







Do you have varieties that are adapted to your...

- climate?
- soils?
- production system?
- specific markets?



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If so, do you have a reliable source of seed?

- OP that is well-maintained?
- OP that is high quality seed?
- F1 that is a mainstay variety?
- F1 that is well-maintained?
- F1 that is high quality seed?
- Is it organically grown?????



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On-Farm Plant Breeding



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Typical Traits to Evaluate

- Plant height
- Plant stature
- Leaf type
- Days to maturity
- Harvestable yield
- Color
- Flavor/texture
- Storage life



Traits to Consider for Organic

- Seedling Vigor
- Pest Resistance
- Disease Resistance
- Weed Competitiveness
- Nutrient Scavenging
- Specialty Markets
- Drought Tolerance
- Heat/Cold/Wind Tolerance



On-farm breeding methods should be...

- Easy for the farmer to execute:
 - minimum (or no) hand pollinations
 - minimum note taking
 - minimum # of pedigree seeds lots
- Deliver a reasonable amount of gain for selection per cycle
- Retain adequate genetic variation for further selection/adaptation, yet have adequate uniformity for the marketplace



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Breeding in a nutshell

- Choose the right crop
- Learn the reproductive biology
- Establish breeding goals
- Conduct trials
- Identify useful variation
 - make crosses if necessary
 - you don't always need to cross!
- Fix important traits in a population



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Choose the right crop



- Is it important to you?
- Do you love it?
- Can you produce seed in your climate?
- Does it fit into your system?
- Selfers vs crossers



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Reproductive Biology

	Selfers	Crossers
Isolation	Less	More
Crossing	Harder	Easier
Self-pollinating	Easier	Harder
Inbreeding depression	Less Likely	More Likely



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Identify breeding goals

- Quality
 - specific traits
- Adaptation
 - climate/system
- Vigor
 - seedling/more?
- Resistance
 - disease/heat/
 - cold/drought



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Start with trials

- Evaluate potential varieties
- Is there a variety that already works?
- Is there a variety that *almost* works? (To cross or not to cross, that is the question!)
- Are there two varieties, when combined, that might work?
- Know your germplasm!
- Learn the fundamentals of conducting trials:

"On-farm Variety Trials: A Guide for Organic Vegetable, Herb, and Flower Producers" M. Colley and J. Myers. OSA Bulletin



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If a cross is necessary then start with a strain cross

- 50-100 plants per variety
- Select 20-30 best before flowering
- Harvest bulk seed from each
- Allow progeny to intermate 1-2 seasons



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On-farm selection methods

- Mass Selection – simplest and most widespread form of plant breeding, can be effective over the long term but is slow!
- Progeny Selection – a fairly simple trick that can speed the breeding process up if used in ways that best fit the reproductive biology of the crop



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Mass selection

Selecting individuals from a population

Tips:

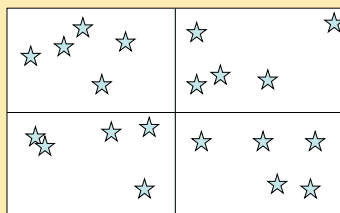
- Select before pollination (if possible)
- Large population
- Uniform conditions
- Select from quadrants



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Mass selection

- Select evenly from quadrants



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Progeny selection - step 1



- Select minimum 50 plants from pop.
- Save seed in individual bags
- Plant 50 individual rows x 2 reps. in the next season



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Progeny selection - step 2

- Select 15-20% of best families based on both reps.

X	X	X
X	X	X
X	X	X
X	X	X
X	X	X
X	X	X



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Progeny selection - step 2

- Select 15-20% of best families based on both reps.
- Eliminate poor families

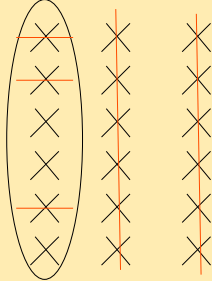
X	X	X
X	X	X
X	X	X
X	X	X
X	X	X
X	X	X



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Progeny selection - step 2

- Select 15-20% of best families based on both reps.
- Eliminate poor families
- Eliminate 30-40% poorest plants from selected rows
- Allow remaining plants to intermate
- Bulk within families



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Progeny selection - part 3

- Plant selected families
- Evaluate
- Bulk as variety if satisfied, or...
- Repeat progeny selection if necessary



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Progeny selection vs. mass selection

Mass selection	Progeny selection
Slower	Faster
Easier	More difficult
No family information	Families give you insight into hidden genetics
No record keeping	Must maintain separate families



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On-Farm Breeding Example: Nash's Red Kale

- Red-purple curly kale
- Downy Mildew resistant
- Upright stature
- Overwintering
- Vigorous regrowth
- Tender and flavorful



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Redbor F1: market standard



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Cross and Mass Selection:



- Two red plants in large field of 'Vates Dwarf Scotch Curled' Kale
- Crossed with much taller Brussels Sprouts
- 10 years of mass selection (1997-2006)



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2008: A signature crop

Qualities:

80-90% true to type OP

Compared to Redbor:

- Better flavor
- More tender
- More cold tolerant
- Better Downy Mildew resistance



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Progeny Selection

In 2008: selected best 50 plants

- Quality traits = leaf type, curl, texture
- Stature
- Color
- Cold hardiness

- Allowed 50 plants to intermate
- Saved seed into individual bags
- Planted 50 short progeny rows in 2009



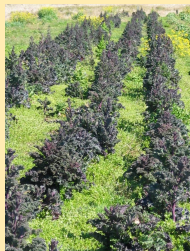
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Progeny Selection

Evaluation based on
progeny row performance

Eliminated:

- Rows with green plants
- Rows with poor curl
- Rows with poor stature
- Rows with early bolters



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Present Population

- Resulted in 13 all red rows
- Seed harvested as single row bulks
- To be planted as 13 x 2 rows and evaluated again.



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OP Dark Green Zucchini

Participants: Bill Reynolds, Eel River Produce & John Navazio, OSA



Zucchini breeding goals:

- Dark green fruits (high lutein content)
- Cylindrical, ridged shape
- Vigorous plants productive in dry-farm conditions
- Open canopy
- Bush habit
- Spinelessness
- Productive









Black Beauty

- Open-pollinated variety
 - Dark fruit
 - Extensive rooting system
 - Long harvest season
- But...
- Has closed canopy
 - Many off type fruit: bulbous, tapered, curved
 - Only 20–25% plants "Grade A" fruit



History of Black Eel Zucchini (1998-2003)

Raven F1' X 'Black Beauty' Population Development

Bill grew field with a large field of Raven & Black Beauty / harvested lbs. of seed (1998)

Drilled large population (20,000 seeds) on 2 acre field and thinned in 3 rounds of selection; 1) vigor, 2) plant type, 3) fruit type / for 4 yrs

This 4 yrs of mass selection produced 'Black Eel' OP / "Seeds Of Change" variety



Resulted in 'Black Eel'







**Self Pollination and Progeny Testing
Participatory On-farm Breeding**

Season 5 attempted selfs on 50 best plants
(2003) / 26 successful selfs

Saved seed of 26 in separate bags. Each bag =
full-sib family.

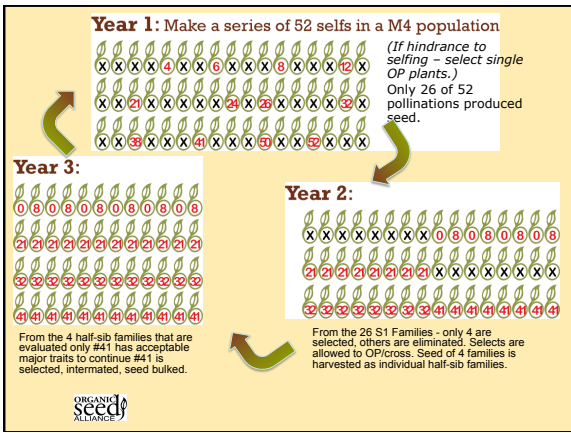
Planted 26 full-sib family progeny rows in
Season 6 (2004) – 4 selected

Planted 4 half-sib families in Season 7 (2005);
only 1 half-sib family selected and bulked

Mass selection to increase seed in Season 8









2006 Baja Zucchini Trial

Tested by large zucchini grower

- Resilient population
- Yielded 5-6 weeks longer than 'Raven'
- Male flowers until the end
- Stocky, open plants
- Low spines
- Less Virus and Powdery mildew symptoms
- More variable than F1's, but "stable" yield



2007 - 2011

- Maintained via mass selection
- Alternate stock seed and production seed years
- Increased acreage in Baja
- Winter 2010-2011: freeze in Baja, 'Dark Star' was the only Zucchini in Whole Foods for most of February



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Participatory sweet corn breeding in Minnesota

Martin Diffley, Gardens of Eagan & Dr. Bill Tracy, University of Wisconsin



Background:

- “Temptation” was choice for spring planting
- Fewer good seed sources

Martin’s needs:

- Cold germination
- Early vigor
- Good husk protection
- Disease resistance
- Eating quality

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- 2 separate populations
- Each from 4 hybrids
- Recurrent selection

Spring 2008:

- ~100 rows planted / population
- Each row from one ear
- Some seed from each ear also saved

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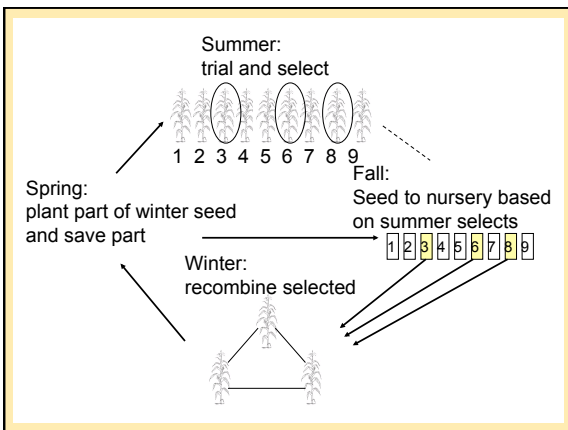


1st selection: Early vigor












Participatory Plant Breeding: 3 Examples

- Nash Huber's Red Kale
 
- Martin Diffley's Sweet Corn
 
- Bill Reynolds' Dark Star Zucchini
 

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