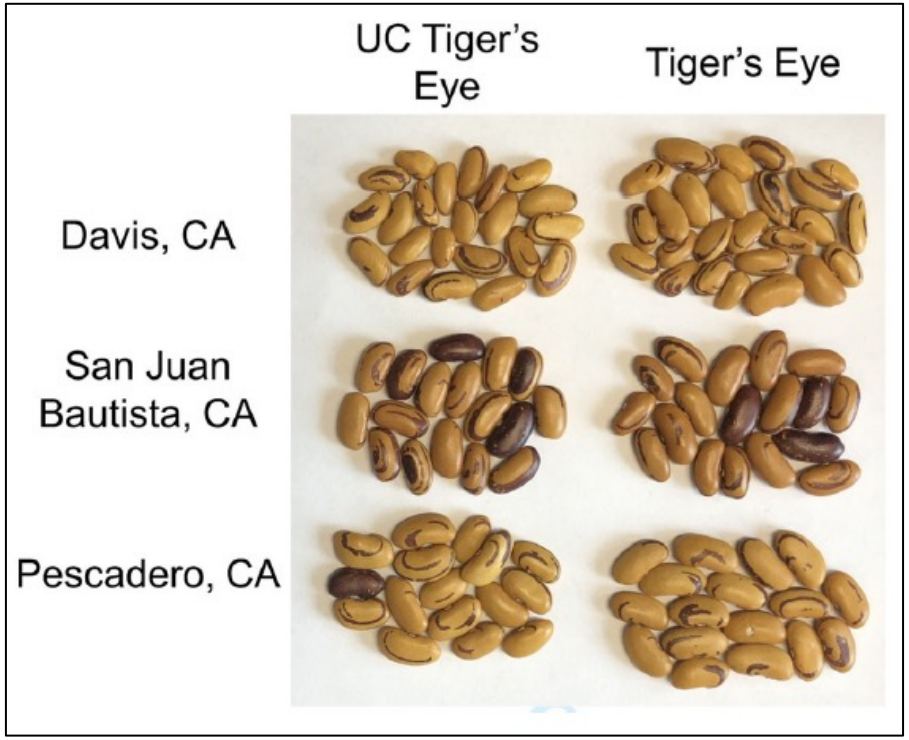
Cultivar

Registration of 'UC Tiger's Eye' heirloom-like dry bean

Travis Parker | Antonia Palkovic | E. Charles Brummer | Paul Gepts

USED GENETIC MARKERS TO INTROGRESS BCMV RESISTANCE GENE

UC TIGER'S EYE = TIGER'S EYE + BCMV RESISTANCE



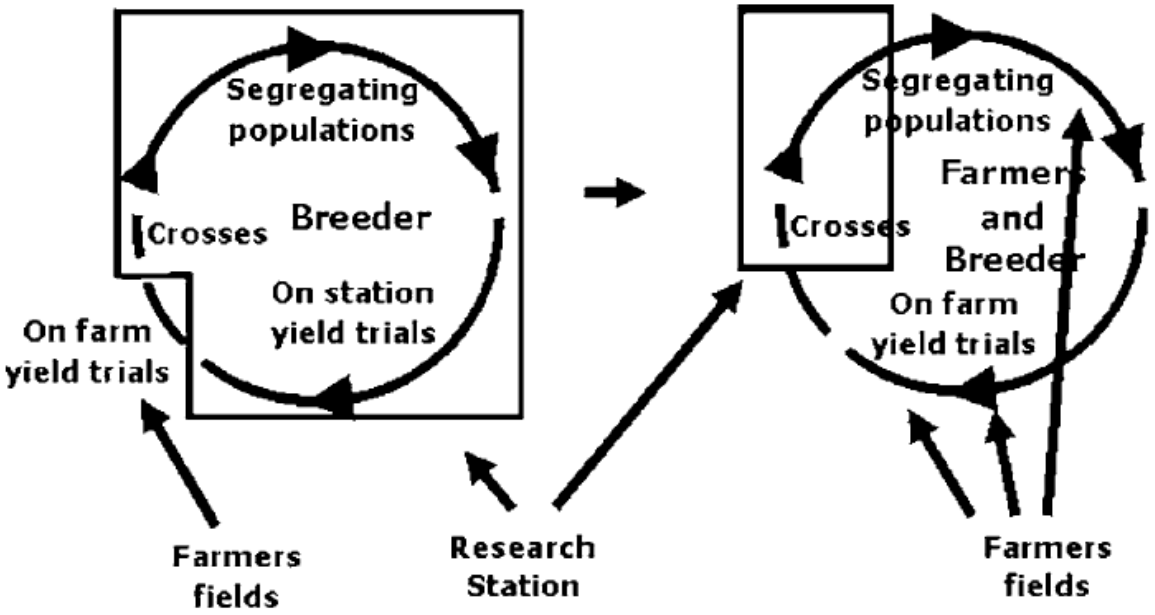
Zinnia Breeding

Make crosses to generate new variation
Stabilize variation within a population

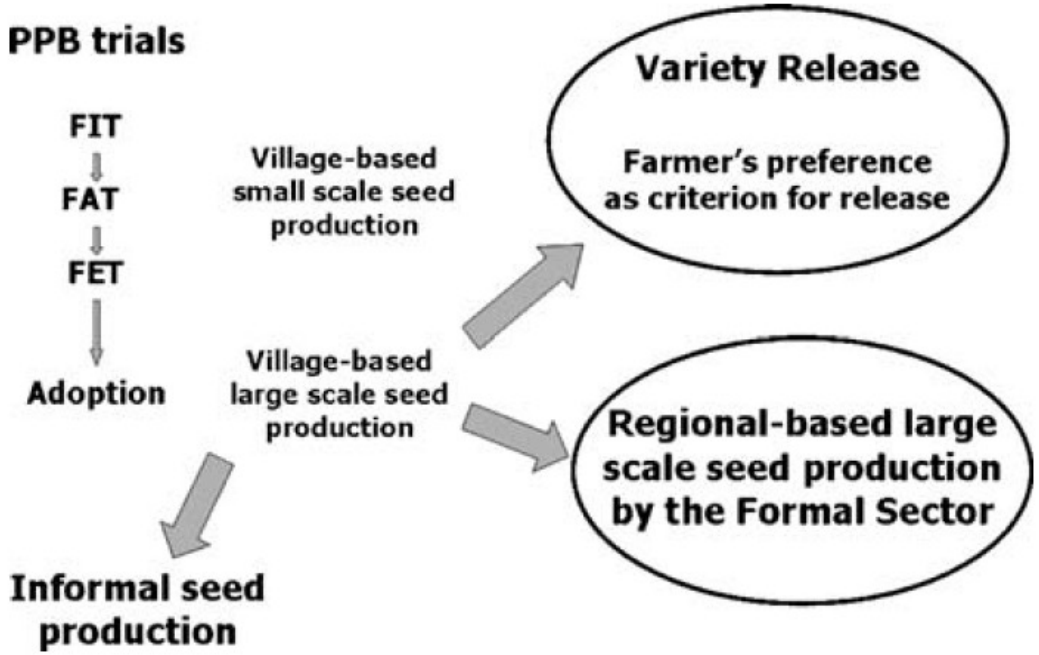
Participatory Plant Breeding

Farmers participating with breeders

Variety testing and/or Selection and/or Evaluation



Variety release in a participatory program



Ceccarelli and Grando, 2007, Euphytica, DOI 10.1007/s10681-006-9336-8

Intellectual Property Protection

Plant breeders can utilize four types of intellectual property protection: (i) contracts, (ii) trade secrets, (iii) Plant Variety Protection (PVP) or Plant Breeders' Rights, and (iv) utility patents. In the United States, companies use several methods to protect intellectual property within the seed. These include language on the bag and other contracts to limit the use of molecular markers on the seed or resultant plant. This has the effect of protecting intellectual property in the seed, including trade secrets. The United States also provides PVP-type protection for breeders of non-tuberous asexually reproducing species under the 1930 US Plant Patent Act. Also, a hybrid crop per se also confers a measure of IPP because parental lines can be maintained as trade secrets and annual seed sales are encouraged due to the reduction in yield potential of the harvested F2 generation seed.

Kurtz, B., Gardner, C.A., Millard, M.J., Nickson, T. and Smith, J.S.C., 2016. Global access to maize germplasm provided by the US National Plant Germplasm System and by US plant breeders. *Crop Science*, *56*(3), pp.931-941.

IP PROTECTION	CAN I SAVE SEEDS?	CAN I SELL SEEDS?	CAN I BREED WITH IT?
NONE	YES*	YES	YES
PLANT VARIETY PROTECTION (PVP)	YES*	NO	YES
PLANT PATENT	(CLONAL, SO MAYBE NO SEEDS OR AT LEAST WON'T BREED TRUE)	-	NO**
UTILITY PATENT	NO	NO	NO**
BAG TAG	MAYBE (but probably no)	MAYBE (but probably no)	MAYBE (but probably no)**

*If seed is saved of a hybrid (F2), it will segregate in the next generation and not breed true.

**There's always the possibility of licensing the germplasm.

Open Source Seed Initiative

http://osseeds.org/seeds/

Luby, C.H., Kloppenburg, J.R. and Goldman, I.L., 2016. Open source plant breeding and the Open Source Seed Initiative. *Plant breeding reviews*, *40*, pp.271-98.

The OSSI Pledge *You have the freedom to use these OSSI- Pledged seeds in any way you choose. In return, you pledge not to restrict others' use of these seeds or their derivatives by patents or other means, and to include this Pledge with any transfer of these seeds or their derivatives.*

Freedom to operate in plant breeding has changed over the last 50 years as our modern IPR framework has been adopted by both the public and private sectors. Germplasm may now be restricted in many ways including patents, licenses, MTAs, and contracts. Plant breeders are therefore more restricted in what germplasm they can use in their breeding programs. OSSI was developed as an alternative to the modern IPR regime. OSSI is a conduit for germplasm that will remain in a protected commons, using the mechanism of an open source Pledge. The viral nature of the Pledge ensures that derivatives of OSSI germplasm remain in the open source commons.

Thank you for listening!
And…any questions?

SCOPE funders and partners

USDA NIFA

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