Organic Seed Alliance
Advancing ethical seed solutions to meet food and farming needs in a changing world
PO Box 772, Port Townsend, WA 98368

2019 Southeast Seed Summit Proceedings

Durham, North Carolina

November 1st - 3rd, 2019

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Introduction

Seed is one of the most critical inputs a farm relies on, and organic farmers are required to utilize organic seed when available. But seed is more than an input. Seed is a natural resource requiring broad and collaborative stewardship. The quality of seed and the suitability of a variety can make a very substantial impact on the profitability, environmental impact, and sustainability of the farming operation. Organic foods sales exceed 45 billion dollars annually, but organic farmers remain dependent on a highly consolidated, conventional seed industry to supply their genetics. Organic farmers in the Southern region are further challenged by a unique growing climate with high humidity, and low winter chilling, which limits the range of species suitable for production of high quality seed. Successful seed production requires knowledge of appropriate production practices, infrastructure needs, markets, agroecological implications, and the suitability of the crop for seed production in the local environment. The 2019 Southeast Seed Summit was convened In order to empower Southeast farmers to expand organic seed production, while addressing the risks and impacts on the whole farm system.

These proceedings came from this summit, which was held in conjunction with the Carolina Farm Stewardship Association's Sustainable Agriculture Conference as a two and a half day conference for seed producers and other stakeholders. The seed summit featured workshops on seed topics including seed production, plant breeding, variety trials, and seed business, as well as sharing, networking and listening sessions. In these proceedings you will find the summaries and notes from listening sessions on how to improve Southeast seed systems, as well as the slides from the workshops.

There is an active movement of Southeast seed growers and their allies working to strengthen Southeast seed systems, starting with the priority initial areas of work detailed here. If you are curious about Southeast seed efforts and activities, want to join the Southeast Seed Network listserve, or want to help to further some of these goals, you can find out more by reaching out to Jared Zystro at jared@seedalliance.org. We look forward to working together with you.

Sincerely,

Kelli Dale
Jeanine Davis
Melissa DeSa
Edmund Frost
Jacob Leech
Jovan Sage
Ira Wallace
Jared Zystro

2019 Southeast Seed Organizing Committee

Agenda

Southeast Seed Summit

Friday, November 1st - Growing Seed in the Southeast Intensive

For most of these sessions, we have identified a few speakers to lead the topic. *However,* this summit is designed to foster peer-to-peer learning. Part of these sessions will be dedicated to participants sharing their experiences and expertise about these topics.

8:30 am – 9:15 am **Welcome and introductions**

Ira Wallace and Melissa DeSa

9:15 am - 9:45 am **Basic seed biology and physiology**

Myra Manning

10:15 am – 11:30 am **Regional pest, disease and climatic factors in seed production.**

Workshop leads: Chris Smith, Ira Wallace, Edmund Frost, and Elizabeth Little

OPEN SPACE SESSION

11:30 am – 1:00 pm **– Lunch**

1:00 pm – 2:00 pm **Facilitated conversation on how to reach the people who are not at the table and what the impediments are to more effective outreach to people of color in the region.**

Jovan Sage

2:00 pm – 4:00 pm **Listening session and Southern organic seed system strategic planning.**

Craig LeHoullier and Jared Zystro

4:00 pm – 5:00 pm **Seed harvesting and cleaning, processing and equipment peer-to-peer knowledge sharing**

OPEN SPACE SESSION

Saturday, November 2nd

7:00 am – 8:30 am **– Breakfast**

8:30 am – 9:45 am **Growing vegetable seed in the Southeast**

Learn from Southeast seed growers and experts about the tools and techniques you need to be successful in growing vegetable seed in our region. Presenters will share information about timing, variety choices, pollination, harvest and post-harvest seed crop management, as well as best choices for tools and infrastructure.

Workshop leads: Edmund Frost, Ira Wallace, Melissa DeSa, and Craig LeHoullier

OPEN SPACE SESSION

10:15 am – 11:30 am **Growing field crop seed in the Southeast**

Interested in growing field corn or small grains as seed crops? Hear from members of the Southern Farmers Seed Co-op about the necessary tools and equipment, recommended variety choices, and seed crop management throughout the season and in storage.

Workshop leads: Peyton McDaniel and Ben Miller

OPEN SPACE SESSION

11:45 am – 1:15 pm **– Lunch**

1:30 pm – 2:45 pm **Seed production economics, marketing, and market niches**

Could commercial seed production be a profitable part of your farm? Find out from experienced farmers and seed industry experts about negotiating seed production contracts, and finding the right scales, markets and seed crop types.

Workshop leads: Debbie Piesen, Brett Grohsgal, Peyton McDaniel and Ben Miller

OPEN SPACE SESSION

3:15 pm – 4:30 pm **Seed Showcase – Everyone can bring seeds and attendees set up tables to showcase their farms and business and swap seeds and ideas.**

Sunday, November 3rd

7:00 am – 8:30 am **– Breakfast**

8:30 am – 9:45 am **Finding farm solutions with variety trials**

Variety trials can help you find the best varieties to grow for the farm and for the customer. Variety trials are also essential for farmer-breeders and seed growers dedicated to the continual improvement of seed. This workshop will help farmers gather useful information through good trial design and data collection without increasing labor and resource inputs. Presenters will share real life examples of variety trial layouts, results, and challenges.

Workshop Leads: Jeanine Davis, Edmund Frost and Jared Zystro

OPEN SPACE SESSION

10:15 am – 11:30 am **Breeding Crops for Resilience in the Face of Climate Change**

Brett Grohsgal and Michael Mazourek

Learn the fundamental skills to develop and adapt seed varieties to your farm in a changing climate. From planning a breeding project to crossing varieties and selecting the best plants, experienced plant breeders will show you how to get started and provide inspiring examples.

Throughout the conference

The CFSA Seed Exchange will be open to for everyone to bring their seeds to share

Lee Barnes and Doug Jones

Listening Sessions

Summary

These notes are from the Southeast Seed Summit listening sessions held in Raleigh NC in 2019. Participants gathered to connect around seed in the Southeast and identify the top challenges, strengths and areas of need for seed in the Southeast and to plan collective actions.

Top Five Challenges for Southeast Seed Systems, in order (number of votes in parentheses):

- **Lack of economic opportunities for seed growers** (16)
- **Lack of coordination between growers, companies, breeders, etc** (15)
- **Climate (and urgency as a consequence of), pests, disease pressures** (14)
- **Appropriation/patenting of culturally significant seeds** (7)
- **Repair work needed to rebuild networks** (5)

Other challenges mentioned:

Stigma with respect to crops most easily grown here - needs to develop markets for them (3)
Global Labor Market issues (2)
Policies - organic vs non-organic, funding and support, politics, regulations (1)
Need more definition of what a regional seed network is (structure, members, roles) (1)
Resources (1)
Uniform understanding of standard terms - heirloom, OP, GMO - as it corresponds to seed identity, use and quality (1)
Lack of regional seed production knowledge (need to cut dependence on expertise from universities) (1)
Using the plants more fully that need to be pulled out (0)
Contamination (0)
Seeds being most often purchased are sometimes not the best fit for this region (0)

Top Five Strengths of Southeast Seed Systems, in order (number of votes in parentheses):

- **Diversity of Cultures and Strength in Farming Cultures** (13 votes)
- **Strong Farming Culture** (10 votes)
- **Lots of Elders and Youth in this Region** (8 votes)
- **Network of Experienced Seed Producers** (7 votes)
- **Number of Regional Seed Companies** (6 votes)

Other strengths mentioned:
Consumers Connected to Farming/Gardening (5 votes)
Time is Right - Need provides the Energy (4 votes)
Diversity of Climates (3 votes)
Critical Mass of People in the Room to Make Progress Now (2 votes)
Culture of Knowledge Sharing and Seed Saving (2 votes)
Organic Seed (2 votes)
Seed Banking and Preservation (USDA, SSE members, etc) (1 vote)

Priority Initial Areas of Work:
The following five broad areas were seen as the most important categories for work to be done. Groups brainstormed potential actions and solutions within each of these areas. The notes from those brainstorming sessions can be found by following the links under each area.

Immediate Next Steps:

The following tasks were identified as immediate next action steps to keep the conversation moving forward.

- Regular zoom calls
- Meetup at seed growers conference
- Meetups at regional conferences
- Listserve

Challenges for Southeast Seed Systems - Session Notes

Identified prior to the meeting in the survey. Vote number indicates those that the team most wished to tackle for solutions in the breakout groups

Climate (and urgency as a consequence of), pests, disease pressures (14)
Lack of economic opportunities for seed growers (16)
Lack of regional seed production knowledge (need to cut dependence on expertise from universities) (1)
Lack of coordination between growers, companies, breeders, etc (15)
Appropriation/patenting of culturally significant seeds (7)

Added during the meeting

Stigma with respect to crops most easily grown here - needs to develop markets for them (3)
Using the plants more fully that need to be pulled out (0)
Policies - organic vs non-organic, funding and support, politics, regulations (1)
Contamination (0)
Repair work needed to rebuild networks (5)
Global Labor Market issues (2)
Seeds being most often purchased are sometimes not the best fit for this region (0)
Need more definition of what a regional seed network is (structure, members, roles) (1)
Resources (1)

Uniform understanding of standard terms - heirloom, OP, GMO - as it corresponds to seed identity, use and quality (1)

Strengths of Southeast Seed Systems - Session Notes

From the Survey in Advance of the Meeting - vote number resulted from the meeting activity - those that most resonated, for voting, are in bold.
Diversity of Climates (3 votes)
Strong Farming Culture (10 votes)
Consumers Connected to Farming/Gardening (5 votes)
Culture of Knowledge Sharing and Seed Saving (2 votes)
Network of Experienced Seed Producers (7 votes)

Added at the Meeting from the Participants
Diversity of Cultures and Strength in Those Cultures (13 votes)
Number of Regional Seed Companies (6 votes)
Number of Ag Universities, Colleges and other Schools and Farm Service Agencies
Seed Banking and Preservation (USDA, SSE members, etc) (1 vote)
Organic Seed (2 votes)
Time is Right - Need provides the Energy (4 votes)
Critical Mass of People in the Room to Make Progress Now (2 votes)
Lots of Elders and Youth in this Region (8 votes)

Priority Initial Area of Work 1:
Internal Network Building (human centric)

Group 1 session notes:

- Grow and connect networks between growers, seed companies, and third party organizations with a wide net
- Find people to support/volunteer to get going on all of this (do winter work) - ensure that you have people who will stick to it
- Identify, define, describe what people want in a "seed system" (also define who the people are who will contribute)

- Find ways to encourage local/OP seeds - buying, farming with, gardening with - will take consumer education - perhaps a podcast, for sharing information between appropriate people
- Create linkages between food and chefs - varieties with great stories
- Grow home gardeners and help advise what they grow - create seed savers, could lead to more farmers

Group 2 session notes:

- Create a trials database where records are shared and exchanged
- Create a network of farmers who are excited about trialing (and identify who they are) for market growers - that are willing to share genetic material and results. Can this group also come up with some economic solutions? Where can the funding come from?
- Involve seed companies - seek their stamp of approval - but would they be willing to publish their own trial work and results?
- There would be power in a network that involves as much of the above as possible
- Need a good marketing pitch
- Could be a decentralized growers network but a centralized marketing/economic effort
- Where to find funding and incentives, esp for non certified farms - grants?
- Need to find out from this group who is interested in driving forward these ideas

Group 3 session notes:

- Building the network - OSA Listserve
- Use Zoom technology for the regular meetings
- Identify conferences - regional, state, Ssawg, Georgia Organics - other zones
- Need to act now - don't put off until tomorrow what can be done now
- Create relationships with extension agents
- "Closed mouths don't get fed!" - so be proactive and ask!
- Invite others in - connect more people in, don't have to be experts
- Exchange your traditions - "your seed is your culture"
- Build the resource list. Those with expertise in histories of seeds - David Shields, Sarah Ross, Craig LeHoullier, Rowan White, Michael Twitty, Ira Wallace. Those with expertise in equipment - David Boule; those with expertise in flavors and nutrition - Row7 seeds, chefs and home cooks. This is just a starting point - need to fill out this list
- Key is making clear why we are doing this - Seeds for What???

Priority Initial Area of Work 2:
External education - celebrate and promote local seed

Group 1 session notes:

- Farmers markets - more outreach and information to the customers - education
- Farmers won't grow it unless they can sell it
- What are the ways to get customers to better appreciate/value regional varieties?
- Can't be only "high end" - must be accessible to all
- Better known and better (tasting) cooking methods for regional (but less well known) crops - can create demand (education needed)
- Create an information campaign - "local seed/local varieties"
- Information to farmers - local seeds are better and locally adapted varieties are more beneficial for them
- Change the USDA certification rules on organic seeds
- Create a podcast, or social media campaign, to create a broader reach
- There is a broad information gap
- Encourage larger institutions to serve locally produced/grown regional food (jails, schools, hospitals)
- Make it accessible for more people - easier, healthy recipes
- Message to community and home gardens - eat what you grow, and grow what succeeds in your garden (regionally adapted/appropriate/sourced)
- Act on these ideas!

Priority Initial Area of Work 3:
Economics of seed production - make viable

Group 1 session notes:

- Large Ag companies vs small farmers - idea is to combine contracts with other small farmers
- Develop a weight-based payment structure (sq ft, hourly, bid-based)
- Low yielding varieties could be better in general, but it is hard to get enough seeds. Consumer education would help - explain to them so they would pay more
- Cost-share the billing for "organic certification", "certified naturally grown", other categories
- Tradeoffs of locally grown landraces vs externally grown landraces for the southeast
- Reputation - high germination rates are important, fosters good relationships with growers

- Increase labor efficiency for homesteaders in seed production (vs vegetable production)
- There is a perception of increased risk, increased labor of seed production (cost is actually 10-20 dollars per hour to grow seed)

Group 2 session notes:

- Use networks to identify and disseminate information on resources (grants, business opportunities with seed companies, identifying markets, etc)
- Raising awareness to expand economic success of OP/Organic seed companies so that we can support more jobs for breeders, etc.
- Promoting cooperatives and sharing
- Education of farmers in finding alternative revenue streams to support seed growing - connecting farmers to the alternative product markets (dealing with waste streams)
- Supporting breeders to collaborate to apply for grants and access resources
- Connecting seed growers with other local farmers to grow out varieties

Group 3 session notes:

- Subsidize seed and all of the pieces - equipment, supplies, lobbying at multiple levels
- Larger seed companies that can buy larger quantities
- Pooled resources for equipment - such as shared seed cleaning; grant?
- Ensure there is kit for each farm
- Form seed growers union to set prices and guidelines and terms
- Standardize incentives for quality
- Risk sharing with companies - pay at growth stages
- Meet ups to support direct sales to growers - could allow for sales of lower germinating seed
- Create a virtual seed marketplace (which existing ones, have)
- Use a label - “SE Growers Seed” - can it demand a premium?

Group 4 session notes:

- We need to get paid more for the seeds that we grow; find ways to actively make this work
- Regional farmers growing regional seeds for regional companies
- Politics of and benefits of seed saving - Jennifer Taylorwould like to work on that. Also with growing out trials and networks
- Debbie- trials network has started putting together a network already
- Regina- interested in working with Jennifer and trials
- Lillian, Ira outreach and education
- Rick hurst- history and education of SE varieties

- Sandy- the work on the history of seed and preservation of stories maybe is a seperate group or sub group of the outreach and education yes but needs it's own focus because it can be really hard to get those histories in order (Ira)
- Sandy Ostracat experience in qualitative interviewing help talking to peole about seed stories
- The larger group can split into sub groups for more effective
- We can send out a google form/survey type thing to gauge their level of participating and
- Strategies and goals are different so trying to fit the interests is difficult
- But lilliane pointed out not to silo themselves and then working within a broader sub group is good
- May be overlaps among the groups will evolve
- Mel- fundraising
- Edmund external and internal network are similar the difference between these two is really fuzzy. Interested in # 3 and #5
- Ira- seed yield and information gathering, Debbie has that in her notes.
- Rick- looking at fundraising and grants
- Mel happy to review/get started
- Angie- default to OSA or work with those already doing the work.
- Jared will send out again the links to possible places where seed meet ups can happen
- OSGC has a dedicated space to do this
- Some folks are going to southern SAWG
- VA Biological conference also in January
- Organic Growers School in Asheville
- Chris- Utopian focused on crop trialing doing good work on this but maybe not a good lead maybe. Tony Kleese founded the People's Seed has a lot of planning background of this network but not much people power
- Sandy thankful for us facilitating all this and grateful
- Doug Jones how will sub groups will form themselves
- Jared- next steps great question. Let folks mull things over before signing up, see where interests lie, what folks might be interested in leading, set a schedule for maybe how frequently they want to meet and we can facilitate those phone calls or separate calls.
- Rejoice will help get people into groups and organized

Priority Initial Area of Work 4:
Create infrastructure for sharing information

Group 1 session notes:

- Set up standards, share solutions, create toolkit for seed reparation work. Need to establish best practices, and hold companies and organizations accountable
- Provide access to knowledge that is stuck in institutions - this will require organized communication exchanges (such as this event), but will require resources as well.
- Create infrastructure/space for sharing (such as museums, libraries, other institutions)
- Important to keep the oral histories for seeds available/attached.
- Look to other regions for resources (such as the PNW)

- Within the context of climate change and food sovereignty, need to build an awareness of seed.
- Need to educate youth on the importance of seed saving and incorporate this into cooking, home gardens, etc
- Database/marketplace/exchange identification or creation
- Need an up-to-date, managed database for educational or job/career or internship opportunities
- Value recognition - such as fair pay - for the work needed
- Need stricter seed production/quality standards (purity, ie) for larger seed companies
- Continue to build knowledge and understanding of the value of heirlooms/diversity of what we grow
- Seed sovereignty - transparency, certification, standards
- Information for sharing with all of the SE Seed People - the Southeastern Seed System

Group 2 session notes:

- Intergenerational knowledge sharing
- What are the sources of information? Indigenous farmers, and who else?
- Technology vs family - value of family/love - support and understanding, especially agroecology and organic seed
- Two types of sharing; in person, and available reference resource
- Educational campaign with guidelines
- Community strengths/networks - small, regional (enhance local seed community - exchanges, funding, space, time) - balance between social media use - how to fund?
- Narrative/story telling - YouTube, Podcast, other social media
- Seed "manners" - ethical growing culture and standards
- Add value and guidelines to messaging of seed saving - Vandana Shiva's Manifesto, ie.

Priority Initial Area of Work 5:
Climate impacts - breeding, trials

Group 1 session notes:

- Needed - a trial/breeding network of farmers and seed savers. It can include university or extension people but needs to be farmer driven.
- We need the diversity and collective power of this group.
- We need a Southeast base of the OSA - or another lead organization
- Need to incorporate international resources - food sovereignty people and movements
- Need regional seed system education and consciousness elevation even in local food, progressive, and organic farmer movements.
- Carry out more variety trials for crops/seeds that are not typical for various areas
- More connections are needed between farmers - rely on our neighbors, those with experiences to share
- But - it can be challenging to sell regional crops
- Important to do more outreach - advertising campaigns promoting foods and crops that actually do well and/or are more appropriate for the region

Information requested by Edmund -

- What are the particular issues in the region? Pests identified - stink bugs, aphids, squash vine borers, Colorado potato beetles, Mexican bean beetles, tomato fruit worm. Diseases - Downy Mildew, Rust, Bacterial Leaf Spot (peppers), Fusarium, Alternaria, Septoria
- More ideas - flip growing seasons (take advantage of the changes), keep with whatever is growing well in your area
- Question - does steam work for seed disease removal?
- Resource - John Navazio has a reference as a list of seed borne diseases (appendix reference in slide pack) - is it for the southeast?
- Nice to have would be a one stop shop - which diseases (viral, fungal, bacterial) can be carried on which seeds (by crop), and which removal methods are effective for each (the info is there for the most part - but scattered)


The Female

Presentations

Seed Diseases in the Southeast - Elizabeth Little

Video available online at: https://youtu.be/Uzoe2_tYxk4

Minimizing Seed-Borne Plant Disease

Dr. Elizabeth Little
Associate Professor/Extension Specialist

Department of Plant Pathology
College of Agricultural & Environmental Sciences
UNIVERSITY OF GEORGIA

What are seed borne pathogens?

- **Seed borne pathogens are "Organisms (i.e. fungi, bacteria, nematodes, viruses) carried with, on or in seeds, some of which may damage the seed and all of which are transmitted by seeds to infect the crops which grow from them (Maude, 1996)"**
- **Vegetatively propagated materials, such as bulbs, corms, etc., are also important sources of disease for crops such as potatoes, strawberries, sweet potatoes, etc.,**

Relative Importance of Seed Borne Microorganisms

1. Infected seed is the primary source of a disease outbreak. If seed infection is controlled, the disease is controlled
2. Important plant pathogen, but infected seed is a minor source of inoculum.
3. Seed borne microorganisms never demonstrated to cause disease
4. Pathogens that infect seed in fields or in storage, & reduce seed quality

If the seed is important or only source of a damaging disease, the crop may be destroyed if the pathogen is present,

This avoids spending any more time or money on a crop that won't make saleable seed. E.g. Black Rot of Crucifers

Other Treatments

Not as effective but some may have growth promoting qualities

- **Natural II – anti-fungal and plant growth promoting microbial seed coating (AgriCoat LLC)**
- **Thermoseed - Seed disinfection treatment for control of seed borne pathogens by the use of hot and humid air (INCOTEC)**
- **Oxidate (peracetic acid) – OMRI listed, not effective**
- **Biocontrol agents – coat seeds**
  - **Kodiak (*Bacillus subtilis),* Mycostop (*Streptomyces grieseoviridis*), SoilGard (*Gliocladium virens*),*Trichoderma harzianum*, Actinovate (*Streptomyces lydicus*).**
- **Compost teas – seed and soil treatments**
- **Plant extracts – seed and soil treatments**

For seed-borne diseases where the seed is not the only or an important source of the pathogen, crops should be grown to keep plants healthy and seed contamination levels low.

E.g. common fungal leaf-spot diseases such as early blight

Seed borne Diseases of Concern in Southeastern Seed Production Systems:

- **Solanaceous (nightshade family):** bacterial spot, bacterial canker, Tomato Mosaic Virus, *Alternaria, Septoria*,
- **Cucurbits:** gummy stem blight
- **Beans:** bacterial blight, anthracnose
- **Brassicas:** black rot**, *Alternaria*
- **Corn:** *Fusarium*
- **Peanuts:** *Aspergillus*

Seed Deteriorating Organisms

- Plant pathogens and non pathogens that reduce seed and seedling viability
- Reduced with good growing, harvesting, curing and sorting practices
- E.g.: *Fusarium, Aspergillus, Colletotrichum*

Seed transmitted organisms must:

- Gain access to the seed
- Survive harvest, cleaning, treatment, storage processes
- Must have ability to establish disease on emerging seedlings

Black Rot

(*Xanthomonas campestris pv. campestris*)

- Red flag disease, seed usual source of pathogen
- Seed borne allowable level is 1 in 30,000 seeds
- Increases asymptomatically before epidemic in field
- Systemic infections kill plants

Leaf Spot of Brassicas

Xanthomonas campestris pv. raphini

- **Not a systemic disease, not as damaging**
- **Can damage leafy crops such as kale**
- **Symptoms can be similar to black rot, get a reliable diagnosis!!**

Bacterial Spot of Tomato/Pepper

- **High to moderate damage, highly seed-borne**
  - **More damage on pepper, may be eradicated from seed by fermentation and/or treatment**
  - **Wet weather disease**

Spots on fruit and leaves. Infects green fruit.

Seed Borne Alternaria Diseases

- Residue can be major source of pathogen

Preventing Seed Borne Disease

- Pre-plant:
  - Remove diseased debris and rotation
  - Use high quality, clean or treated seed
  - Isolate seed crops
- In season
  - Keep foliage dry
    - Do not overhead irrigate
    - Consider using high tunnels for tomatoes/peppers
  - Inspect during season for disease and obtain an accurate diagnosis
  - Harvest, cure and store appropriately

Hot Water Seed Treatment

- **Advantages:**
  - More effective than bleach
  - Kills disease both inside and outside of seed
  - May fully eradicate heat-sensitive pathogens
  - No residue
- **Disadvantages:**
  - Requires an investment in equipment
  - Requires precision, can damage seed
  - Not appropriate for large seeded crops
  - Shortens long term viability of seed
  - Make sure treatment is needed

Each type of seed has an optimum temperature and time

- Tomato: 50°C for 25 min or 51.5°C for 20 min
- Pepper, cabbage: 50°C for 25 min
- Cauliflower and broccoli: 50°C for 20 min
- Carrot: 50°C for 20 min
- Lettuce: 47.8°C for 30 min. Some feel lettuce is too sensitive to treat
- Seed must be fully immersed and evenly treated, typically in cotton bags
- Not suitable for large batches
- Need temperature controlled water bath

Bleach Treatment

- **Advantages:**
  - Fast, easy, requires little to no special equipment
  - Can be done during washing of wet-seeded crops
  - Good for reduction but not eradication of disease
- **Disadvantages:**
  - May not be allowed under organic standards, check with certifier!!
  - Toxic compound – disposal a problem
  - Not likely to completely eradicate disease
  - Requires careful handling, can damage seed coat
  - Kills disease only on seed coat, not internally

Bleach Seed Treatment

- Soak seed in a 10 to 20% bleach (e.g. Clorox) solution
- Recommended times vary (1 to 40 minutes), active ingredient can quickly deactivate.
- Bleach can be added to final wash on wet seed harvest
- New solution must be made for each batch of seed

Resources for Seed Treatments

- **Hot Water and Chlorine Treatment of Vegetable Seeds to Eradicate Bacterial Plant Pathogens, S. A. Miller and M. L. Ivey, Ohio State** http://u.osu.edu/vegprolab/publications/grafting-publications/hot-water-and-chlorine-treatment-of-vegetable-seeds-to-eradicate-bacterial-plant-pathogens/
- **Hot Water Treatment of Tomato and Pepper Seeds, B. Gugino, Penn State** https://extension.psu.edu/hot-water-treatment-for-tomato-and-pepper-seeds
- **Small-Scale Cost-Effective Hot Water Seed Treatment** www.wsu.edu
- **Managing Pathogens Inside Seed with Hot Water** http://vegetablemdonline.ppath.cornell.edu/NewsArticles/HotWaterSeedTreatment.html

Vegetable Crop Selection for Seed Production in the Southeast - Ira Wallace

Video available online at: https://youtu.be/YXKVEjFdjWU

Crop types and Best Conditions for Seed Production

* Hot season wet (moderate to high humidity possibly easiest choice for Southeast): cucumbers, squash, melons, tomatoes, peppers, eggplant.

Crop types and Best Conditions for Seed Production

* Hot season dry (temperatures often above 90 degrees F –may do well with special attention to harvest and drying): garden beans, dry beans, limas, onions, sweet corn, edamame, okra.

Planting Multiplier Onions

- Multiplier Onions are similar in needs to Garlic but are usually ready 1-2 weeks earlier than the earliest Garlic.
- They can be planted in very early Spring, as well as Fall. Fall planting produces the best yields

Preserving Biodiversity

"The global number of plant species is projected to be reduced by 10 to 15 percent as the result of habitat loss alone over the period 1970-2050." - Kew Gardens' Millennium Seed Bank


South Carolina
Glaze collard
Purple Curly collard
Old Timey Blue collard


There are some amazing decorative and flavorful tender perennials to consider!

Pest, Disease and Climatic Factors in Southeast Seed Production - Edmund Frost

Video available online at: https://youtu.be/9_n5E4qIBtI

Regional Pest, Disease and Climactic Factors in Southeast Seed Production

Edmund Frost
Twin Oaks Seed Farm &
Common Wealth Seed Growers
Louisa, Virginia

Challenges for Southeast Seed Production

- Unpredictable rainfall makes dry seed harvest more difficult and can affect quality.
- High heat can impact pollination and fruit set, and can damage some kinds of seeds during processing.
- High heat and humidity are not good for seed drying and storage.
- High heat and humidity (and lack of cold winters) lead to more pests and diseases, and to pest and disease pressures that are unique to the Southeast. This includes seed-borne diseases.

So Why Do It Anyway?

- These are also the conditions we grow our food crops in. We need seedstocks that are adapted to all the pest, disease and climactic challenges Southeast growers face.
- Seed work in other regions won't solve our problems.
- Regional food production is essential for food security and food sovereignty. Seeds are an important part of this.
- The Southeast has strengths other regions don't have, like longer production windows and abundant water.

Challenges for Southeast Seed Production

- Unpredictable rainfall makes dry seed harvest more difficult and can affect quality.

Solutions: Vigilant harvest timing; more frequent harvests; high tunnels in some cases; selection for plants that can handle rain at the seed stage

- High heat can impact pollination and fruit set, and can damage some kinds of seeds during processing.

Solutions: Crop timing, selecting for heat tolerance, grow in cooler parts of Southeast

- High heat and humidity are not good for seed drying and storage.

Solution: Climate-controlled drying and storage (air conditioner and dehumidifier combination is cheap and easy, at least at the scale needed for vegetable seed).

- High heat and humidity (and lack of cold winters) lead to more pests and diseases, and to pest and disease pressures that are unique to the Southeast. This includes seed-borne diseases.

Solutions: Comprehensive Southeast seed system work – see next slide

Addressing Disease, Pest and Climactic Challenges through Robust Seed System Work and Thinking

-Selection during seed production/stock seed production

-Trials!

-Breeding

-Information sharing/communication/intact feedback loops

-Access to diverse genetic material from both within and outside the region

-Strategic collaboration with seed producers in other regions

Sumter 8/31

Marketmore 76 8/31

'Shandong Si Gua 1210' PI 432885
Shandong, China 8/31

PI 426170 (Luzon, Philippines) 8/31

CWSG DMR Pickler F3 8/31

DMR 401 8/31

Approaching Seed-Borne Diseases

- A) educate ourselves about what diseases to look out for, and on disease identification
- B) active scouting of crops for signs of disease
- C) disease testing
- D) hot water seed treatment and other seed treatments
- E) fermentation (eg: controls watermelon fruit blotch,
- F) crop rotation, with particular disease issues in mind
- G) sanitation practices (eg wash/sterilize seedling trays and metal stakes; don't re-use wooden stakes for the same crop type etc.)
- H) need for more collaborative work and focus to develop protocols for addressing seed-borne diseases?

Growing Vegetable Seed in the Southeast - Edmund Frost, Ira Wallace, Melissa DeSa, and Craig LeHoullier

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Video available online at: https://youtu.be/tT7cA_IKGdo

Seed Production in the Southeast

Does it work with your farm/ garden crop plan?

Get to know your plant

- Will it produce seed in your climate?
- What is it's unique scientific Latin name?
- Is it open-pollinated or a hybrid (F1)?
- How is it pollinated?
- Is isolation required?
- What is the minimum population?
- What is the seed harvest and process method?

SELFERS **CROSSERS**

Inbreeding
Minimum
isolation

Outbreeding
Minimum
isolation

5' **500'** **2 miles**

Lettuce Peas Tomatoes	Beans (common) Okra Peanuts Rice	Beans (lima, runner) Cowpeas Cucurbits Eggplant Pepper	Brassicas Carrots Herbs Spinach* Sunflower Tomatillos	Corn*

*wind

5 plants **25 plants** **200 plants**

Examples

Cherokee Purple Tomato

Yellow Cabbage Collards

Cherokee Purple Tomato

Hello, my name is:

Solanum lycopersicum

Cherokee Purple Tomato

Open-pollinated or hybrid?

Open pollinated

Cherokee Purple Tomato

Pollination Method?

Mostly selfing/inbred, some insects*

Cherokee Purple Tomato

Isolation Distance?

10-50' (just to be safe)

Cherokee Purple Tomato

Population Requirements?

As little as 1, 20+ is much better

Cherokee Purple Tomato

Seed harvest and processing?

Wet processing with a fermentation step

Cherokee Purple Tomato

- **Hello, my name is:** *Solanum lycopersicum*
- **Open-pollinated vs. hybrid?** Open-pollinated
- **Pollination method?** Mostly selfing/inbred, some insects*
- **Isolation:** 10-50' (just to be safe)
- **Population requirements?** As few as 1 plant, more is always better!
- **Seed harvest and process?** Wet processing with a fermentation step

Tomato flowers can be tricky

Fermentation Processing

Wet Seed Processing

Yellow Cabbage Collards

Hello, my name is:

Brassica oleracea

Yellow Cabbage Collards

Open-pollinated or hybrid?

Open-pollinated

Yellow Cabbage Collards

Pollination method?

Outbreeding via insects (with ALL other *B.oleracea*!)

Yellow Cabbage Collards

Isolation?

½ mile (from ALL other *B.oleracea*!)

Yellow Cabbage Collards

Population requirements?

As little as 5 but 80+ is much better!

Yellow Cabbage Collards

Seed harvest and process?

Dry harvest seed pods, thresh & winnow

Yellow Cabbage Collards

- **Hello, my name is:** *Brassica oleracea*
- **Open-pollinated vs. hybrid?** Open-pollinated
- **Pollination method?** Outbreeding via insects (with ALL other *B.oleracea*!)
- **Isolation?** ½ mile (from ALL other *B.oleracea*!)
  Population requirements? As few as 5, 80+ best
- **Seed harvest and process?** Dry harvest seed pods, thresh and winnow

A word of caution about HUMIDITY & RAIN.....

Twin Oaks Seed Farm

Growing certified organic seeds since 2006, for Southern Exposure Seed Exchange, Fedco, Sow True Seed, Baker Creek, Common Wealth Seed Growers and others. 6 Acres in Rotation.

Crops at Twin Oaks Seed Farm:

Cucurbits: Cucumber, Summer & Winter Squash, Watermelon, Melon, Gourd
Nightshades: Tomato, Pepper, Eggplant
Legumes: Beans, Lima Beans, Peanuts, Cowpeas
Brassicas: Collards, Turnip, Rutabaga
Poaceae: Corn, Sorghum
Asteraceae: Sunflowers, Cosmos
Alliums: Multiplying Onions, Garlic
Malvaceae: Okra, Cotton
Convolvulaceae: Sweet Potato (slips)

Okra Seed Crop

Watermelon Ferments

Common Wealth Seed Growers – Started in 2014

Trialing, breeding, direct relationship with people who use the seeds we grow, small regional seed growers network

South Anna Butternut (bred from a cross between Seminole Pumpkin and Waltham Buttternut)

Planning and Contracting for Seed Production Growouts

- What do you excel at growing in your conditions and climate and with your equipment?
- What seed crops fit your needs in terms of labor/management timing, crop rotation, isolation?
- **Pay attention to variety choice and to pay rates. Expect to reject many of the seed growouts you're offered.** Prices can vary a lot between companies.
- **Expect that you will grow some seed crops that don't make money in the course of figuring out what works.**

Isolation Distance

- Proper isolation is essential to avoid crossing between different varieties of the same species.
- Can be affected by many factors; see isolation distance guide at **savingourseeds.org**
- Examples: Peppers: 150-300 feet; Cucurbits: 1/4-1/2 mile; Tomatoes: 10-100 feet; Corn: ¼ mile (more if neighboring crop is GMO.
- Hand pollination may also be an option, but not for contract production

Prices for Small Growouts (at Twin Oaks Seed Farm)

- Peppers, Tomatoes and Eggplant (1-5 pounds): $300-$720 per pound
- Cucurbits (up to 50 pounds): $50-$70 per pound
- Beans, lima beans, cowpeas, peanuts (up to 300 pounds): $7-$12 per pound
- Corn (up to 700 pounds): $7 (dry corn) -$10 (sweet corn) per pound
- Okra (up to 30 pounds): $30 per pound
- Turnips and collards (up to 15 pounds): $60-$100 per pound

Planning Considerations

- Different seed companies are ready to offer contracts at different times. It is often necessary to act quickly to secure contracts, and sometimes it can be a gamble.
- Finding and/or creating seed crop yield data is an important part of planning.
- Isolation requirements (in addition to rotation requirements) add another layer of complication to planning field layout.

Field Day, Downy Mildew Trial, August 28th, 2018
Part of a cucumber and melon research project funded by
Organic Farming Research Foundation

Variety Types

Open Pollinated A stable variety that breeds true from seed. Seed of OP varieties are usually produced by allowing plants to "openly pollinate" with others in the population.

F1 Hybrid A variety that is created by the controlled crossing two parental types. Seed saved from hybrids does not breed true to type.

GMO Created in a lab by manipulating DNA.

Heirloom An older open-pollinated variety.

Landrace A stable population that is more diverse than most modern varieties.

Wet Seeded Crops

Fermentation

-Breaks down germination-inhibiting gel that surrounds tomato and cucumber seeds

-Help control seedborne diseases, including bacterial fruit blotch and bacterial canker

-Breaks down solids, which can make seed separation easier.

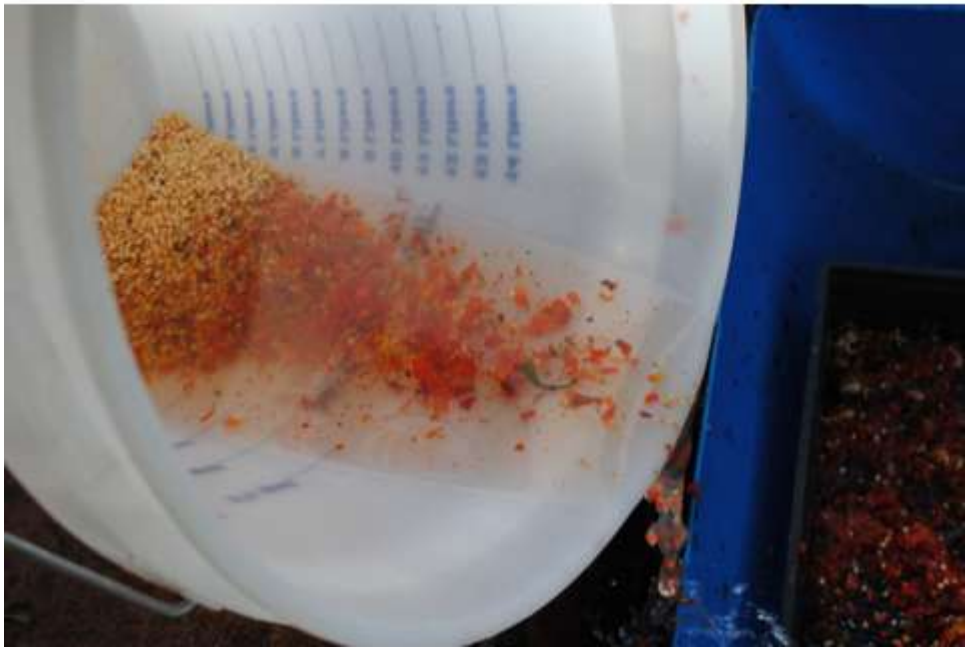
-Duration of fermentation depends on temperature.

-In summer, 2-3 days for cucumbers, melons, watermelons, and tomatoes; 0-1 day for peppers and eggplant; 0-3 days for squash.

-Stirring needed twice a day to prevent mold on surface.

Processing Ferments

- Basic Principle: with most ferments, the good seeds sink and everything else floats.
- Start with a half-full bucket of ferment, and fill to the top with water.
- Let settle briefly, then pour off mix of water and pulp (consider using a 'second chance' bucket to catch pour-off; then re-pour).
- Repeat until all that is left are (mostly) clean seeds.
- Put on a screen to dry.
- Winnow the seeds when fully dry (or store and winnow them later).



Bell pepper seeds can tend to have more problems with underdeveloped and/or moldy seeds. We cut out and look at the cores, and then use or freeze the peppers.

Harvest Timing for Wet Seeded Crops

- You want to process the fruits when they are as ripe as possible but before they start to rot.
- Curing, either in the field (in windrows) or out of the field can be important to ensure optimal ripeness.
- Removing fruits from the field can also allow for more timely weed control when crop is finished growing.

Seed Crops take longer and grow bigger than produce crops for many species. This means they may need:

- Wider spacing
- Longer-lasting or later-season weed control
- A longer-lasting fertility plan
- This is especially true for greens and root crops, but also for cucumbers, summer squash, sweet corn and okra among others.

Seed Crops Have Higher Disease Control Needs

- Use drip irrigation instead of overhead.
- Consider hot water treatment before planting for nightshade and brassica seedstocks.
- Familiarize yourself with potential diseases for the crop, especially seedborne diseases.
- Have a plan for disease sampling and identification.

Dry Seeded Crops

Harvest Timing for Dry Seeded Crops

- Harvest when seeds are dry or mostly dry
- Rain can damage seeds
- Shattering can lose seeds
- How many harvest passes you make depends on the crop type, variety (determinate or indeterminate?) (prone to shattering?), and occurrence of rain.
- Dry beans in the East can take multiple passes of hand harvest to avoid rain damage.

Selection Basics

- Rogueing versus Selection
- Saving Stock Seed
- It can be good to wait till the second season growing a variety to make much of a selection.
- Very uniform varieties may be hard to shift.
- Open-Pollinated varieties are always shifting and changing. Not selecting is a selection.

Managing Stock Seed

- Is this done by the seed company or the grower? May depend on scale.
- If its done by the grower, what are the criteria, expectations and compensation for maintaining stock seed?
- Be careful of unintended consequences in your selections. Think it out ahead of time, and be thoughtful and observant.
- It may be hard to do much stock seed selection the first time you grow a variety.
- Take care to maintain enough genetic diversity, and diversity for vigor (according to plant type).

Okra seed crop processed in a stationary combine

Scaling Up

Do you have the necessary equipment and/or labor?

Will the increased efficiency of larger growouts make up for lower prices?

Larger scale seed crops mean larger scale mistakes to learn from.

More In-Depth Seed System Thinking

- Are there varieties you want to improve (or preserve) for food production use on your farm? Is there a way to do this and also make money selling seed?
- Sometimes profitable seed contracts make money for the wrong reasons, for example varieties that are extra seedy. Sometimes the best varieties don't pay to grow on contract. How will you weigh your desire to make a quality contribution to organic seed systems with your need to make money on the seed crops?

Grants for Trialing, Breeding and other Research Projects

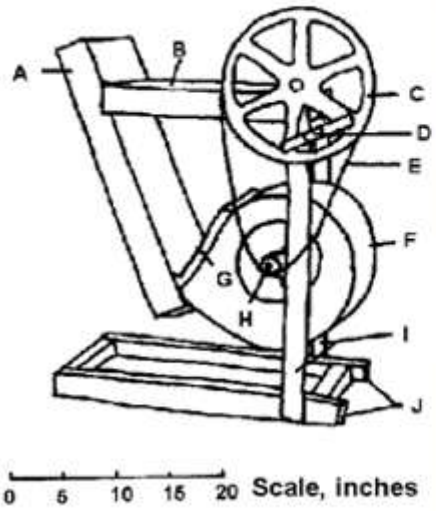
- SARE producer grants (up to $10,000 for a farm or $15,000 for a farmer organization) Deadline is in November.
- Organic Farming Research Foundation offers grants up to $20,000 for certified organic growers. Deadline for letters of intent is in July.
- Participation in grant projects led by university or nonprofit researchers.
- Trials funded by seed companies.

Seed Saving Resources

- Jeff McCormack's Seed Saving Guides for the Southeast: Savingourseeds.org
- Organic Seed Alliance: Seedalliance.org
- Seed Savers Exchange: Seedsavers.org
- Suzanne Ashworth: Seed To Seed
- John Navazio: The Organic Seed Grower
- Carrol Deppe: Breed Your Own Vegetable Varieties and The Resilient Gardener, and The Tao of Vegetable Gardening
- Jared Zystro and Micaela Colley: The Seed Garden

Instructions for building simple machines, like this hand operated winnower, are freely available

Scaling up production without much cash will take some ingenuity.



Tools can be made, borrowed, or bought used. The more growers your farm is associated with, the more tools and resources are available to everyone.

Air Screen Cleaner at Southern Exposure


BIRD
RUSSIAN RED
ZEMO
GERMAN
HARDY
PURPLE STRIPE
ELMERS
MARINO
BIGBOY


Inchelium Red
Chesnok Red


S & H Silverskin
Egyptian Walking Onions


There are some amazing decorative and
flavorful tender perennials to consider!

Jewels of Opar

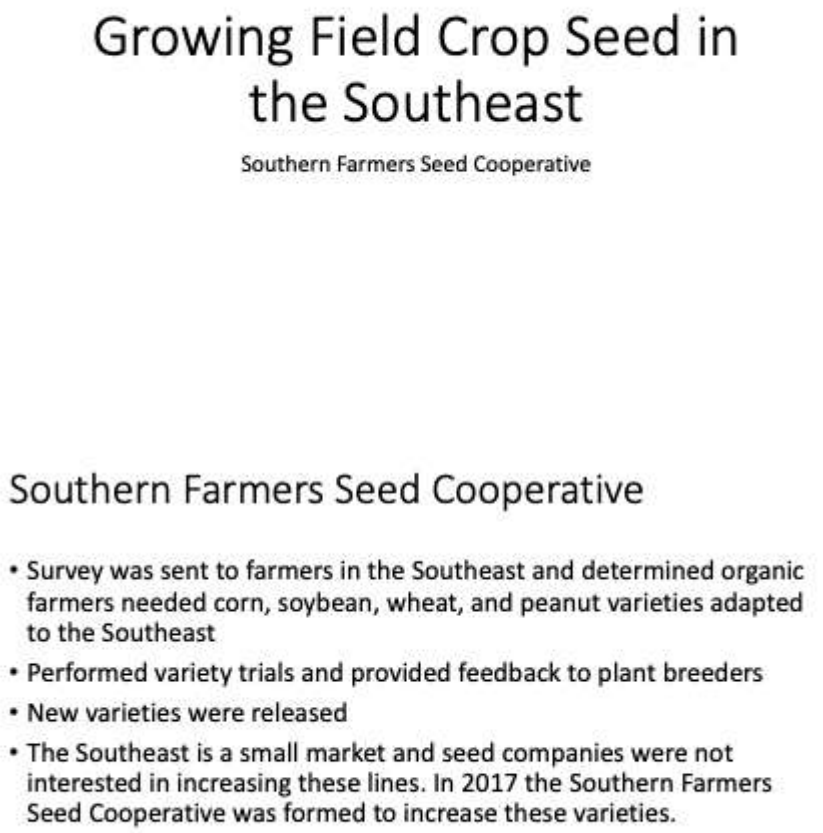

Allow pods
or seedheads
to dry further


South Carolina
Glaze collard
Purple Curly collard
Old Timey Blue collard

Yellow Collard Cabbage at the Collard Shack in Ayden, N.C., which trumpets itself as the "collard ca
rld." For as long as anyone can remember, this community has tied its civic identity to the thick, lea
. Benny Cox and his wife, Vickie, run a roadside stand called The Collard Shack. You won't find the
ere that are common throughout the South. Instead, the Coxes grow yellow cabbage collards — ar
variety that's rare outside this part of North Carolina to fill a local niche market. They not only sell
eens with a yellow tinge but also collard seeds and plants for the home gardener and smaller local

Growing Field Crop Seed in the Southeast - Peyton McDaniel and Ben Miller

Video available online at: https://youtu.be/sqxT3j4P0OY



Field specifications for soybeans

- The soybeans cannot be grown on land on which soybeans were grown the previous crop year, unless that crop was grown from certified, registered or foundation seed of the same variety.
- At least one field inspection shall be made when variety purity can best be determined, preferably after the leaves have dropped. Fields producing foundation seed should also be inspected at a time the blossom color may be observed.
- A field or portion of a field may be approved if the area to be certified is clearly defined and the inspector has proper assurance that seed from the certified portion will not become mixed with the other seed.
- Isolation: A field boundary shall be a strip of ground not in soybeans and at least five feet in width.

Soybean Harvest & Storage

- Inspection of field at leaf drop. If producing Foundation seed a field inspection at bloom and leaf drop.
- Clean the combine and all seed cleaning equipment between varieties
- Inspection of cleaning equipment is needed from NC Crop Improvement for certified seed
- Samples of each lot of seed are sent to NC Crop Improvement (minimum 80% germination, 98% pure seed, 2% inert matter)
- Store cleaned seed in cool, dry environment

Specifications for corn

- Corn needs to be at least 660 feet from other corn
- It should not be planted in a field where corn was grown the previous year
- The female plants need to be detassled daily for about three weeks preferably before 9am.
- If a tassel is missed plants in a three foot circle around missed tassel should be removed
- Female and male plants are planted in a 6:2 ratio

Corn Harvest and Storage

- Only the female plants are harvested for seed
- Clean harvesting, cleaning, and storage equipment
- Store cleaned seed in a cool, dry environment

Field Specifications for Small Grains

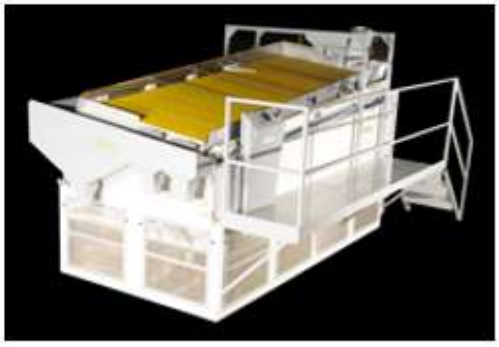
- A crop of small grain will not be eligible for QA certification if planted on land which produced small grain the previous small grain season unless the previous crop was grown from QA seed of the same variety. In fields where hard, red or white winter wheat was grown, there must be two growing seasons between crops of small grains to be classified QA if the previous crop was not from QA seed of the same variety.
- Barley, Oat, Triticale, Wheat A field producing any class of QA seed of a specific crop kind shall be separated from fields producing other varieties of the same kind by a minimum distance of ten (10) feet.
- Rye A field producing QA seed shall be separated from fields of any other variety or fields of the same variety that do not meet the varietal purity requirements of the class of seed inspected and are of the same chromosome number by at least: Breeder, Parent 1,320 feet QA 660 feet Isolation between diploid and tetraploid rye shall be at least 15 feet.

Seed Cleaner

Spiral Separator

Gravity Separator

Gravity Separators, also known as gravity air tables or density separators, use a combination of air for weighing, vibration for fluidization and conveying and tilt (or slope) for separation.



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Seed production economics, marketing, and market niches - Debbie Piesen, Brett Grohsgal, Peyton McDaniel and Ben Miller

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Video available online at: https://youtu.be/L0oVbltdle8

Opportunities for entering the organic seed market

- Wholesale to farmers
  - Growing for yourself
  - Growing for others
    - OSA's producer database

Opportunities for entering the organic seed market

- Contract with seed companies
  - Understand the terms: minimum germ, maximum weed seed and inert, delivery date and payment date, price for overage

Opportunities for entering the organic seed market

- Growing on speculation for seed companies
  - Opportunity to find additional market for crop
  - Contact companies in fall, after they know what they still need for catalog

Debbie Piesen

Living Energy Farm

Brett Grohsgal

Even' Star Organic Farm

Ben Miller

Reedy Fork Farms

Peyton McDaniel

Hickory Meadows Farm

- What markets have you sold to and why? (e.g. wholesale seed company contracts, producing for yourself, selling retail, selling to other farmers, receiving breeding royalties, etc.)

What have been some of the biggest economic challenges around seed production and sales?

What have been some of the biggest economic benefits?

- Are there ways in which you might imagine a system that better supports regional breeding and seed production?

- What role do you see for genetic improvement and genetic adaptation to specific large regions in typical seed production work? Can selection and genetic improvement even occur when producing large amounts of seed?

What advice would you have for farmers considering including seed production in their farm enterprises?

How to Conduct a Meaningful Trial - Jared Zystro

Video available online at: https://youtu.be/AtAxc16dqAk

Planning the Trial

- Identify crop species
- Identify crop type
- Identify goals of the trial
- Identify varieties

ORGANIC seed ALLIANCE

Advancing the ethical development and stewardship of the genetic resources of agricultural seed

What varieties go into a trial?

- Important commercial varieties in your region
- Popular commercial varieties of the crop type nationwide
- Older standards
- Any of your own varieties and breeding projects.

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Reducing and accounting for field variation Increases confidence in your results

ORGANIC seed ALLIANCE

Advancing the ethical development and stewardship of the genetic resources of agricultural seed

Consistent Field Conditions

- Soil type
- Irrigation
- Cultivation
- Fertilization
- Harvesting

- Always strive to do any treatment on the same day. But always treat by block if any possible differences in treatment are necessary across time.

ORGANIC seed ALLIANCE

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Replication trial

B	B	B	B	B	B	B
B	3	2	1	4	5	B
B	1	3	5	2	4	B
B	5	2	3	4	1	B
B	B	B	B	B	B	B

Augmented trial

BORDER	BORDER	BORDER	
CHECK	Trial Var. B		
Trial Var. A	Trial Var. E		
Trial Var. F	Trial Var. I		
Trial Var. C	CHECK		
CHECK	Trial Var. D		
Trial Var. G	Trial Var. H		
BORDER	BORDER		

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Marking and Mapping the Trial

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Evaluating the Trial

What is important?
Measuring vs scoring
Timing of evaluations
Data collection tools

Measuring traits

Scoring traits

- Use a 1 to 9 scale
- 1 = poorest, 9 = best
- Use all the numbers in the range, esp. 1 & 9
- Always “set” the trial by walking the trial and finding the 1, 5, 9 first

ORGANIC seed ALLIANCE
Advancing the ethical development and stewardship of the genetic resources of agricultural seed

Trials are Ongoing

- Eliminate the poorest performers after 2 years
- Always test the newest vars. from good sources

On-farm Variety Trials - Edmund Frost and Jeanine Davis

Video available online at: https://youtu.be/AtAxc16dqAk

On-Farm Variety Trials

Presented by Edmund Frost of Common Wealth Seed Growers, Louisa, Virginia

Common Wealth Seed Growers: What We Do

- Organic seed production
- Variety trials
- Plant breeding and selection
- Retail and wholesale seed sales
- Farm-based, seed source transparent
- Southeast seed system education and promotion

Why Variety Trials

- To tell us what varieties work and don't work in our growing conditions, in our region, on our farms.
- To confirm observations and theories that we come to in the course of growing crops for production.
- To compare different seedstocks of the same variety or check integrity of seedstocks.
- To identify a replacement variety when an important F1 hybrid is discontinued.
- An important starting place for breeding work.
- To test results and progress made in breeding and selection work.
- An essential element of a healthy regional seed system.

2010 Cucumber Seed Growout with Heavy Downy Mildew Impact

Weighing cucumbers from plants severely impacted by downy mildew in a 2013 observation trial

Kinds of Variety Trials

- **Informal observation of crops** when growing multiple varieties of the same type for production. Farmers are always doing this, and it is an important way that we gather information.
- **Observation Trial:** one plot of each trial entry. Level of formality and rigor in data collection varies.
- **Replicated Trial:** 3-4 plots of each entry allow for statistical analysis of results, and guard against being misled by incidental, non-genetic variables.
- **Augmented Trials** use a combination of multiple replications (to confirm field uniformity) and single or double entries.
- **University Variety Trials**
- **Seed Company Variety Trials**
- **On-Farm Variety Trials**

Pumpkin, Watermelon and Winter Squash Observation Trials (August 2018). Not replicated or funded.

Cucumber and Melon Bacterial Wilt Trial (July 2018). This is an example of a funded, replicated, on-farm trial.

Importance of On-Farm Variety Trials

- Trials done on your farm yield results that are especially relevant to you.
- If you want something done, you may have to do it yourself. You know what problems are most relevant to your farm. Maybe no one else is doing that work at all.
- On-farm trials merge farmers' knowledge of production and market challenges with a process of scientific evaluation.
- On-farm trials of material generated in university programs are an important way that such programs stay grounded in producer needs (mother-daughter trial model).
- Farmer participation and empowerment in seed systems increases seed and food sovereignty.

SARE-funded melon, cucumber and winter squash trials in 2014, and winter squash research in 2016

2014 DM Cucumber Trial

2014 DM Winter Squash Trial

2014 Winter Squash Trial

Evaluation and release of Cornell DMR cucumber and melon seedstocks.

(Mentorship and advice from Michael Mazourek at Cornell has been central to many of our research and breeding projects)

DMR 401 Cucumber

Trifecta Melon

Planning a Variety Trial

- What are you wanting to find out?
- Who will be using the information?
- Are you planning to publish the results?
- What resources are you willing to devote to the trial?
- Are there outside resources or funding to support the trial?
- **What traits will you evaluate?**

Why Variety Trials

- To tell us what varieties work and don't work in our growing conditions, in our region, on our farms.
- To confirm observations and theories that we come to in the course of growing crops for production.
- To compare different seedstocks of the same variety or check integrity of seedstocks.
- To identify a replacement variety when an important F1 hybrid is discontinued.
- An important starting place for breeding work.
- To test results and progress made in breeding and selection work.
- An essential element of a healthy regional seed system.

Finding Material to Trial (Sourcing Germplasm)

- USDA germplasm bank (GRIN) **www.ars.grin.gov**
- Seed Savers Exchange yearbook and collection
- Call university plant breeders, researchers and extension agents
- Call independent and small seed company plant breeders
- Commercial seed catalogs
- Seed swaps
- Understand that there can be variation between different seedstocks that have the same variety name
- Record lot number as well as source
- Retain enough seed for regeneration if possible

Include Control (Check) Varieties

- Controls provide a point of reference, something to which we can compare innovative or new seedstocks.
- Include varieties that are widely planted to serve as a point of reference for others who view your trial results.
- Consider including different kinds of controls (susceptible, moderately resistant, resistant, etc.).

Utilizing Screens (or not)

- Using a screen means trialing in an extreme environment for a particular trait. For example, testing for drought tolerance by trialing with no irrigation, even though you might normally use some irrigation.
- My Downy Mildew trials are all planted late because DM is more certain to be present.
- You could evaluate Anthracnose tolerance by planting where you know there was Anthracnose last year.
- Alternatively, it may be most useful to you to focus on reproducing regular production conditions for your trial.

Trial Layout and Planning

- Choose a field with as uniform conditions as possible, in terms of drainage, soil type, fertility, soil amendment and crop history etc.
- Where there is variation in a field, set up the trial so each replication has as uniform conditions as possible.
- Consider edge plantings to diminish 'edge effect.'
- Make a good list, good labels and a good map.
- Randomize layout for each replication
- Make a spreadsheet of all seed sources and seed lots used, and save seed packets

Plots, Entries and Replications/Blocks in a Randomized Trial Design

Replication #1	A	B	C
	D	E	F
Replication #2	B	E	D
	C	A	F
Replication #3	C	A	F
	D	B	E

List of Cucumber and Melon Seedstocks for Variety Trials

Entry Number	Variety Name	Lot Number	Source	Downy Mildew Trial Reps	Bacterial Wilt Trial Reps	Organic?	Species
1	DMR 401	SYF 2016 927	CWSG/Cornell	2	5	yes	C. sativa
2	DMR 264	DQS416ALW	CWSG/Cornell	3	5		C. sativa
3	County Fair	94452	Sustainable Seed Company	3	5	yes	C. sativa
4	DMR Pickler	R x (H, A, OO)	CWSG	4	5	yes	C. sativa
5	Marketmore 76	96117	Sustainable Seed Company	3	5	yes	C. sativa
6	Shandong Si Gua 1210 (PI 432885)	00ncai01SD	NCRPIS	2	5		C. sativa
7	Luzon 15 (From PI 426170)	LU217ATK	CWSG/NCRPIS	2	5		C. sativa
8	Homemade Pickles	93995	Sustainable Seed Company	1	5	yes	C. sativa
9	Sumter	93024	Sustainable Seed Company	1	5	yes	C. sativa
10	MM97FF x MM80BW	13-6101-6 x 6102-5	Cornell	1	5		C. sativa
11	Marketmore 80 BWR	13-6102-2	Cornell	1	5		C. sativa
12	DMR 17-7407-4	17-7407-4	Cornell	2	5		C. sativa

Trial Evaluation

- Decide ahead of time what you will evaluate. Avoid overcommitting. Choose only the most important traits to evaluate. That said, new issues may emerge that merit or require evaluation.
- Make data entry tables to fill out for evaluating the crop.
- Assign a number to each trial entry. Identify each plot with the entry number plus the replication number.
- Quantitative data: yield, fruit size, plant height etc.
- **Qualitative data with rankings: rank different traits on a 1-9 or a 1-5 scale.**
- Descriptions: adding a verbal description can at times be helpful, but can be hard to incorporate into analysis.
- Photographs can document aspects of a crop we don't know to be looking at, and provide something to go back to. Photographs can easily tell the story when presenting your results to others.

"Development and Assessment of Bacterial Wilt and Downy Mildew Resistant Cucumber and Melon Seedstocks"
- a trialing and breeding project funded by Organic Farming Research Foundation (OFRF) for the 2018 and 2019 growing seasons

2018 Project Elements

- Bacterial Wilt Trial (early planted)
- Downy Mildew Trial (late planted)
- DMR Pickling Cucumber Breeding Trial (F3 generation)
- DMR Pickling Cucumber Breeding Trial (F4 generation)

Cucumber and Melon Bacterial Wilt Trial (July 17th 2018).

Bacterial Wilt Trial Stats

- 39 Entries (13 melons, 24 cucumbers and 2 anguria species gherkins)
- 5 Replications/Blocks
- 183 Total Plots (due to seed availability issues a few entries had fewer than 5 plots)
- 3 Plants per Plot

Bacterial Wilt Trial Methods

- Transplanted May 20th (early to avoid downy mildew). Did not use row cover or any other methods to control the striped cucumber beetles that spread bacterial wilt.
- Surrounded the trial with cucumber and melon border planting.
- Trained each plot separately.
- Evaluated BW impact on each plot about every 10 days from July 8th – August 11th, rating plots on a 1-6 scale. 5 indicates severe BW damage; 1 indicates no damage; 6 indicates that a plant has died.
- Harvested cucumbers starting in early July and melons starting in early August, **but did not measure yields**.
- Downy mildew started showing up in early August, so the last rating reflects combined disease impact.

Bacterial Wilt Trial August 23rd

Downy Mildew Trial

- Augmented Trial (some entries are replicated 4 times, others only 1 or 2 times).
- Transplanted July 6th.
- 9 plants per plot.
- Measured yield (harvested every 2-3 days) and DM severity on foliage.
- Trouble with damping off led to late direct seeding of some plots. These plots can be compared to each other but not transplanted plots.
- Used row cover until flowering to exclude striped cucumber beetles.

Downy Mildew Trial, July 26th

DM Trial, August 26th

Field Day, DM Trial, August 28th

DM Trial, September 3rd

NOVIC Plant Breeding Workshop
September 10th

DM Trial, September 17th

Homemade Pickles 8/31

DMR 264, August 31

CWSG DMR Pickler F3 8/31

Marketmore 76 8/31

DMR 401 8/31

DMR 17-7408-1 (Cornell) 8/31

Sumter 8/31

West Indian Gherkin (Cucumis anguria) 8/31

Follow Through

- Once you have all the evaluations done and the crops are gone you still have a lot to do:
- Data entry
- Data analysis: what conclusions can you draw?
- Outreach and dissemination of results
- Write and submit your report
- Decide what the next step is. Another trial with different setup? Re-trial the standouts? Begin breeding work?

2018 Early Growout / Breeding Trial (F3)

40 plants from six F2 selections; planted on May 1st; evaluated starting in mid June; harvested in mid July; maternal selection only.

2018 Late Growout / Breeding Trial (F4)

230 plants from five F3 selections; planted in late July; evaluated starting in early September; the best plants crossed to each other from September 26th – October 4th; still harvesting seeds from fruits.

September 18th

October 3rd

Hand pollinated fruit: plant 16 x plant 10, pollinated on September 26th

See 2018 results and final report at commonwealthseeds.com/research

2019 Cucumber Project Elements

- Just cucumbers (no melons)
- Bacterial wilt trial repeat
- Remote trials at several other farms, and at U-Mass and NC A&T Universities – Participatory Plant Breeding model
- Late-planted pickler and slicer breeding trials at our farm
- Winter seed increases in Hawaii

Breeding South Anna Butternut (focused on downy mildew resistance - from a cross between Waltham Butternut and Seminole Pumpkin) 2011- ongoing

Organic Seed Alliance has great resources to learn more about variety trialing and plant breeding: www.seedalliance.org/all-publications/

- "The Grower's Guide to Conducting On-Farm Variety Trials"
- "Introduction to On-Farm Organic Plant Breeding"
- Organic Seed Production Webinars (2nd episode focuses on trialing and selection)

Resources

- Contact me with questions or ideas! commonwealthseeds@gmail.com 540-223-5861
- This presentation will be posted on our website: www.commonwealthseeds.com/research
- Organic Seed Alliance: www.seedalliance.org
- Organic Farming Research Foundation www.ofrf.org
- The Peoples Seed www.thepeoplesseed.org
- E-Organic Organic Variety Trials Database www.varietytrials.eorganic.info
- Northern Organic Vegetable Improvement Collaborative www.eorganic.info/NOVIC
- Southern SARE www.southernsare.org
- Southeast Organic Seed Listserve
- Keep an eye out for a Southeast organic seed conference some time soon.

Funding

- Producer grants frome SARE (due Nov. 15th).
- Organic Farming Research Foundation (OFRF). Next application due next summer.
- Seed companies sometimes fund on-farm trials.
- University breeding projects that want on-farm trial input.
- Possible Southeast OREI grant.

[Video not available due to recording problem]

Make up your mind for now

- Pick a crop and set some goals
- Need that others are not addressing
- Joys that you feel compelled to dive into anyway
- Crops that make sense for your place and setup

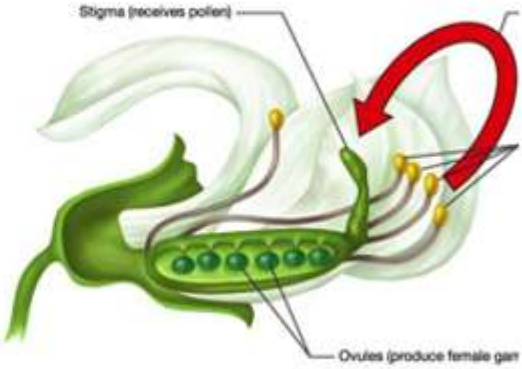
@FourSeasonFarm

Explore Biodiversity

- Find your communities of information
  - Cuisine, growers, researchers, seed stewards
- Test crops from different sources
- Ask how your grow out will affect your evaluations

Making a cross

- Selfers
  - Laborious pollination
  - Many selections
  - Stagnate
- Crossers
  - Automatic pollination
  - Homogenize
  - Evolve



Evolve

- Save seed from the best
- Seek your goal
- Be open to serendipity
- Beware of "nice"

Purge

- Spectrum/Quantitative traits
  - Roguing off-types means progress
- Categorical/Qualtitative traits
  - Roguing off-types likely means propagating your problems
- Progeny rows
- Mass selection

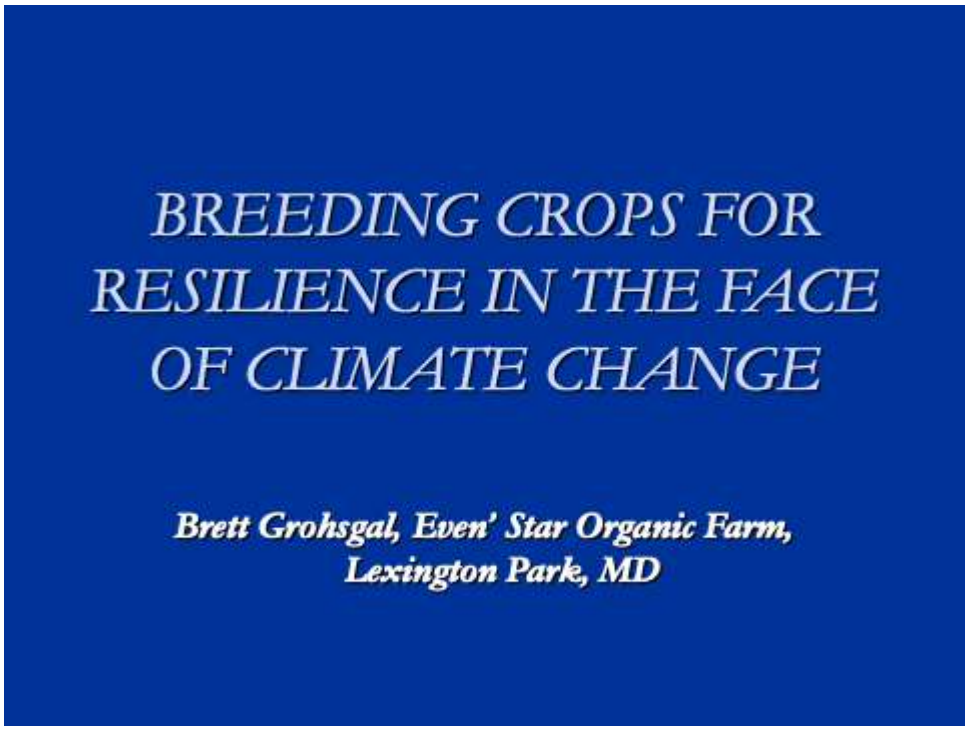
Anticipate success

- We often plan for the struggle
- Success can go awry

…, the Honey Zepper is a cross between a rare heatless habanero and its traditional, spice-wallopping counterpart. The result is a pepper that's mild, aromatic and slightly tangy, dialing up the flavor of the chili pepper while eliminating the heat. Previously available only at select farm-to-table restaurants, the Honey Zepper is now being distributed via...

Breeding Crops for Resilience in the Face of Climate Change - Brett Grohsgal

[Video not available due to recording problem]



big picture continued

Since 1996, 1st, 2nd, 5th, 7th and 10th worst recorded droughts (dating to 1840) in our region. Also wettest year on record: 2018: 81 inches. Some Shenandoah growers got 101 inches in 2018, without any hurricane contributions.

3. Higher variability in seasonal temps: chilly vs. ++hot summers; spring frost dates; wintertime extended warmth vs. coldest T.

4. Salinization of low-lying coastal farmland.

From the breeder perspective, TWO MAIN TYPES OF CLIMATIC CHANGE

1. Gradual upward or downward shift in temperature or rainfall. Probably what occurred with the Ice Ages. Likely what we're seeing with Alaska's permafrost and glacial melting. *Easier to breed for.* Versus
2. Cataclysmic: Really ugly happens really fast. Example: rashes of ++strong typhoons or hurricanes, or typical summer temp spikes to 105°. *Harder to breed for*, eg. Irene and Lee.

SPAWN OF CLIMATE CHANGE: THE LITTLE PICTURE

1. plant pathogens and many insects are co-evolving (adapting) faster than humans. Have higher reproductive rates per unit time.
2. A given crop geneline must be able to adapt to likely greater temp. extremes.
3. During crop life cycle, the ***timing*** of low vs. high temps. may be critical (germination, pollination, etc.)

All those scary truths. Now for our strengths:

1. Anyone doing big-population breeding for at least 3 years (or even simple decently-executed seed saving) **has already been selecting for crop tolerance to climate change.**
2. The genetic libraries of many plants are amazing, diverse, and adaptive. Many species will likely be around long after humans are gone.

Even' Star Organic Farm Gold Star cherry tomatoes, 10/10/2019

A coyote of the crop world: adaptive, feral, competitive.

Even' Star Ice-Bred Arugula

THREE BREEDING APPROACHES

1. **Recurrent Mass Selection**: depends on large populations of potential breeders. Harsh screens are imposed before sex starts. Death is good. Survivors permitted to make seed *en masse*. Large numbers of fruit or mother plants are GROUP or INDIVIDUALLY selected to make the next generation. Ideally happens every year.

basic breeding approaches continued

2. **Hybridization/pedigree line programs:** traditionally start with 2 inbred lines and small, relatively unrelated parent populations. The F1 offspring are remarkably uniform. Easy example: crossing two *Cucurbita pepo* squash cultivars.

3. GMO approaches: typically depend on a mutation of a single gene, or very few linked genes, OR insertion of foreign DNA into the crop's genetic code.

Land Races, Hybrid Programs, GMOs, & Global Climate Change

Recurrent Mass Selection and its continual adaptation likely gives more tools than hybridization/pedigree line breeding or GM.

WHY?

RMS starts with larger, more genetically diverse populations.

RMS adapts every single generation.

RMS is easier for many farmers to execute.

Hybridization: pluses and minuses

- Simple/traditional hybridization starts with small populations of 2 inbred lines for the cross. Offspring will be the sold F1 seed. *A minus, due to low heterogeneity (genetic diversity) within each inbred line. Many hybrids are prima donnas: field conditions must be perfect for outstanding growth and yields.*
- Hybrid vigor (aka heterosis) is real and powerful and very often profitable. *A big plus, but perhaps oversold by seed companies who want you to buy. See discussion in* First the Seed, *by J.R. Kloppenburg.*

GMOs: pluses and minuses

- Not do-able by most farmers
- Adaptation to severe pest outbreaks, to temperature extremes, to drought or excess rainfall, etc. ARE RARELY IF EVER GOING TO BE GOVERNED BY ONLY ONE GENE, or even a few linked genes. Multi-genic and interactive effects to these stressors will determine crop failure or success.
- Poss. decent project (likely already started): sorghum X corn. *Sorghum better in drought.*

Our Reality:

ESOF has used hybridisation to create 7 of our 14 core genelines, followed by de-hybridisation and establishment of super-adapted land races through RMS.

Seven other core genelines: strictly RMS, over many years. Easier. Similar results.

Gold Star Cherry Tomato

- **Initial 3-way hybridization in 1993.**
- **Goals: GREAT FLAVORS; HIGH YIELDS; LENGTHY FRUITING PERIOD; SUPERIOR DISEASE TOLERANCES.** ***Attained early.***
- **Followed by decades of recurrent mass selection.**

Photo taken Oct. 20, 2019

Peachy Mama ***pepper*** (likely *C. chinense; poss. C. frutescens)*

Initial: purchased at indigenous farmers' market in the Amazon, 1992. Noteworthy: outstanding flavors and aromas of this pepper species, but none of the heat. Foolishly re-named for better marketing. No hybridization.

Recurrent mass selection every year to adapt to our soils and to the climate of the mid-Atlantic.

Other goals: disease tolerances and high predictable yields.

Hurdles: quite capable of crossing with other hotter *C. chinense* and possibly even with hotter *C. annuum.*

Apollo "heirloom" tomato

- Initial: acquired fruit of much smaller heirloom from the great produce farmer Ward Sinclair in 1993.
- Decades of recurrent mass selection from parent line. In 2010, started selecting for size to replace Mtn. Gold and Gold Jubilee heirlooms
- Goals: DEEP FLAVORS; SUPERIOR DISEASE TOLERANCES; SIZE. *Attained early.*

Photo taken Oct. 20, 2019

DRILLING DOWN FURTHER: WHAT WE MUST SELECT FOR

(through hybrid programs and/or through recurrent mass selection)

Increased Insect Pressures

- Higher average global temps in all seasons likely lead to more generations of many insect pests per year, and to higher insect metabolic rates.
- Shortened generation times over longer warm periods = more generations = greater insect pressure.
- More generations/year = more insect sex, and faster adaptation to our sprays.
- May see more invasions of southern pests.

Insect pressure con.

- Suggestion: focus on physical barriers to insect problems, eg. Remay/Agribon at the field level, or hairy leaves at the plant level.
- Chemical crutches may be overwhelmed by higher insect reproductive rates and evolution. How much longer will Bt and Entrust work?? Prediction: not very.

Increased Fungal Pressures

- Same reproduction rate x temp dilemma as we face with insect pests, but
- Greater existing DNA library in some co-evolved crops that may provide tolerance or resistance to the pathogens (but note the quick failure of Eleonora basil against mildew).
- So very targeted hybrid crosses, followed by return to recurrent mass selection and land race development, appears advised.

Increased Bacterial and Viral Pressures

- Same reproductive rate x temp dilemma as we face with the above pathogens/pests, and similar good plant genetic libraries as with fungi, but (critically):
- Bacterial and viral exchange of resistances to human control methods are now a deep challenge (phage- and conjugation-mediated etc.). In support: MRSA in humans. In denial: easy ESOF management of TMV by RMS.

Gold Star: multiple disease tolerances, esp. *Septoria, Fusarium, Verticillium*, TMV.

RMS every year since 1993.

photo: October 20, 2019. Transplanted out May 18th; first yields July 2.

Unpredictability of Temperatures

Crop vulnerabilities:

- Germination in abnormally cold (or hot) soil. So much for timely sowing of the corn crop . . . .
- Flowering and successful pollination are often very dependent on both photoperiod and temperature, and the interaction between these.

Warmer Than Normal Temperatures

The Capsicum annuum example: pollen tubes in most varieties abort more when temps are above appr. 92° F. Poor fruit set.

Needed: thoughtful breeding in the right climates to keep sweet peppers profitable, at least in the US south.

Winter crops at Even' Star

Snow and cold are good! These prolong harvests and slow down bolting.

Land-Race collards, Feb. 2010

ESOF arugula (L) & Chinese Thick-Stem Mustard (R)

- Outstandingly flavored and productive crops. Fully winter-hardy. BUT
- Too warm an autumn or winter induces premature flowering.
- Then ice storms or temps below 25° F cause those CTSM plants that have flowered to die. Ice-Bred Arugula doesn't die. Not even the flower buds.
- RMS partly selecting against premature flowering.

A breeder's nightmare

Apple tree in bloom, Oct. 10, 2019. We can't improve woody crop species nearly as fast as we can the annuals.

Two of the last 4 years: regional plum crop failed due to late April bud break and flowering, followed by temps dipping below 28° F. Flowers and tiny fruits abort. Goodbye income.

BREEDING AND EXTREME EVENTS

- The most important time to harvest for genetics and not for market is right AFTER an extreme weather event, eg.
- Tomatoes: 7-12 days after a hurricane
- Over-wintered greens: spring after really cold winter, for example spring 2014 or spring 2018
- Park your desire to earn fast $ from challenged crops. The genetics and the future are the goal.

Late harvest Cherokee Purple heirloom

- Three genetic harvests annually: early, mid-season, and late season.
- Here: a vigorous plant, for mid- October, and decent fruit set.
- The easy sales of late tomatoes are outweighed by the long-term value of the best fruits as seed sources.

WHAT OUR CROP BREEDING HAS ATTAINED

- Much better flavors
- Tolerance to low levels of soil nutrients
- Some disease tolerances, especially in tomatoes. Breeding failure so far: *Xanthomonas.*
- Better overall seed quality than is buy-able.

our breeding results con.

- More stability of yields, especially in extreme drought, cold, heat, or rains
- Outstanding yields of open-field winter greens

Because the RMS has been every year since 1992-3, the genetic work has SELECTED FOR TOLERANCE TO *GRADUAL* CLIMATIC CHANGE. Our crops' genetics have evolved with the climate.

One of the greatest naturalists of our era, Rachel Carson, noted in 1955 in *The Edge of the Sea*:

- " . . .it became clear by about the 3rd decade of the 20th century that Cape Cod was (no longer an) absolute barrier . . . for warm-water species attempting to round it from the south. Curious changes have been taking place, with many animals invading this cold-temperate zone from the south . . . . (This is) related to the widespread change of climate that seems to have set in about the beginning of the century and is now well-recognized—a general warming up noticed first in arctic regions, then in subarctic, and now in the temperate areas of northern states."
- Sound familiar, right? And a few in the U.S. still deny climate change?

WE AND OUR CROPS MUST ADAPT. And farmers and breeders can be at the forefront.

Vigorous Red Star cherry tomato, Oct. 20 2019

BASICS OF GENETIC MANAGEMENT AND CROP BREEDING

Genetic Management . . .

Is managing the presence and frequency of certain genes in a breeding population over time. Sounds complex but isn't. Genetic management is really about us

SELECTING the best individual plants to set seed. We then plant that seed next year. Over time, this really improves the crop. The main plant breeding technique for thousands of years.

RECURRENT MASS SELECTION

- A breeding strategy, like hybridization or pedigree line development.
- Depends on large populations of potential breeders, subjected to harsh screens before sex starts. Survivors permitted to make seed en masse. Large numbers of fruit or mother plants then INDIVIDUALLY or GROUP selected to make the next generation.
- Ideally happens every year (our farm).

VOCABULARY

- **Land race: a locally adapted, heterogenous, genetically diverse breeding population. Resilient and reliable under adverse conditions, and vigorous when times are good.**

The land race is our goal in most cases.

A great land race:

2-acre field of Ice-Bred Arugula. Uniform only in winter-hardiness, flavors, and vigor

VOCABULARY

Phenotype: what the plant or animal looks like, or expresses in traits. Usually an interaction of environment and genetic potentials. ***This is the basis of how we select. "Appearance" is the working approximation of what the genes actually are in individuals or groups.***

Ice-Bred Arugula

Note paler central leaves of the plant.

Versus this neighbor

Darker leaves. N difference? Or genetic?

Phenotype!

more vocabulary

- **Genotype:** what the plant or animal has in its genes; many characteristics are expressed only after specific environmental triggers
- **High-grading or top-grading:** removal of the best individuals from a population before final breeding has occurred
- **Culling:** removal of the weakest individuals from a population

more vocabulary

- **Rogueing:** removing off-types, and runts as well, from the breeding population
- **Geneline:** like a variety or cultivar, a group of individuals with very similar characteristics that can and do interbreed. Animal example: Holstein cattle.

more vocabulary

- **Selection:** the act of deciding which traits are most important for the next generation, and then choosing to breed those individuals that best show these traits. Ex.: freeze tolerance.
- **Screening:** to subject a population to a truly unpleasant reality, in the hopes of getting some tolerant survivors.

more vocabulary

- **Hybrid:** the offspring of two relatively unrelated parents. **DO NOT NEED TO CREATE HYBRIDS TO DO RECURRENT MASS SELECTION.**
  Segregation: when offspring of a cross (or, more often, 2+ generations of crossing) display differing degrees of the same characteristic(s).

RECURRENT MASS SELECTION

- A breeding strategy, like hybridization or pedigree line development.
- Depends on large populations of potential breeders, subjected to harsh screens before sex starts. Survivors permitted to make seed en masse. Large numbers of fruit or mother plants then INDIVIDUALLY or GROUP selected to make the next generation.
- Happens every year, or at least often.

Seed Saving . . .

Is harvesting and storing that seed properly. Ideally you replant the crop every year, so new fresh seed is harvested annually. Seed saving for us should be a tool of genetic management, not an end unto itself. For us, seed saving without genetic improvement is bad.

Genetic management has become a vital tool that we cannot give up. Usefulness of on-farm breeding has been accentuated by truly variable weather.

Example of Land Race Development

- 1993: knew that would start commercial farming by 1997.
- Knew that the hybrid cherry tomato Sungold had great flavor but was a poor late season producer, split too much, etc.
- Did two-generation, 3-parent crosses to make a better cherry tom. *Started with these segregating hybrids.* A hassle, but intentional.

Developing a land race, con.

- Goal was to de-hybridize but to end up with a resilient, well-flavored, disease-tolerant land race that would produce until first frost. De-hybridization of (3) excellent lines was required.
- Gave great initial genetic diversity, perfect for a land race.
- Most of the de-hybridization work occurred between 1994 and 2000. Still some off-types.

Developing a land race, con.

Recurrent mass selection practiced every year:

- Top 60% of seedlings get to be transplanted.
- Rogue out any plants with TMV, early-onset wilt diseases. *Very few now indeed.*
- Only high-yielding, vigorous mother plants with no post-rain fruit splitting get their toms chosen.
- 3-5 genetic harvests annually: early; mid-season; slightly later, and after tough times. Seed bulked.

Gold Star cherry tom con.

- Per genetic harvest, minimum of 80 mother plants have their best fruits chosen, out of total of 1200+ plants in this land race.
- But we do NOT necessarily choose the same mother plants each genetic harvest. Intentional.
- Harvesting for MARKET ALWAYS OCCURS AFTER the genetic people have gone through.

By 2002 the land race, Gold Star, has very high yields:

- Under conditions of extreme heat and rationed irrigation water
- With low soil nutrient levels: Gold Star is thrifty, as we use only ¼ of the fertilizer N, P, K that we are permitted (our environmental ethic)
- These yields split very little
- These yields taste really good
- And are under strong disease pressure

THEN CAME "THE SUMMER WITH NO SUMMER": 2013

- Record low temps, May-September
- All of a sudden, insufficient heat for ripening, especially of our heat-selected genelines. Very low tomato yields: 30% of the norm. *BAD!*
- Recurrent mass selection nonetheless occurred, looking for most vigorous mother plants with the most ripe and under-ripe fruits.
- So 2013 imposed a different selection pressure!

2013-2014

Then when 2014 had very similar spring/summer weather (too cool), the justifiable fear was that our tomato yields would be as low as they had been in 2013.

That was the case with new purchased tomato varieties.

2013-2014

- But WAS NOT how it worked with the genelines we had been breeding for 4 to 24 years. These 9 genelines had already been through one "summer with no summer".
- AND IN 2014 PRODUCED THE SECOND-HIGHEST PER-PLANT TOMATO YIELD SEEN IN OUR FARM'S HISTORY.

WHAT HAPPENED?

- Likely that this was a genetic, not environmental, effect: in same field, the 2 purchased genelines did poorly, but the 9 core Even' Star tomato lines did great.
- The genetic diversity in Gold Star nicely responded to the different screen (yields under cold conditions of 2013) after only one year of selection. CAPACITY OF A LAND RACE.
- Will we see a hiccup when scorching summers return? We hope not.

HOW TO START: CHOOSE ONE FAVORITE CROP, AND TAKE ADVANTAGE OF EXTREME EVENTS

Can choose almost anything: a project to breed for freeze tolerance in winter crops or for disease tolerance in summer crops (eg., powdery mildew in zinnias)

That first crop to breed . . .

- Should be one you and your customers love
- Should be one whose seed is not always purchasable (eg., NOT Black Beauty eggplant)
- Easier if open-pollinated or heirloom; much harder to de-hybridize a hybrid variety
- Should be one already somewhat adapted to your region and soils (neg. ex: carrots and clays)

For that first crop to breed . . .

You must research how it has sex and makes seed:

- Cucurbits, corn, eggplant easy to make crosses. Recurrent mass selection not needed at first.
- Tomatoes a bit harder to cross (smaller flowers)
- Brassicas mostly by insects, on a large scale
- Know of subtleties, eg. pollen tubes & peppers

Make your crosses and then . . .

- Plant out and subject to the screens. Never baby a seed crop once it is out of the seedling stage!
- ALWAYS be wary about unwanted cross-pollination. Many crop species are really promiscuous.
- Save that seed well. Is VALUABLE!
- Resources: see anything by Bryan Connolly on crop breeding

Seed companies

- too often tell us that hybrids or GMOs can help grow more food in a changing, harsh world
- But hybrids and GMOs are usually adapted to a narrow range of good conditions. Are like pampered dogs.
- Land races with broad genetic diversity are a much better bet

What We Farmers Can Do

We need to select for the *COYOTES* of the crop world: strong, wild, needing few resources, and resilient under harvesting and pest pressures.

Hear the Howl, and Watch Out for Your Pets

Even' Star Ice-Bred Arugula

Completed 2021

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Photos courtesy of Carolina Farm Stewardship Association unless otherwise noted

Educational Materials