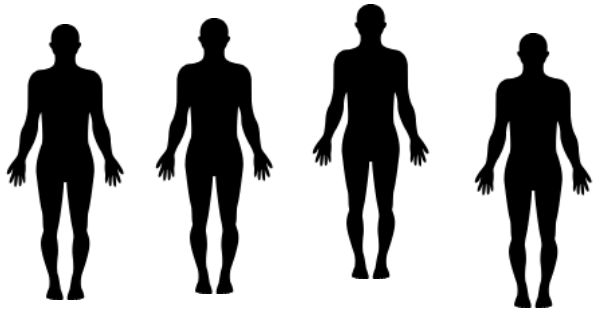
Genomics and Marker-Assisted Breeding

Pat J. Brown, UCD

November 5th, 2018

Marker = SNP = Single Nucleotide Polymorphism



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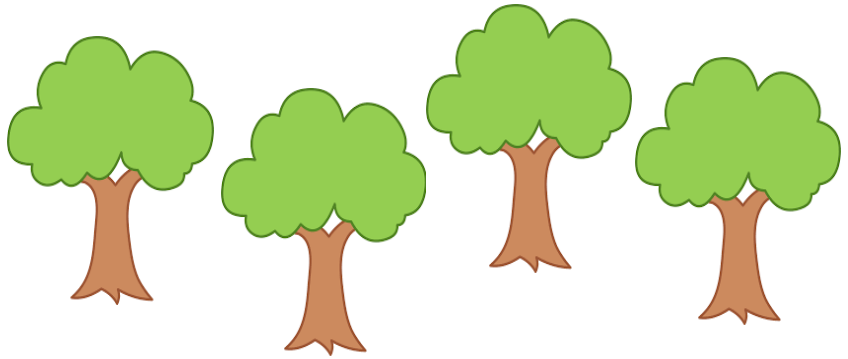

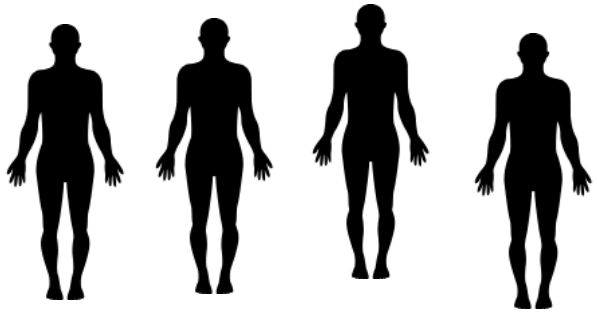

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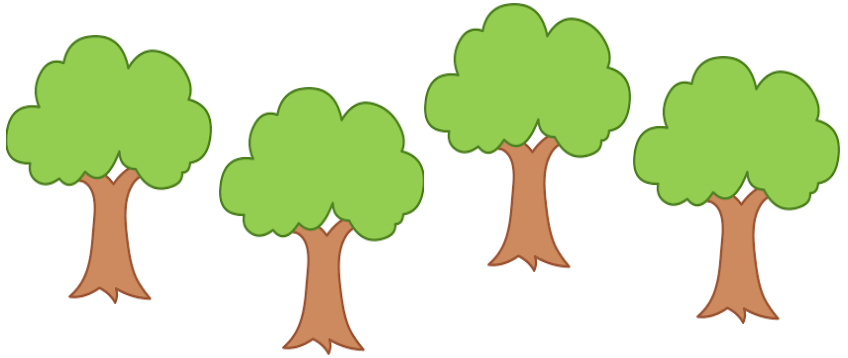

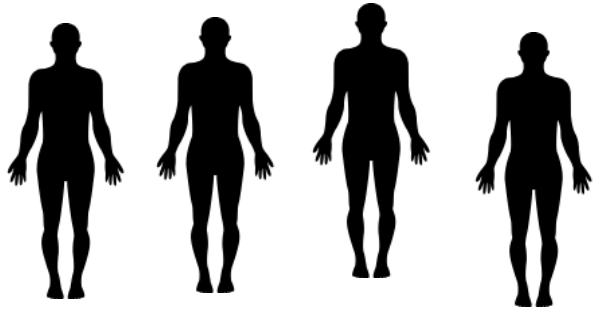

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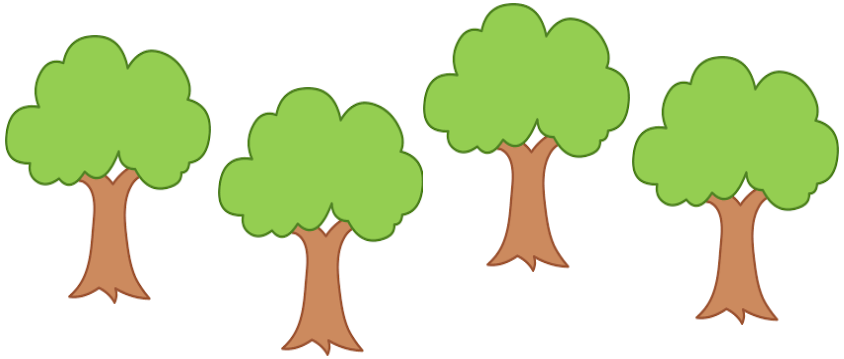
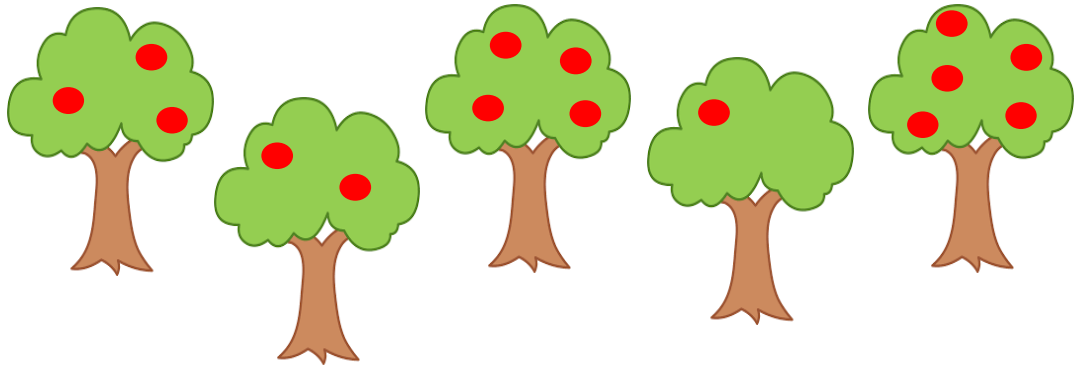
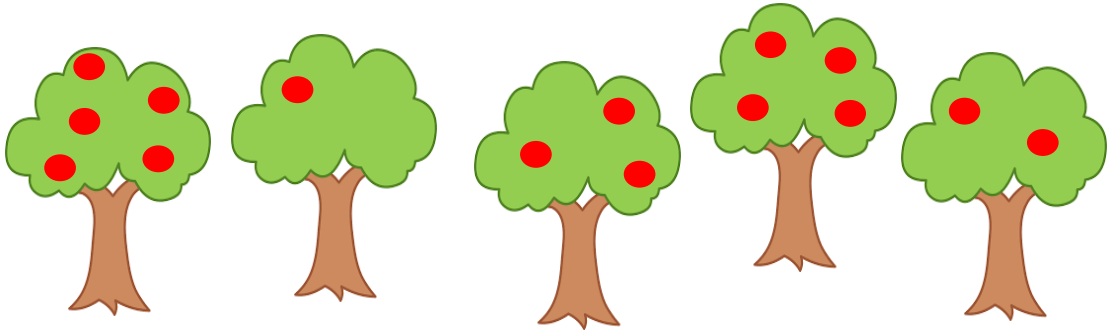


Most markers are not very interesting

0



1



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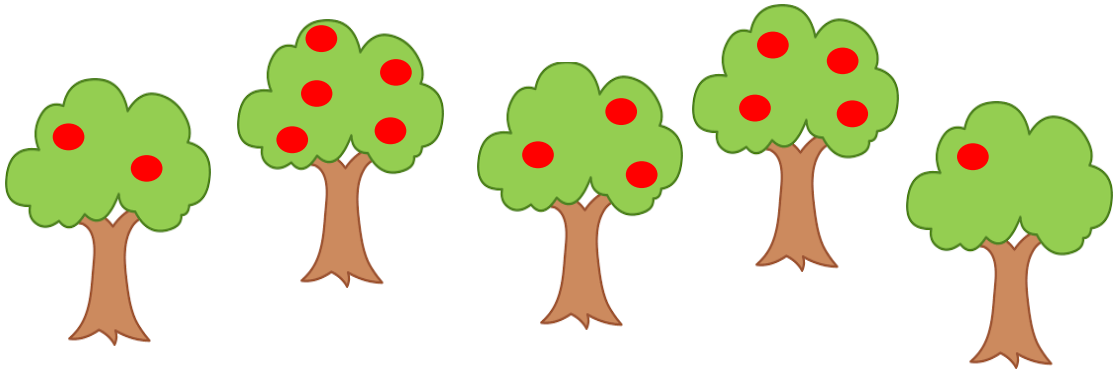
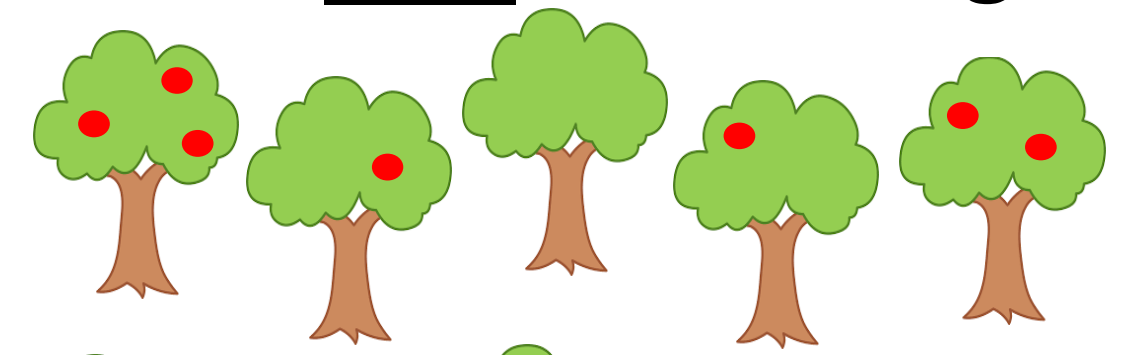
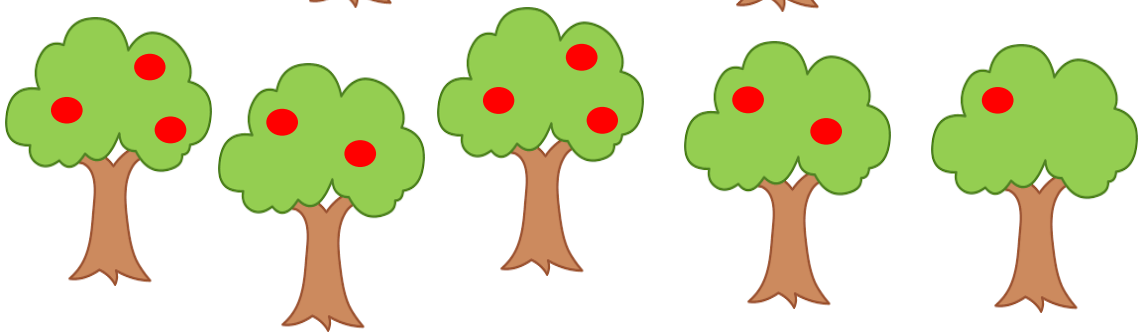


But a few markers are very interesting!

0



1



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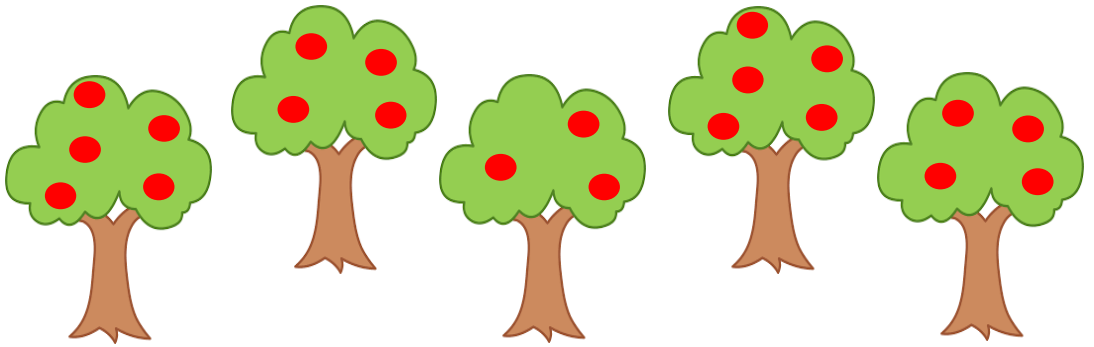
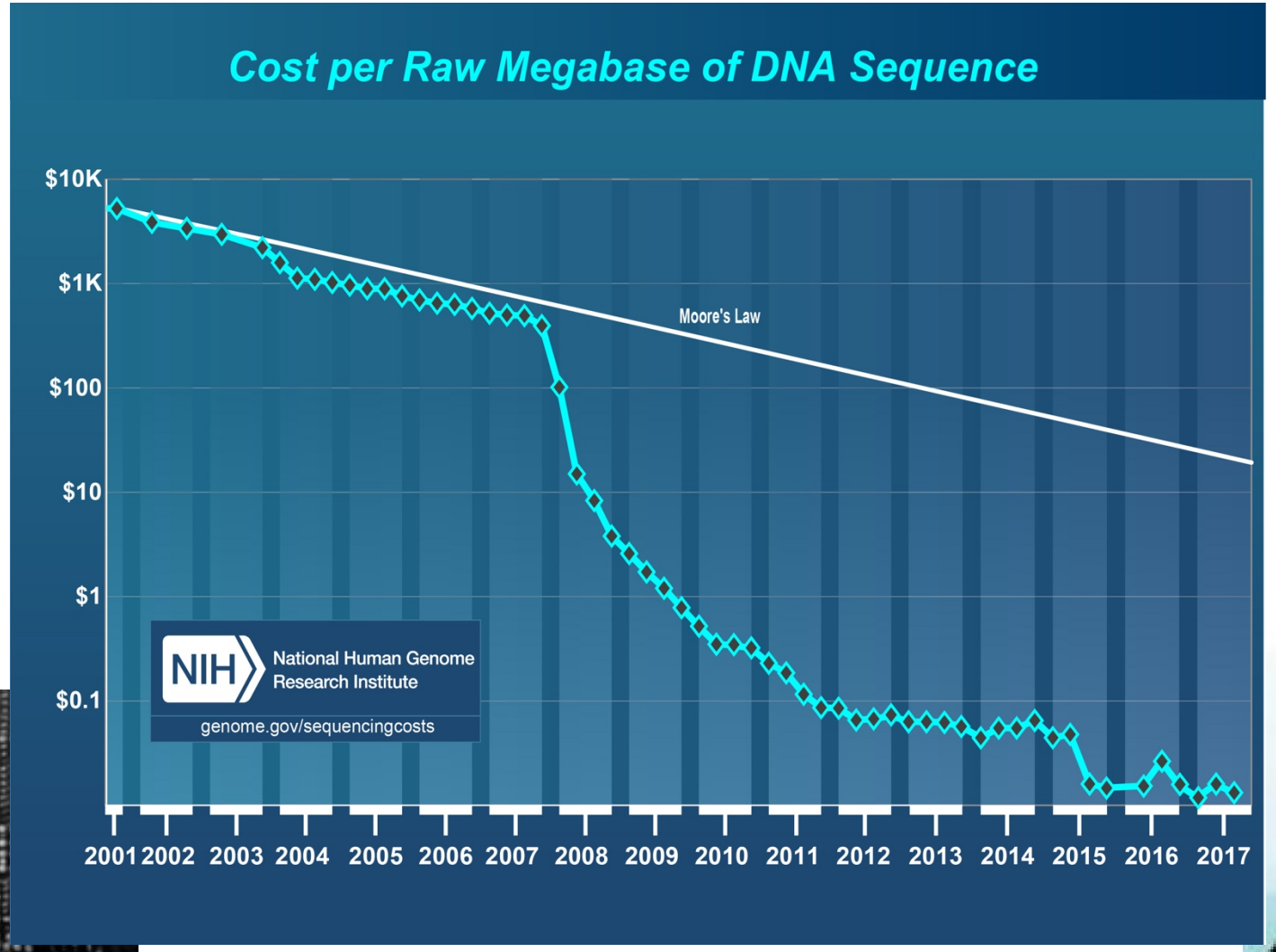
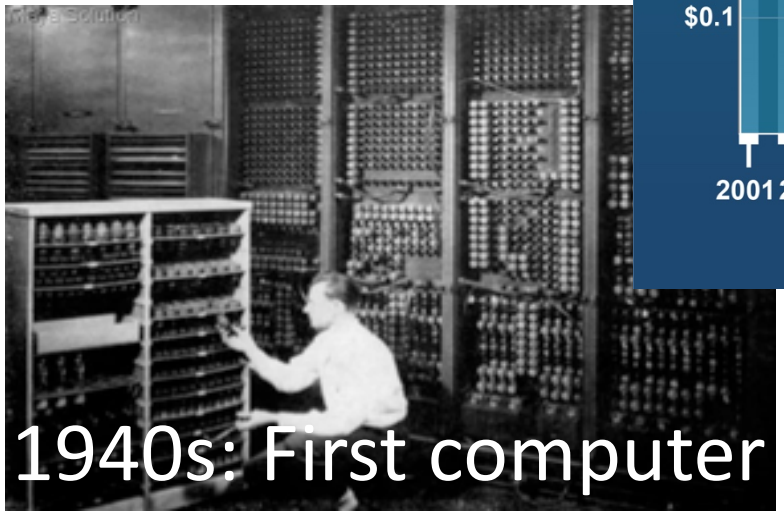


GENOTYPE DATA ⟷ PHENOTYPE DATA

Why all plant breeders should use markers





Technology

Why tree breeders *especially* should use markers

DNA-based Prediction

Save time and $

Save more time and $$$

Breeding scheme

1500 new nuts per year

100%

Seedling blocks

- Own-rooted *J. regia*
- Unreplicated
- 6’ spacing

< 1%

Selection blocks

- Grafted onto Paradox
- Replicated
- 20’ spacing

Grower trials
Release

Parents of controlled crosses

Increasing genetic gain

3000 new nuts per year

50%

Seedling blocks

- Own-rooted *J. regia*
- Unreplicated
- 6’ spacing

< 1%

Selection blocks

- Grafted onto Paradox
- Replicated
- 20’ spacing

Grower trials
Release

Parents of controlled crosses

Increasing genetic gain

6000 new nuts per year

25%

Seedling blocks

- Own-rooted *J. regia*
- Unreplicated
- 6’ spacing

< 1%

Selection blocks

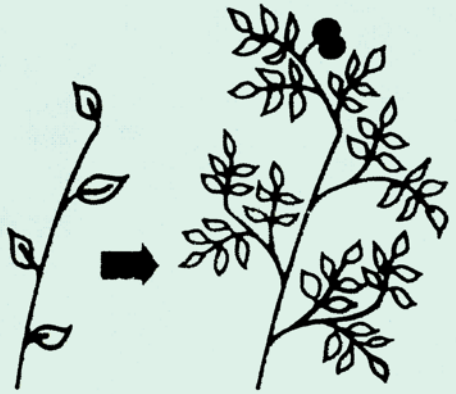
- Grafted onto Paradox
- Replicated
- 20’ spacing

Grower trials
Release

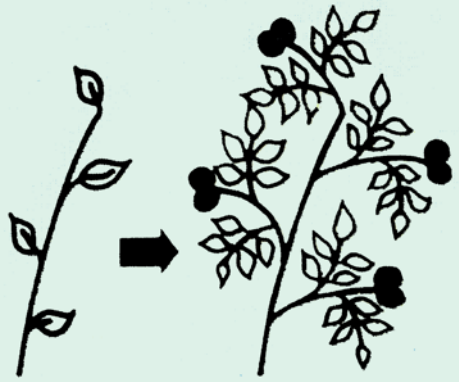
Parents of controlled crosses

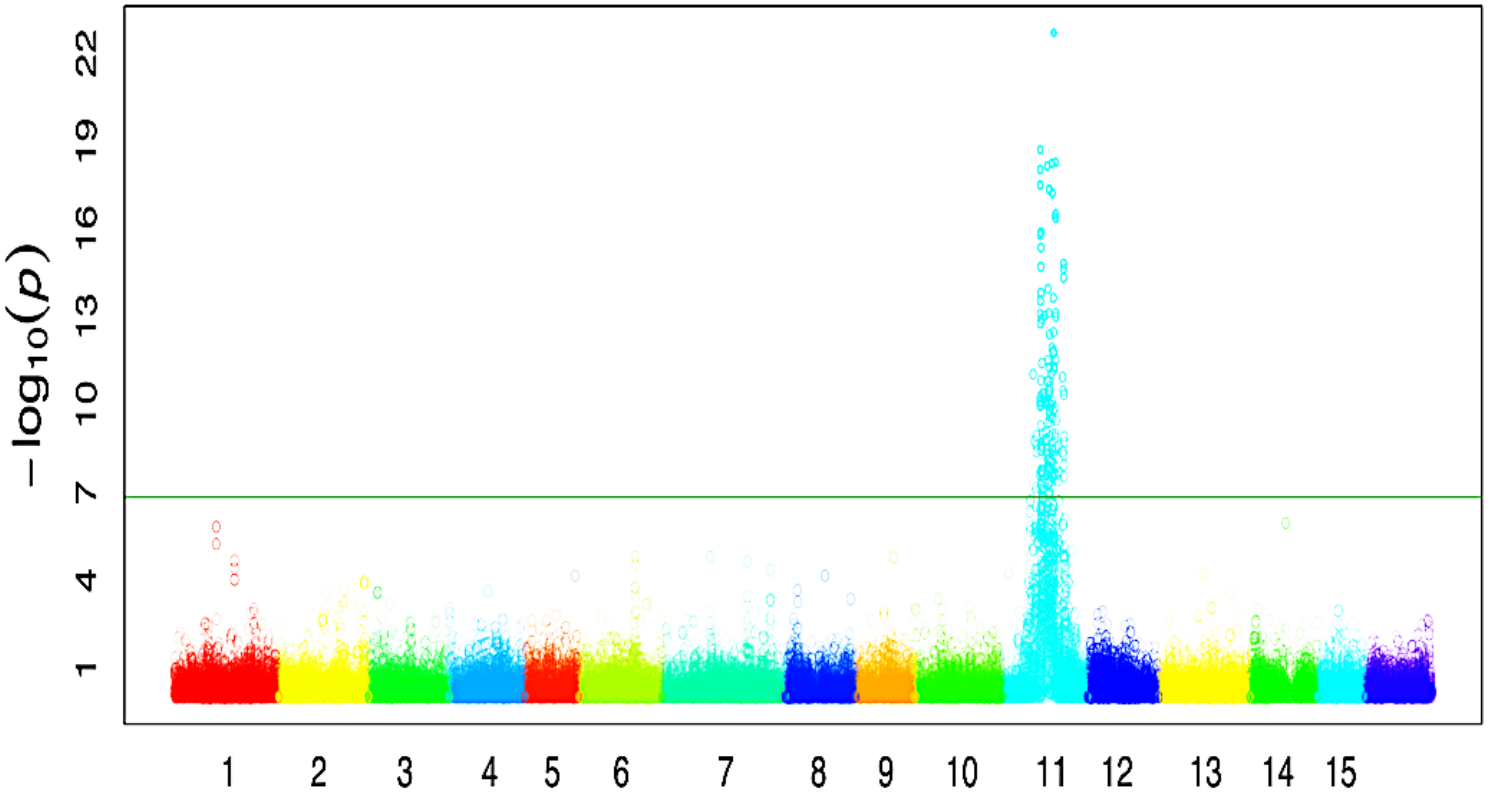
Lateral bearing provides early yield

Terminal



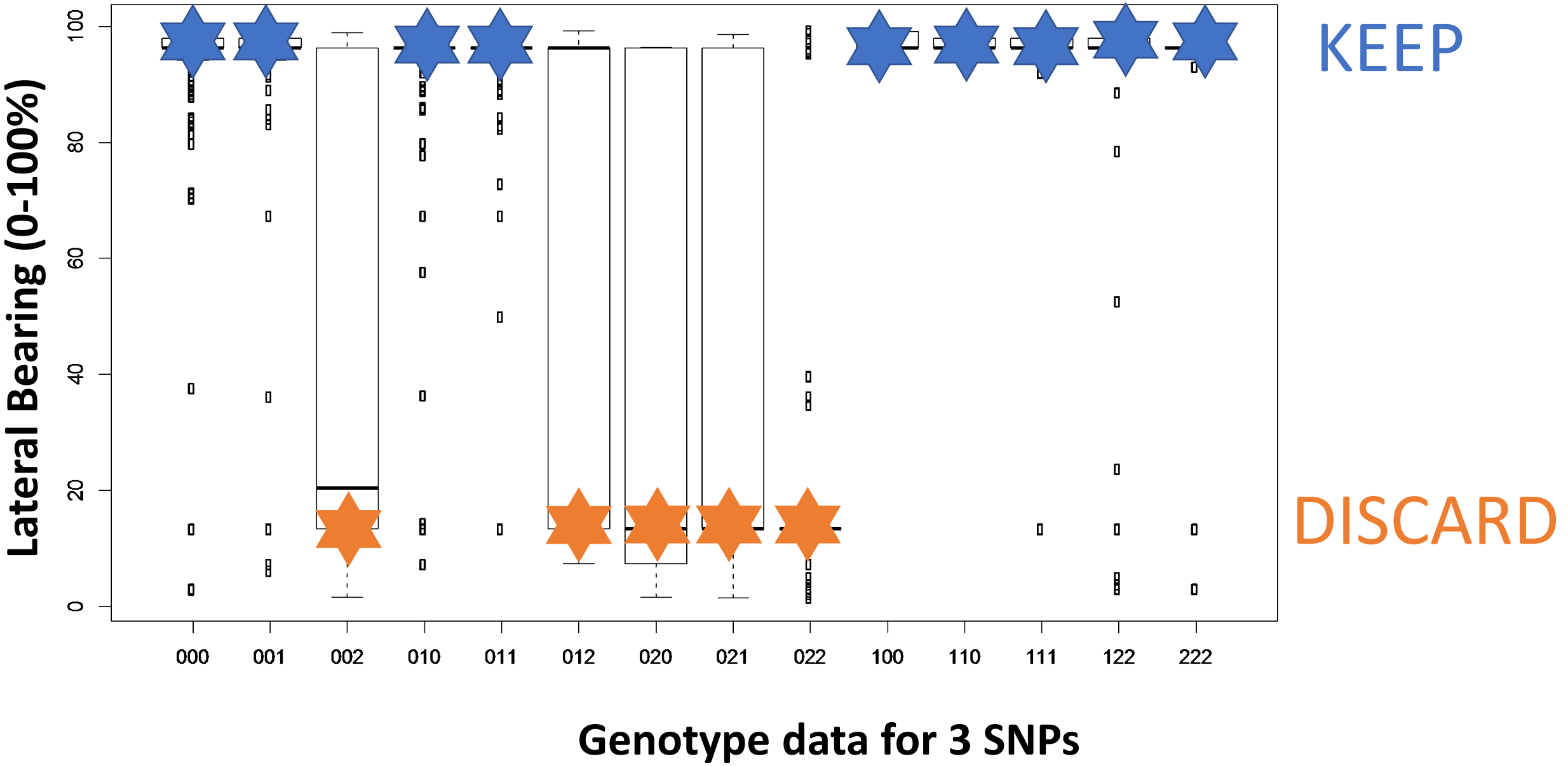
Lateral





- Genotype data: 100,000 SNPs
- Phenotype data: lateral bearing in 2700 trees
- One spot on chromosome 11 controls lateral bearing

Predicting lateral bearing in the breeding program

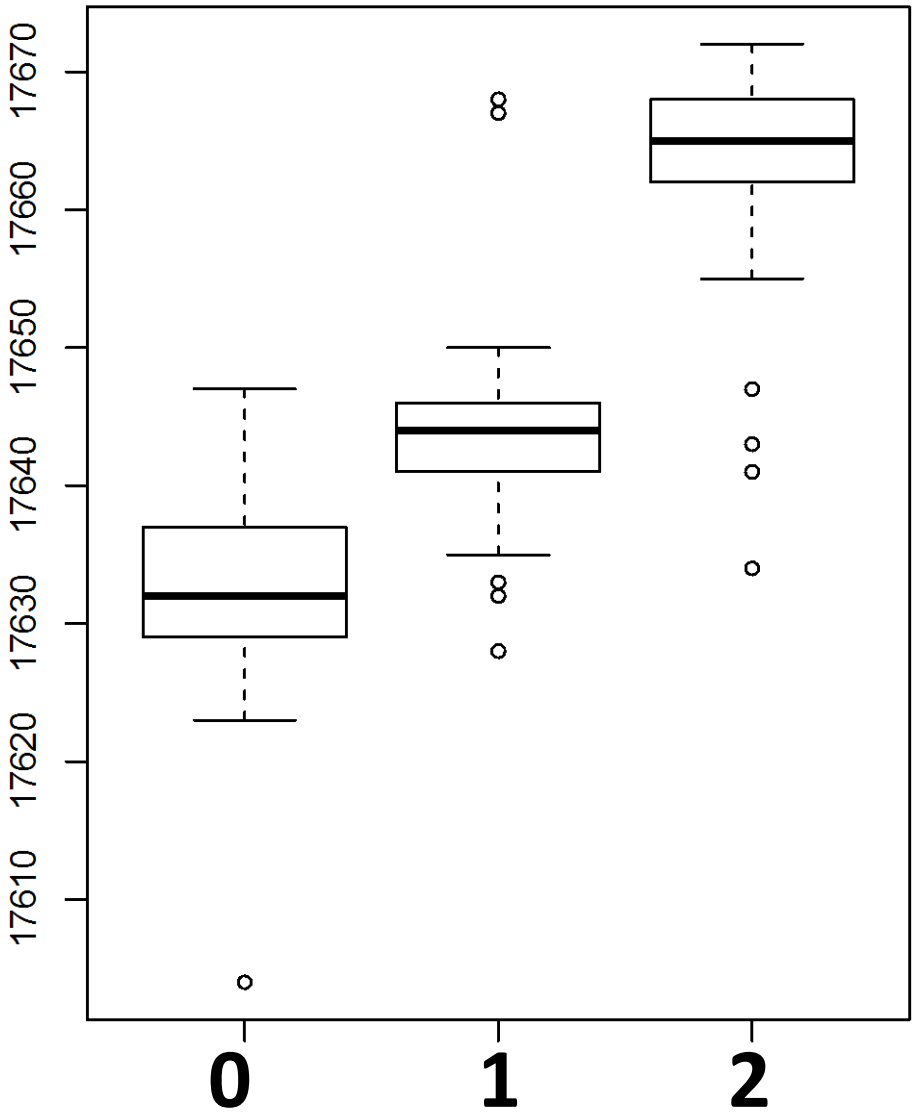


Terminal-bearing germplasm contains valuable traits

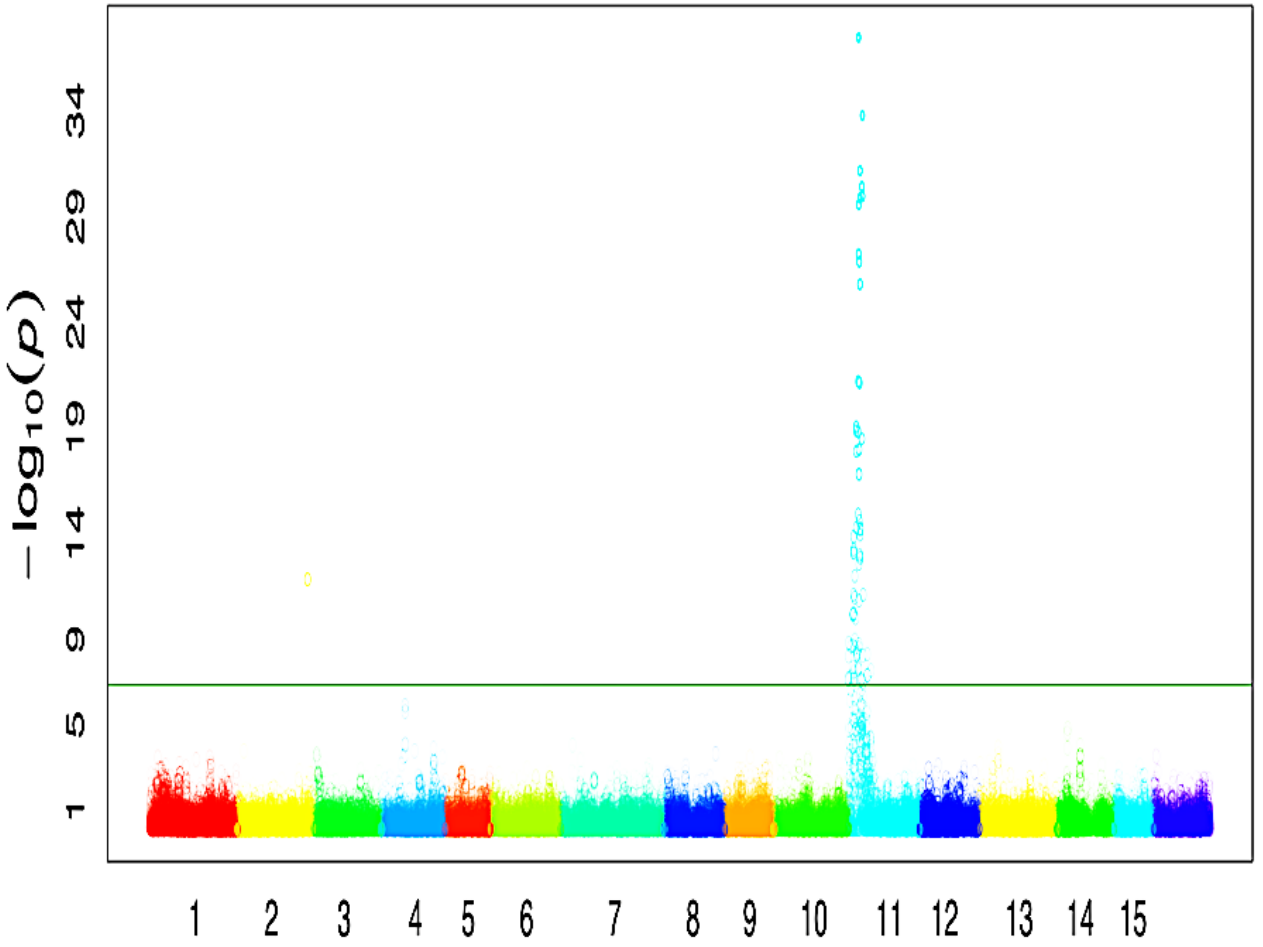
Markers for lateral bearing will enable its efficient use

Red-hulled, fuzzy Himalayan material for blight/pest resistance

Predicting leafing date



Predicting protandry/ protogyny



Protogynous Chandler would harvest 9 days earlier and be perfect pollinizer

Genotype once, phenotype forever

Husk Fly

Bob Van Steenwyk/
Steve Seybold

Botryosphaeria

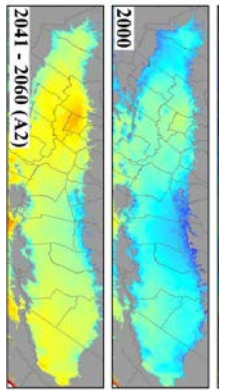
Themis Michailides

Blight

Jim Adaskeveg

PFA

Chilling



CLRV

Sudhi Mysore

Crown gall

Dan Kluepfel

Phytophthora

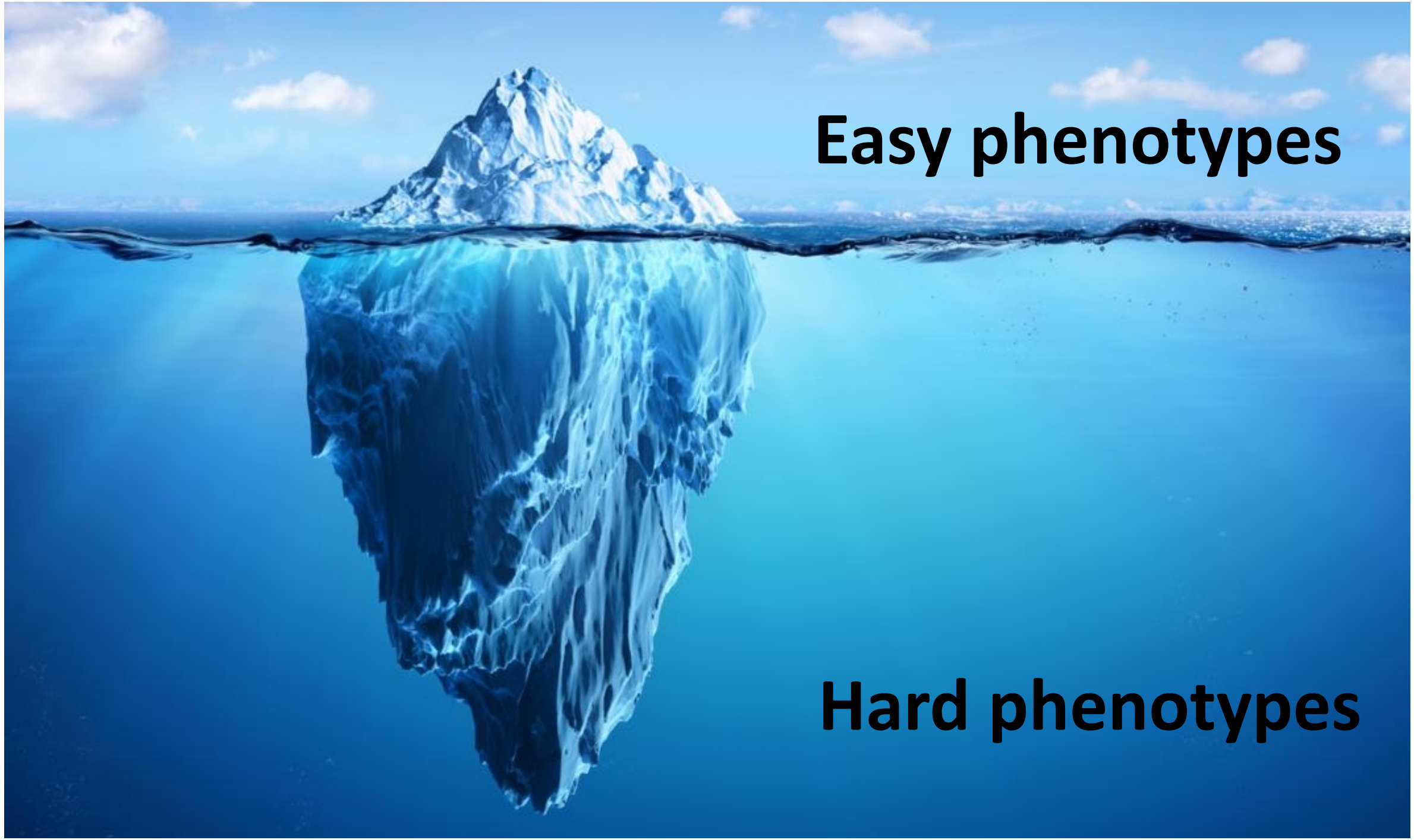
Greg Brown

Nematodes

Andreas Westphal

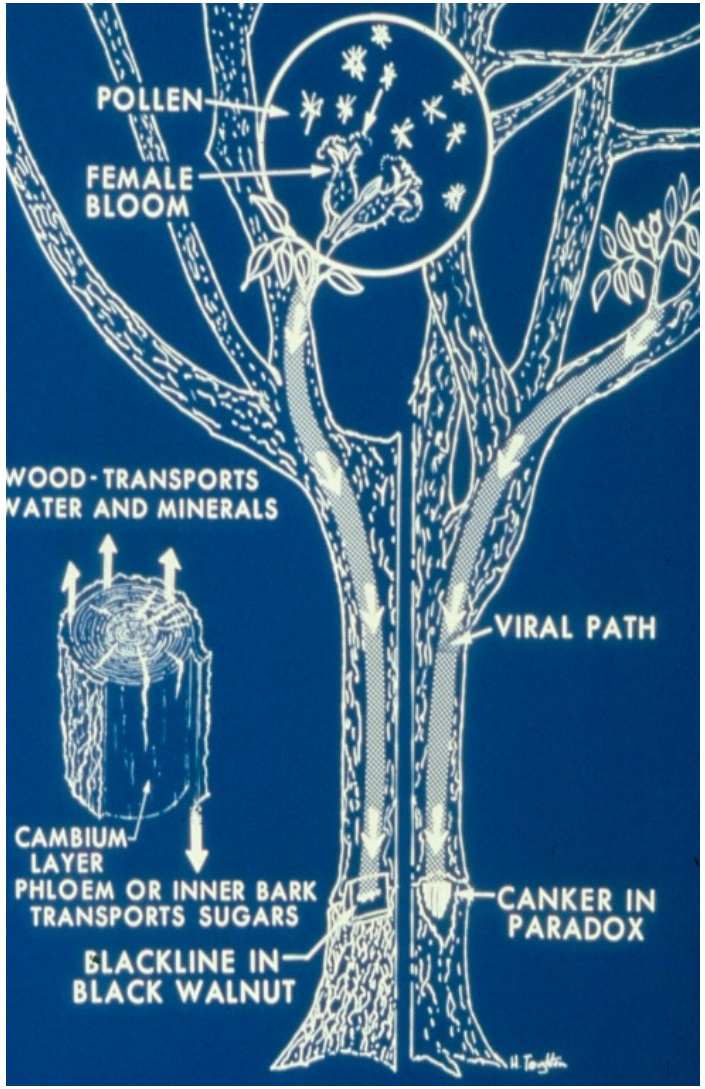
Armillaria

Wes Hackett


Easy phenotypes
Hard phenotypes

Blackline – Cherry leafroll virus

Pollen transmitted, inherited as a single dominant gene



36 years of breeding for blackline resistance (1982-2018)

Black X English

↓

Paradox X English

↓

BC1 seedlings X English

↓

BC2 seedlings X English

↓

BC3 seedlings X English

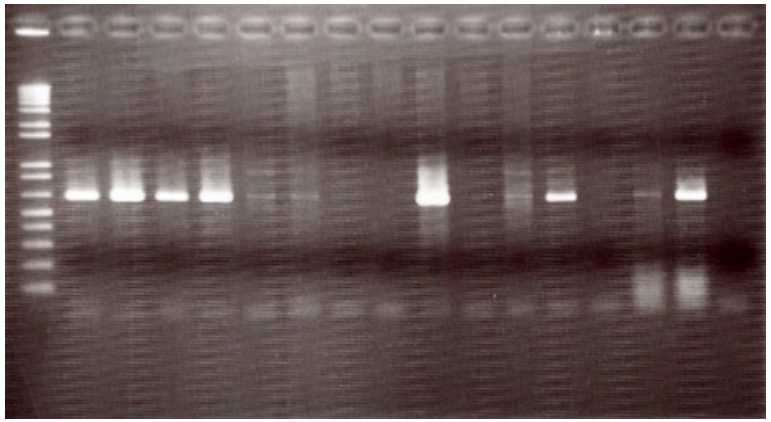
↓

BC4 seedlings X English

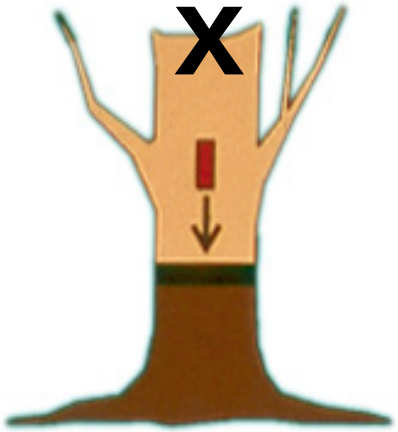
↓

CLRV Resistant Cultivars

SCAR marker: 90% accurate

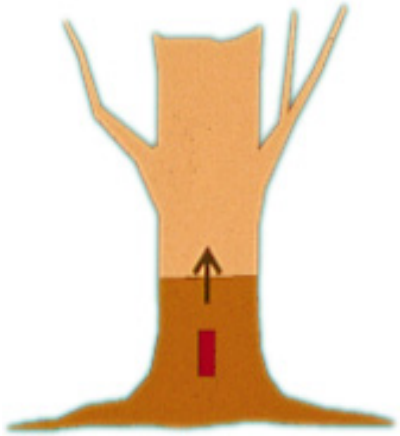


Field screening for blackline resistance

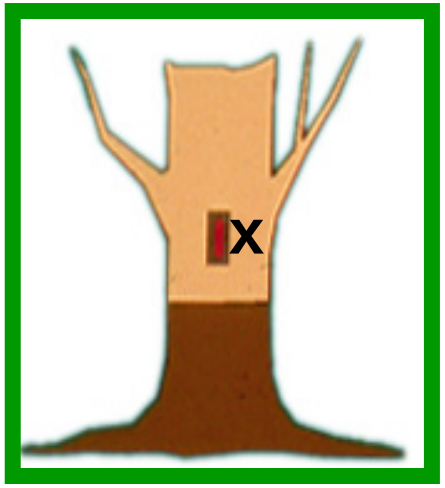


Black

Tolerant

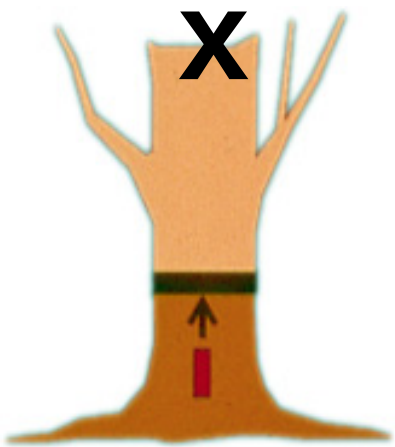


English



Black

Resistant

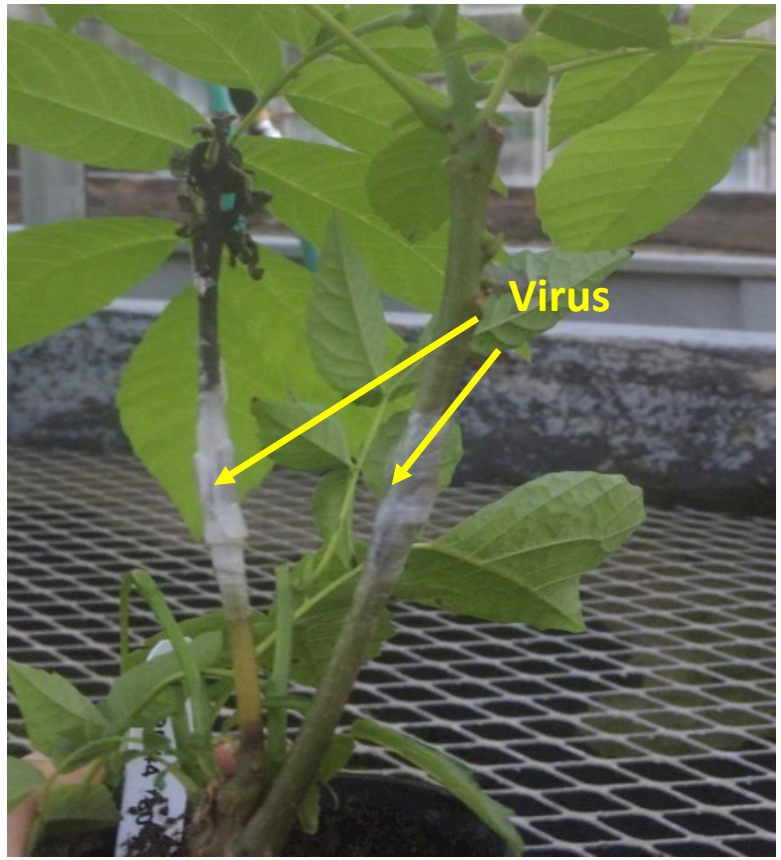


English

More rapid screening for blackline resistance

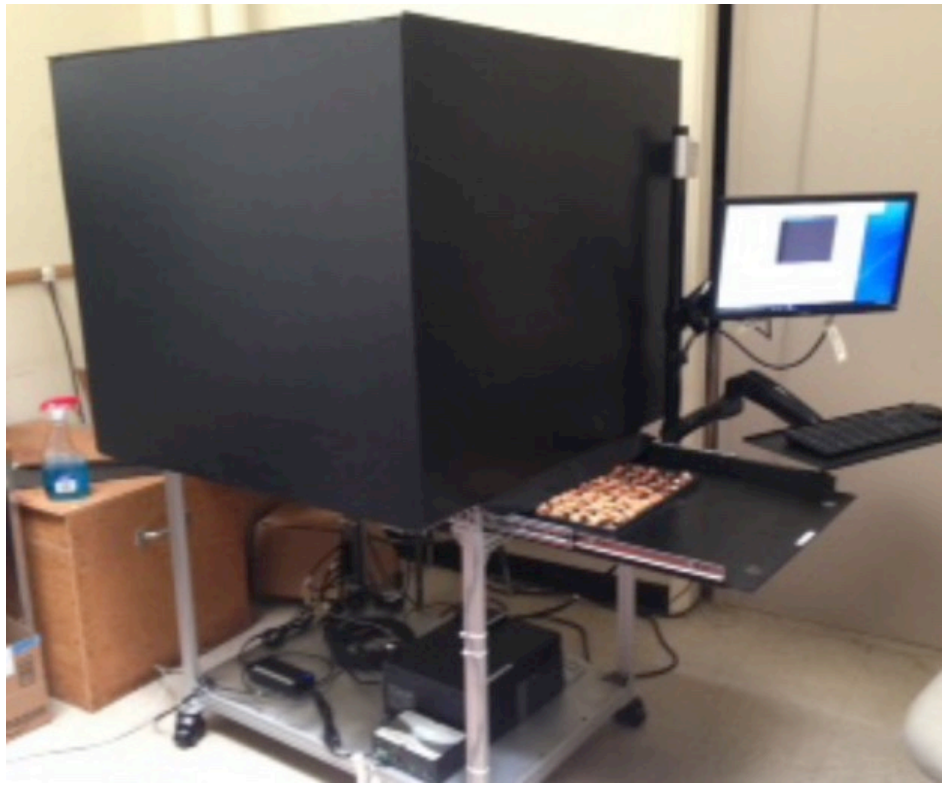
Containerized plants
in greenhouse

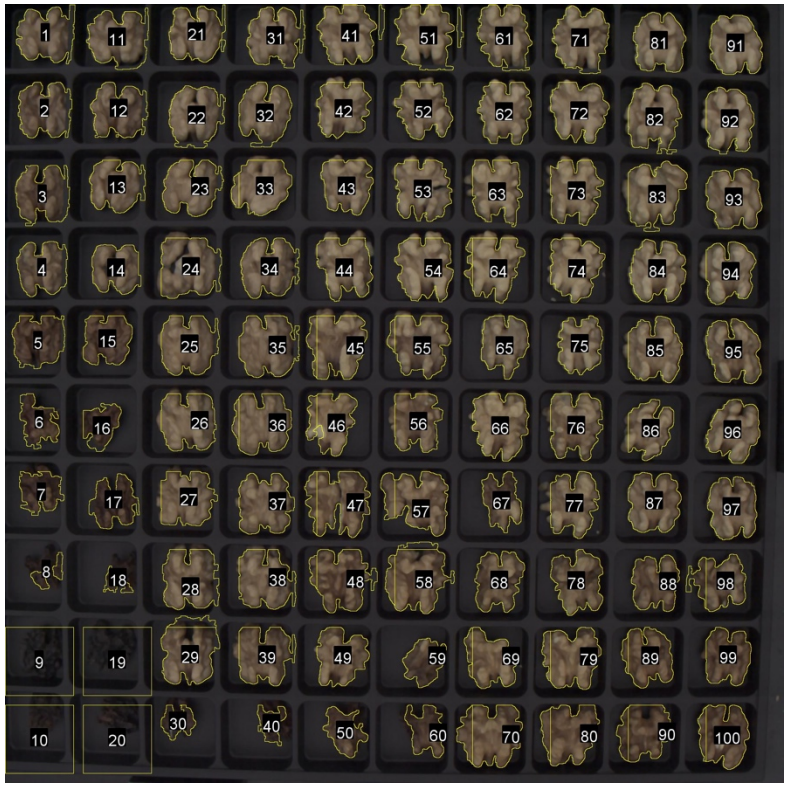
Approach grafting



Patch in virus

A Computer Vision System for objective measurement of pellicle color



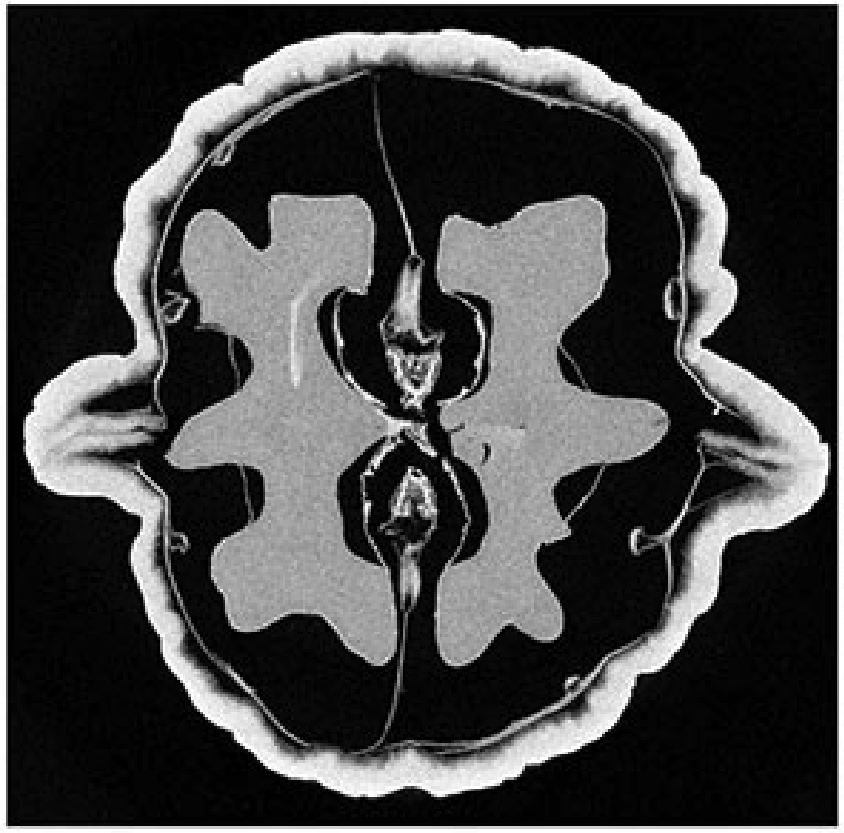


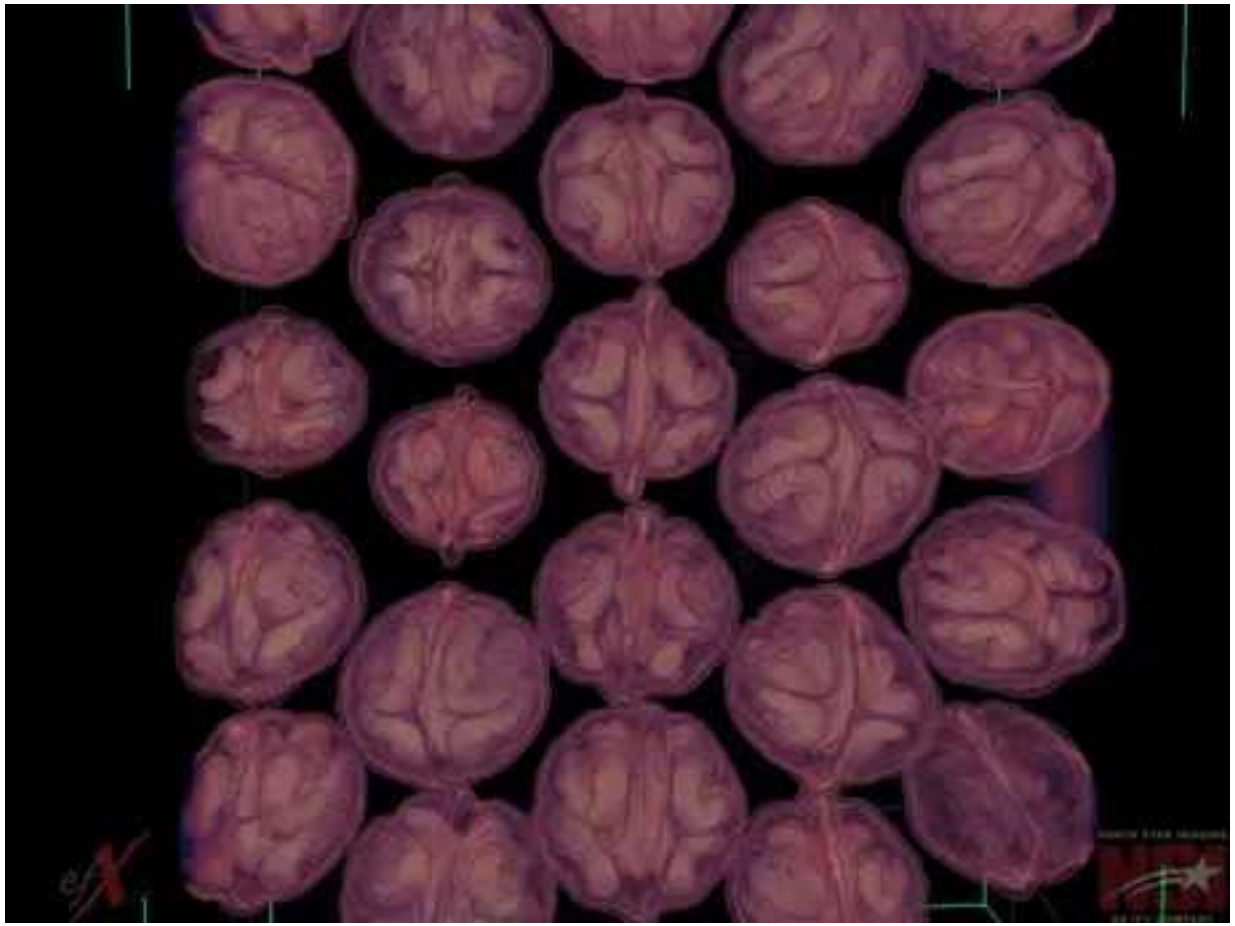
Irwin Donis-Gonzalez, David Neale, Gina Sideli

Measuring leafing date: human vs. drone

Walnut CAT scanning

How does 3D structure of shell, kernel, and packing tissue affect ease of removal and percentage of halves?





Collaboration with Dr. Dan Chitwood, Michigan State

Coming soon: walnut genotyping service

- Free for growers and farm advisors
- Mail/deliver dried leaf sample(s)
- Scion and rootstock testing
- We'll report sample(s) matches to:
  - Scions: Franquette, Hartley, Vina, Chandler, Howard, Tulare, Serr, Ivanhoe, Solano, Durham, Robert Livermore, etc.
  - Rootstocks: RX1, VX211, Vlach, …

Send your ideas, requests, complaints:

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Walnut Improvement Program:

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Pat Brown
Dave Cripe
Steven Lee
Chuck Leslie
Kristina Toporovskaya