Proceedings of the 10th Organic Seed Growers Conference

February 12 - 15, 2020 | Corvallis, Oregon

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Many thanks to the conference planning committee:*

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Matt Levitt, Albert Lea Seed
Cara Loriz, Organic Seed Alliance
Theresa Podoll, Prairie Road Organic Seeds
Don Tipping, Siskiyou Seeds

A very special thanks to our conference chair: Cathleen McCluskey, Organic Seed Alliance

*We received over 60 conference proposals. An additional 25 members of the organic seed community reviewed these proposals and provided input on the agenda, including seed growers, policy advocates, graduate students, university plant breeders, and seed and food companies.

Our mission
Organic Seed Alliance advances ethical seed solutions to meet food and farming needs in a changing world. We accomplish our mission through research, education, and advocacy programs that closely engage farmers and other seed community members.

Our vision
We envision organic seed systems that are democratic and just, support human and environmental health, and deliver genetically diverse and regionally adapted seed to growers.

Our work
OSA has a 17-year track record in addressing seed industry consolidation through fostering regional seed networks that result in transformative change at the national level. Our **research** expands access to high-quality organic seed through participatory plant breeding and other research that emphasizes diversity, ecology, and shared benefits to meet regional and national seed and food needs. We provide **education** in on-farm plant breeding and seed production through events and publications in order to build the base of knowledge necessary for stewarding seed and enhancing biological diversity. Our **advocacy** work promotes the benefits of organic seed while simultaneously confronting threats to organic seed systems by engaging in policy actions, discussions, and research at the national level.

Our values
Action: We value taking action to support seed growers and to remove structural barriers to a just and equitable seed and food system.

Civility: We value civil discourse on issues that matter to our constituents.

Collaboration: We value public participation in decision-making – in the field and in policy – beginning with the grassroots, resulting in the co-creation of knowledge and shared solutions.

Community rights: We value a community's right to determine whether and how culturally important seed are used and shared.

Diversity: We value genetic, biological, cultural & social diversity in our seed and food system.

Equity: We value the equitable treatment of all individuals and equitable rights for all, and the equitable exchange of seed with appropriate acknowledgement and compensation.

Fairness: We value fair competition, labor, markets, and opportunities for all.

Farmers: We value the leadership and rights of farmers across time and scale in research, education, policy, seed stewardship, and food security.

Health: We value a healthy environment and the health of all species, including the right to clean air, soil, and water.

Inclusivity: We value an organizational and program environment that is inclusive of all.

Integrity: We value the integrity of seed and personal and professional integrity in the people who steward them.

Precaution: We value preventative actions and policy positions in the face of uncertainty.

Public good: We value actions, programs, and policies that aim to serve the public good first.

Conference Agenda — Friday, February 14

7:00 - 7:30 a.m.	Yoga with Leta Fetherolf
7:00 - 8:45 a.m.	Registration check-in for main conference Research poster set-up
7:30 - 8:45 a.m.	Breakfast
9:00 - 10:30 a.m.	**Session I**
	• Producing Organic Flower Seed • Accessing Agrobiodiversity: Practical Knowledge for Finding and Using Rare Seeds • Finding a Path Forward on Seed Licenses • Visualizing Our Seed Network: Bubble, Bubble, Toil & Trouble
10:45 a.m. - 12:15 p.m.	Welcome address: Organic Seed Alliance 2020 keynote panel: Reflect. Renew. Resolve
12:30 - 1:45 p.m.	Lunch
1:15 - 1:45 p.m.	Research poster presentations (during lunch)
2:00 - 3:30 p.m.	**Session II**
	• What the Hemp? Exploring Cannabis Breeding and Seed Production Opportunities • Utilizing Agrobiodiversity: Breeding for Diversity, Resilience, and In Situ Genetic Conservation • In the Trenches and in State Capitals: Legislative Work to Protect Organic Seed • Seed Ownership and Seed Commons (Part 1)
3:30 - 3:55 p.m.	Break
4:00 - 5:30 p.m.	**Session III**
	• Stepping Up Biennial Seed Production • What are We Learning from Trials? Applied Tools Can Improve Plant Breeding and Variety Testing • Moving the Dial Forward on Organic Seed Policy • Seed Ownership and Seed Commons (Part 2)
5:30 - 9:00 p.m.	Seed Expo (trade show)

5:45 - 6:45 p.m.	Research poster session (presenters available to discuss posters)
5:45 - 6:30 p.m.	National Organic Research Listening Session
5:45 - 7:15 p.m.	Variety tasting
7:30 - 9:00 p.m.	Dinner
9:00 - 10:00 p.m.	Synergy Space, bar, bookstore

Saturday, February 15

7:00 - 7:30 a.m.	Yoga with Leta Fetherolf
7:30 - 8:45 a.m.	Breakfast
9:00 - 10:30 a.m.	**Session I** • Small-scale Contract Seed Production • Participatory Plant Breeding: Learning from International Farmer Breeders • Toward a Radical Vision of Food and Farm Policy in the U.S. Centered Around Regenerative Organic Agriculture • Community Seed Stewardship Workshop
10:40 a.m. - 12:00 p.m.	Keynote address: Ricardo Salvador, Union of Concerned Scientists
12:00 - 1:15 p.m.	Lunch
1:30 - 3:00 p.m.	**Session II** • Seed Processing Roundtable • Knowledge Exchange on Breeding Better Brassicas • Excluded Methods: An Industry Perspective • Seeds of Resistance, Resilience, and Reconciliation (Part 1)
3:00 - 3:25 p.m.	Break
3:30 - 5:00 p.m.	**Session III** • Seed Economics: Balancing Passion and Profitability in Seed Growing • Knowledge Exchange on Breeding Better Tomatoes • Where Does Open-source Seed Fit in an IP-Dominated Industry • Seeds of Resistance, Resilience, and Reconciliation (Part 2)

5:00 - 9:00 p.m.	Seed Expo (trade show)
5:15 - 6:15 p.m.	2020 OSGATA annual meeting (open to public)
5:30 - 9:00 p.m.	Seed swap
7:00 - 8:15 p.m.	Dinner
7:30 - 8:00 p.m.	Closing remarks from Organic Seed Alliance and Seed Expo raffle
9:00 - 10:00 p.m.	Seed Expo breakdown

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Organic Seed Advocacy and Policy

Seed Ethics

Poster Abstracts

Welcome to the 10th Organic Seed Growers Conference

Cathleen McCluskey, Outreach Director and Conference Chair

Welcome to the 10th Organic Seed Growers Conference. This 10th biennial event represents 20 years of this community working to build a future where organic seed systems are healthy, diverse, equitable, and just.

As we celebrate the 10th Organic Seed Growers Conference, we reflect on why this event is revolutionary to so many participants. Past conference goers report that the most impactful opportunities at the conference are those that allow them to collectively take stock of our histories, identify and renew their commitment to shared values, and resolve to stay true and connected to these values as we all go our separate ways to further the good seed movement. And so this year's conference theme captures a charge to participants, to Reflect. Renew. Resolve.

We're grateful to Washington-based artist Nikki McClure for sharing her art with us to make this conference theme even more inspiring – and beautiful!

In the program you'll find sessions covering a range of issues falling under four tracks: plant breeding, seed growing, policy advocacy, and seed ethics. A track dedicated solely to sessions focused on seed ethics is new to the conference this year, and OSA staff and our planning committee are especially excited to offer it. We know that agronomics, field techniques, and policy work are only part of what makes for a thriving seed community. It's the people, histories, accountability, and values that are the beating heart of the good seed movement. That's why we're convening integral discussions focused on seed ownership, stewardship, and resistance, resilience, and reconciliation at this year's conference.

We're honored to welcome Ricardo J. Salvador as the Saturday keynote speaker. Ricardo is the Director and Senior Scientist of the Food & Environment Program at the Union of Concerned Scientists in Washington, DC. He leads a team of scientists, economists, policy analysts, and organizers to make the case that modern, sustainable practices can be highly productive while also protecting the environment, producing healthy food, and creating economic opportunity for all. His agronomic background coupled with his social justice work makes him the ideal person to deliver this year's address focused on the sordid history of agriculture's exploitation of both people and the planet.

OSA would like to thank our tireless conference planning committee, the seed ethics intensive and track planning committee, and our conference proposal review committee. Collectively, more than fifty members of this seed community helped make decisions about the conference agenda, keynote speaker, and other event logistics. We would not have been able to pull off this year's conference without the following individuals: Heron Breen, Fedco Seeds; Melissa DeSa, Working Food; Steph Gaylor, Invincible Summer Farms; Ken Greene, Seedshed; Chelsey Lenczyk, Bejo Seeds; Matt Levitt, Albert Lea Seed; Jovan Sage, Sage's Larder/Gilliard Farms; Jacqueline Pilati, Reclaim Seed NYC; Theresa Podoll, Prairie Road Organic Seed; Don Tipping, Siskiyou Seeds; Andrew Still, Adaptive Seeds; and Owen Taylor, Truelove Seeds.

Thank you for joining us here in Corvallis, Oregon. We hope you will use this time to learn and evolve your understanding of the topics discussed at this year's conference, and to contribute your own perspective and experiences to the tapestry of seed stories woven throughout the weekend. It's our hope that after this week's conference these connections deepen and become a part of our everyday work, and that this tapestry of the good seed movement is even larger, more vibrant, and woven together when we gather again in 2022.

May we all resolve to deepen our commitment to the work ahead of us: to embrace and expand diversity at every level as we, together, create a sustainable food and farming future that begins with organic seed.

Organic Flower Seed: What Do You Grow, How Do You Sell, and How Do You Set Prices?

Frank Morton, Wild Garden Seed

frank@wildgardenseed.com

Apparently the word has gotten out that flower seed is the next big opportunity for organic seed producers. We are told that this was the topic most requested for exposition at the 2020 Organic Seed Growers Conference, and that cleaning, marketing, and pricing are the aspects of the topic most growers want to hear about. As an older grower who thought maybe flower seed would be a quiet niche to retire into, this isn't the most welcome news, of course. There's nothing like a gold rush to ruin a quiet stream.

I am going to share with you the small amount I've gathered on the flower seed topic in four growing seasons in hopes that we can all make meaningful income in exchange for quality work. We all know that the dumbest game in farming is chasing a trend we can't get in front of, and the worst way to get hurt is with overproduction followed by dumping on the market. Everybody goes home suffering.

Please keep this in mind as you exit this presentation. You will need to develop your market for flower seeds. And you need to maintain prices at a level that actually pays you to grow them, otherwise you may as well grow something you can eat.

What to Grow

There is tremendous species and varietal diversity in flowers. This is both an opportunity and limitation, for while the list of possibilities is long, the amount that may be sold of any one variety may be very limited. Also, a significant portion of the flower diversity is in perennials, which sounds intriguing at first, but remember that people only buy perennials once, which means the market for perennial flower seeds is inherently smaller. Annual flowers generally have larger market opportunities, but by observation one can see that prices for annual flower seeds vary wildly. There is always an inverse relationship between volume and price, even in flowers. Some flower species are grown to be broadcast for a "wildflower meadow" effect, while others are grown for cutting, often for specific events like weddings, perhaps in specific color ratios. Guess which seeds are more valuable by the unit, and which has more potential to make use of a combine? "Meadow flower" seeds are very cheap by the ounce, but the market for them can be quite large, meaning the total income potential from California poppies might be large as well. On the other hand, bridal quality varieties may be worth $10 per 1000 seeds, but you can only sell 100,000 seeds per year, limiting that variety's value to $1000 per year. You will need quite a few such varieties to make a living of it.

Deciding what to grow is first a problem of learning which flowers will grow in your location. More specifically, which flowers will succeed in setting and ripening seed. Like lettuce, many flowers can be grown for fresh cutting in most climates, but only certain climates accommodate the entire life cycle of the plant such that you get quality seed by season's end. Do you get rain in August and September? Maybe squash or tomato is a better bet for your location. Flower seeds are dry seeds, and nearly all are susceptible to grey mold (Botrytis) if the ripening heads

are subject to repeated rains or prolonged wet periods. The later the species ripens, the greater danger this presents for crop loss. Vegetable seed growers will be surprised by how long some common flowers take to mature. For example, zinnia seed ripening takes as long as peppers for us in western Oregon, and the harvest period goes right up to killing frost or Botrytis blowout, whichever comes first. Do not assume that flower seed will fill and ripen just because flowering begins in midsummer.

In order to test species and varieties for their suitability as seed crops, we did two years of broad-brush trials, growing out 100 varieties each year, giving us a quick scan of 200 families, species, and varieties, we had never grown before. One of my favorite flower discoveries was Joey Lambs Tail, an amaranth relative from Australia. I have a zillion pictures of it, but not a single seed was set. I tried it twice. Aside from lessons like this, we wanted to learn if we could successfully harvest, condition, and clean the seed. If someone can show me how to clean statice seed, I will be most grateful. By growing out 50 plants of each variety we were able to see the range of variation, get a sense for pests and diseases, and some idea for yield potential in our location. It doesn't matter what an "average yield" is for these crops. That data is mostly unavailable, and even if you could find it, it means nothing to you in your location. Yields from different varieties of the same species are hugely different, even when grown in the same year in the same field. Location in your field also affects yield. Flowers can be very susceptible to root rots of various kinds, and there's nothing like Sclerotinia or Fusarium to mess with your seed yield data. I'm sure there is data available on sunflower seed yields-- but if you have blackbirds, it doesn't apply to you.

I cannot emphasize enough the importance of trialing flower varieties on your farm before committing to producing them for seed. We have many instances of complete failure of one variety and success of another within the same species. Celosia is a prime example, where some varieties are very easy and productive, but others require more heat units than the Willamette Valley will provide. Good thing I didn't try to grow Dragon's Breath on contract.

How to Sell

Once we knew what would grow for us, and we had that seed, clean and in hand, we could begin to explore selling it. This was pretty easy for us because we have a seed catalog and contacts with catalog companies that sell flowers. One shouldn't expect a company to buy your seed until they have grown it out in summer trials. This step extends the entry period into this market for seed you have produced on speculation. On the other hand, seed companies are unlikely to give a grower a contract for flower seeds unless there is a good chance of success. It is good to be able to demonstrate experience.

One reason I took up flower seeds in a big way was the obvious surge in interest around local flowers. Every farm conference suddenly had workshops on cut flower farming, and they were packed. These were organic flower growers, and they should be growing with organic seed. But there wasn't any organic seed for flowers. More than once I was questioned about the need for organic flower seed. Who eats flowers? Integrity, is the one-word answer to that. We heard the

same question about the need for organic vegetable seed at one time. It is good to be able to suggest that you are filling a need with your offerings.

There are different marketing scales to consider. In my experience, the catalogs that organic growers use purchase smaller seed lots, but pay well if you can make a sale, and then remain a reliable supplier. Companies that fill seed racks in nursery centers nationwide purchase much more per year, but the price is considerably less per unit, and demand for a particular item more sporadic. I have not dealt with the "wildflower meadow" scale, but this is for growers who want to use equipment on acreage. Each of these markets has a different varietal preference. Meadow flowers are the easiest to grow and the most generic. Seed rack flowers from national brands tend to be old reliable kinds with familiar names. Catalogs are always in search of something new, and are the gateway for new introductions at premium prices. Catalogs themselves come in different styles—well known national brands, smaller regional vendors, alternative local or national farm-based producer-sellers, or tiny idiosyncratic catalogs. There's also a new kind of outlet, "the internet seed seller," that buys and sells seed online out of their home address. You find these vendors in your mailbox, online, at nursery outlets, in advertising, or on a friend's coffee table. Write them, call them, try to get into their trials, or offer to grow a straightforward crop to build confidence in your ability to deliver.

Without a doubt, the most direct route to seed selling is to have a farm catalog. It gives the small grower a means to present all your seed choices at once to whomever might be interested. Our first catalog in 1994 was really only intended to tell seed buyers at our favorite catalogs that we were serious. It took a few years, but it worked. Within two years we were in other regional catalogs, then we were visited by national catalog reps, and by 2000 we were regular suppliers to a dozen other companies. A catalog allows a seed grower to introduce yourself, express yourself, to show your wares, and to set your own prices. There are more farm-based regional (and national) seed catalogs each year, and they seem to be finding success. There may be a limit to how many seed businesses can fit in this marketplace, but I think our community can claim a small victory with this recent renaissance in small seed companies. We are not just seed brokers, buying and reselling seed from "the industry." We are seed producers and breeders in our own right, bringing to market seeds grown on real organic farms with regional accents and ethical integrity. This isn't hard to sell.

Setting Prices

This is what everyone wants to know—how do you set prices? Doesn't matter what you are selling, this is always the question for beginners. Start by going shopping, looking at the prices you find in catalogs and online. This includes not-organic catalogs and online sources. You will be confused by this process as you see the broad range of pricing within each crop type. Don't be. The same is true if you go through vegetable catalogs. The old workhorse open-pollinated varieties (OPs) are cheap, the shiny new hybrids are eye-popping, new OPs are somewhere in-between, heirlooms are unpredictable, newly popular varieties suddenly cost more than they used to. This is all supply and demand. Something new and expensive 10 years ago is cheap today. Salanova® is one price, Salad Bowl is quite another. In this case, the difference has little to

do with seed yield, and everything to do with trends and marketing, with a heavy dose of intellectual property protection.

Study the bulk pricing to get some sense of what the cost of seed is to the purveyor. Commonly, the cost of the seed is about 60% of the largest bulk unit sale price, +/-10%. This is just an estimate of the going price, but it gets you in the ballpark for that purveyor of that variety. Of course, once you enter negotiations around actual prices the purveyor will tell you the price they presently pay, which is probably for non-organic seed. An organic grower should expect some premium, but the percentage on this is vague, seldom more than 30%, often less. It's a negotiation. I often ask the purveyor to give an offer (if I have no established price), and sometimes it is more than I would have asked for. If it's not, I will ask for what I had in mind. If the final price feels a little low, I'll agree to try it once to see how it works out. If I can deliver the full amount with excellent quality, I am in a stronger negotiating position next time around to get a more desirable price. Reliability is priceless.

Do not go for cheap. Never undercut another producer just to make a desperate sale. That is the road you do not want to do business on. That producer you undercut now has a legitimate gripe with you. It has happened often enough that I know the feeling, and it undercuts the desire to share information and good will. Of course, setting your own price in a reasonable range and engaging in competitive pricing is all part of a healthy marketplace, and isn't at all the same as undercutting another grower's relationship with a buyer in order to move in between them. Just sayin'.

The units of sale are a big clue about seed value. Seeds sold by the pound are like vegetables. They are common, and sold in big volumes. Seeds sold by the ounce or gram have a limited market, are more valuable per square foot, and are smaller in size. Flower seed, new releases, rare seed, precious seed, difficult seed, seed in limited supply, patented seed, and breeder seed are often sold by the seed count, specifically by the 1000 unit, the M. Mille is Latin for a thousand. This is a new idea for many of us, and takes some getting used to. It requires a lot of seed counting, something I resisted most of my career. I actually find it interesting at this point — the grams of seed per thousand, the seeds per gram, the value per M. It is a new way of looking at seed value, and I can see it is more profitable when it comes to seed with a limited market and availability. The M unit is a great convenience to cut flower growers who think in terms of stems per week, or nurseries that think in production units by the M. Conversions from grams or fractions of an ounce into seed numbers is difficult, and the M unit avoids all of that.

Finally, we should all be trying to find or breed something new to offer the marketplace, to expand offerings. It is good to remember that new varieties come from breeders doing creative work, recently. The market value of that seed has been established by the breeder (an individual or company) in hopes of recouping costs and staying in business. Some companies protect that value with intellectual property protection, others do not. Do not take advantage of those who keep their work in the public domain by putting downward pressure on their seed's value. The seed may be free for use, but don't undervalue it.

What the Hemp? Exploring Cannabis Breeding and Seed Production Opportunities

Seth Crawford, Oregon CBD

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As most know, there is a very big difference between "seed making" and structured breeding programs. The cannabis seed space has an unfortunate historical legacy of unstable polyhybrid matings being passed off as a "variety," and this confusion has bled into early hemp seed efforts with often disastrous consequences. If the wrong seed is used, the past five years has demonstrated that chaos ensues: flowering time variations leads to reduced yield or crop failure, blatant chemotype errors (high THC or mixed CBD/THC) endangers field compliance, and poorly made feminized seed can result in pollen contamination over a hundred square miles. Now, regulatory uncertainty relating to sampling protocols and mandatory harvest timing proposed by the USDA under the 2018 Farm Bill threaten to raise the bar even more, to the detriment of legacy type III cultivars and small-scale breeders.

What is the future of hemp? The answer depends on production goals, pending rule changes on growing, and the real size of the non-intoxicating cannabinoid market. There is still a future for small-scale seed makers to supply the backyard, home-grown markets; however, large scale operations require stability and uniformity only attainable in structured programs, particularly as it relates to ensuring appropriate levels of ploidy and feminization rates.

What the Hemp? Exploring Cannabis Breeding and Seed Production Opportunities

Tiffany Fess, Green Thumb Health Co.

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Passionate about organic seed systems and crop production, I'm currently completing my Ph.D. candidacy at West Virginia University in Agricultural Sciences. My dissertation focuses on determining differences in nutritional quality and gene expression in crops produced with opposing forms of nitrogen fertilization. Additionally, I have been involved with research projects assessing biological pest control in green bean crops, production of heirloom tomatoes, improving disease resistance in tomato and industrial hemp crops, as well as assessing quinoa production in regional organic systems. Currently, I'm also a sitting board member of the Society of Organic Seed Professionals (SOSP) and serving on the organizing committee for the 2020 Student Organic Seed Symposium (SOSS).

Aside from my academic career, I'm co-owner and director of grow operations at Green Thumb Botanicals in Bridgeport, West Virginia. Green Thumb Botanicals, founded in 2016, is a boutique farming operation focused on producing high-quality hemp for the flower and cannabinoid extraction markets. In house, we have been working to isolate and identify a fungal pathogen of hemp that is commonly observed in our region in order to develop varieties with improved disease resistance and regional importance. When we first started our hemp journey, we hoped to play a part in the resurgence of agriculture in West Virginia, everyday this aspiration motivates us. We are committed to quality, from the seed we source, to the passion with which it is grown and harvested.

Being immersed in the cannabis industry, we have learned a lot as we navigate the ever changing legal landscape and regulatory uncertainty. Over the past few years, we have seen numerous crops test "hot" ($> 0.3\%$ thc) and subsequently be destroyed largely due to poor genetics and field performance. The production and acquisition of quality, field-tested hemp seed, backed with the proper analytical reports is the most significant investment when scaling cannabis production. It is important for those entering the market to be aware of the risks, expense, and potential loss associated with a hemp business, especially for the next few seasons as the USDA irons out the final rules and regulations governing the crop.

Phytonyx Response to the USDA Interim Hemp Ruling

Tenasi Rama Lazar, Phytonyx, Founding Partner & CSO

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I have been a cannabis grower for over a decade and am inspired by the healing potential of CBDs. In 2014 I fused my passions of botany and engineering to focus on hemp seed breeding. With the passing of the Oregon Hemp Farm Bill in 2015, I joined forces with partners Justin Tombe and Izzy Jaramillo to launch Phytonyx as a producer of the highest quality phyto- and terpene-rich hemp seeds in the world. I utilize my diverse skillset for Phytonyx, selecting desired genetic expressions, crafting and implementing breeding strategies, optimizing agricultural systems, and developing collaborative business and academic partnerships.

In my role, I have had the opportunity to develop and express concerns about the new USDA hemp regulations. It is important for anyone engaging in the hemp industry to understand these regulations and their implications, and to work to change them when needed.

USDA or USDEA Rule

The pre-harvest hemp sampling procedures to test for total THC content (< 0.3%) currently defined by the USDA interim rule restrict pre-harvest sampling to only be conducted by DEA registered labs, of which there is currently only a handful. Why is the USDA involving the DEA for hemp? The process for DEA lab certification currently takes 6 - 9 months, which will surely result in pre-harvest sampling bottlenecks for the thousands of American hemp farmers (17,000 in 2019, and expected to double for 2020).

Phytonyx objects to the DEA registration requirement for labs and requests USDA to allow similar type state licensing/accreditation to the ORELAP accredited/OLCC licensed labs that currently test recreational marijuana in Oregon, or to require labs to have ISO accreditation.

Non-representative Sampling Methods

Rather than utilizing full-plant pre-harvest sampling, the USDA interim rule restricts the plant sample to be composed of clippings from only the top two inches of the hemp flower, which contain higher concentrations of THC than the rest of the plant harvested for hemp biomass. This is not an accurate representation of the total THC level, but rather the highest THC level. Phytonyx requests that USDA change the pre-harvest plant sampling to include full-plant representative samples.

The 15-Day Harvest Rule

The current USDA rule limits farmers to 15 days from the time the pre-harvest sample was taken to await the results and then harvest their entire crop. It cannot be overstated that part of the 15-day window is waiting for the results of the test, which currently takes up to a week, and

considering the potential bottleneck of relying on DEA registered labs could easily take two weeks. (If the pre-harvest sample is not under the legal total THC limit of 0.3%, the farmer has to destroy the crop.)

If the pre-harvest sample tests under the legal limit, the farmer then has only a short time to harvest the plant before the 15-day window is up. Harvesting an entire hemp field, even with mechanized harvesters, often takes over a month. As the new USDA rule currently stands, if the farmer doesn't make the 15-day deadline, the crop has to be tested again and the farmer will again have to wait for the second round of pre-harvest results before they can continue harvesting. This 15-Day rule was clearly not well thought out and it puts farmers at risk of losing their crop due to logistical nonsense.

The previous test-to-harvest standard (in Oregon) was 28 days. Phytonyx opposes the new USDA 15-day limit and recommends the deadline be changed to 30 days.

0.3% vs. 1.0% Total THC Testing

Let's be honest. Nobody is getting high off of hemp. The USDA's regulation of THC in hemp should be intended to prevent hemp farmers from growing high-THC cannabis in their hemp fields. The USDA's adherence to a strict 0.3% total THC limit for hemp is not based on sound science or any non-psychedelic metric. Rather it is based on an arcane Canadian hemp standard implemented for the hemp grain market in the 1990s. Because the natural range of CBD:THC in hemp is 20:1 to maximum 40:1, limiting the total THC to 0.3% limits the maximum CBD percentage in hemp to (0.3 x 40) = 12%, which is less profitable to the farmer than growing current varieties that are 20% - 25% CBD with only 0.5% total THC.

An adverse result of this unreasonable 0.3% total THC limit will be the emergence of genetically modified THC-compliant hemp that boasts higher CBD concentrations. Phytonyx highly recommends that the USDA adopt a more reasonable 1% total THC limit for hemp flower and biomass.

Violations and Penalties

Farmers face penalties if their hemp tests over the permitted limit. If the pre-harvest samples test over 0.3% total THC, the crop will have to be destroyed. The proposed regulations also set forth a "three-strike" policy. This means that if a farmer's hemp tests over 0.5% THC, they will need to destroy the crop and will be given a strike. If they get three strikes in a 5-year period, they are barred from growing or processing hemp for 5 years. This range is too tight. While the crop may still have to be destroyed if more than 0.3%, the farmer shouldn't be further penalized for going inadvertently hot.

Additionally, per the USDA rule a violation "with a culpable mental state greater than negligence" will be immediately reported to both the U.S. Attorney General and the chief law enforcement officer of the state or tribe.

If the total THC limit remains at 0.3% total THC, then Phytonyx recommends a more realistic 1% total THC threshold before the farmer faces any strikes or consequences.

Takeaways

Once the USDA integrates the comments received and issues the final rule, they will guide the hemp industry for at least the next three years.

Phytonyx strongly advises our farmers to personally respond to the USDA interim rule and advocate for:

- A 1% total THC limit for hemp.
- If the 0.3% total THC remains, then establish a 1% total THC threshold before the farmer faces any strikes or consequences.
- Pre-harvest compliance testing protocols that are representative of the entire plant.
- A time period of 30 days from pre-harvest sampling to harvest the crop.
- Well-equipped professional labs to be certified by the state or ISO-accredited, rather than registered with the DEA.
- Ensuring that fingerprinting and background checks are only for owners and top management that are on the licenses. The rest of the workforce shouldn't be required to have formal checks.
- A system that allows the CBD concentrate to be legally stored, handled, and transferred to other processing facilities. Prior to crossing state lines or inclusion into a retail product, the concentrate will need to be diluted back to the legal limit.
- Alternatives to the current crop destruction methods for non-compliant hemp lots. These could include remediation methods, conversion to biochar, or even rapid composting as means to improve soil tilth.

Hemp Breeding and Intellectual Property

Jessica Staha, Phylos Bioscience

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Hemp and cannabis will soon be the third largest U.S. agricultural crop. Phylos is a crop science company committed to unlocking the full potential of this plant. By pairing science and sustainability with its unique versatility, we aim to positively impact the economy, society, and the environment. Since 2014 we've worked to build the infrastructure necessary to aid growers' success in this new and frequently changing industry. Growers are supported with high-quality seed backed by our diverse scientific team including breeders, data scientists, and agronomists. Success is fostered and risk is mitigated by engaging with growers on the ground in planting, cultivation, and harvest.

As Chief Technology Officer, I have worked with the Phylos team to develop tools and methods that support cannabis and hemp breeding. While the introduction of hemp into the federal system has expanded the breeding discussion, it has also complicated things. It is especially hard to both listen to market needs and implement variety changes in a timely fashion. But the dedication of knowledge, time, and resources are key considerations that every grower must assess before entering.

Through my experience, I have found that there are four primary hurdles that many analyze upfront to mitigate risk. These include the following:

1. Understanding agricultural inputs required to meet predictions about consumer and industrial product demands.

2. Converting these needs into variety selections that are regionally appropriate.

3. Focusing internal resources through the use of publicly available genetic and phenotypic tools.

4. Ensuring both collaboration and protection through the use of intellectual property and/or material transfer agreements.

This panel serves as an opportunity for audience members to hear recommendations on how to effectively navigate each of the aforementioned components to better support their productivity and bottom line while learning more about the intricacies of cannabis and hemp breeding.

Biennial Seed as Part of a Diversified Farm Operation

Beth and Nathan Corymb, Meadowlark Hearth Farm

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Meadowlark Hearth is a 540-acre certified organic and Demeter certified biodynamic farm situated on the North Platte River on the western edge of the Great Plains. It is in a semiarid high plains climate with 12 to 14 inches of annual precipitation in planting Zone 4B at 4000 ft. elevation. Extreme fluctuations of temperature, strong winds, and frequent hail are some of the challenges we face. The farm is very low input, producing all its own fertility. It has a mix of irrigated crop ground, dry land crop ground, range land and wild lands. Production includes a grass-fed/grass-finished raw milk beef/Dairy operation, poultry, vegetable production and seed production. The focus had been on growing seed integrated into a diverse whole farm setting with vegetable seed coming out of the vegetable production plant populations.

Meadowlark Hearth retails seeds through an online offering and contract grows for about 7 other organic and biodynamic seed companies. Seed crops of biennials produced have included a full range of the crops adapted to temperate climates that are grown mostly as annual vegetables but usually produce seed only in their second year of growth. Biennial seed crops grown commercially have included carrots, parsnips, beets, spinach, cabbage, kohlrabi, chinese cabbage, radish, turnips, celeriac, onions, leeks, chicory, and endive. Larger scale contract production of biennials has focused on carrots, parsnips, cabbage, celery, black storage radish, turnips, rutabaga, and onions, and for annual contracts tomatoes, peppers, and melons.

The climate does not favor wild populations of biennial crops like carrots and parsnips which are otherwise widespread through most of the country, so this natural isolation from cross-pollination is a big plus. Also the low humidity provides a relatively disease free environment for many of the fungal and bacterial seed-borne diseases. The winters are harsh, with some spells of nights at 10-20 F below, requiring protection and/or lifting, storing, and replanting of seed stock. Since the seed stock comes out of larger vegetable production populations, this provides the opportunity for a very good mass selection regime. Also virtually all the vegetable crops are grown from highly selected seed, so this provides the opportunity for continual maintenance and improvement as well as opportunities for developing new traits. Our vegetable CSA in which we use the biennial and annual seed we grow allows us to check in with many of the varieties each season.

The challenges include wide temperature fluctuations, especially during winter, periods and incidences of extreme or sustained high winds, frequent and occasionally devastating hail storms, and the relatively short season with average first freeze in mid-September and light frost in early June are not uncommon.

Economically seed production has been the largest income of the farm, but closely balanced with vegetable production and animal products, each providing a similar income flow depending on the season. About 1% of the land is in vegetable and seed production, with about 10% of that 1% directly in seed production. Vegetable production is primarily for a year-round local on-farm pick-up CSA. The wider national market and distribution of seeds as well as the varied

seasonal distribution of labor needs has provided a good balance. Also many of the crops produce both food and seed. The animals largely consume the waste products from seed processing and the animal compost provides the fertility basis. All vegetable and seed refuse is composted in a separate pile from the animal manure/straw compost and the veggie refuse compost pile is put on outlying pastures and does not go back on the vegetable and seed growing fields. Each season, both our farm consumption, CSA and market observations gives us a continual feedback, so this provides a built in vegetable trialing. All in all the balance and interweaving of these elements creates a very synergistic living farm organism that has been able to provide a sustainable and developing economic base for the farm.

The non-profit Living Environment Foundation also has its venue at Meadowlark Hearth Farm. It focuses on biodiversity, environmental justice, and social justice. It is an education, research, and charity organization providing nature education and classes in cooking, seed gardening, an annual Labor Day seed festival, seed farm internships, high school, college and grade school visitors and community service volunteers. As farmers we find that gardening, farming and seed growing are cosmopolitan and radical life changing activities toward healing the Earth and building community. We are working on protecting the farm in perpetuity as an organic farm/biodiversity preserve as a seed for the next agrarian generation.

We will cover and discuss the cultural and practical ways we have learned to meet these challenges and develop these opportunities with a seed business that focuses on in situ biodiversity including biennial seed production.

"Custom collaboration:" An Approach to Biennial Crop Selection and Seed Production for Challenging Environments

Petra Page-Mann, Fruition Seeds

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In the Finger Lakes of New York, Fruition Seeds focuses on regionally adapting organic seeds for the Northeast. In our current biennial seed production, we grow radishes, kale, cabbage, carrots, onions, and beets. All of our biennial work is in collaboration with other market growers, meaning we share different parts of the observation, selection, and seed production process with partner farms in our region and beyond.

There is a reason commercial seed production doesn't often happen in New York! Our high humidity and heat in summer are our key challenges. Overwintering can also present issues. Onion, beet, chard, and carrot seed crops are grown in high tunnels, which helps limit the effects of rainfall on dry seeded crops. We can develop some great genetics; the trick is then to turn that material into high-quality saleable seed.

We store our overwintering biennials in a walk-in cooler (cool bot, humidifier) at 40F, keeping the humidity high. Cabbage heads are field cut and plants dug up after several frosts. Their root balls & main stalks are then packed in bins with moist peat moss; we use the same peat for several years. Kale is overwintered similarly. Onions are stored in mesh bags so they breathe. Carrots are stored, soil on, in plastic bags. We try to prevent them from getting too much humidity in bags so they resist rot. Beets are stored similarly. There are tremendous disease risks in all seed production. Brassica crops in humid climates are particularly prone and we are careful to space the plants widely and scout always.

We're so grateful to collaborate with market growers to select and develop new biennial crops. Market growers produce large population sizes (for example: ~2,000 cabbages, 4 acres of kale) for selection. After selecting the next generation with the farmers, we either grow the seed crop ourselves or send the stecklings, for example, to other collaborators (out West, in the case of carrots) who grow the seed crop. We call this "custom collaboration." It works well because it allows us to select for the traits that will be immediately beneficial to our partners, and similar farms, while ensuring that the seed crops can be produced in a climate well suited to its biological tendencies.

While the market opportunities for producing biennial seed crops in challenging climates may not be huge, we see a big opportunities for selecting varieties to thrive in bioregions, resisting commodity models. In that sense, the market opportunities are invaluable.

Small-scale Contract Seed Production

Beth Rasgorshek, Canyon Bounty Farm

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Both farmers and seed companies risk much when it comes to contracting a seed crop. The farmer needs a long and beneficial season to produce the seed, and the seed must germ at an acceptable rate before the farmer even thinks about getting paid. Seed companies have sent stock seed to the farmer, the crop is listed in the company's seed catalogue and website, and ahead of all that have invested in and produced various trials and grow outs to settle on that particular seed lot to increase production.

It's a complicated relationship between the farmer and seed company. There are successes and failures. But failures are the best way to become a better farmer. And if the seed company can appreciate that then you are well on your way to a healthier relationship with those businesses.

The farmer-seed company relationship is built on trust. And appreciating what each is bringing to that relationship is helpful to negotiate price, expectations, and needs. With that in mind, here are some thoughts to consider before taking a seed contract:

• How do seed harvest timelines match up against other farm demands? Can the arugula seed crop survive the demands of the farm when watermelon and sweet corn are hitting peak harvests?

• Be realistic about the financial aspect of seed production. Relative to fresh harvest it is truly the longest crop to grow. Project, with the help of enterprise budget sheets, how much time you will have committed to growing, harvesting, and cleaning that crop.

• Communicate, communicate, and communicate with the seed company. They need to know immediately if you have a crop failure. Don't forget they spend the month of August working on the next year's seed catalogue so a quick update to them about their crop status is a courtesy to them.

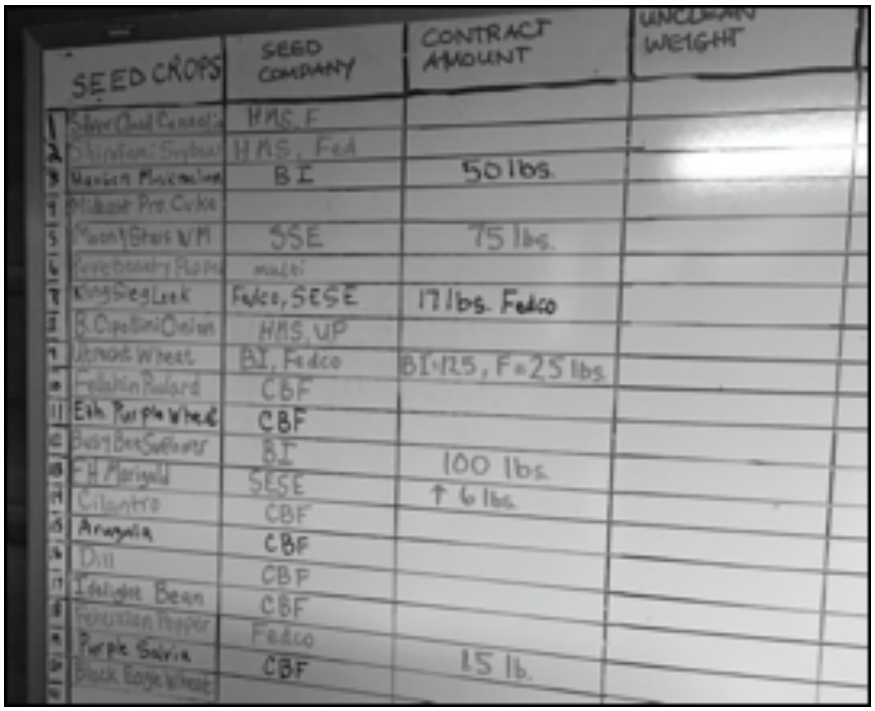
• Clarify ahead of time if you are expected to rogue for off-types. This should impact your contract price if the company expects you to do quality control.

• Seed cleaning is another important task that needs to be clarified ahead of time. If you can't clean the crop, can a neighbor? If additional seed cleaning is needed will the seed company charge you for it?

• Always ask for a contract. It doesn't have to be elaborate but it should cover some basic details: crop variety, price paid per pound, minimum germination, isolation standards. And most importantly, read the contract several times and clarify details you don't understand or want to change.

• Play off your strengths as a farmer: your region produces the best kind of XYZ seed, your valuable farm experience, why organic seed production is important to you, etc.

- The relationships you cultivate with organic seed companies are just as important as your farming skills. It's important to know that you will be there for each other no matter what hiccups are experienced in that relationship. We all have the same desire — producing and distributing high-quality organic seed.



Pictured: A white board consolidates basic seed contract information to track progress when cleaning seed.

Seed Economics: Balancing Passion and Profitability in Seed Growing

Winston Oakley, Highland Economics; Karl Sutton, Fresh Roots Farm; Judy Owsowitz, Terrapin Farm; Steph Gaylor, Invincible Summer Farms; and Micaela Colley, Organic Seed Alliance

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Many farmers are drawn to growing seed for reasons other than financial gain. Witnessing the cycle of plant reproduction is fascinating. Seed crops can also provide diverse ecological benefits from pollinator habitat to crop rotations and landscape diversification. Many small- to mid-size diversified farmers start to grow seed to ensure they have access to varieties that work well in their environment or meet their market needs. Only select farmers are driven to enter into seed primarily as an economic opportunity. Yet all farmers must grapple with balancing the costs of time, land, equipment investments and market opportunities with the potential for return on investment. In addition to annual financial gain many farmers find seed crops a good way to diversify income, balance risks, and retain cash flow by providing an income stream in the winter off-season, when their market for other farm products is low.

Organic Seed Alliance, Highland Economics, and eOrganic have joined forces to support the economic success of organic seed producers. The team created an online Seed Economics Toolkit with support from a Montana Department of Agriculture Specialty Crop Block Grant. The toolkit provides online economic management tools that complement on-farm implementation, education, and outreach to help seed growers track their costs and improve their understanding of the economics of their own operations. Training farmers to assess their own costs versus income allows each operation to evaluate different production and sales scenarios whether they are selling retail, wholesale, or using seed for their own input on-farm.

In this workshop we provided a training on the seed crop enterprise budgeting tool developed by Highland Economics and then asked a panel of seed growers to share their experience and advice to other farmers considering entering into seed production. Lastly we asked them each to reflect on what additional tools, resources, or opportunities for collaboration might improve the future economic potential of organic seed production.

The Seed Economics Toolkit for Organic Seed Producers can be found here:
https://eorganic.org/node/25243

Download the Enterprise Budget Tools here:
https://seedalliance.org/publications/seed-enterprise-budgeting-tool/

Winston Oakley, Highland Economics

The Organic Seed Enterprise Budgeting Tool was created by Highland Economics, under contract with Organic Seed Alliance, to capture, analyze, and summarize growers' production costs and revenues. The tool consists of a Microsoft Excel workbook that utilizes User Forms, which allow the grower to quickly and easily input information on their production costs. Once a grower provides the required information, the tool automatically organizes and records their responses. It also analyzes and summarizes the information to provide useful insights on the grower's operations.

To use the tool, growers provide basic information on their operation for a single crop. The required information includes the size of the production area, the type and volume of crops produced, prices received for those products, labor needs and costs, equipment used in the crop's production, description of activities involved in production, along with the amount and cost of inputs utilized. Once submitted, the tool automatically generates summary tables, which include a visual display of when all production activities take place over the year (called a Gantt chart) and tables that report production costs and revenues in the form of an enterprise budget. These cost and revenue summaries are generated both for the production area as a whole and converted to a per-acre basis, which is useful for comparing different crops, management practices, or other production variables. Once complete, the file can be saved and used by the grower for future reference and can also be emailed to Organic Seed Alliance, where it will contribute to a better understanding of organic seed production economics.

Steph Gaylor, Invincible Summer Farms

Our farm is relatively small scale. We farm between 10 - 19 acres a year and have several pursuits that support our seed work. Optimally, these should also reflect a diverse model for financial sustainability. Invincible Summer Farms is a fresh production farm and we sell wholesale to high-end restaurants and large restaurant groups in New York City. The seed production side of the farm regenerates rare seeds highlighting small independent breeders as well as our own varieties. Building relationships with chefs is time consuming, and requires care and dedication to make that relationship work. However, the relationship affords the grower, and the restaurant, a great deal of latitude in rolling out new and novel varieties. In that seed work we also have a small seed company where we sell online. Lastly, I run Long Island Regional Seed Consortium, a "no-profit" organization that does a wide spectrum of initiatives.

Advice to other seed growers:

1. Assess your particular demographic, and also other growers' demographics, in order to determine needs and limitations. Assessment of needs should be done both anecdotally and in situ.

2. Use ethical partners, and have clearly communicated expectations and stated agreements, and build the relationship over time. Determine within your demographic what a fair relationship looks like. This is probably one of the biggest obstacles I have observed working competitively in several markets.

3. Don't pay for anything you don't need. While in the minority, some agreements will prey upon ignorance or naiveté. Whether this is a lease, for equipment, or inputs — the result is the same insofar as you are reducing any profit you might make.

4. Be realistic in terms of what profit actually is versus what it potentially might be.

5. Lastly, don't make farm decisions in January or August.

In my experience, farmers are relatively isolated due to workload and there is little time for much else. For seed producers that is even more so. That isolation and workload has the tendency to limit creative problem solving in a system that is rife with challenges. Many of these

challenges are fundamentally rooted in the lack of compensation. Working within a social network increases the chances of profitability. These networks can begin to coalesce possible solutions to wide-ranging problems that seemingly vary across demographics. In one instance, it may be forming a collective for using necessary equipment and in another it might involve education to consumers.

However, irrespective of the specific type of seed work, there is a collective need for a shared general philosophy and code of ethics in order to strengthen financial sustainability, community, and biodiversity.

Judy Owsowitz, Terrapin Farm

Organic seeds are integral to the organic farmer. Hopefully, sometime soon, we will have the demand, and the supply, to meet that demand, for 100% organic seed for organic certification. With that thought in mind, I believe it is the responsibility, and the privilege, of all organic farmers to maintain and improve at least a few seed varieties. While seed production at Terrapin Farm is not a major part of the revenue generation, it is an important part of the farm program. Out of the 40+ years of my farming, with 25 years certified, there has been an element of seed work for 30 of those years. This was initially due to the loss of varieties appropriate for our short (sometimes 60+ days) frost-free season. As time went on consolidation in the seed industry led to the loss of morally acceptable available seeds, necessitating more participation on the part of our farming community.

We have been farming on approximately 7+ acres of sandy soil, with over 1 acre of seed production integrated into the system. Some production is outdoors, while some is in hoop houses or high tunnels for both isolation and season extension. Seed work can keep us busy cleaning and packing when we are primarily done in the fields. It can supply cash flow in an otherwise leaner time of year.

In considering seeds as part of your system, there are many factors to keep in mind. Some of them are outlined here:

1. Start small. Be sure you can grow that crop before you contract to do so.

2. Grow what you love (and does well in your climate).

3. Will it limit your other crops? (i.e., pepper heat can cross into sweet peppers in the first year)

4. What are your neighbors growing? (GMO canola?)

5. Match your scale of equipment to your scale of production.

6. Failure happens. No matter how good a farmer you are. Keep a reserve of your seed variety to rebuild if necessary.

There are some excellent books and resources available, but we need more. Organic Seed Alliance provides us with much needed research and information dissemination. We also need more avenues to share things as we learn. We do not all need to reinvent the wheel simultan-

eously. We at Terrapin Farm are a part of Triple Divide Organic Seeds Co-operative. It is not the major market for us or for many of our members at this point. We do hope it will get there! We have cooperatively owned equipment, but at the scale at which most of us grow it does not merit driving the miles to access it. There is considerable work to getting seeds ready to leave the farm. After that there is still a great deal involved in getting them to the consumer. The seed packets sold 4 packs for $1 in the grocery store do us an immense disservice. Many customers don't understand the difference between those cheap seeds and regionally adapted, organically grown seeds. Consumer education about quality food production as a whole, and seeds in particular, falls into our lap.

Karl Sutton, Fresh Roots Farm

Fresh Roots Farm is located in western Montana. We began producing certified organic seed on contract in 2013 with one 100-pound bean contract. In 2020, we have grown our production to about 2.5 acres and $35,000 - $50,000 in contracts. Our primary production is dry-seeded cool and warm season crops with the occasional warm to hot season wet-seeded crop. Most of our plantings range from 1,000 – 2,000 bed feet.

We participated in the enterprise budgeting project with the intent of better understanding what crops were most profitable in our farm system and to use the information to better negotiate contracts and evaluate systems that can bring efficiencies to our farm. We chose to primarily focus on crops that we have grown for several seasons and wanted to include both an annual and biennial crop. In 2018 we evaluated the production costs of lettuce and beets, and in 2019 we evaluated the production costs of three vegetable seed crops, lettuce, beets, and carrots, and one flower seed, bachelor buttons.

We gathered our information using our farm cell phone. We recorded major activities by taking photos, using the phone stopwatch and emailing the information to a farm record email account. We entered the information into the enterprise budget tool at the conclusion of the season. We have found the tool to be relatively easy to use, and once baselines are established for certain fixed costs, we found it easy to add crops to analyze.

We were pleasantly surprised by the net returns for most of the crops we analyzed. In 2019 we had a cold wet June, but a typical dry July through fall season that produced a good yield of lettuce resulting in a per acre net revenue of $33,089. Similarly, our beet crop produced a per acre net revenue of $30,370. In 2020 we were challenged by an extremely late spring, cold wet summer, and uncharacteristically wet and cold fall. The weather challenges created a poor yield in both the lettuce and beet crops. Lettuce generated a net revenue of $8,601 and beets $20,196. Despite our low yields the beet and lettuce crops proved to show some economic resiliency for us in a challenging growing season. Bachelor buttons, on the other hand, yielded extremely well for us in 2020 but only netted $11,152 per acre. Based upon the numbers, bachelor buttons are a crop that we can find success with but will need to negotiate contract prices that bring the net revenue up to a total more comparable to other crops we grow.

Les Refardes: Heirloom Seeds, Produced Locally

Ester Casas Griera, Les Refardes

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Les Refardes is a non-profit cooperative started in 2005 situated in Mura, Barcelona, Europe. Its main purpose is the promotion of cultivated biodiversity, mainly through artisanal production and the sale of organic seeds of local varieties from Catalonia. Les Refardes involves as many local stakeholders as possible to slow down the genetic erosion through the reintroduction of a wide range of local crop varieties in food and agriculture.

The main objectives

Les Refardes works to reintroduce a broad range of plant genetic resources into the agri-food system that are at risk of extinction. In this way, professional and amateur farmers, nursery owners, cooks, nutritionists and consumers can know and use them. These cultivars have been prospected from traditional farmers mainly from Catalonia that had preserved and selected them for generations. They have offered both their plant genetic resources and farmer knowledge associated with the handling and management of those resources. Thanks to these collaborations along with participatory morphological and organoleptic description works, Les Refardes currently has seeds from approximately 500 varieties of 66 different species.

Les Refardes has also emerged to provide solutions related to the lack of supply of organic seeds in Spain. This is done as a response to a big paradox. In a country rich in agricultural biodiversity, the organic seed offerings are mainly done by conventional, relocated seed companies offering mostly hybrid or intellectual property or patented varieties.

Thus, the cooperative is a pioneering initiative, authorized to produce organic seeds, and also responsible for the expansion of the organic seed supply through the introduction of heirloom varieties into the "database of organic seeds and reproductive vegetative material" managed by the Spanish Ministry of Agriculture, Food and Environment (see: https://www.mapa.gob.es/app/EcoSem/ListadoSemillas.aspx?idPro=39&idEs=-1&idPa=-1).

Les Refardes is working to strengthen and expand a network of 18 farmer-collaborators and producers of organic local seeds that already cultivate and distribute local products. The goal is to introduce as many local varieties as possible into production and then on to consumers. For that to be happen, cooperative coordination needs to take place, in order to offer the seeds produced by the network of farmers to a greater audience.

Les Refardes is an open and collaborative project that has served and still serves as a methodological example for the development of professional use of local crop varieties in Spain. Initiatives from different regions, most of them involved in organic and agro-ecological production, found in Les Refardes an example to follow and a place to receive productive, administrative, and commercial advice and consultancy. In this way, this initiative has had a dynamic and multiplier effect and its success and development has a positive impact on the generation of local agri-food collective networks working on the efficient and sustainable use of plant genetic resources.

Les Refardes organizes and collaborates in workshops, courses, and technical conferences aimed at farmers, technicians, and consumers, addressing matters related to the production of seeds and valorization of the local varieties. It also participates in a great deal of training and advocacy, working with key stakeholders who work on issues related to the dynamic management of plant genetic resources on both theoretical and practical levels.

The cooperative connects to participatory research through a quarterly Open Doors Day. On these days, professional farmers, amateurs, restaurateurs, food distribution professionals, and consumers participate in the creation of information about local varieties as: characterization works, visits to the seed production gardens, tastings of different varieties of species cultivated in each season, a place to exchange seeds and information among the key stakeholders, theoretical and practical workshops about seeds and seedlings self-production, and more.

Alliances

Since its outset, the cooperative participates in and belongs to other local, national and European organizations. On a local level the Catalan Seed Network, is a federation of 11 community seed banks created in 2004 to promote the production and consumption of local varieties as well as seed exchanges (see: https://graners.wordpress.com). On a national level there is the Red de Semillas "Resembrando e intercambiando," created at the end of the 90's (see: www.redsemillas.info). This is a decentralized network of a technical, social, and political nature, which aggregates 25 local seeds networks scattered all over Spain. The setting up of relationships with networks and groups at a local, national, and international level and the appreciation from others as an expert group in the analysis of the legislation and public politics that affect agricultural biodiversity were other achievements. At the European level, Les Refardes takes part of an artisan seeds micro-enterprise network called Croqueurs de Carottes, which consists of 7 artisanal micro-enterprises of organic seeds.

Structure and finances

All the activities done by this cooperative are developed currently by 4 working partners (Ernest, Paula, Anna, and Ester), with the same salary and are in charge of: the seed production (planning, field work, sanitary control, agronomic, and organoleptic valuation); accompaniment and invigoration of the farmers-collaborators network, communication, training and networking; trade channels, accounting management; post-harvest duties; germination controls, seed cleaning, packaging, and placement of orders.

Production and processing

The farm where 60% of the seed production is done is at an altitude of about 500m in the tiny town of Mura, Barcelona. The gardens have optimal conditions for plant propagation: it is isolated from others that could entail a contamination risk, especially of cross-pollinated species. It also has a clay loam soil, slightly basic, with humid continental climate and very low temperatures during winter time. It is the only farm in the growers network fully dedicated to seed production.

The other 17 farmers have been adding slowly to the cooperative looking for a complement to their incomes through seed selling, or searching suitable locations with specific climatic needs to multiply the varieties and also to facilitate the multiplication of cross-pollinated species. They are mainly dedicated to organic vegetable production, and all of them value their products throughout direct selling into local markets, consumers groups, and cooperatives. This farmers are progressively being trained and empowered to become self-sustainable with seeds.

The network is coordinated by Les Refardes, which plans the production and joins the visits to the properties, looking for good selection and optimum seed health. Once a year we meet all the seed producers to evaluate the campaign, agree on the seed prices, remind them how it should be delivered, which varieties should be multiplied, address technical troubles or successes, and more.

The warehouse where the seeds are processed (cleaning, sieving, germination testing, packaging, and selling) and stored is in the same town of Mura, Barcelona. Also available is a seed storage chamber with optimal conditions of temperature and humidity.

Through a Vegetal Protection Association, which the cooperative is a part of, sanitary tests have been done to all the seeds from the core collection to control the virus, bacteria, and fungus.

The commercialization

Les Refardes mostly commercializes the seeds directly to markets, fairs, or via the web (see: www.lesrefardes.coop). Most of the seeds (86%) are sold in the region of Catalonia, and the rest mostly in neighboring regions. Seventy percent of its customers are amateurs, 25% are professional small farmers, and the remaining 5% are organic nurseries.

Currently, we are practicing civil disobedience, since 70% of the varieties we offer are not in the government's officially accepted catalogue of varieties.

Going to the Roots of Crop Diversity

Phil Simon, USDA-ARS, Vegetable Crops Research Unit, Department of Horticulture, 1575 Linden Drive, University of Wisconsin, Madison, WI 53706

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Genetic variation is the engine that drives plant breeding, and with that, the development of new cultivars for crop improvement. The diverse sources of that variation include new combinations of variable genes in recently developed and heirloom cultivars of a crop from all global production regions, as well as genetic variation in crop wild relatives and cross-compatible crops. The breadth of genetic variation collectively held by cultivars grown at any given time embodies only a small subset of the variation found in those diverse germplasm sources, and much of the full breadth of variation is not necessarily of immediate interest in any ongoing breeding program at a specific time. But the plant breeding community has realized and demonstrated that variation within that full breadth of genetic diversity can provide highly valuable, often untapped sources, of genetic variation — for resistance to impending biotic and abiotic threats to production, for the development of new breeding systems (e.g., cytoplasmic male sterility and haploids to develop hybrids), and for the development of new plant products and even new crops.

Recognizing the potential value of diverse germplasm, the need to collect, maintain, characterize, distribute, and utilize as much of that natural genetic variation as possible has become recognized to be essential to sustain current and future crop improvement. The processes involved in mobilizing the agricultural and ecological scientific communities to protect and collect crop diversity are not simple. They involve not only scientific expertise and action but also social and political sensitivity and engagement to be successful. But progress is being made.

Collecting Plant Germplasm

An appreciation for the high value of plant germplasm has had a prominent role in U.S. history going back to our founding, and today the USDA-Agricultural Research Service National Plant Germplasm System (NPGS) oversees the collection, maintenance, and distribution of plant germplasm for the U.S. (Byrne et al., 2018). The USDA-ARS annually invites plant exploration proposals to collect and exchange germplasm through its National Germplasm Resources Laboratory (NGRL). Collecting expeditions abide by the NPGS Code of Conduct for Plant Explorations principle of national sovereignty over plant genetic resources recognized in the U.N. Convention on Biological Diversity (Williams, 2005). Under these guidelines host countries are closely involved in all planning and collecting, and a portion of each accession collected is left with the host country. Information about collecting proposals is best obtained through Crop Germplasm Committees (CGCs) described at GRIN, the Germplasm Resources Information Network (http://www.ars-grin.gov/npgs/).

There are currently 43 CGCs, each with a focal crop, or collection of crops. Current CGCs include Crucifers, Cucurbits, Leafy Vegetables, Phaseolus, Root and Bulb Vegetables, Tomatoes, and Vigna. CGCs develop crop vulnerability statements that describe threats to food security and include a summary of resources available (i.e., the numbers of taxa and accessions available

for distribution). CGCs also develop descriptor lists used to describe germplasm in the collection (e.g., flowering habit, fruit shape, and color for each accession), and they provide technical support for curators of germplasm collections held by the USDA.

If you are interested in collecting germplasm it is best to work through the appropriate CGC to identify germplasm deemed to have a high priority for collection based upon factors such as low representation in the collection, or vulnerability of cultivated or wild populations that might be lost. Once a proposal is approved for funding, which covers travel costs, it takes several months for the NGRL to establish arrangements for collecting and importing germplasm to be collected in international expeditions. All germplasm collected is delivered to the NPGS where it becomes increased, as needed, and freely available to those requesting it, with no restrictions for use, beyond those conditions of agreements signed with the host country. For example, under the International Treaty for Plant Genetic Resources for Food and Agriculture, national authorities may choose to provide access to the germplasm under the terms of the Standard Material Transfer Agreement described in the Treaty.

Germplasm collectors use published flora for the region in which they are collecting to locate wild germplasm and they rely upon collaborating local scientists accompanying them on expeditions to locate not only local seed markets, but also local farmers, gardeners, and herbalists willing to share germplasm. Like many farmers who produce their own seeds in the U.S., farmers in the rest of the world are often eager to share germplasm they have maintained or developed. While not as dramatic as plant collection by naturalists like Charles Darwin, or as challenging and tragic as germplasm collection by Nicholay Vavilov, germplasm collection is a thrill for plant enthusiasts today. Beyond the NPGS program, other international organizations such as the Millennium Seed Bank of Kew Royal Botanical Gardens also collect plant germplasm.

Maintaining, Characterizing, and Distributing Plant Germplasm

Beyond germplasm collection, a significant component of the NPGS effort is the maintenance of its collection of over 575,000 accessions from over 15,000 plant species, and distribution of over 250,000 accessions each year (Byrne et al., 2018). Samples of accessions can be requested through the GRIN website. The database for accessions includes collection information such as collection site and date, and basic plant description. Detailed descriptions for traits of interest to plant breeders, such as disease resistance, are not able to be generated by germplasm curators. Without this type of information, germplasm requestors have little to base their decisions on about what accessions may be of interest, so one task of CGCs is to identify researchers able to characterize key traits of interest. Funds to support characterization are available though many CGCs annually and that data is archived in GRIN to stimulate germplasm utilization.

The National Plant Germplasm System is a formal, structured source of novel and diverse germplasm which is available to users through the complicated and time-consuming, but very rewarding, process of collecting expeditions. It is also available through the very simple and convenient process of requesting seed through GRIN. No particular training or experience is required to participate in collecting expeditions or in CGCs, and participation is encouraged.

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Developing Modern Landraces

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Summary

Modern landraces are a viable option for reliably growing food in difficult and ever changing conditions, and for conservation of biodiversity.

Setting for Project

I started breeding crops for my own farm, because I live in a difficult ecosystem: high-altitude mountain valley, short-season, cold-radiant cooled nights, sun-drenched, super-arid, silty high pH soils, ~100 frost free days. The crops that most easily adapted to my farm are modern landraces: genetically diverse, locally adapted, and promiscuously pollinating. I choose organic methods to avoid poisoning myself and loved ones, and subsistence methods to minimize input costs and externalities.

Method

The essence of a landrace is that it is genetically diverse and adapted to the local ecosystem and society. My most successful landraces have been community efforts, where many people in the community are growing the landrace, saving seeds, and swapping the seeds with other members of the community, even adding genetics to it on an ad hoc undocumented basis.

A simple way to develop a landrace is to plant a number of varieties together, allow them to cross-pollinate as much as they will, and then repeating year after year, allowing a combination of natural selection and gentle farmer and community selection to move the population toward better local adaptation and more reliable productivity. My landrace development projects generally start with between 5 and 200 varieties.

Another easy way to develop a local landrace is to import a landrace from far away, and then allow the genetics of the population to shift over the years to match local growing conditions and social norms. I particularly enjoy swapping landrace seeds with people from far away where the ecosystem is somewhat reminiscent of that at my farm.

Observations

I call the third year the magical year in landrace development. By the third year, the types that do poorly have tended to die out, and the types that do well under local conditions have crossed with each other. Landraces are most quickly developed in more promiscuous populations.

Any species that has any crossing at all can eventually turn into a landrace. I watch for naturally occurring hybrids in the mostly inbreeding species, and plant them separate, so that there are more opportunities for genetic diversity. By saving seeds preferentially from natural hybrids, I

am selecting for offspring that are somewhat more promiscuous. I may also make manual hybrids with the mostly inbreeding species to quicken the rate of local adaptation.

Successes

By selecting for varieties that thrive under local conditions, flavor can be amazing. Landraces tend to be highly resilient, because they have so much genetic diversity that some family or other does well in spite of growing conditions, pests, diseases, or a farmer's errors. It's really rewarding for a plant breeder when a neighbor says, "Thank you, this is the first time that cantaloupe ever got ripe for me." It's really nice to be the only farmer at market that can grow certain species. It's lovely to be able to grow without -cides, fertilizers, or other inputs.

One of the great joys of landrace style growing is that worries about seed purity, isolation distances, and "doing it wrong" are greatly reduced. People can participate in the joy of growing, without fussing about technical details. It's really nice to only select for traits that matter like productivity and flavor, while allowing all other traits to be whatever they happen to be.

Broad community participation in selecting which parents to include in the landrace, and which to save for seed, really helps a landrace to become part of the local community.

Difficulties

By including too much genetic diversity in the original plantings, we have sometimes introduced non-preferred traits such as bitterness in cantaloupes or exploding watermelons. Clientele may have to be trained that a round butternut tastes exactly the same as a necked butternut.

Gratitude

I'd like to express gratitude to: the plants, Earth, sun, water, soil, and life in general. World Tomato Society for covering my travel expenses to attend this conference. Rocky Mountain Seed Alliance for finding me and getting me off the farm. The Open Source Seed Initiative for inspiration and wisdom. Alan Bishop of Pekin, Indiana for my first landrace seeds, and for teaching me about the value of growing genetically diverse crops. My current collaborators, and ten thousand years worth of illiterate landrace plant breeders that domesticated every variety that I currently grow.

Shaping Diversity for On-farm Organic Plant Breeding of Wheat (and Other Cereals) in France

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Summary

Organic farming needs diversity at all levels and especially in seeds. However, in Europe, for main crops, varieties marketed are very homogeneous because of seed regulation. Some organic farmers and researchers, working together through participatory research programs, create genetically diversified populations through different strategies to stimulate local adaptation.

We propose to present examples developed by farmers and researchers to shape diversity for on-farm breeding.

Two main strategies are used to create diversified and dynamic populations: mixing and crossing varieties.

"Mixing" can mean at least 2 things: 1) mixing different varieties known to have complementary characteristics (those characteristics are evaluated over years), or 2) starting from a great number of accessions (with very little knowledge of each) and mixing them according to common and useful basic characteristics (chosen according to the context of the farmer).

“Crossing," the other strategy presented, can be done with 2 (bi-parental crosses) or more varieties (Composite Cross Populations), increasing diversity while increasing the number of parents.

We will give two examples of on-going experiments to foster on-farm breeding for diversity: the COBRA experimentation, comparing a dynamic population and a CCP created with the same parents, trying to answer farmers’ questions about the differences of the two strategies; and the creation of so-called “DOP” (Diversified Oriented Populations) composed by researchers of numerous accessions from gene banks, but with common characteristics asked by farmers.

If the results of the COBRA experimentation are difficult to use at the moment, DOP meet a certain success.

Organic farming needs diversity at all levels and especially in seeds. However, in Europe, for main crops, varieties marketed are very homogeneous because of seed regulation. Some organic farmers and researchers, working together through participatory research programs, create genetically diversified populations through different strategies to stimulate local adaptation and increase their empowerment.

Two main strategies are used to to create diversified and dynamic cereal populations: mixing and crossing varieties. Those 2 strategies can be applied differently according to the actors and their contexts (farmers, researchers, type of relationship between them, and means available).

We will give an overview of the different forms of both strategies that exist in France across the farmers' seed networks for cereals, and then present 2 research experimentations aimed at supporting on-farm breeding for diversity.

In this paper, we will use the word "population" instead of "variety." Indeed, in France, the word "variety" preferably refers to commercial varieties that are stable and homogeneous, maintained to be always the same. It is not the "spirit" of farm varieties we describe (even when they are single and not mixed or crossed) that are diversified, "open pollinated," fostering evolution. This is why we will use the word "populations."

On-farm Breeding Practices for Diversity

Different strategies are developed by French farmers to create genetically diversified cereal populations (autogamous species), adapted and adaptable to organic farming, territories and practices. On-farm breeding is often done in collaboration with researchers, and farmers are often gathered in seed associations, doing participatory research and plant breeding.

Mixing and crossing are two strategies developed on-farm to increase diversity in the populations, including different practices for each, according to the context.

Mixing strategy: a lot of farmers breeding cereals on their farm create population mixtures (Dynamic Populations — mix of different populations harvested and re-sown every year) in order to increase the level of diversity of their populations, and foster their natural adaptation. They mix from 2 to numerous varieties/populations, having different and complementary known characteristics or not, they mix on purpose or randomly.

Some farmers have real "varietal screening platforms" on their farms. They precisely study a lot of populations and often choose to create dynamic populations with populations they know well, and with a specific objective. Others often create an enormous mix of all the reaming seeds of the platform, creating randomly a very diversified and evolving population (maintained in natural selection). However, dynamic populations can also be created by "occasions;" a farmer receiving different populations from another one but losing the names, as an example, or the impossibility to harvest different populations being multiplied separately. Mixing practices depend also on the seed quantities available on the farm at a specific moment. Thus, there exists a large panel of mixing practices.

Crossing strategy: In order to generate new diversity and be able to select within this new diversity, some farmers create bi-parental crosses in collaboration with researchers. A larger number of populations can be crossed (Composite Cross Populations - CCP), but this practice is done by researchers only because it is very time-consuming. However, some farmers are interested in this. In France, an "old" wheat CCP from INRAE is circulating in some farms, and in Italy, this practice met a certain success through the work of Salvatore Cecarelli in the recent years. The number of varieties and schemes chosen for the crosses give an infinity of possibilities for creating such diversified populations.

Complementary Research Works to Support On-farm Breeding for Diversity

The existence of both different strategies to increase population diversity and the large range of practices to create them stimulate questions and debates among farmers and researchers in France, raising different questions. This situation led the INRAE-ITAB research team to build up two experiments to support on-farm breeding for diversity (through European research projects – currently LIVESEED project).

The COBRA experimentation – CCP vs. Dynamic Population

Some farmers think that mixing populations is sufficient to increase cereals diversity and that crossing is too intrusive of a technique. They rely on a natural crossing rate and collaboration between plants to create new diversity and adapt to the context. Some others think that crossing will increase breeding potential because of the high level of recombinations, increasing adaptation.

In order to explore these two hypotheses, an experimentation was built by the INRAE-ITAB team, aiming at identifying the differences between the two strategies of mixing and crossing, comparing the evolution, level of diversity, processing quality, and more of a CCP and a Dynamic Population, and the importance of different factors (place of cultivation, human selection).

Diversified Oriented Populations (DOP): "starters" for on-farm breeding for diversity

On one hand, we notice that there is a lot of accessions (landraces, varieties, etc.) conserved in several gene banks, but they are neither cultivated anymore nor described, while they could add value to organic farming through on-farm breeding. On the other hand, there is an increasing demand for "old varieties," landraces or organic adapted and diversified populations from more and more farmers in France, but most of them don't have the option to cultivate a lot of populations individually to start on-farm breeding (very time consuming). In front of this analysis, our INRAE-ITAB research team decided to build a bridge between those farmers and accessions, creating "Diversified Oriented Populations:" mixtures of various accessions with one or different common phenotypic characteristics asked by farmers (with agronomic or any other kind of interest). With this proposition, the idea is to give a basic diversified populations to farmers, diversity being a potential of adaptation, but with already some characteristics known, in order to speed the breeding process and foster the adoption of diversity quite rapidly and at a large scale. This practice allows the mixing of a lot of accessions, not completely randomly but not completely complementary (on certain phenotypic characteristics only). We started to create DOP with rivet wheat and have already distributed some for 2 years.

COBRA experimentation, need of a magnifying glass to see changes

Method

A Dynamic Population and a CCP of bread wheat were created in 2013 with the 6 same parents (French landraces from a gene bank, amplified and observed for several years by a farmer with a big varietal platform). They were chosen because they were adapted to the farmer's place and different from the other (in order to maximize the diversity). Thirty crosses were realized (each

population crossed with the 5 others, as male on one hand and as female on the other hand) in the field at 2 INRAE research stations. The seeds of the 6 parents were mixed in equal quantities to create the Dynamic Population.

Both populations are multiplied in natural evolution (re-sowing a part of the harvest) in 2 locations (2 regions of Western France) since the third year after their creation. In 2018, a farmer realized a selection in both populations in one place and 2 bakers did the same in the other location. They have been maintained in natural evolution since then. Each year, phenotypic characteristics and yield components are observed in all of the populations (10 populations from 2019). Not only means are calculated but diversity is evaluated through graphics, BoxPlots, and PCA for quantitative characteristics, graphics, and Nei Index for qualitative characteristics.

2019 results

We can draw two main outcomes from 2019 observations, but they are highlighted by statistics and differences are hardly visible in the fields:

- The factor that mainly impacts the populations is the human selection, then the location, and finally the breeding strategy. This conclusion was obtained by listing the characteristics affected by each factor. The factor "human selection" shows the most important number of changes in the populations, then the cultivation location, and finally the breeding strategy. This elaboration of the results was done at a global level from graphics and PCA schemes and relies on human observation. It doesn't take into account the interactions between all the factors (groups of comparable populations were done to evaluate each factor) and can of course be improved.

- The human selection done on the populations globally conserve diversity. Farmers and bakers who have done it are concerned by diversity and we can observe that their selection, while emphasizing certain traits, conserves the global level of diversity.

The fact that the two breeding strategies don't seem to express real differences is quite surprising to us. However, we only look at "visible" characteristics and have not yet explored quality, processing, or organoleptic ones. This will be done in the future.

The results might also be different according to the number of parents used to create populations, and this would need an experimentation at a larger scale.

To answer the farmers' questions, some years of research will still be needed!

<u>DOP, promising beginnings</u>

Method

Knowing that in the gene banks, accessions are highly numerous, genetically homogeneous (because of in situ conservation) and poorly described, and that very few seeds are provided when asked, we elaborated the DOP methodology to foster the spreading of this unused diversity in the farms.

The creation of DOP requires different steps once the species to work one is chosen:

- Gathering information on the species history, cultivation, uses, and breeding (including the history of breeding, which is very important to be able to choose adapted accessions).

- Listing the diversity available in the gene banks.

- Choosing and gathering accessions (according to the information available in the gene banks, the IFOAM guidelines about acceptable criteria for breeding techniques, and the means available to cultivate small plots of numerous accessions).

- Multiplying and observing all the accessions individually for 2 years at least (to strengthen observations and amplify the seed amount).

- Creating diversified and personalized populations (or DOP) according to the farmers' requests scheme and distributing them.

- Ensuring a follow-up of the dynamic evolution of the populations on farms and evaluating the performance of the methodology through farmers' satisfaction and observation of the populations in situ.

We started this experience in 2016 (gathering information and seeds) with rivet wheat because there was a demand from several farmers among the different seed associations of the farmers' seeds network (RSP - Réseau Semences Paysannes) in France. Multiplication and observation (more than 25 traits observed) of more than 170 accessions from a Spanish gene bank lasted for 2 years (2017 and 2018), and DOP were distributed in 2018 (just after harvest) and 2019 with remaining seeds.

Results

This first experience is quite promising to us. Indeed, from 172 accessions multiplied for 2 years, 157 of them were distributed in 2018 (included in DOP) and some that were not part of DOP in 2018 took part of new DOP in 2019. In 2018:

- 29 different DOP were created

- 24 traits were asked to create DOP (from 1 to 4 traits per DOP)

- there were about 30 accessions (3 to 77) per DOP

- 23 farmers asked and received DOP (1 to 9 per farmer, 44 samples distributed)

In 2019, we had new demands, increasing this list.

We also asked information about the behavior of the populations received last year and globally the farmers said that the populations corresponded to the characteristics asked, so it is a first encouraging result. We would like to have a look at the different populations evolving in their specific contexts and ensure a follow-up. We still have to work on this aspect (human and financial means). Another return is that farmers would like to have bigger quantities than those received (they received 20 to 200 grammes and it is quite difficult for some of them to start from

so few). Then we will need time (years) to measure the adaptation of the populations in the farms (in natural evolution and/or submitted to farmers selection).

Aware of the demand for spelt and oats, we have to start the multiplication of a panel of accessions for these two species and hope to increase the number of species in the following years. Indeed, there is still a lot of accessions in the gene banks to "liberate," and so many cultivated species to diversify. As an example, demand is starting for forage and we are starting to adapt the DOP methodology to alfalfa which is an allogamous and perennial species, obliging us to think about new strategies again, enriching the "bank of possibilities" by facing new challenges.

To get diversity in the fields, we observe diversity of strategies, due to diversity of contexts and possibilities with the farmers. In participatory research, researchers usually "answer" farmers' and other actors' questions. This is the case for the COBRA experimentation, in which we try to identify the differences between 2 breeding strategies for diversity. For the time being, we only see very slight differences between them and still need to explore other traits than agronomic ones. We hope that further research on these experimental populations will bring elements to farmers to guide them in their breeding choices. Complementary to this work, from our knowledge of the genetic resources context (a lot of accessions available but not cultivated) and the increasing demand for diversity on the farms, we decided to propose a new concept of populations with the DOP to stimulate the adoption of diversity (the farmers not being the starters of this experience, but involved after) and we observe promising results, with good returns from the farmers, encouraging us to continue and to think further about the development of this idea.

These two examples of research show that diversity is required in participatory research and breeding approaches to foster diversity on the farms.

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Can Crowdsourcing Technology Transform Collaborative Testing?

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In response to very centralized and controlled breeding/testing, multiple collaborative testing initiatives have grown in North America, Europe, and developing countries led by universities, non-profit organizations, seed banks, and emerging regional private seed companies. Collaborative testing has many advantages, such as being closer to real use conditions, engaging end-users directly, and empowering farmers. These networks can also lead to better adoption of newly released varieties. However, they can have weaknesses, including logistical challenges in organization, data collection, sharing results, and making advancement decisions. Through this session, we reflect on what has been done over the last 20 years in terms of the methods used (trial design, data collection, information sharing, etc.); evolution in stakeholder engagement (farmers, breeders, chefs, gardeners, consumers); and scale (number of participants). We present some developments in crowd-sourcing data and online platforms that may help simplify some of the logistical challenges of participatory research as well as allow for more efficient experimental designs in on-farm research.

2019 SeedLinked Platform Beta Test

Our goal is to demonstrate that crowdsourcing variety performance aggregated by farmers and gardeners via web and mobile platforms can predict performance as well as, or better than, conventional trialing.

The SeedLinked platform has two target audiences: 1) vegetable growers (small farmers and gardeners) and 2) trial managers (e.g., seed companies, universities, non-profit organizations, and farmer organizations). In 2019, we had 326 farmers and 535 gardeners on the platform. Population group/age: 30% of users were in the 35 - 44 year old group and 26% in 65+ years old; 62% of participants were female (Mailchimp analytics, 2019). In 2019, we had 28 trial managers use the platform to conduct 57 vegetable performance trials. Seed banks, universities, non-profit organizations, and seed companies were excited to use the platform to help better manage and execute vegetable performance trials.

Adoption and participation

17,932 single reviews were submitted into the platform across 37 states/regions in the U.S. and Canada by 620 active growers.

Participation rate (people who fully reviewed and completed a trial vs. total people who initially began the trial) ranges from 48% to 70% depending on each specific trial manager's network/organization of growers. On average, farmers have a 10% higher participation rate than gardeners. We also saw noticeable differences across crops, with some crops being more difficult to grow and review. Tomatoes and lettuce were the most successful with 72% and 81% trial success and completed review. Carrot and cucumber were the most challenging with 52% trial success and completed review. In comparison, in 2018, an organization that was using paper data sheets had a very low response rate for their trial at the end of the season. The trial managers

spent countless hours calling farmers to ask them to complete the trials, which increased trial success and completed review rates to 59%, although the increased time reaching out to participants delayed trial results reporting. The trial managers also spent a lot of time typing responses submitted on paper, interpreting handwriting, and standardizing terminology for analysis, which delayed results reporting further. This meant that results were available only after the point where most farmers had purchased seed for the following season. With SeedLinked, data is collected in real time and results are shared when a trial is completed allowing growers to make data-driven decisions when deciding what varieties to grow in the next growing season.

Appearance was the most frequently rated trait by gardeners at a response rate of 75%, while yield and harvest date were the least frequently rated at 54%. Vigor, disease, flavor, marketability, and earliness averaged 64% completed rates for gardeners. The trend was the same for farmers. However, gardeners completed appearance ratings at a higher percent than anything else. Disease resistance appeared harder for gardeners as completion rates dropped for this trait.

Testimonials:

Erin, farmer: “If you are not already using the SeedLinked app I highly recommend it. I have an old apple phone and downloaded the app yesterday and it is so user friendly, intuitive, and pretty.”

Dan: “It's quite easy to use”; Lisa “Initial information provided was terrific.”

Mary: “I loved having one digital place to enter all data.”

Rob: ”SeedLinked has drastically improved the way trial results are recorded. It’s very easy.”

Mark: “I liked using the app for uploading photos in the field. It made it really easy to complete the trial without writing anything down.”

Bill: “I was able to enter data through the season as I collected it.”

Discriminative ability by crop:

We determined the discriminative ability, defined as the number of varieties that can be statistically distinguished from the best variety ($p < 0.05$) using PlackettLuce coefficients, closer to one the better.

Basil had the highest discriminative ability (0.75) followed by snap bean, lettuce, and corno di toro peppers (0.60 to 0.67), then carrot and tomato (0.46 and 0.40, respectively). Finally snow pea, Asian cucumber, and bell pepper had the lowest (0.31, 0.25, and 0.2). Cucumber was very much impacted by the cold weather, which created a lot of variability unaccounted for simply by variety type. Different ranges of genetic variability within a trial also impacted the ability to discriminate among varieties within the trials.

Discriminative ability by trait

Individual trait difficulty was assessed by subjecting ratings to a Thurstone-Mosteller model, which allows for parameter effect size to be interpreted as mean performance intervals (the range of strong and weak performers within a rated trait); higher intervals indicate greater differences and easier assessment. Median intervals in the traits assessed ranged from 0.20 to 0.54 closely reproducing previous estimates ranging from 0.18 to 0.52 in Steinke et al. (2017), with an overall median difficulty interval of 0.27.

Overall, precision of traits across basil, carrot, corno di toro pepper, lettuce, bell pepper, and tomato, disease resistance and yield had the lowest agreement among observers. This result is exactly in line with Steinke et al. (2017). Vigor, appearance, and earliness were the easiest to review, similarly to the results of Steinke for plant architecture (eq to appearance) and vigor. Surprisingly, flavor shows strong agreement among reviewers and across crops. This confirms the results from the UW-Madison Seed to Kitchen Collaborative that, contrary to popular belief, flavor is actually a trait that shows consistency in chef evaluations. We validated that finding by doing crowdsourced flavor evaluations with two sets of reviewers (N=34 & N=17) for 6 red carrot varieties. Flavor rankings were identical in both evaluations. We found that flavor ranked second (very close to yield) in terms of trait utility for small vegetable farmers when deciding which varieties to grow. This highlights the potential of the SeedLinked platform to evaluate flavor preference.

For snap beans and snow pea we saw an opposite trend where yield and disease resistance had strong discriminative ability while appearance and vigor were in low agreement.

Finally, overall score (combining all trait ranking together) had the highest agreement across all traits and showed the highest correlation with RCBD replicated quantitative data.

Correlation (RCBD vs. Triadic)

Only Asian cucumber, carrot, and corno di toro peppers had both triadic collaborative trial and two locations randomized (RCBD) design trials.

The two RCBD trials were in Wisconsin, one near Madison in hardiness zone 5a and one in northern Wisconsin in hardiness zone 3B. The corno di toro pepper triadic trials were run across 9 states and 9 hardiness zones. The carrot triadic trial was run across 10 states and 7 hardiness zone. The Asian cucumber trial was run across 11 states and 7 hardiness zones. However, across the 3 crop, 65% to 69% of reviewers were in the same hardiness zone as RCBD trials.

Corno di toro pepper: N= 41 for triadic trial.

The correlation (Pearson) between RCBD yield (marketable weight in grams) vs. Triadic Pl coefficient for yield is: R-Squared= 0.35 with P value = 0.21. However, if we combine Triadic reviews (yield, vigor, disease, appearance, and earliness): R-Squared = 0.57 with P value = 0.085. Kendall correlation factor is 0.46 (ranking correlation). So an increase of 20% of PL coefficient or 1 to 5 score (overall traits) results in 21% increase in quantitative yield (grams) for corno di toro pepper.

Carrot: N= 35

The correlation (Pearson) between RCBD yield (marketable weight in grams/linear meter) vs. Triadic Pl coefficient for yield is: R-Squared = 0.42 with P value = 0.24. However, if we combine Triadic reviews (yield, vigor, disease, appearance, and earliness): R-Squared = 0.74 with P value = 0.06. Kendall correlation factor is 0.40 (ranking correlation). When carrot overall score increases from 3 to 3.5, yield increase of 1Kg/linear meter.

We see a stronger agreement between quantitative yield from replicated trial in 2 locations vs. combining multiple visual agronomic review. Perfect agreement is impossible as triadic trial covered from 30 to 35 sites while replicated only 2 sites. These results demonstrate how powerful crowdsource visual rating is to discriminate between varieties and help farmers and seed stakeholders to make better decisions.

Challenges and limitations of the online platform

- 20% of participant are reluctant to the use of technology.
- User experience (UX) in platform is essential. SeedLinked UX needs to improve to increase adoption.
- Limited apps connection: SeedLinked is developing an app that will be able to run without WIFI or data.
- It is just a tool and will never replace in-person seed story exchange.

Conclusion

- Many more people than expected participated in trials on SeedLinked
- 8 out of 9 crops showed strong discriminative ability with N from 15 to 46.
- All traits showed some significance difference, with appearance, vigor, and overall traits showing the strongest agreement across observers.
- Some traits like yield show strong agreement in one crop and weak agreement in others. Visual rating agreement can also vary from crop to crop.
- We saw very strong ranking and performance agreement between RCBD and triadic for carrot and corno di toro pepper. The wisdom of the crowd principle via triadic and scoring is then demonstrated opening tremendous potential for a platform like SeedLinked.

The validation of the crowdsource model for the seed industry opens new doors, as it will drastically decrease testing cost, make breeding for local adaptation more feasible, empower farmers to be closer to breeders, and create a tool for farmers to see what seed best fits their needs in a way that revolutionizes the current, cost-prohibitive system.

Future development milestones are:

1. Build organization accounts with multiple user roles.

2. Improve UI/UX across platform.

3. Integrate a self-trialing functionality as more than 80% of small farmers are doing their own trials in addition to third party trial.

4. Create crop specific ontologies with automated reminder when reviews are needed.

5. Analytics tool improvements for visualization and insight.

6. Build in sample size simulations to set threshold on the number of observers needed by trait and crop for maximum accuracy.

Using Multi-environment Trials to Get More Information about Stability and Disease Resistance: A Case Study from the TOMI Organic Breeding Project

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Introduction

As organic varieties are developed, two key breeding goals are to find stable varieties and to find varieties that are resistant or tolerant to the key diseases affecting that crop. Trials can help identify superior varieties; however, a given location may not provide all the information necessary to understand the variety.

There are two key limitations to trials in a single location:

1. Single location trials offer no information about how well the variety might perform across a range of temperatures, humidity, soils types, etc. In other words, a single location trial does not provide information about variety ***stability***.

2. Often, important diseases appear in a given location sporadically. They may not be present every year, and, if they are not present, a trial will not provide any information about how varieties resist those diseases.

Multi-location trials can tell us how a variety performs in varied environments. They also provide more opportunities for the disease of interest to be present.

Case Study

The Tomato Organic Management and Improvement project, known as TOMI, is a multi-state, interdisciplinary project developing an integrated approach to manage foliar pathogens while allowing growers to deliver tomatoes with exceptional flavor to the local marketplace. It is a partnership between Organic Seed Alliance, Purdue University, University of Wisconsin – Madison, Oregon State University, North Carolina State University, and North Carolina A&T State University, and is led by Dr. Lori Hoagland of Purdue University. This project was funded in 2014 by the Organic Research and Extension Initiative grant No. 2014-51300-22267.

As part of the project, new disease-resistance slicer-type tomato varieties are being developed. Integral to the breeding process are multi-environment trials. These trials have been conducted each year from 2015-2018 and will be continuing in 2020. The trial sites have been in Indiana, Oregon, Wisconsin, and North Carolina. Each trial site is set up using an augmented design with 4 replications of commercially available "check" varieties arranged systematically throughout the field, with 16 or more experimental varieties grown in unreplicated plots. By only replicating experimental varieties across locations while using "checks" to provide some estimates of within-location error, the project was able to efficiently use the limited funding available to get better information.

To compare these varieties visually, the R statistical software platform is used to create plots that display normalized plot values for the traits of interest (Figure 1). This allows a quick visual assessment both of the highest performing varieties across locations and the most stable. The normalization process is to adjust the values within each location so that the location mean is 0 and the location standard deviation is 1. This is done so that the relative performance of each variety within each location can be compared without the confounding effects of the location. Without normalization, it can be hard to see the differences between varieties, for example, at a location where the overall yield was lower compared to the highest yielding locations.

The value of multi-environment trials for the TOMI project can also be seen when evaluating disease resistance (Figure 2). Here, the critical diseases of interest were not present in all locations in a given year. However, by having multiple sites, many of the most important diseases were seen in at least one trial site, providing information about disease resistance.

Conclusion

Multi-environment trials provide valuable information that is not obtainable in single-location trials. New software tools allow for quick visual summaries to be generated. When developing a breeding or trial program, it would be wise to consider whether to invest in trials at multiple locations, even if the size and number of replications at a given location is smaller.

Figure 1. Marketable weight of TOMI tomatoes in 2016

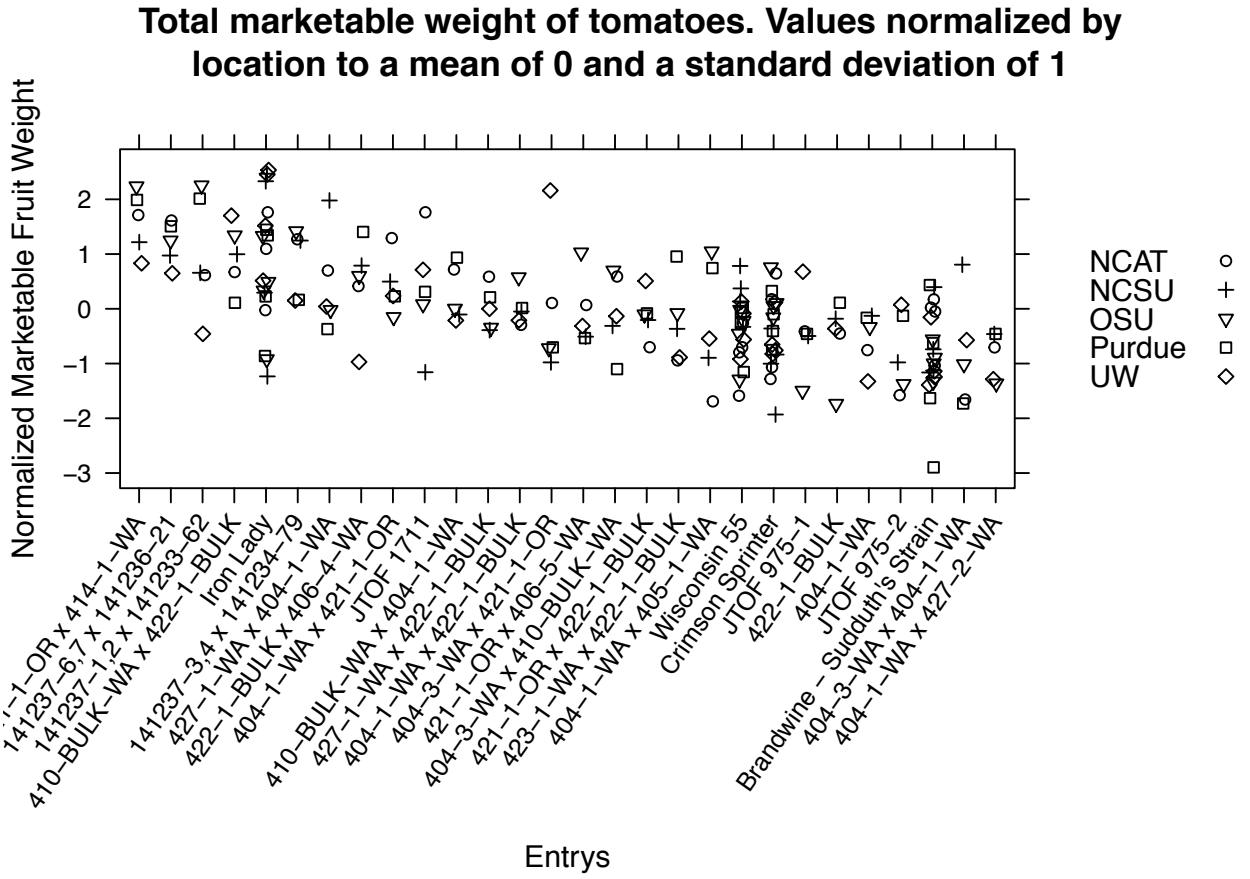
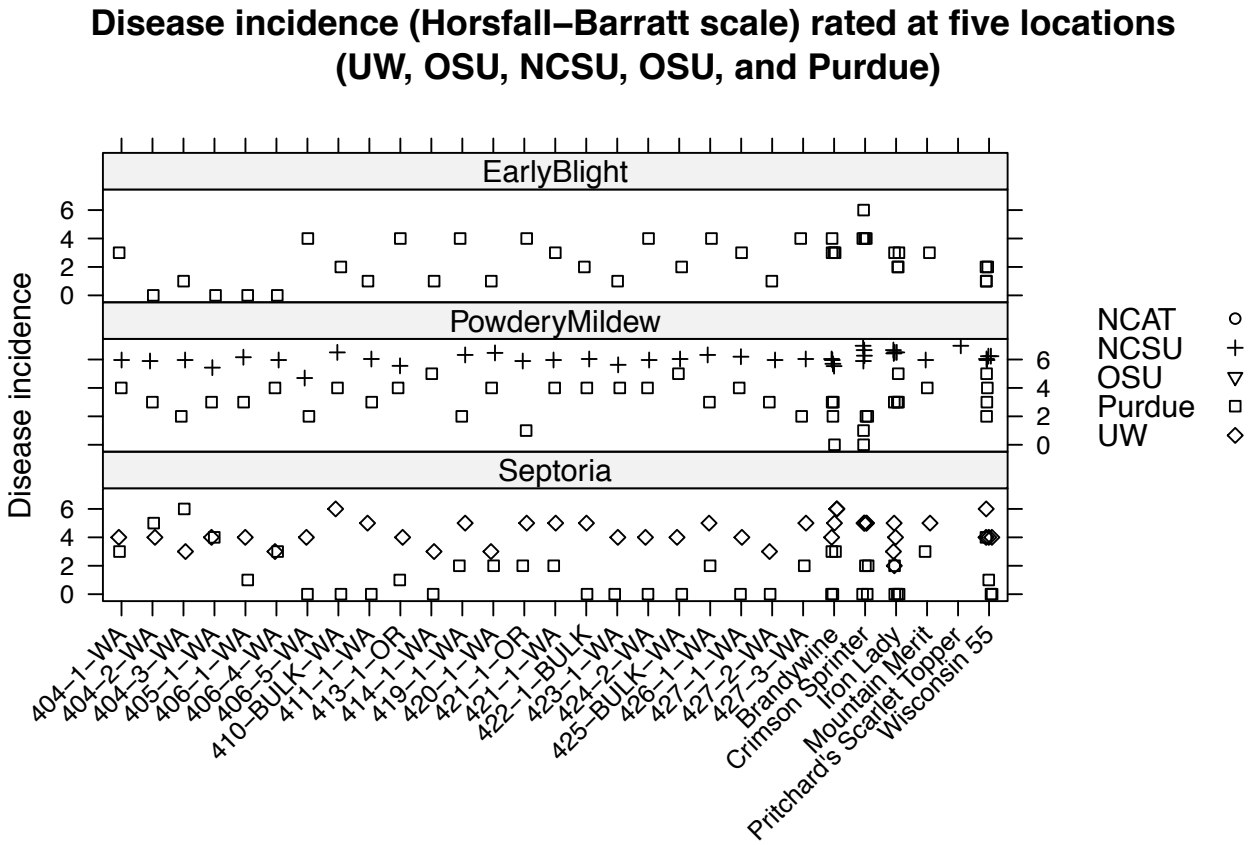


Figure 2. Disease incidence of TOMI varieties in 2015



Cauliflower and Cabbage Participatory Breeding in Brittany

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The agricultural area of the North of Brittany specializes in vegetable production, mainly cauliflower. The region benefits from the oceanic climate and allows cauliflower production in autumn, winter, and spring. Since the end of the nineteenth century, Brittany has developed this production which increased mainly since 1960 and then, when the F1 hybrid types were generalized, at the end of the eighties. Even as Brittany underwent a great intensification of its agriculture in the second half of the 20th century, this region of France was involved in organic agriculture very early. Several pioneers of organic farming appeared at the same period in this area.

In Europe, when the EU Regulation 1452/2003 requiring the use of organic seed for planting went into force in the year 2000, organic seed professionals were not ready to fulfill the demand. Thus, in Brittany, a group of organic farmers and their organizations started to meet with researchers to build participatory plant breeding (PPB) projects. In Brittany, the need for varieties for organic farming arose more specifically for the Brassica species because of the unsuitability of most modern varieties to the principles of organic agriculture. Now, most seed companies use cytoplasmic male sterility (CMS) for the creation of F1 hybrid varieties of Brassicas (cauliflower, cabbage, broccoli, and others).

A regional organic umbrella group (IBB, Inter Bio Bretagne), and researchers from the National Institute for Agricultural Research (INRA), initiated a PPB program for organic cabbages and cauliflowers in 2001. The aim was to include all concerned actors (farmers, processors, traders, trainers, and researchers) in defining the objectives and the means to reach them.

In 2021, a new organic regulation will enter into force and will enable certification of genetically heterogeneous seeds via organic certification. The aim is to provide routes to market for more genetically diverse cultivars that do not need to comply with DUS (Distinctiveness, Uniformity, and Stability) or VCU (Value for Cultivation and Use) testing nor seed certification processes. It aims to follow a simple notification process that does not present an administrative or financial barrier to smaller breeding initiatives and individuals (e.g., farmers).

Nowadays, on-farm plant breeding is an important activity of the farmers, members of Kaol kozh (KK). The objectives are to continue the research of genetic resources of traditional cultivars or landraces on one hand and to create new types on another hand. The main genetic structure is the population obtained either by mixtures or crossing. The last creation of KK was the “bricoli” which answers to the aim of combining good taste (from sprouting broccoli), modern broccoli form (crown) and violet color to be easily recognized by consumers. It is still in development but chefs are already interested in its originality and its quality.

Some farmers have also worked on the size of traditional cabbage such that of “Chou de Lorient” formerly used to supply, in winter, the sauerkraut manufacturers of Alsace. It was a large cabbage and some farmers succeeded to reduce its size to be sold to families to be cooked or in salads, because it is softer and sweeter than many other cabbages on the markets. To reach these

aims, farmers use mass selection, directly in traditional cultivars or in diversified populations obtained after crossing several populations with different origins as it was the case for the bricoli.

Brassica Breeding in a Network: The Story of Kaol Kozh

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At the beginning of this participatory research, from the evaluation of genetic resources to seed production, the experimental station of IBB (PAIS, Plateforme Agrobiologique d'Interbio-Bretagne à Suscinio) was the meeting point for all partners of the project. There, farmers found technical and scientific information and then they conducted the breeding steps on their own farms. In 2007, a farmer association named "Kaol kozh" (which means "old cabbage" in Breton or "common good" in Russian) has been set up to collectively organize seed exchanges and seed production, and also the exchange of knowledge and training. Nowadays, the association counts about 150 members (half gardeners, half farmers). In France, the marketing of heterogeneous seed was not allowed until now. Within the framework of the association, farmers have created the conditions to exchange seeds with the payment of the time spent to produce the seeds to overcome the current seed law.

Over time, the work carried out in participatory selection has made it possible to save many varieties of cauliflower and cabbage in the northern littoral zone. Then, other species were introduced in Kaol kozh activities as the famous pink onions of Roscoff or the leek of Armor.

The collective dimension also allows the means to provide machines for harvesting and cleaning seeds. Since March 2019, Kaol Kozh has installed a "Maison des Semences Paysannes" (or community seed bank) at the Laber in Roscoff. This place is close to the sea and includes a renovated farmhouse and 5000 m2 of land of which 2000m2 are devoted to the demonstration garden.

On his farm, JM Morel, like other farmers and gardeners of Kaol kozh, explored the genetic resources of Brassica species. Three years ago, a collection of 60 Brassica landraces were trialed. Ten of them were then multiplied by other farmers of Kaol kozh to each isolate interesting populations. Five will soon be developed for their markets, such as cabbage of Pontoise, an early cabbage (60days), an original "kale type." Generally, it needs 7 - 8 years between the rediscover of the cultivar and its presence on the markets.

Nevertheless, to help the organic sector, Kaol kozh members wish to sell some seeds via the new organic regulation which will allow heterogeneous cultivars in 2021. One of the first varieties proposed to be sold on the seed market under this regulation will be a bean cultivar named "ZAD" (in memory of the farmers and activists who have defended the place of Notre Dame des Landes, also named ZAD, area to defend, as the farmers' seeds).

The Biological Considerations of Brassica Breeding

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The domestication of Brassica species as vegetable crops is an interesting study in the plasticity of a genus. The main species of economic interest are comprised of three diploid and three allotetraploids arising from intercrossing among the diploid species. Not only have several species been domesticated, but within species diversification has been enormous. In B. oleracea alone, from a leafy progenitor similar to kale, our ancestors selected types with large apical buds (cabbage), axillary buds (Brussels sprouts), enlarged basal stems (kohlrabi), enlarged petioles (Portuguese cabbage), and large heads of floral primordia (cauliflower) or flower buds (broccoli). Even within a crop such as kale, there is abundant leaf diversity among varieties. New vegetable crops have been derived from these original domestications such as collards (loose headed cabbage), spigarello (leafy broccoli), and kalettes (leafy Brussels sprout buds). The only niche not filled in the B. oleracea portfolio is a root crop, but crops in other Brassica spp. with this trait include turnip (B. rapa) and rutabaga (B. napus).

The malleability of the Brassicas extends to interspecies crossing relationships, particularly among diploid species that share a genome with an allotetraploid species. For example, B. rapa and B. oleracea hybridized to produce B. napus and gene flow especially between B. rapa and B. napus continues. In other cases, such as with B. oleracea and B. napus, interspecies crossing barriers makes gene flow a rare event from natural crosses. But with the assistance of embryo rescue or somatic hybridization, breeders have overcome these barriers. It is the use of these laboratory techniques that has created a dilemma for the organic community using F1 hybrids that rely on cytoplasmic male sterility. I will say more about this below.

Most of the Brassica spp. are outcrossers that are predominantly insect pollinated. The natural state for a Brassica population is a group of highly heterozygous individuals randomly mating in an open-pollinated (OP) population. Outcrossers have certain characteristics such as heterozygosity among individuals in the population, shifts in gene frequencies over time due to introgession from the outside or via genetic drift, show inbreeding depression if population size becomes too small, and exhibiting hybrid vigor when inbred individuals are crossed.

Brassicas possess perfect flowers, so self-pollination is possible, but the presence of a self-incompatibility system normally prevents this from happening. Methods such as bud pollination or CO2 treatment have been used by breeders to allow selfing to create inbred lines. These inbred lines are then used to make F1 hybrids. Inbred lines suffer inbreeding depression, but hybrid vigor can be restored by crossing two genetically different inbreds together. Over time, and through their selfing efforts, breeders have shed deleterious genes and have reduced the severity of inbreeding depression to the point that some inbreds could be released as varieties.

In making F1 hybrids, breeders need pollen control techniques to achieve the volume of seed production required on a commercial scale. In the past, breeders relied on self-incompatibility (SI) to facilitate hybrid seed production, but this process is not very precise and allows accidental selfs of the female line to occur. It is also a finicky process in that only those inbred combina-

tions will work where inbreds do not share SI alleles. Cytoplasmic male sterility (CMS) is nowadays used more commonly than SI. It has the advantage of never producing female selfs, and there is less concern about the presence of the same SI alleles in the inbreds. The development of CMS systems, however, is controversial for the organic grower community. CMS naturally occurs in wild radish populations and was transferred into Brassica spp. by protoplast fusion to create somatic hybrids. The CMS trait is found in the mitochondria in the cell cytoplasm whereas most genes controlling the Brassica phenotype are in the nucleus. These two genetic systems are inherited differently with the nucleus exhibiting biparental transmission with recombination through meiosis. The mitochondrial genome shows maternal parent transmission only. Thus, to create a CMS Brassica plant, the nuclear genome of the Brassica spp. was placed in the cytoplasm of the radish spp. A third genome, the chloroplast genome is also maternally inherited, and the Brassica chloroplasts had to be retained in this 3-way swap. The result is the Ogura CMS that has been transferred into most of the Brassica spp. and is widely used commercially for F1 hybrid production of many Brassica crops. It is the way that CMS was introgressed into the Brassica genus that is controversial. The original National Organic Program (NOP) restrictions on breeding methods prohibited protoplast fusion, thus, Brassica hybrids created in this manner were not permitted. The problem came about with there being both SI and CMS derived hybrids in the marketplace, but a lack of information on which varieties were which. In some cases, a seed company might share that information, but other seed companies would not. As a result, the NOP regulations were modified to allow the use of protoplast fusion technologies if the cross was between species within the same family. In this case, both Raphanus and Brassica genera fall within Brassicaceae. The U.S. stance is controversial and remains at odds with the international organic community. The ultimate solution to this may be to identify naturally occurring CMS systems within Brassica spp. and use conventional breeding methods to transfer into the desired species background.

Brassicas generally prefer a cool growing season. A number of the Brassicas are biennial, with initial vegetative in late summer and fall followed by vernalization in the winter and flowering and seed set in spring. Some crops, such as some types of broccoli and cauliflower, have been converted to annuals which are planted in early spring for a summer harvest. In my vegetable breeding program, we work mainly on broccoli and this crop is particularly sensitive to high temperatures during heading. There is a a 5 - 7 day window when the broccoli plant is transitioning from vegetative to reproductive growth and the bud primordia enlargement is initiated that excessive heat is most detrimental to broccoli head formation. It is difficult to screen broccoli varieties for heat tolerance particularly under conditions where temperature varies across the season. In addition, high temperature may present in different forms. In the humid eastern U.S., nighttime temperature are often too high during summer months whereas in the west, daytime temperatures may be too high but nights do cool off. We have begun screening broccoli for heat tolerance using relay plantings one week apart through the growing season. This maximizes the chances that one of the plantings will be transitioning at the vulnerable stage during a heat event. This type of screening will become more important into the future as temperatures rise.

All in all, the Brassica vegetable crops are a wonderfully entertaining group to work with, and with their genetic plasticity, we will continue to be surprised by the types and traits that develop going into the future.

Knowledge Exchange on Breeding Better Tomatoes

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Summary

At Artisan Seeds we have been breeding tomatoes since 2002. Initially we worked primarily in a large community garden plot, but since 2006 our primary breeding site has been on our small farm in Sunol, California. For the past six years, however, we have extended and strengthened our breeding efforts through collaborations with The Chef's Garden (Huron, Ohio) and Heirloom Farms (Ensenada, Mexico). The approach we have developed, through trial and error, can be summarized in 4 steps. Step 1: Identify project goals. Step 2: Trial existing lines relevant to project goals. Step 3: Cross existing lines and select new true-breeding lines. Step 4: Use novel true-breeding lines to create synergistic hybrid lines.

Step 1: Identify Project Goals

While it is not always necessary to focus on narrowly defined goals, it is beneficial to breed for exceptional results within a specific niche. In our breeding, we were initially focused on flavor and fruit aesthetic, because that was what we were most passionate about. In breeding for flavor, we were most successful when breeding with a small group of high-flavor lines, without regard to other characteristics. The resulting high-flavor lines, the Artisan Striped Cherry tomatoes, were successful in attracting the attention of critical collaborators.

More recently, farming challenges have inspired us to incorporate longer fruit shelf-life and better overall plant vigor and disease resistance into our newer varieties. These projects have been carried out to meet agreed-upon goals with our collaborators.

Step 2: Trial ExistingLines Relevant to Project Goals

After defining project goals it is important to gather working material from a variety of sources (both true-breeding and hybrid). To identify tomato varieties to use in our breeding, we have often tried to first identify those that, by consensus, are agreed to be excellent performers in a variety of environments. Importantly, however, we have chosen not to simply identify lines of interest and immediately start crossing. Instead, we have typically trialed lines before identifying the lines we will use for crossing. This has allowed us to initially cast a wider net. It has also given us the opportunity to use our own observations, over the course of a full season, before we take on time-consuming chores related to crossing and subsequent selection. There is no substitution for FIRST evaluating/selecting (and narrowing) the varieties that will be used for subsequent breeding work. Trials are most effectively done under the field conditions relevant to project goals, keeping in mind that in some cases the best "trial" conditions may be harsher conditions than would be optimal for best production.

Step 2a: Learn to Recognize When Your Breeding Goals Have Been Met by Someone Else

In doing our surveys of existing varieties, at times we identify lines that are so outstanding, in our hands, that breeding a similar "type" variety that is superior seems almost impossible. In that case, our breeding goals may be satisfied without any breeding at all. For example, in our hands the variety Captain Lucky is so productive, disease resistant, and flavorful that the idea of breeding for a new green-when-ripe indeterminate beefsteak seems quite silly. We just grow Captain Lucky. Thank you, Millard Murdock.

Step 3: Cross Existing Lines and Select for New True-breeding Lines

Once useful breeding material has been gathered, initial crossing/selecting work is devoted toward the enhancement of the most important trait(s). In our initial breeding work, we started with a focus on flavor. We learned that if we wanted great flavor, we needed to narrow our work almost exclusively to combinations where BOTH parents have great flavor. That is the only way to potentially elevate flavors to levels higher than that of the parents. Selections of our initial novel true-breeding lines took place largely in our own Sunol, California field. Some of the resulting true-breeding high-flavor lines were released (by Johnny's Selected Seeds and others) while some lines were held back and have been used in subsequent projects.

Once we had developed a genetic toolbox with many new true-breeding high flavor lines – then we moved toward incorporating additional traits that we desired into our existing high-flavor lines. But, attempting to first be exceptional in one area – flavor – served us well. It must be noted that many of our primary customers during our initial breeding work were high-end chefs, and our focus on flavor fit well with their priorities, as well as ours.

Other traits which we have subsequently identified as important to us and to our customers are shelf-life, balanced architecture and general vigor/disease resistance. To incorporate these traits into our lines we have found it important to collaborate with others. For example, selection in harsh disease environments in Ohio and southern Baja California have been critical for the selection of disease resistance in our breeding lines. Furthermore, we rely on our primary partners (Heirloom Farms), who is much more sophisticated at tomato production than we are, to tell us which lines meet their exacting high standards for plant architecture and vigor/production. For this reason we have moved as much of our selection as possible to their fields and greenhouses.

Step 4: Use Novel True-breeding Lines to Create Synergistic Hybrid Lines

Our breeding approach has evolved over time to embrace the creation of hybrids as useful new varieties, not just as a vehicle for producing new true-breeding varieties. This is primarily because in our years growing and observing hybrid tomatoes, true-breeding tomatoes and tomatoes at every step in between, it has become clear that general hybrid vigor and hybrid trait synergy are real and useful.

Although we continue to release varieties that are true breeding, we are also actively making and evaluating hybrid lines with the purpose of releasing them as distinct F1 varieties. In some cases, hybrids offer unique opportunities that simply can't be duplicated with true-breeding varieties. For example, we are using the rin trait to extend fruit shelf-life significantly, typically

with little or no negative effect on texture or flavor. But, the rin gene that confers extended shelf-life is most effective when only one parent carries the rin gene. In other words, the rin heterozygote (rin/+) has the best shelf-life/flavor characteristics. This is a clear case of hybrid trait synergy, as fruit qualities in rin heterozygotes are clearly superior to either parent.

In addition to trait synergy, we have also consistently observed the general phenomenon known as "hybrid vigor" in tomatoes. It is not surprising, since whenever you make a hybrid, a variety has many more potential genes in the toolkit – as each parent donates alternative gene forms for many genes.

Some final comments about hybrids

Hybrids do not lock up genetic resources. People do. All of the genes in our hybrids are freely available to anyone who grows them, and these include genes from both parents. What we have is our trade secret (the identity of the two parents). And our trade secret only has value if we have created a variety that is clearly superior to a true-breeding line that could be used as a substitute. And if we have done that, is it so crazy to want to be able to make a little money from our invention?

Acknowledgements

Any tomato breeding successes we have had only occurred because of significant support from Johnny's Selected Seeds, AP Whaley Seed Co., Michael Glick/Vesta Foodservice, The Chef's Garden, Heirloom Farms, and many additional gardening, farming, and chef collaborators.

Perspectives on Licensing Barley at a Land-grant University

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The Oregon State University (OSU) Barley Breeding Program has used a range of mechanisms to release varieties and germplasm over the years (Table 1). Demand, end-use, and purity of the seed have been the primary drivers behind the chosen form of release. Additionally, the Office for Commercialization and Corporate Development (OCCD) has used a range of release options for cereals that define the structure of the release. These include:

No license
- Public release with or without PVP
- Public release without PVP, with sale of certified class of seed only
- Germplasm release

With license (with or without PVP)
- Non-exclusive
- Exclusive

Releasing licensed varieties can be advantageous because the licenses help maintain pure seed. This is especially important for malt barley, which needs to germinate evenly and consistently during the malting process. They can also bring royalties into public breeding programs to be used for research and breeding purposes. However, licensing where plant-back restrictions are specified can be problematic for growers interested in saving seed or purchasing organically certified seed (currently there is very little production of doubly-certified barley seed). The different release mechanisms that the OSU Barley Project has chosen to use offers a wide range of options for growers, while also striving to reconcile the dual objectives of generating revenue and providing access to germplasm resources.

Table 1. Varieties released from the OSU Barley Breeding Program

Name	Release status	Year released	PVP?	Principal end use(s)
Alba	Public Variety	2012	No	Feed, malt
Buck	Public variety	2015	No	Food, malt, feed
Oregon Naked Barley Blend (ONBB)	Germplasm	2017	No	Food, malt, feed
Full Pint	Public Variety	2014	No	Malt, feed
#STRKR (Streaker)	Germplasm	2014	No	Food, malt, feed
Thunder	Non-exclusive licensed variety	2019	No	Malt, feed
Maja	Formerly licensed variety, returning to public domain	2006	No	Malt, feed
Verdant	Formerly exclusive licensed variety, returning to public domain	2012	Yes	Forage

License Overview and How IP is Applied in the OSU Breeding Program

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For better or worse, intellectual property (IP) protection has come to define commercial crop breeding in the 21st century. Several forms including Plant Variety Protection (PVP), plant patents, utility patents, trademarks, and licenses are employed. The differences among these forms of IP are often confusing and may keep someone from working in an area or may lead to someone violating an IP protection law. The basic reason for IP protection is that the government grants the inventor a limited exclusive monopoly in exchange for the inventor providing the methods by which they created the invention. By and large, this approach has been very successful in promoting innovation. The system does have drawbacks when applied to plants. Chief among these are that most plants are self-reproducing entities whereas most inventions are not. Innovation in the plant world involves crossing, and often IP protection prohibits this without the permission of the inventor. A similar issue is the saving of seed for personal use.

One of the newer forms of IP protection is the use of licenses usually with other forms of IP protection. Licenses fall under contract law, and their application differs markedly from various forms of patents. Licenses are used in a number of different ways. They are rarely used alone because by themselves, they are not particularly strong. They may take the form of a material transfer agreement (MTA) where seeds are conveyed from the inventor to another party. The MTA spells out how the seeds may be used. Licenses are sometimes included on seed bags and tags of commercial seeds. They are used to restrict the use of those seeds for purposes other than commercial production. Technology use licenses are like "bag tag" licenses but apply specifically to genetically engineered technologies. A fourth way that licenses are used is in conjunction with patents and PVP. While patents and PVP provide a legislatively backed framework for the use of the technology, licenses are used to add additional restrictions. When used in this way, they may determine who may produce the seed and in what manner. A license may specify that only one entity may produce the seed, or that a certain group or anyone may produce seed. While PVP has a breeders' exemption that allows a non-inventor to use the cultivar in breeding and a farmers exemption that allows farmers to save seed for personal use, a license may be written in a manner to prohibit breeders' and farmers' exemptions. Licenses should be written with a sunset clause – they should expire in a few years and should certainly not exceed the 20-year life of a patent. Such language is rarely found in licenses though.

The OSU vegetable breeding program has used PVP and licenses with some recent releases. It is applied on a case by case basis with the main criteria being whether public funds were expended in the breeding process. If not, then IP protection is justified to recoup funds spent in the breeding effort. We do seek royalties to come back to the breeding program with an example being the indigo tomatoes. We have never had grant support to aid in breeding these with the sole source of funding to keep the breeding program going being royalties. Our first indigo tomato release (Indigo Rose) was initially done with a nonexclusive license, but our tech trans-

fer department converted this to an exclusive license. A comparison of sales before and after the switch in licensing shows greater revenues with the exclusive license and this is in line with what other programs have observed.

The fundamental question is: How do breeders get compensated for their work? Prior to about 1980, much of the breeding was done by public programs who where well supported by federal Hatch dollars. In this era where federal dollars are scarce, public breeders have had to become increasingly like a private breeding program. Finding a way to compensate public breeders without applying IP protection to varieties remains elusive.

Finding a Path Forward on Seed Licenses

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A simple answer to finding a path forward regarding the licensing of seed varieties from universities, USDA-ARS, or private breeding programs is clearly unlikely. Licensing of varieties and plant genetics is not new. However, the increased use of licenses can be linked to the increase in intellectual property rights (IPR) protection for plant genetics which began in 1970 with the implementation of the Plant Variety Protection Act (PVPA) followed in 1980 with U.S. Patent & Trademark Office (USPTO) granting patents on plants. Licenses have been used to provide additional control and communication between the parties (breeders, seed dealers, and growers) regarding plant genetics. Breeding programs, in the process of developing and introducing new varieties and educating new breeders at universities via breeding programs, have experienced increased cost. Private breeders have always expected a return on their investment and have looked to licenses (contracts) and other available intellectual property protection such as Plant Variety Protection, Plant Patents, Utility Patents and Trademarks. Somewhat new are license agreements found in public breeding programs at universities and USDA-ARS. As these public breeding efforts come under pressure to generate income from breeding efforts, it is not unexpected to see these intellectual property rights tools being used. I would offer that the path forward will therefore require organic seed growers and others in the seed industry to adapt to these norms regarding seed licenses. Consumers and users of improved plant varieties are being asked to pay for the investment and risks taken by both private and public breeders in developing these improved varieties.

As to the matter of varieties going out of availability, that is not a new issue. All varieties follow the normal curve of increased demand and then decline as new improved varieties are introduced. When the demand for a variety, either in volume or minimum income and where it is no longer possible to produce a seed crop economically (mostly due to contract field size), varieties are discontinued. All in the seed distribution chain should keep informed regarding important or critical varieties as to supply, availability, and status. But most importantly, those in the distribution channels should continuously evaluate new varieties being offered. In that regard, a close communication and working relationship (sharing of information) between the breeder producer, distribution channels, and growers is vital. From my perspective, based on my experience in the private sector, seed distribution channels need to anticipate change and look forward to new opportunities. And, possibly most importantly, support breeding programs developing and maintaining organically adapted varieties.

Restrictive bag tags and associated limited use agreements are also not new. Over the years the cost of breeding has increased and, not unexpectedly, so has the use of intellectual property rights. These increases in IP protection have evolved to help assure return on investments in variety improvement. The goal being to control pirating and plagiarism using all available IP including bag tag limitations. Single use of the seed, to prevent saving seed or vegetative propagating, has become another widely used tool in efforts to assure return on investment to businesses and universities creating new varieties.

In summary, I see that organic growers, organic seed distribution channels, and organic seed producers need to support the investment and cost in developing and introducing organic adapted improved varieties. Look forward to new organic varieties being offered and find ways to adapt to the market forces that appear out of our control.

Resisting Cultural Appropriation in New Mexico

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Communities along the Rio Grande have worked for hundreds of years in partnership with the seeds that nourish them. These resilient seeds can withstand adversities such as temperature extremes, drought and flood, salinity, pests, and disease. In 2008, New Mexico's landrace chile nativos became imperiled.

Genetically Engineered Chile

Through frantic emails and phone calls, a small network of us received notice that the NM Chile Association (NMCA) had secured funds from the state legislature for development of a genetically engineered (GE) chile. This was the first time the community had heard about a GE chile. We soon learned that funding for the GE chile had started in 1993, but the bills had been hidden behind innocuous names like "Economic Sustainability of Chile Industry." And they had been sent to misleading committees, such as Education. The lack of transparency led to the uncovering of appalling evidence that tobacco settlement funds had been used for the GE chile research.

In 2006 NM State University (NMSU) created the non-profit NMCA from what was formerly called the Chile Task Force. This allows the NMCA to lobby the state legislature for chile industry research funding that goes to NMSU. Comprised primarily of commercial chile processors, the NMCA has secured millions of NM tax dollars for the GE chile research. NMSU will own the patent in conjunction with its biotech partners (ERD committee hearing Sept. 2010). There are questions about whether the NMCA, and/or anyone else, may be owners of the patent as well.

For many small farmers and families in NM, chile is a primary food crop. Seeds have been saved and replanted for around 500 years, perhaps longer. These native chiles run the risk of cross-contamination from the GE trials and eventually the final GE chile. In the process of examining how we could protect the chiles, we learned that GE alfalfa trials had taken place in NM in 2007. At that time, every county in NM except one planted alfalfa. And only two local alfalfa seed producers were left. We quickly realized that even more was at stake.

GE Contamination

In NM, water rights, both surface and underground, are attached to the land. Many farmers irrigate their crops through irrigation ditches called acequias. These waterways serve as a venue for seeds to travel for miles, sprouting volunteer plants along the way. Dried red chiles are often strung as ristras and transported in open trucks along the road. Alfalfa bales are also transported in open trucks with escaped bales lying along the roadside. The seeds from both crops can easily hitchhike NM's strong winds or go for a swim in the acequias.

Farmers may unknowingly come into possession of patented traits in the seeds they save because of these volunteer plants or due to cross-pollination with the GE chile or alfalfa, as test-site locations are undisclosed to the public. This could result in farmers being sued for patent

infringement and, worse, almost certain loss of the invaluable and unique traits of their own seeds, developed through years of breeding. Farmers have a right to save their own seed for future planting. This right was, and still is, now at risk.

Farmer Protection Act

In 2008, the community sought to confront this threat through a united effort call the "Save NM Seeds Coalition." Its first action was to introduce a bill aimed at protecting those who grow our food by establishing a basic right of due process. The Farmer Protection Act was introduced through bipartisan sponsorship for three consecutive years (2009, 2010, and 2011).

The Farmer Protection Act would have protected any person who was unintentionally in possession of a patented GE product. In 2011, the biotech industry managed to get the bill amended to state that no one would be sued for a de minimus amount, yet refused to specify what that amount would be. The bill made it to the House floor where the first vote resulted in a tie, then failed in a second vote. Yet the close vote made it clear to everyone that this was, and would continue to be, an issue for anyone growing their own food. Of course, even if this bill had passed, it would not have protected the integrity of any seed from GE contamination.

New Mexico Chile Advertising Act

Since 2008, the Save NM Seeds Coalition has been educating and informing New Mexicans about efforts to undermine our way of life and commodify the commons. Falsehoods such as "[t]he NM chile industry is in a steep decline" have been used to pass laws restricting New Mexicans' rights and freedom to farm.

The NMCA and NMSU, in collaboration with BIO (the national biotech lobbyist), the Farm Bureau (Monsanto-Bayer), and ALEC (Koch Brothers), have successfully introduced legislation in NM to take away our commons, making sure we do not have access to things that are inherently ours. By enclosing the commons, the awareness of the connection is lost. When we lose our language, such as calling our chiles by their geographic names, the connections begin to disappear, tearing down the ethics that protect the commons. The loss of NM's vernacular is the loss of the commons.

In 2011 a bill was introduced on behalf of the NMCA called "The New Mexico Chile Advertising Act" (NM Chile Act). The NMCA claimed that chile grown outside of NM was being sold in the state as "New Mexico Chile."

> 1. In 2011, the New Mexico Chile Advertising Act (NM Chile Act) passed. It requires compulsory registration of anyone who describes or sells any kind of "chile" pepper (Capsicum annuum)" as "New Mexico Chile."
>
> 2. In 2012, the NM Chile Act was amended. The reason cited for the amendment was that non-NM chile was being sold as "Hatch chile," negatively impacting the Hatch chile growers. Yet, there is no variety of chile called "Hatch."

The amendment requires compulsory registration by anyone who describes or sells chile called by the name of any city, town, county, village, pueblo, mountain, river, or other geographic fea-

ture or features located in New Mexico, even though that is the varietal identity of landrace chiles grown in places such as Española, Chimayo, and various pueblos.

3. The NM Chile Act Absurdities:

a. This law only applies to chile peppers grown or sold in NM.

b. The law applies to any type of NM-grown chile peppers (capsicum annuum), including: jalapenos, bell peppers, shishitos, yellow hots, etc.

c. 5% per weight of a chile lot can be non-New Mexican grown, yet still be called "New Mexican Chile."

d. Compulsory registration if you identify your chile peppers as "New Mexico" or any other geographic place or feature in NM.

e. If you register, you can call any chile by any geographic name (such as "Hatch"!), even though it may be planted in Gallup.

f. Compulsory registration requires disclosing location of chile fields, chile products sold, list of customers, sales outlets, and copies of invoices for proof. Yet, we New Mexicans are not allowed to know if a GE crop, such as the GE chile trials, are planted next to our fields.

g. There is no chile variety called "Hatch." There are only chiles grown around the city of Hatch, which are varieties developed by NMSU, such as Big Jim, Joe Parker, and NM 6-4.

h. In August 2014, the NMCA implemented the use of a certification mark — "New Mexico Certified Chile"— for members of their association.

Efforts have been made to have the NM Chile Act repealed or to cease funding the enforcement of this law. But everything is at a standstill. Farmers are still using their chiles' rightful names and not registering, but when the chile is being sold, it is simply called "local."

In an outrageous turn of events, we learned in 2019 that the "New Mexico Certified Chile" mark in use by the NMCA since 2014 had not even been approved by the U.S. Patent and Trademark Office (USTPO)! On November 13, 2019, the USTPO denied the NMCA use of the certification mark for "New Mexico Certified Chile" because the NM Department of Agriculture enforces the NM Chile Act. If you will recall, the NM Chile Act was introduced and passed on behalf of the NMCA.

Non-transparency by the NM Department of Agriculture and NMSU

On October 17, 2012, a select group from the agricultural community was invited by the NM Department of Agriculture (NMDA) to participate in a closed meeting, entitled: "Coexistence Opportunities and Challenges." No one knew who was being invited to this meeting. When some of us asked for the agenda or list of who else would be attending, NMSU refused to provide the information.

In attendance were representatives from USDA/APHIS (Animal and Plant Health Inspection Service), NMSU, the American Seed Trade Association, the biotech companies Monsanto and Dow, and their lobbyists. Other people were present, but NMDA refused to disclose their identities. At this meeting, an agreement was reached with Rep. Paul Bandy not to reintroduce the Farmer Protection Act. Monsanto stated in return that they would not sue New Mexicans for de minimus or trace amounts of GE contamination, but refused to define what the amount was. This was similar to the language of the 2011 Farmer Protection Act. To date, repeated requests to NMDA Secretary Witte for the minutes of this meeting have never been provided.

State Preemption of the Regulation of Agricultural and Vegetable Seed

In 2017, Dow/Pioneer and DuPont merged, further consolidating the commercial seed market. That June, the NMCA formed a partnership with the Western Growers, who have Political Action Committees (PACs) and are supported by the biotech industry.

House Bill 161 was presented in the 2018 state legislature by the lobbyist for BIO (national biotech lobbyist). It failed after immense public protest. Titled "Establishing State Preemption of the Regulation of Agricultural and Vegetable Seeds," HB161 would have amended the NM Seed Law to give the state supreme power over all aspects of any seeds possessed or grown in NM, including those in gardens, a concern confirmed by the NM Attorney General's office: "…The result is that decisions on what can be grown locally will be taken away from local control and exist exclusively in the state domain…'Vegetable seed' includes the seeds of those crops which are grown in gardens…" (January 2018, HB161 Fiscal Impact Report)

In the 2019 NM state legislature, a line was inserted into the final budget by an unknown legislator that would have funded the NMDA "to promulgate rules to solely regulate seed." This was a nefarious act, as rules cannot be created until the Governor has signed a law. This effort was an attempt to circumvent the entire legislative process.

NMCA Industry Influence

The NMCA is an organization whose mission is to "create an environment in the NM region that reinstates us as the world leader in chile production, processing and innovation, ensuring the viability, prosperity and growth of the chile industry." NMSU developed modern chile varieties for the chile processing industry grown predominantly in southern NM. These seeds are not saved. This is why "Hatch" chile does not exist. No indigenous, local variety has been grown traditionally in Hatch or the surrounding areas. The NMSU varieties grown there include Joe Parker, Big Jim, and others.

All the legislative efforts introduced by the NMCA and collaborators are blocks in an entire construct of laws designed to control who owns chile, and now all seeds, and to regulate how they are described, possessed, grown, shared, or sold.

It is wrong to use taxpayer money to prop up one troubled industry at the expense of viable local economies. The NMCA should not be functioning as a governmental entity. It is an association for private business and has no right to determine laws that affect other businesses, busi-

ness people, or anyone else. The NMDA should not be functioning as an enforcement arm of the NMCA.

The net effect of this law is that lobbyists and corporations have moved into the legislative and regulatory bodies of government, and are using taxpayer money to do so. Efforts to trademark and further commodify a staple food crop should never come at the expense of a successful and healthy way of life. Or, as the late historian and chile nativo grower Estevan Arrellano put it: "Stay out of our huertas!"

Lessons Learned

1. Find legal assistance. Well-funded corporations that treat us as uninformed farmers are playing these games in courts and state legislatures. Find lawyers who can translate your needs into corporate/legal language and point out the absurdities of the efforts that threaten your seeds, farms, way of life, and the commons.

2. Create a coalition. To protect the commons, we need to unite. We all are defending the commons.

3. Words matter. Listen to, investigate, and counter your adversary's messaging. Find the holes in it, provide documented proof, and continuously counter.

4. Sit at all the tables. Get representation on all committees or other groups that deal with similar issues or could provide support.

5. National Recall of the Pre-emptive State Seed Laws. We should all be working together to repeal the seed laws passed in other states.

6. Share information. Let other groups know throughout the U.S. and around the world what is happening in your area, county, or state. Speak at all events possible.

7. Conduct tasting events. Through tasting events conducted at farmers' markets across the state, consumers were able to taste the real NM chiles and helped to revive small producers and become educated on issues facing all of us, whether farmers, small backyard growers, or children planting in school gardens.

Grange Advocacy for Seed Protections

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Introduction

Seed savers, farmers, and granges in Oregon have been hard at work in recent years bringing people together to protect a world-class seed producing area in the Pacific Northwest.

The history of the Grange goes back to the 1900's and the Grange is the oldest American agricultural advocacy group with a national scope. Many grange halls across the country continue to serve as the center for rural life for many farming communities.

In recent years, the grange network has seen a revival, with dozens of granges in Oregon alone rallying new leadership to get people involved in state and local issues that impact their communities.

Since 2015, Bellview Grange #759 in Ashland, OR has initiated a number of resolutions to the Oregon State Grange (OSG) system that include: support for protecting genetic diversity and local access to seeds; creation of a special agriculture district for non-GMO crops in Southern Oregon's Rogue Valley; and a resolution calling for accountability when GE/GMO contamination happens to farmers who want nothing to do with the technology.

I have been involved in this work since 2012 and have spearheaded an effort to bring Granges together across the state in support of the seed movement.

How the Grange Works

The Grange resolution process begins when a member of any grange brings a resolution to their local grange for adoption. Once a resolution has been adopted by the membership of that grange, usually in the spring, the resolution is submitted to the State Grange for review. The resolution will then be voted on at the annual OSG convening in June. If adopted, a resolution becomes part of State Grange policy and is carried out or advocated for by the organization's leadership or a special committee, often with the assistance of the organization's lobbyist who travels to Salem each legislative session.

Recent Grange Activity In Oregon to Protect Seeds

A few years ago a resolution was passed at the annual OSG that highlighted the Grange's commitment to placing community seed resources as an important part of local food system resilience. There has been continued support for the seed movement within the Grange, as evidenced by the passage of additional seed resolutions at recent Grange conventions.

After a state law was passed in Oregon (SB863), which prohibited local communities from taking action to protect local seeds from the threats of GE contamination, efforts have continued by community groups across the state, and within the state grange network, to move legislation

forward to ensure there are protected areas in the state in which to safely grow seed, free from GE cross-contamination concerns.

In 2019, OSG voted to support the right of Josephine County, Oregon to join neighboring Jackson County to enforce 2014 ballot measures banning GE/GMO crops. Jackson County is the only county of 36 in the state legally allowed to prohibit GE crops.

Other resolutions have been proposed to hold companies who make GMO seeds accountable when their product contaminates other farmers, as well as resolutions protecting farms in the state from hazardous chemicals associated with GMO growing systems.

And with new lobbying power enacted by OSG to advocate for resolutions passed by the organization, these ground-breaking resolutions could set a new precedent for farmers and seed savers across Oregon.

Legislative & Agency Advocacy in Oregon to Protect Seeds

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Background

Oregon is the world's fifth best seed growing region, yet there are no statewide regulations to protect organic seed growers from the harms of genetically engineered (GE) contamination, and all counties, except Jackson County, are preempted from regulating seed in their jurisdictions. Many farmers, non-profit organizations, lawyers, and grassroots activists have been fighting an uphill battle to advocate for organic seed protections in Oregon. This paper will provide a brief overview of Oregon's efforts to protect organic seed stocks from GE contamination, and will also look at what other states have done to address GE contamination concerns.

Efforts in Oregon to protect organic seed stocks

Jackson and Josephine County GE Bans

In 2012, farmers in Jackson and Josephine Counties became alarmed at increased GE sugar beet production in the Rogue Valley. The GE sugar beet growers were invited to work with the Southern Oregon Seed Growers Association (SOSGA) to come up with a pinning plan that would work for all, but ultimately, the GE interests walked away from the table and GE contamination became inevitable. In short order, Chris Hardy, of Hardy Seeds, was forced to tear out seed crops as a result of GE sugar beet production near his fields.

Since Oregon does not have a statewide policy regarding GE crops, Chris and other Rogue Valley farmers decided to take action to protect traditional farming and seed protection methods. In 2014, the Our Family Farms Coalition led a successful ballot measure to ban GE crop production in Jackson County, and Oregonians for Safe Farms and Families, did the same in Josephine County. Both counties prevailed despite nearly $1 million in opposition funding, largely provided by Monsanto (now Bayer) and other chemical agribusinesses.

Unfortunately, when corporate interests learned of the upcoming Southern Oregon ballot initiatives, in addition to funding opposition campaigns, they lobbied the Oregon legislature to approve Senate Bill 863 during a Special Legislative Session in October 2013. Senate Bill 863 prohibited Oregon counties from regulating or banning genetically modified organisms. Jackson County was exempted because the campaign had already officially filed their initiative with the state. Despite Josephine County having clear intentions to run an initiative at the same time, their campaign was not yet filed and Josephine County was not exempted. However, the campaign moved forward in spite of the new state law and qualified for the ballot in 2014.

Legislative and Agency Advocacy to Address GE Contamination and Local Control

Many advocacy and other groups were disappointed by the passage of SB 863, and worried about increased contamination risks. Since 2013, several legislative concepts have been intro-

duced to address such concerns. To date, none of these concepts have become law, though some have come close, and incremental progress has been made.

- House Bill (HB) 3292 (2013) Prohibits reproductively capable GE material from being grown in Oregon, and also addressed GE fish.
- HB 3290 and HB 3291 (2013) GE Alfalfa ban.
- HB 2715 (2013) Authorizes counties to establish control areas for GE commodities.
- HB 2736 (2013) Requires notice and provision of GE information to the Oregon Department of Agriculture (ODA) prior to open field growing of GE plants, and ODA is required to report the data aggregated by county to the legislature.
- HB 3293 (2013) Requires commercial producers to provide GE information upon request of adjacent landowner or ODA and establishes a civil penalty for noncompliance.
- HB 2319 (2013) Allows a person who believes that GE cultivation on nearby land is interfering with, or might interfere with, their farming practice to request ODA to conduct a site inspection; requires ODA to conduct the inspection and to order precautions and safeguards to prevent the spread of GE material.
- HB 2675 (2015) Requires retailers and wholesalers provide ODA with copies of signed royalty agreements for use of GE seed, seedling and nursery stock, and provide information on their use, including planting locations and times.
- Senate Bill (SB) 207 (2015) Grants ODA authority to establish control areas for GE commodities.
- HB 3554 (2015) Grants ODA authority to establish control areas for GE management and to establish market production districts.
- HB 2674 (2015) Requires that ODA establish control areas for GE commodities.
- HB 2675 (2015) Requires that ODA designate crop production areas for GE crops, and allows ODA to establish reserve areas where GE crops are prohibited.
- HB 2739 (2017) Creates patent holder liability for GE contamination events in order to avoid pitting farmer against farmer.
- HB 2469 (2017) Eliminates the statewide agricultural seed preemption when a local government deemed it necessary to protect non-GE seeds, and would have created legal protections for the Josephine County GE ban to stand.
- HB 2882 (2019) Creates patent holder liability for GE contamination events in order to avoid pitting farmer against farmer.
- SB 434 (2019) Creates patent holder liability for GE contamination events in order to avoid pitting farmer against farmer.

Limiting Canola Acreage in the Willamette Valley

The ongoing debate about increased canola acreage in the Willamette Valley is another factor that pre-dates, but also runs concurrent to, the GE bans in Southern Oregon, and amplifies the need for specialty seed grower protections. In addition to legislative efforts to protect seed growers from contamination via canola production, agency advocacy—specifically at ODA—has also been required, and both efforts will be ongoing. Currently, a 500-acre cap on canola cultivation is in place but it will sunset on June 30, 2023, and many farmers in the Willamette Valley want unfettered access to grow as much canola as they want. For more history of the canola issue, see Lynne Curry's June 2019 article on the Civil Eats website.

Legislation to address canola acreage includes:

- SB 433 (2013) Prohibits canola production in Oregon. (Unsuccessful)
- HB 2427 (2013) Establishes 500-acre canola production limit in the Willamette Valley Protected District (WVPD) to be used for research purposes only. (Became law)
- HB 3382 (2015) Allows 500-acre annual commercial canola production in WVPD until January 2, 2020. (After which time, without any intervention, there would have been no limits on canola acreage.) (Became law)
- SB 885 (2019) Continues 500-acre annual commercial canola production in the WVPD until June 30, 2023. (Became law)

ODA also had to address the conflict around canola acreage in 2019 since the 500-acre rule was going to sunset at the beginning of this year and there was no guarantee that the legislature would produce a "fix." (SB 885 actually passed on the last day of the 2019 session.) As a result, ODA announced that it would do rulemaking around canola and convened a Canola Rules Advisory Committee (RAC), which was comprised of various stakeholders including corporate interests, pro-canola voices, as well as some farmers who supported protections for conventional and organic seed growers. There was a hearing at ODA in June 2019 in which the public could comment on the agency's proposed canola rule, and due to grassroots outreach, many organic seed farmers and advocates submitted testimony, and/or showed up to testify.

Seed growers and advocates will need to continue to educate the legislature and ODA about cross contamination issues stemming from canola, as the fight for additional canola acreage will inevitably return as the June 2023 "sunset" of the 500-acre limit draws near.

General Lessons Learned and Next Steps

It is heartening that Oregon has one GE-free zone, Jackson County, and the aforementioned canola protections for seed growers in the Willamette Valley. However, it is disappointing that the legislature has not been responsive to more equitable approaches to GE contamination that create a level playing field for organic famers. Grassroots coalitions that work on these issues

simply lack adequate funds and resources to successfully stand up to the full time coterie of lobbyists that are funded by corporate interests.

As the market value of organic seed increases, organic seed stakeholders in Oregon will need to raise funds to better advocate in Salem. That said, solid incremental progress has been made in that these bills are getting hearings and legislative champions are emerging. At the end of the 2019 session, legislators promised to convene a work group to address organic and GE contamination issues. The Oregon Organic Coalition is currently taking the lead in convening the work group with the goal of creating a "Oregon Organic Action Plan" that would prepare legislation to introduce in the 2021 session. The goals of the Oregon Organic Action Plan include:

- Formalize a state-assembled Oregon organic task force
- Expand organic trade and market facilitation
- Initiate an organic sector gap analysis
- Evaluate financial and direct assistance that increases organic farm and business performance
- Leverage organic education and research opportunities

Oregon Organic Coalition members understand the importance of organic seed and will work to include seed protections in the plan. Pennsylvania created a similar plan and has seen monumental growth in their organic sector. There is also an Organic Stakeholder Group that meets with ODA quarterly and the group hopes to raise the profile of the organic industry within the agency so that policies can be more supportive of growing organics—seeds and all.

<u>Other Recent Legislative Efforts to Protect Seeds</u>

1. The New York Senate passed S4206A which would allow for an affirmative defense against liability if the party can show that he or she did not knowingly and intentionally introduce the genetically engineered or genetically modified organisms into his or her plants or seeds. While the bill passed the Senate, it did not pass the House and become law. It appears that a version of this bill has been before the New York legislature since 2001.

2. In 2019 Vermont's legislature passed a law that creates a committee to review new genetically engineered seed traits before they can be sold, distributed, or used in the state. This law makes Vermont the only state to require additional approval of seed technology on top of the federal process.

<u>Other States Efforts to Address Coexistence</u>

U.S. GE Bans

• California: Six of California's 58 counties have banned GE crop production; the counties are mainly clustered on the northwest coast: Mendocino County (2004), Trinity County (2004), Marin County (2004), Santa Cruz County (2006), Humboldt County

(2014), and Sonoma County (2016). The cities of Arcata (2004) and Point Arena (2005) also prohibited the sale, distribution, and production of GE seeds or crops

• Maine: The Town of Montville (2006) banned GE crop production

• Washington: San Juan County (2012) banned GE crop production

• Colorado: Boulder County (2016) banned GE corn and sugar beets in the county, though transition deadlines don't occur until 2021 and 2025 respectively. The City of Boulder banned GE crop production

• Hawaii: Three of Hawaii's four counties (Hawaii, Maui, and Kauai) passed prohibitive GE regulations, and all three were struck down by the courts, finding the laws were pre-empted by state jurisdiction

• Vermont: The City of Burlington has a moratorium on GE food

Control Areas & Protected Districts

• Oregon: Established GE bentgrass control areas banning it from the Willamette Valley and restricting its growth in Jefferson County. The state also established protected districts where canola growth is limited

• Idaho: Established Protected Districts where canola growth is limited

• Missouri: Biopharmaceutical GE crops have grower districts, established cooperatively between farmers

Mandatory Disclosure of GE Cultivation

• Hawaii: Kauai County passed an ordinance requiring large farms and companies to disclose where they grow GE crops (overturned in court)

• Oregon: Mandatory canola pinning within Willamette Valley Protected District

• Washington: Brassica crop pinning is required by state law

Voluntary Mapping & Pinning

• Illinois: DriftWatch is a specialty crop site registry that was designed by Purdue University and is operated by a nonprofit company in collaboration with agricultural stakeholders. The primary participants have been the organic sector

• Oregon: The Willamette Valley Specialty Seed Association (WVSSA) maintains a voluntary mapping and pinning website for specialty seed crops; The Southern Oregon Seed Growers Association (SOSGA) also maintains a voluntary mapping and pinning website

Mandatory Best Management Practices (BMPs)

- Maine: Best management practices are outlined in rule to promote coexistence of GE crops with conventional and organic crops

Voluntary BMPs

- Minnesota: The University of Minnesota agricultural research center published a co-existence guide for farmers that includes best management practices and resources for GE and non-GE producers

International Efforts

While an assessment of international regulations is beyond the scope of this paper and presentation, it is worthwhile to note that many countries have more advanced approaches to preventing GE contamination than the United States. For example, Portugal goes above the standard European Union regulations for GE "co-existence" and requires training and notification and data management for all GE growers. Portugal also has GE-free areas and a compensation system for farmers who can demonstrate that they have suffered economic loss due to accidental GE cross contamination. The fund is financed by taxes applied to GE seed packaging that is marketed and sold within Portugal and the Treasury department collects the taxes from seed producers and packers. Interestingly, if a GE grower does not comply with the coexistence rules and contaminates another grower's crops, the GE grower can be civilly liable.

Developing a Radical Vision for Federal Agriculture Policy: Putting Organic and Regenerative First

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It's easy to forget how all-encompassing the role of government is in our national food and farming system. But there is hardly a single facet of American agriculture uninfluenced by government action, which affects what we grow, where we grow, how we grow, and even who does the growing. For the last half-century at least, federal policy-makers have marched in lockstep with the giant "agri-business" corporations now responsible for most of the calories consumed by most Americans. And thus our government's agriculture policy consistently supports and entrenches the primacy of industrial agriculture, ignoring its deleterious effects on workers, consumers, the environment, and the climate. This panel and group discussion seeks to collectively imagine a future in which government policy not only supports rational alternatives to the destructive status quo — namely organic, regenerative, and agroecological systems — but also actively opposes industrial farming, recognizing it for what it is: a threat to the future of humanity.

This exercise may seem pie-in-the-sky, but I believe it is necessary and perhaps even timely. Given a U.S. presidential election this year — with multiple candidates proposing progressive agricultural policies — and an increasing understanding within the population that our conventional food and farming system is broken, we could very well be nearing a major inflection point in American agricultural history. Yet, as Frederick Douglass said, "Power concedes nothing without a demand." So that leads to the overarching question we seek to begin answering with this session: "What are our demands?"

Of course, this leads to many more questions, starting with the obvious: who is included in this "we"? Since these are the proceedings of the Organic Seed Growers Conference, it's tempting to suggest that "we" must be the amorphous and decentralized "organic seed movement" or the broader "organic farming movement," but I hope this conversation will include perspectives of those who may not consider themselves part of either movement, and instead align themselves and their practice with related movements or currents, including agroecology, Afroecology, Indigenous, regenerative, permaculture, biodynamic, agroforestry, anti-GMO, open source seed, and others. To my mind, "we" includes anyone who believes industrial farming is dangerous and must be rolled back or abolished.

As a jumping-off point for discussion, I offer here a suite of proposals (which I first compiled as a longshot congressional candidate in 2018, later modified as policy director for a longshot presidential candidate in 2019, and have again modified for our purposes here), followed by an essay featuring background information and deeper explanations of some of these policies:

1. End subsidies for conventional/industrial farming corporations, while dramatically increasing subsidies for farmers practicing or transitioning to sustainable methods.

2. Strengthen antitrust laws and enforce them in the agricultural industry in order to combat consolidation and monopolistic business practices.

3. Restore accountability and oversight to the USDA and FDA by removing former corporate lobbyists and other industry-affiliated individuals from positions of power.

4. Improve, expand, and create programs to help farmers (and prospective farmers) of color and others from historically disempowered communities (Black, Indigenous, and People of Color, or "BIPOC") to access farmland, services, and credit.

5. Establish an agency within the USDA to make reparations to individuals and descendants of individuals whose lands or livelihoods were lost due to federal action or inaction rooted in bias and discrimination.

6. Dramatically increase funding for the Bureau of Indian Affairs' agricultural programs, to enable all Native Americans, Alaskan Natives, and Native Hawaiians to make a living as farmers if they so choose.

7. Create a 21st Century Sustainable Homestead Act, including provisions to create a permanent National Land Bank, to put unutilized farmland back into production (under strict sustainability requirements), increase opportunities for would-be farmers (giving priority to BIPOC farmers), and expand access to healthy organic food for all.

8. Pass laws to stop foreign countries and corporations from buying up U.S. farmland.

9. Increase public nutrition assistance for needy families, with additional subsidies to encourage the purchasing of organic food.

10. Increase funding for community-based programs and education relating to healthy food preparation, farmers markets, and urban and community gardening.

11. Improve working conditions and strengthen human rights protections for migrant farmworkers, while expanding guest worker programs in agriculture and related industries.

12. Pass a federal law to supersede and ban state or local "gag laws" (which prevent whistleblowers and journalists from revealing industry behavior), and "seed preemption laws" (which prevent local municipalities from banning certain types of seed).

13. Ban utility patents on living beings (or at least plants) by amending 35 U.S. Code §101.

14. Initiate a wide-ranging inquiry into "Right to Farm" laws and explore the feasibility of federal legislation to ensure that such laws protect small farmers but do not allow industrial farmers to pollute and cause other public nuisances with impunity.

15. Enshrine into law a federal "Right to Repair" farm equipment and other high technology.

16. Establish through law that no state or municipality may prohibit a property owner from growing food plants anywhere on their property.

17. Institute mandatory on-package country-of-origin labeling for all agricultural products.

18. Institute mandatory on-package labeling of genetically engineered foods (GMOs) in clear, visible language.

19. Launch a thorough and rapid inquiry into the safety and efficacy of GMOs, along with the legal processes by which GMOs have been approved for sale, in order to determine whether or not they should remain available.

20. Launch a similar inquiry into the safety and efficacy of chemicals commonly used in agriculture, with particular attention paid to known hazardous compounds like glyphosate, dicamba, atrazine, chlorpyrifos, malathion, neonicotinoids, and others.

21. Prohibit the production and use of agricultural chemicals deemed dangerous.

22. Legalize cannabis (hemp and marijuana) farming with no restrictions on its sustainable cultivation.

23. Direct more federal funds toward research into organic and regenerative agriculture.

24. Incentivize farmers to use regenerative, carbon-sequestering methods through loans, grants, and tax deductions.

25. Expand funding for public plant breeding and the Agricultural Research Service (including the National Plant Germplasm System).

These proposals are far from complete, but if enacted they would certainly lead to a significant shift in America's farming landscape. It is my hope that other participants in this discussion, including attendees and fellow panelists, will offer their own proposals, and that together we might begin to create a platform to help guide activism and advocacy for years to come.

The Rise of Corporate-Industrial Farming

In the 1930s, there were nearly 7 million farms in the United States. Today, there are just over 2 million. We lose more farmers every year, and the average age of farmers is at an all-time high (around 58 years old). As the number of farms and farmers decline, the farms that remain are getting bigger: in 1987, only 15% of all cropland in the U.S. was on farms 2,000 acres or larger; by 2012, that number had risen to 36%, and it continues to rise. The result of all this is an agricultural system in which small and mid-sized family farms struggle to compete, and our rural communities are left socially and culturally gutted (and with dwindling tax bases) as young people leave to seek opportunities in urban and suburban areas.

These trends have many roots, but among the most pernicious is a corporate environment defined by constant consolidation through mergers and "vertical integration," along with a lack of due oversight by the federal government. In recent decades, hundreds of seed companies have been swallowed up by giant international conglomerates to the point that now just four companies control 60% of global proprietary seed sales. In the United States, one company — Monsanto, now a part of the German firm Bayer — has cornered the market on seed sales to such a degree that over 80% of corn acreage and 90% of soybean acreage are planted with

Monsanto's patented genetics. Not only does this lack of competition mean higher prices for farmers, but it also means a dangerous decline in crop biodiversity with potentially grave ramifications for all of us.

In livestock industries, the trend toward vertical integration — with single firms controlling every part of the supply chain — has led to staggering declines in family farms. Take the pork industry: in 1978, according to the USDA's agricultural census, there were 512,292 farms raising hogs, and the average farm had an inventory of just 115 pigs. In 2012, the number of farms raising hogs was down to 63,436, a decline of 87%, and the average inventory per farm was over 1,000 head, with 83% of all animals in operations with over 5,000 hogs. In the chicken industry, the three biggest companies now have a 90% market share. All of this came to pass despite the government having the power to put a stop to it.

Since the peak of the gilded age, when "robber barons" amassed unimaginable wealth on the backs of poorly treated workers, the U.S. government has passed and exercised a wide array of antitrust laws to combat monopolies and cartels, and prevent mergers and acquisitions that create barriers to fair trade. These powers have been utilized to break up such massive companies as Standard Oil and AT&T. Yet, in the field of agriculture, the government has failed utterly to hold large corporations to account. The federal government (acting through the Department of Justice, the Federal Trade Commission, and the Department of Agriculture) has the power to prevent further consolidation in agriculture, and even to break up monopolistic businesses that are harmful to fair competition. It also has the power to stop subsidizing the massive farming corporations that already make huge profits at the expense of small farms and farming communities. It is time for the federal government to act.

Agriculture & Climate Change

In order to convince policy-makers and the general public to make drastic changes to our agricultural system, we will surely need to educate them about the role farming plays as a driver of climate change, which itself is increasingly understood as an existential threat to humanity. Few people realize that a huge percentage of global greenhouse gas emissions come from agriculture and land use. In fact, according to the Intergovernmental Panel on Climate Change (IPCC) farming and forestry are just about as responsible for the high level of greenhouse gases in the atmosphere as electricity and heat production (agriculture and land use are responsible for 24% of global greenhouse gas emissions, electricity and heat production for 25%). Transportation is only responsible for 14% of global greenhouse gas emissions.

Modern agriculture, which our country has exported around the world over recent decades, is a huge driver of climate change, especially through annual tillage, deforestation, and livestock management practices. The Rodale Institute has studied this topic for many years and calculates that if we converted 100% of all crop and pasture land to regenerative organic practices, we would remove more carbon dioxide from the atmosphere every year than we currently emit. In other words, we could start reducing excess carbon from the atmosphere today through better farming practices.

But farms big and small must be given the tools and support they need to transition to more climate-friendly practices. If we incentivize enough farmers to make the switch — and if we also

devote substantially more resources toward research into organic farming, agroecological farming, perennial staple crops, sustainable ruminant grazing, and soil science — we can make agriculture a potent weapon against climate change, instead of just another driver of it.

Farm Justice & Land Access

In 1920, there were nearly a million Black farmers in the United States. Today, there are fewer than 50,000. While many people no doubt made the choice to leave the farm, far too many were forced to leave — sometimes even at the barrel of a gun. Decades of discrimination against Black farmers (and other farmers of color), by the USDA, private lenders, and even their own neighbors, has resulted in a historically low percentage of non-white farmers. It will take concerted federal action to ensure that anyone who wants to farm can farm, no matter the color of their skin (or their national origin, religion, sex, sexual orientation, gender identity, or gender expression). Additionally, reparations for past wrongs will be key to building trust and ensuring that past oppressions are not repeated.

Such farm justice is not only important for moral reasons, but practical reasons as well: we simply need more farmers — and especially farmers willing to produce food with regenerative organic practices. We need more farmers in every region, so more people can access locally produced food. And we need to expand the ranks of America's farmers to include more people of color, more women, more LGBTQ+ people, and more young people. In order to achieve these goals, it's time to create a National Land Bank as part of a 21st-century Sustainable Homestead Act. A federally-run land bank would be mandated to acquire abandoned, foreclosed, repossessed, or tax-delinquent land suitable for farming and ranching — current landowners could also donate all or some of their farmland to the Land Bank in exchange for significant tax credits — and the Land Bank would provide allotments to applicants who commit to bringing the land into production using sustainable methods. Loans and grants would be made available for the construction of "green buildings" for housing and barns, as necessary, and priority should be given to applicants from historically disempowered populations. Participants in the program would need to demonstrate over 7 years that they are utilizing and improving the land in order to gain full ownership.

A National Land Bank and Sustainable Homestead Act would revitalize rural communities, begin increasing the number of farmers, and help society deal with the twin crises of climate change and environmental collapse by dramatically increasing the use of carbon-sequestering farming practices. It would also help us begin to deal with another major issue: foreign countries and corporations buying up more and more U.S. farmland. Foreign concerns, including those associated with the Chinese, Russian, and Saudi governments, already own over 25 million acres of U.S. farmland, an area larger than the entire state of Indiana. A well-funded Land Bank would have the ability to buy cheap farmland that might otherwise be snapped up by foreign investors, but it is not the only solution to this problem. We should also pursue legislation to tackle this issue directly, similar to the laws against foreign ownership of farmland already on the books in six states, including major farming states like Iowa and Minnesota. We cannot accept a situation in which more and more farmers find themselves forced into working for foreign entities simply because they cannot afford land themselves.

Food Security & Plant Germplasm

Considering how much rhetorical focus politicians place on "national security," it is shocking how little they seem to know or care about food security over the long term. In the face of climate change and under threat of total environmental collapse, we must realize that maintaining a basic food supply is going to become ever more challenging. We as an organic seed movement need to focus policy-makers' attention on critical issues that impact food security, from soil health and water quality to new farmer incubation to preserving and expanding agrobiodiversity.

A century ago, farmers could get quality seeds, adapted for their local region, provided for free by the federal government. USDA seed banks (or "germplasm repositories") and research stations in every corner of the country hummed with activity. Up until just a few decades ago, public plant breeding was a major federal expenditure, with government plant breeders often working in collaboration with land grant universities to ensure farmers' access to top quality seeds, resistant to emerging pests and diseases, and with high yields and strong vigor. The plant varieties produced with public funding were considered the intellectual property of the federal government, so they effectively became public varieties, freely available for farmers to grow and other plant breeders to use in future breeding efforts. This system encouraged innovation in agriculture and undoubtedly helped America become the world's "bread basket" by the mid-20th century. But in 1980 the Bayh-Dole Act was passed. It dealt with intellectual property, and included provisions allowing universities and other organizations to seek patents themselves for research conducted with public money. It likely wasn't the intention of the authors, but this law has led to a flood of corporate money into public research institutions like universities, with licensing agreements that allow corporations to profit off of what were formerly considered public domain plant varieties. At the same time, the federal government has slashed public funding of plant breeding and agricultural innovation, resulting in fewer and fewer new public domain varieties and increased reliance on private companies whose primary motive is profit, not the public good.

Diversity is our best hedge against climate change, with its extreme weather, unpredictability, and increased spread of diseases and pests. We need to expand crop diversity through public plant breeding and by directing more resources toward the preservation of whatever agrobiodiversity remains, both ex situ (such as in genebanks) and in situ (in the wild or in traditional farming communities). It is time for the federal government to step up and once again make germplasm conservation, plant breeding, and improvement a national priority. As the climate warms, it will become harder and harder to farm with existing methods and crops. Plant varieties that once thrived in a certain place will have to be grown hundreds of miles farther north, and will need to be resilient enough to withstand increased droughts, precipitation events, and extreme temperatures. This will require more crop biodiversity, not less, and it will require an army of plant breeders just to stay on top of emerging pests and diseases.

We cannot rely on corporations, whose behavior is dictated by quarterly profits, for our long-term food security. They cannot be the only ones breeding plants and releasing new seeds. Innovation in agriculture must be aimed at public benefit, not private profit.

Conclusion

Revolutionizing our food and farming system will not be easy. But it is not impossible either. Our deeply flawed government is supposed to enact the will of the people, and who among us would actually wish for the agricultural system currently in place? Politicians rarely make an issue of sustainable farming policy — indeed, they rarely make an issue of farming policy at all, unless pandering to their farming constituents — because most people are not concerned about sustainable farming. While this situation is changing, it is not changing fast enough. It is therefore incumbent upon all of us, as people who understand the importance of organic and regenerative agriculture, to educate people about the reality of our situation and to push policy-makers to make the changes we know are necessary.

If we don't start growing the agricultural future we want — which not only means developing alternatives, but also fighting the status quo — it may soon be too late.

Risks and Opportunities of Open Source in the IP-dominated Seed Industry

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Seed sovereignty is an all-hands-on-deck, right now, kind of mission. Time is running out and the stakes are high. As many others, I have been driven by my passion for the Earth for as long as I can remember. So, why of all things did I pursue an education in economics, entrepreneurship, and innovation? As I said, this is an all-hands-on-deck kind of mission; it requires every talent, resource, passion, and idea. To ensure biodiversity, we need to protect seeds, farmers, and gardeners who ensure that they live on, and the breeders who use their creativity to create the best possible future for our children. This cause also needs entrepreneurs and economists, advocates and educators, funders and customers, scientists, storytellers, artists, leaders, and followers – people of diverse ages, genders, and races. Solutions are hiding in places we can't see, yet. Seeds affect everyone living on this planet. It should, and can, be financially sustainable for those who want to contribute to protecting seed biodiversity to do so. I'd like to paint a picture of how this might happen, given the resources that I have learned to seek.

As the seed industry evolves, the rapidly expanding network of intellectual property restrictions and condensing network of ownership erode seed sovereignty. Simultaneously, the Earth is more than ever in need of seed biodiversity for immunity from the various threats of climate change. More specifically, humans need seed biodiversity if we are to keep living on this planet. The open source seed movement is addressing an urgent problem – the steep decline of seed biodiversity, from the source – the restrictions imposed on the availability of genetic resources which limit people's freedom to own, save, breed, and sell seeds. Key components of a healthy ecosystem are being held hostage by a handful of companies, and the chances are slim that we can replace them once they are gone. The risk is high.

For agrichemical giants, genetic modification is the vehicle, intellectual property rights are the key, and unparalleled business strategy is the engine. Genetic modification allows for maximum exploitation of land and technology for maximum profitability. It is becoming an exponential technology, wherein the efficiencies will continue to make innovation cheaper and faster than ever before. When innovation in genetic modification of seeds comes with an increase in industrial agriculture methods, pesticide use, and biodiversity loss, this presents a breadth of dangers for people and the planet. Intellectual property rights hinder the competitive potential of organic seed companies through barriers to entry, such as restrictions on genetic resources, fear of litigation, and increased overhead costs. This hinders the potential of small and independent seed developers, pushing the market into a centralized and concentrated hub of power backed by legal, financial, and genetic resources. The recent evolution of the industry, which includes the increasing use of Big Data, changing market structure, and rapid technological innovation require a reevaluation of legal and organizational strategies implemented by organizations fighting for seed diversity and freedom from restrictive ownership.

The Open Source Seed Initiative (OSSI) aims to reserve seed varieties for public use, protecting them from privatization, thereby inhibiting further consolidation of market power over seed. By using "copyleft" contracts to achieve this end, OSSI uses the concept of open source to ensure

future seed diversity. The open-source strategy allows for sharing of information and the freedom to improve upon others' innovations, both incentivizing competition and stimulating cooperation among innovators. Such collaboration also increases the likelihood of food security in the face of environmental uncertainty by granting access to interdisciplinary experts and professionals. OSSI is one of the many organizations fighting to protect seeds from extinction and restrictive privatization. They have been able to prove that open source seed is a viable and desirable pathway to achieving this goal, backed by the many partners and pledged seed varieties. Now that the primary stakeholders have approved what could be viewed as the "prototyping" phase, it is time to seek funding opportunities and craft the rest of an innovative business model, such that there are enough monetary incentives for more breeders, companies, farmers, and organizations to participate.

Biotech giants have diversified their revenue streams, making them extremely risk tolerant to making large investments. This diversification provides these companies with a back-up plan. Diversification occurs either through mergers and acquisitions with other companies operating in the same sector or through expansion of business activities into other sectors of the industry (simultaneously taking advantage of horizontal and vertical integration). Using cross-subsidization means that if a harvest, investment, product or market fails, they have a safety net and can continue to expand and win market share, despite the short-term loss. At present, the open-source seed movement is missing that safety net – but, it would be achievable given a proper capital and finance structure. Organizations are still small and often dependent on donation-based funding, and are susceptible to losses due to a bad harvest, diminishing margins, legal battles, or contract failure.

There is a hope that raising prices on the grounds of being a social-benefit movement like "fair trade" will motivate income, but higher prices shouldn't be the go-to solution to financing issues for a variety of reasons. First, this will ultimately make organic seeds even more inaccessible and the food security gap will continue to widen. We should not count on higher seed prices or breeder's royalties to balance out investment shortages and sustain breeding programs if we indeed are looking for justice and inclusion. Second, raising prices on seeds won't make a significant difference in the earning potential of independent seed developers. Third, the margins earned by increasing seed prices likely won't be big enough to spark the momentum in open source breeding that is required for scaling this project, so there would be a limit to the achievable impact. Most importantly, when relying on one revenue stream, there is no safety net.

However, by applying a bit of creativity when it comes to financing and organizing the initiative, integrity and sovereignty can be restored while providing more non-IP incentives to breeders, as well as ensuring their livelihoods. Open source, on its own accord, does not necessarily put organic seed breeders and farmers in a position of advantage. Just as patenting a seed won't financially suffice to compensate breeders to continue to do their work. Rather, it is the legal and business structure surrounding open source that will provide security in the quest for biodiversity conservation, seed justice, and resistance to restrictive intellectual property.

As I see it, an important step to figuring out how the Open Seed Source Initiative will be the most successful (achieve its mission on the greatest scale, delivering maximum impact to those

it serves) is to assemble a team dedicated solely to performing an analysis of the business model. This means thoroughly analyzing financial, organizational, and qualitative data across sectors, areas of specialization, customers, potential funders, partners, and other stakeholders. Identifying and tracking key metrics alongside the financial data will lead to a better understanding of what the outcomes really are, and what changes need to be implemented for improvement. The assumption that the problem being addressed is the correct problem should also be proven. Alongside an analysis of what is happening now, all the available resources should be evaluated, and whether they are being used to their full potential. Ideas like blockchain, hybrid business models, cooperatives, impact investment, interindustry collaboration, niche markets, entrepreneurial talent resources like the Stanford d.school, and many more should be thoroughly considered.

The goal of performing a business-oriented industry-wide strategy analysis would be to build out a plan to improve financial feasibility, create space for testing and iterating approaches rapidly, and ensure the potential to scale. For organizations fighting for a social cause in spite of rapidly changing constraints from their competition, it is important to be nimble. The odds that the first version of a solution will be the best one in a situation where there are so many stakeholders and overlapping issues are slim. An appropriate source of funding would give organizers flexibility, adaptability, and autonomy in achieving their mission. An increasing number of businesses classified as social enterprises have made a living making a positive impact on social and environmental issues by getting creative about their financial and organizational strategies. Seed sovereignty can be strengthened by identifying and achieving a capital structure and business model that would expand the reach of the open source seed movement beyond what has previously been imagined. The complexity of this issue means that no one viewpoint, approach, idea, action, group, demographic, or talent is enough. This is just one of the many things that should be done.

Where Does Open-Source Seed Fit in an IP-dominated Industry?

Claire Luby, Open Source Seed Initiative

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In this session, I will be reflecting on my experiences co-founding, and being executive director and board member of, the Open Source Seed Initiative (OSSI, www.osseeds.org). We will be discussing both the concept of open source release mechanisms hypothetically and the experiences of the Open Source Seed Initiative in practice. By definition, "open-source" generally refers to utilizing some mechanism of intellectual property rights to ensure continued access to or use of an "open-source" seed, and its derivatives. This is distinguished from "open access" or "the commons," which would allow anyone to use the seed for any purpose, including developing a new variety with that seed and restricting others use of the new variety through IPR. "Open-source" allows for use of a variety for any purpose, given one restriction: that the user agrees not to restrict others continued use of that variety or any derivatives of that variety. This, in a sense, creates a "protected commons" of plant varieties that would be available to use now and into the future.

This concept is more challenging to enact for plant varieties than it is to articulate how it might operate hypothetically. The concept of open source was first developed for software code. A person who wrote a new piece of software code could claim copyright over their code, and then attach a "copyleft" license to that code to ensure that other developers would be able to use their code and iterate on that code, but they would be agreeing to allow others the same ability to iterate on their iterations. However, a plant breeder cannot claim copyright over a new plant variety. Legally, this makes developing an open source system for plants more complicated than it was for software. Without the inherent control afforded by copyright, a copyleft license has much less effect. Since licenses are a form of contract law, that license or contract must be passed along with each transfer of the seeds. As everyone in the seed world knows, having a piece of paper follow every seed of a specific variety would be nearly impossible. In order to develop at least one system of open source for seeds, we founded the Open Source Seed Initiative in 2015.

OSSI has developed an open source release mechanism for new plant varieties that ensures that those varieties, and the genetic diversity they represent, remain available to use for breeding, seed saving, and research (and more) given that the user agrees to allow the same freedoms to others on derivatives of the open source variety. We have done this through the creation of the OSSI Pledge, technically a short license, which reads: "You have the freedom to use these OSSI-Pledged seeds in any way you choose. In return, you pledge not to restrict others' use of these seeds or their derivatives by patents or other means, and to include this Pledge with any transfer of these seeds or their derivatives."

The Pledge ensures the four seed freedoms:

1. The freedom to save or grow seed for replanting or for any other purpose.

2. The freedom to share, trade, or sell seed to others.

3. The freedom to trial and study seed and to share or publish information about it.

4. The freedom to select or adapt the seed, make crosses with it, or use it to breed new lines and varieties.

Since 2015, OSSI has worked with 40 plant breeders who have released 500 varieties of OSSI-Pledged seeds sold by 68 seed companies in the U.S., Canada, the U.K., Australia, and New Zealand. OSSI has also collaborated with groups in Germany, India, and Argentina to develop open source seed systems that work in different legal and cultural frameworks. In addition to maintaining a database of open source varieties and working with partner plant breeders and seed companies, OSSI has also been involved in many conversations about developing new funding solutions for plant breeders, as well as conversations about seed sovereignty and justice.

In this panel, I will reflect on our experiences developing OSSI and working with our many partner plant breeders and seed companies to address some of the questions presented to the panel. For example, I will talk about the freelance plant breeders who release varieties through OSSI, and include examples of how some of them are able to support their plant breeding work in various ways. I'll also discuss the "next generation" OSSI Pledged varieties, and the challenges and advantages of the viral nature of open source systems. Additionally, I'll discuss how OSSI pledging does and doesn't influence quality and supply needs compared to other market forces. And lastly, where and for whom the OSSI system is working and how it might be improved to contribute more to seed justice and inclusion.

IP and the Farmer Breeder—Why Patents and PVPs Don't Work for Me

Frank Morton, Wild Garden Seed

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The Open Source Seed Initiative was born from a need to keep the traits and associated germplasm found in our common seed heritage from being privatized by corporate entities intent on controlling different sectors of the seed industry. OSSI's Pledge to keep germplasm in the breeding-and-using commons is a type of intellectual property claim in itself, a kind of anti-patent, that says what may be done with the seed (everything), and stipulates that every use and progeny of that seed is as free as the seed itself, evermore.

One of the uses OSSI is most concerned with is the potential usefulness of every seed in breeding varieties of the future. OSSI contributors are generally independent breeders, folks unaffiliated with employers that have an economic interest in the breeding outcome. Independent breeders usually wish they could get paid (somehow) for breeding, but this is seldom the case. Mostly they breed for passion and pay the bills otherwise. I grow seeds for sale, and breed on the edges of that. My breeding gives me different seeds to grow (over time), and this is how everything gets paid for—seed sales. New varieties seldom make money right away; they slowly grow an audience. As we often say around the house, overnight success takes about 15 years. Plant Variety Protection (PVP) and patents expire in 17 or 20.

Independent breeders of the farmer sort are busy with the demands of farming, and there isn't much free time or loose money to invest in something as risky and vague as IP protection of a vegetable or flower of our own creation. To patent a variety or trait is an expensive and long-term endeavor, between $10,000 - $20,000 and 3 - 5years. Getting a PVP certificate on a finished variety is a deal, by comparison, perhaps $2,000 - $3,000 and 3 years. Once a patent or certificate is issued, it must be policed and defended, possibly by going to court. Failure to do so nullifies the protection.

Breeders with corporate or institutional backing might be eager to accept these costs and enforcement challenges, but these breeders don't have to pay for the lawyers and staff to police their claims. When an IP protected variety is released by a corporation it is backed and promoted through advertising and sales rep presentation, perhaps it is offered exclusively through the biggest seed catalogs in a market area, and that catalog will put special effort into promoting the variety. Independent breeders have none of the clout, staff, attorneys, advertising, or cash reserves to capitalize on the exclusivity of the intellectual property they might generate.

To add personal perspective to this, I have released around 150 varieties or gene pools in 26 years. While many of these are not worthy or eligible for IP protection, they all contain interesting traits that I would not want patented by others. The cost in time and money to protect my releases would be losing propositions in most cases, and would cost more than the variety is worth in the marketplace. And if I had to go to court to protect and defend "my intellectual property," there is no variety that could justify the expense. In other words, the normal means of IP protection does not work for me as a farmer breeder.

The great virtue of the OSSI Pledge and the registry is its simplicity and negligible cost to the breeder. By publishing the description and origin of the variety and traits of interest, the OSSI system establishes a record of prior art and a breeder's intentions to keep the germplasm and its embodied traits in public circulation. The prior art aspect of this is critical in challenging patents that would infringe on OSSI-pledged seeds and their traits. Patents are for inventions that embody novel aspects, and the existence of "prior art" should disqualify an invention from receiving patent protection on those aspects of a new product. In the case of seeds, the identification and description of plants and their traits that arise from those seeds should prevent others from claiming those traits as novel, making them ineligible for patent protection.

I don't think OSSI should have been necessary to protect natural plants in the first place. All of the traits found in plants are the creation of nature, in my view, and the idea that any natural plant embodies the novel invention of a person is pure hubris. I will accept that plants modified by transgenic insertions of genes from unrelated species are novel, and could constitute a legitimate "novel invention." But that is a separate issue. I will also accept that there can be new "genetic combinations" embodied in plants, what we commonly call "new varieties," and that there is some legitimacy to a breeder making a claim to that variety as their own piece of work, the same way a poet or songwriter makes a copyright claim to a new arrangement of words. But this is authorship, not invention, and the difference is significant. Authors don't prohibit others from using the same words to make new works, but that's because words cannot be patented. It should be the same for the natural traits of plants. People did not invent them, and should not be allowed to prevent others from using those traits to create new varieties.

While I don't employ the PVP system to prevent others from growing and selling my new varieties, I can at least understand the logic behind Plant Variety Protection. It is the copyright logic we have all grown up with, and it is a recognition that creating new varieties requires work, and work should be rewarded. The PVP system as it is currently written allows others to use the variety in any manner, including for breeding or saving one's own seed for use in growing crops. Its only restriction is to prevent others from selling the protected variety without permission of the breeder, just as I may not publish the writings of Wendell Berry without the author's consent. I get the fairness principle at work here, even if the expense of PVP is a hindrance. New versions of PVP regulation may eliminate the allowances currently provided, in which case, PVP would be as restrictive and objectionable as patents.

Presently, OSSI is the best model of IP protection available to independent breeders in the U.S. who want to share, and to defend the idea of a genetic commons against corporate attempts to own and control genetic resources. A better idea is to challenge the patentability of the works of nature, including natural genes and the living traits that arise from them. That will be a long struggle in the USA.

Community Seed Stewardship

Melissa DeSa, Working Food; Noah Schlager, Native Seeds/SEARCH; Daniela Soleri, UC Santa Barbara

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Melissa DeSa, Working Food

I am a co-founder of Working Food, a non-profit organization based in Gainesville, Florida. I spent most of my education and career pursuits in the realm of ecology and wildlife, and hold a Masters degree from the University of Florida in Interdisciplinary Ecology. This background and passion for wildlife and wild places has brought depth of knowledge and understanding to my current non-profit work tackling food systems — specifically with a focus on seed stewardship and outreach. I have 10 years of experience in non-profit start up and management, community organizing, food systems, seed stewardship, gardening, farming, education, outreach, and youth programming.

One of the core programs of Working Food is our Southern Heritage Seed Collective program, which focuses on stewarding seeds important to our climate and culture in a way that is accessible and community-based. The program has grown organically over 10 years, from a small seed library to a thriving community program providing classes, workshops, trainings, regional seed varieties, and collaborative work on seed system projects with regional and national partners.

We operate synergistically with a partner non-profit organization, Grow Hub, whose mission is to provide training, opportunity, well-being, and employment to adults with disabilities through agricultural and horticultural work. The day to day efforts of maintaining seed production and trial gardens, seed harvesting, processing, and packaging provides opportunities for adults with disabilities to participate at all levels. Sharing labor in this way is mutually beneficial. As a small non-profit with limited means to pay full salaries with benefits, we can pay hourly work to a population that cannot typically offer full time labor anyway, and cannot earn beyond a certain capped amount that would make them ineligible for social security benefits on which they depend. Furthermore, it provides them ways to use their bodies and minds keeping them active and engaged in a beautiful place with meaningful work and social support. Grown with an expanded sense of care, we have made our seed growing and processing accessible through modified and often very simple adaptations. We can work at a pace that accomplishes the tasks necessary but without the stress or pressure to move fast and do more. The model has worked well for both organizations, sharing resources that accomplish both missions.

Seeds are made available to local growers primarily through a CSA membership style program, but also for sale at retail prices in our office and at two grocery locations. We do not ship or do online orders, even though we have been asked about this many times. We package about 10,000 packets a year, representing about 30% locally grown in addition to other varieties that are known to do well here but we cannot save due to our climate or limited growing space. Our actual seed collection is growing to over 500 accessions, representing a cornucopia of rare, heritage and regionally adapted varieties. As we've grown, we seem to be straddling a place of a

commercialized seed model AND a deeply rooted community of organizers with a passion for more than just seeds. This has given us pause, and in the coming months we will be re-evaluating our efforts to learn where we can best position ourselves for meaningful work and contribute to the overall good of agricultural biodiversity in our region.

Noah Schlager, Native Seeds/SEARCH

My background in both conservation of land and seeds really begins with my family. Through my mother, Donna Wiggins, I am Mvskoke-Creek and Florida Catawba/Cheraw— mixed with Carolina Indian, West African, and European Settler heritage. Through my father, Dan Schlager, I am Jewish of Eastern European descent. They raised me in the San Francisco Bay Area, but stayed connected to family and homelands in what's currently the border of Alabama and Florida. My maternal grandmother, Mama Nell Wiggins, was the one who first taught me to garden, forage, and cook foods that have been in my family since time immemorial. From her I began documenting and learning the food and land care traditions of my family and have gone on to learn from and partner with other Indigenous seed keepers and land/water protectors. A major concern of mine has been the historic exclusion and marginalization of Indigenous people from the dominant conservation and environmental movements, and working to recenter Indigenous voices and knowledge.

I acquired my masters in Environmental Science from the Yale School Of Forestry and Environmental Studies, focused on the history of Indigenous land dispossession and contemporary reclaiming of homelands in the United States with a particular focus on the Bear Ears National Monument. I also helped build a partnership between the Yale's Native American Cultural Center and the Yale Sustainable Food Program to open up space at the school farm for Indigenous students to grow food and medicine plants from their homelands and heirloom seeds of the Indigenous peoples of southern New England. A big part of this work was overcoming structural colonial assumptions of ownership, consultation, agreement, and reciprocity. Solutions are not one size fits all, but ultimately come from integrating proper Indigenous protocols and placing Indigenous knowledge holders and seed keepers at the center of these conversations.

Last year I accepted the position of Conservation Program Manager at Native Seeds/SEARCH (NS/S) on unceded Tohono O'odham and Yaqui land (Tucson, AZ). NS/S stewards close to 2,000 accessions (varieties) of heirloom arid lands seeds, the majority of which are the cultural property and relatives of around 40 Indigenous nations. While an important leader in conserving Southwestern heirloom seeds and advocating for Native farmers, the organization has a mixed reputation and history within Indian Country. Issues around the sale of seeds, cultural ownership, adherence to Indigenous protocols, lack of Native representation, and ultimately who has been given authority to make decisions over the future of the seeds are just a few of the issues that have come up in recent years. I would also diagnose a major issue being the default of the organization to dominant models of conservation, which while touted as objective and science-based, have colonial structural elements which marginalize Indigenous leadership and points of view. Writers like Paul Nadasdy (who wrote Hunters and Bureaucrats and The Politics of Traditional Ecological Knowledge) have shown how even well meaning conservation projects can fail to empower Native people when they do not interrogate the power structures and sys-

tems they recreate. We are actively having to look at the current seed system NS/S has developed, and reshape it into one that better serves and responds to the need of Native growers.

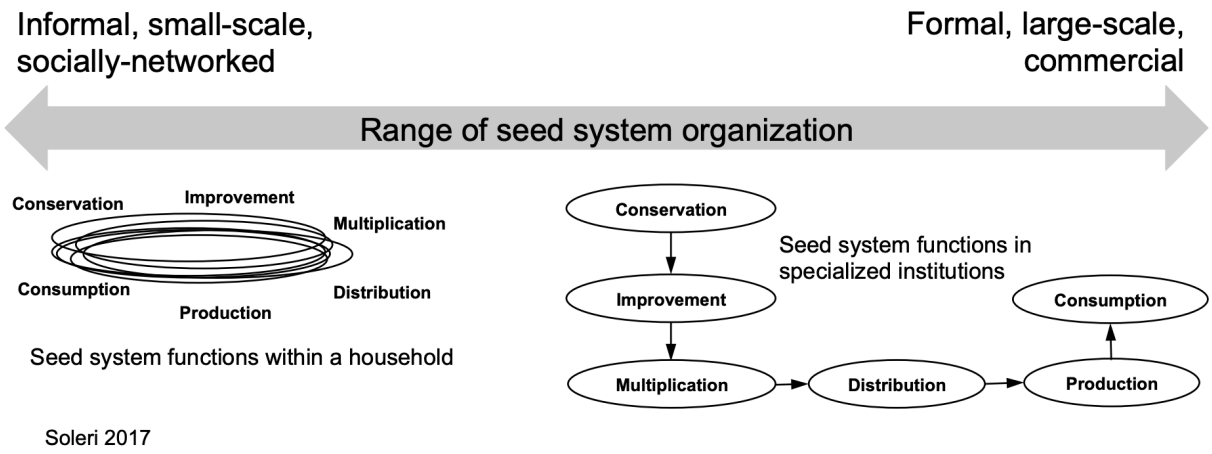
I have taken my position to integrate and demonstrate a conservation and seed banking model which centers Indigenous knowledge/science and actualizes Indigenous protocols into conservation policy. I want to see these seeds integrated into an Indigenous food system which NS/S is supporting at all levels under the guidance and direction of Native leaders from the communities NS/S serves. This process is still in its early stages, but this has included changing seed labeling from English to Indigenous names, restricting the distribution of ceremonial or culturally sensitive seeds, building new and stronger partnerships with Native farmers to grow seeds in-situ, and ultimately working to discuss rematriation of seed varieties to their nations, clans, and families. We hope in the near future to build opportunities for Indigenous focused extension services, facilitating intertribal and multi-community resource and knowledge exchange/partnership, and opportunities for hosting Indigenous knowledge holders and seed keepers to teach the next generation of young Indigenous growers.

Daniela Soleri, UC Santa Barbara

I am an ethnoecologist with a background in anthropology and plant science. My research investigates agriculturalists' knowledge systems, including values and practices, and how those affect crop diversity and human wellbeing. Overall, the goal is understanding farmers' and scientists' knowledge systems to support better collaborations that include diverse forms of knowledge. Frequently my work involves quantifying traditional or informal practices to better understand their value, and to test assumptions often made by researchers about those practices. I have worked with plant breeders, biologists, and other formally trained scientists, and with small-scale farmers and gardeners, including Indigenous Oaxacan maize and bean farmers, Hopi and Zuni Native American farmers, and others, and conducted a 2016 survey of California seed libraries. I coauthored a 2019 book, Food Gardens for a Changing World, with colleagues David Cleveland and Steven Smith. That book is a resource for gardeners, students, researchers, policy-makers, activists, and others for growing food gardens in ways that mitigate or adapt to the major challenges we all face: the anthropogenic climate crisis, increased environmental degradation, and rising social inequity.

In work with farmers and gardeners I have found the diversity of seed systems to be inadequately characterized by concepts of formal and informal, or local and global. Instead, a framework that recognizes the basic functions of a seed system can be more useful. Those functions are: conservation, improvement, multiplication, distribution, production, and consumption. For example, for conservation, all formal, commercial seed systems have relied on traditional agriculture as the original, and often the ongoing, source of germplasm. Many traditional seed systems also include material that has been improved and/or multiplied and distributed by institutions of the formal, commercial seed system. I have found this framework helpful for seeing our seed systems, for comparing them and seeing their interconnections, and for changing them to better reflect our goals and values. Like most conceptual models, this framework isn't necessarily "right," but it is useful, and can be improved. This session asks two questions: Based on participants' own experiences, how can we strengthen the ability of community based

seed management to meet our goals? And, How is community based seed management different than other forms? We will use the framework as a starting place for that discussion.



Participatory Study of Planting Density for Certified Organic Hybrid Field Corn Seed Production

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The poor emergence, vigor, and lack of sufficient leaf area to suppress weed growth of inbred parents hampers the production of certified organic hybrid seed. Many foundation seed companies recommend lower planting density for seed production under organic conditions. Due to high seed costs, seed production companies calculate the quantity of seed to be planted, while many seed grower contracts are written such that yield determines compensation. Given the lack of publicly available research documenting recommended planting density for maximizing yield under organic conditions, research in the organic sector would serve to inform both seed companies and growers in order to foster more productive working relationships. Seed treatments are commonly used in field corn breeding programs and in seed production to overcome poor germination, however, commonly used seed treatments are disallowed under the National Organic Program (NOP). An even and full stand reduces competition from weeds and ensures high seed yields. Therefore, reduced emergence under organic conditions needs to be accounted for in planting density. In 2019 an on-farm participatory study was conducted with GroAlliance LLC, a seed production company, and two contract growers in southwestern WI. Four planting densities, both below and above recommended density, were planted in replicate on the two farms. Measurements of stand, plant and ear traits, and yield in bushels per acre of hybrid seed were taken and evaluated across the four densities. Results from this first year show a trend of increased yield with increased planting density, and some environments show a threshold with decreased yield after planting density is increased to a certain level. As expected, emerged stand was less than planted density in all four environments, with emerged plants per acre ranging from 2,309 to 20,030 fewer than seeds planted. The number of kernels per row and rate of tip blanking did not show clear differences across planting densities.

A Breed Apart: The Plant Breeder's Guide to Preventing Patents through Defensive Publication

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For plant breeders concerned about agribusiness "locking up" stores of plant genetic diversity in utility patents, the current state of defensive publication is discouraging but not hopeless. Current USPTO practices are largely ineffective at capturing non-patent literature, the type of defensive publication that many plant breeders are best equipped to create. However, there are still several valid reasons to believe that defensive publication is worthwhile and that change is possible within the patent examining process. Drafting defensive publications may protect plant breeders from patent litigation by creating a credible timeline showing when they created the plant in controversy. Defensive publications also help the plant breeding community as a whole by facilitating open sharing of plant breeding knowledge. The sum of defensive publication literature amounts to a library of valuable knowledge on which plant breeders can rely, both in a practical sense and as a possible defense to a charge of patent infringement.

Les Refardes: A Tool to Encourage the Use of Local Varieties through Organic Seed Production and Valorization

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Les Refardes is a non-profit cooperative started in 2005 and with its head office in Mura, Barcelona. Its main purpose is promoting the use of cultivated biodiversity mainly through artisanal production and the sale of organic seeds of local varieties from Catalonia. Les Refardes tries to involve as many local stakeholders as possible to slow down the genetic erosion through the reintroduction of a wide range of local crop varieties in food and agriculture. This initiative has certain items and structural approaches that make a big difference to others that also work on the conservation and promotion through the valorization of plant genetic resources. Les Refardes is an open and collaborative project that has served and still serves as a methodological example of the development of considerable experiences in the use of local crop varieties in Spain. Initiatives from different areas, most of them related to the organic and agroecological production, the valorization of products that came from local varieties, found in this association a roadmap example to follow and a place to receive equally productive, administrative, and commercial consultancy. This is why this initiative has a dynamic and multiplier power and its success and development has a positive impact on the generation of local agrifood collective networks for an efficient and sustainable use of plant genetic resources. Its goal is to reintroduce a broad range of plant genetic resources that are at risk of extinction so that professional and amateur farmers can use them. These cultivars have been prospected from traditional farmers. They offered voluntarily both their plant genetic resources and farmer knowledge associated with their handling and management. Thanks to this collaboration and participatory morphological and organoleptic description works, the entity has seeds from approximately 150 varieties of 66 different species through short marketing channels.

Accelerating Corn Elite Selections (ACES) Organic Breeding Program: Novel Strategies to Develop Field & Sweet Corn for Organic Producers

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The goals of the ACES project include: improved disease, weed, and pest resistance, stress tolerance, nutrient efficiency, performance in soil-improving and climate-friendly systems such as organic no-till, quality and yield improvement, and genetic mechanisms to prevent inadvertent introduction of GMO traits through cross-pollination. Our project is developing close-to-variety (elite) organic sweet and field corn genotypes carrying a genetic mechanism for spontaneous haploid genome doubling (SHGD), as well as gametophytic cross-incompatibility (GCI), which will enable more rapid development of superior organic varieties protected against transgene contamination. These materials will be made available to organic breeders, seed producers, and farmers. Both genetic mechanisms together will allow implementation of doubled haploid (DH) technology in organic corn breeding. The DH technology we are implementing does not require application of chemicals (e.g., colchicine), and it is combined with gametophytic cross-incompatibility (GCI) to exclude pollen from transgenic field corn – an urgent problem for organic farmers today. Cooperative research for the ACES project is flourishing through a network of organic farmers, government agency staff (NRCS, ARS), organic seed companies, and university researchers, based on on-station and on-farm that will include plant breeding activities and organic seed production.

Cultivars and Conclusions from Three Seasons of Participatory Beet Breeding in Wisconsin

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Earthy aroma, conferred by the volatile terpenoid geosmin, is identified as the signature flavor of table beet. Earthy flavor in beet is unpalatable to some consumers but enjoyed by others. Table beet geosmin concentration is heritable and due to endogenous geosmin biosynthesis, not association with geosmin-producing microbes. Thus, development of beet cultivars with extreme geosmin levels is both desirable and possible. Participatory plant breeding (PPB) facilitates selection for complex traits in environments, like organic farms, that differ from conventional plant breeding environments. Farmer involvement in PPB can lead to increased varietal adoption and thereby greater program cost efficiency. Thus, a participatory approach was used for a three-year project that sought to:

- Begin development of novel, locally adapted, flavor-identified beet cultivars suited for organic production in Wisconsin.
- Investigate best practices for PPB by comparing single-farm and broad-outreach models.
- Investigate consumer preference for table beet geosmin concentration, flavor profile, and appearance.

Three cycles of participatory selection yielded five experimental cultivars, which comprise the first table beet cultivars with quantified flavor components. PPB facilitated understanding of the geosmin trait and the suite of characteristics associated with hedonic liking of beet. Cultivars with both extremely high and extremely low geosmin concentration were well liked by tasters. Cost efficiency will depend on adoption of collaboratively bred cultivars by farmers and consumers, which will be influenced by flavor liking. Preliminary tasting data suggest that sweet flavor, rather than geosmin concentration, is likely to predict consumer acceptance. The involvement of chefs and multiple farmers in the outreach model may allow for streamlined marketing and increased cultivar adoption.

Agronomic Approaches to Improve Weed Competition, Yields, and Nutritional Quality of Lentils in Organic Cropping Systems

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Organic lentil (Lens culinaris Medik) growers in the U.S. Northern Great Plains have relied on the recommended seeding rates for conventional lentil production of 130 plants m-2 as the appropriate seeding rate for attaining optimum yields. However, the agronomic practices between the two systems are different mainly on the choice of inputs used to manage soil fertility and weeds. The objective of this study was to determine the optimal seeding and inoculum application rates for organic lentil production by considering the choice of lentil variety (based on seed sizes: small, medium and large) on nodulation, yield, weed suppression, protein and mineral content, and the effect on soil microbial communities. Field experiments were conducted at three sites in Montana between May and September of 2019. Treatments included three lentil varieties: CDC Indianhead, CDC Marble, and CDC Greenstar seeded at 100, 200, 300 and 500 seeds m -2 and two rates of a commercially sourced pre-mixed rhizobia + mycorrhizae inoculation applied at the recommended rate and a 2X rate. Increasing the seeding rates of CDC Marble reduced weed population counts in the three sites and CDC Greenstar had low weed counts at the highest seeding rate compared to the lowest seeding rate in only one of the three sites. Nodule counts increased with the x2 inoculation rate across all varieties in two of the three sites. At one location, nodulation only increased in the BBL samples. Yields only increased when seeding rates were increased from 100 to 200 plants m-2 but no significant yield difference was observed between the 200, 300, and 500 seeding rates suggesting a negative return on investment with increased seeding rates above 20 plants m-2.

Varietal Improvement for Direct Market Dry Bean Production in the Northeastern United States

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Edible dry beans were historically an important crop for the Northeast region of the United States, and as a legume species are beneficial for low-input, diverse crop rotation systems. Growers and consumers are increasingly interested in regionally produced staple crops, including traditional varieties valued for their culinary, visual, and agronomic traits as well as their history. However, dry bean production in the Northeast has declined sharply over the past decades, and most variety improvement efforts focus on arid environments and production for the canning industry. At the same time, heirloom bean cultivars increasingly demanded by consumers lack important modern disease resistance and often are difficult to harvest mechanically. Expansion of cultivar options with high culinary and aesthetic value as well as favorable agronomic traits has the potential to increase productivity and profitability for growers and meet consumer demand for high quality edible beans.

This project seeks to increase the viability and profitability of dry bean production in the Northeast by: 1) conducting a needs assessment of organic and specialty dry bean producers; 2) identifying cultivars and breeding lines that can better meet grower needs through trialing and outreach; 3) developing "improved heirlooms" with modern disease resistance and agronomic traits through classical and marker-assisted breeding; and 4) convening growers and other stakeholders to document and share existing knowledge on growing high-quality dry bean seed in the Northeast.

Breeding Cover Crops for Organic Systems

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Legume cover crops are essential to the long-term sustainability of organic cropping systems because they fix nitrogen, improve soil health, suppress weeds, and provide resources for beneficial organisms, such as pollinators. Unlike cash crops, however, cover crops have not been bred to optimize the traits that organic farmers need. The Legume Cover Crop Breeding (LCCB) team is comprised of plant breeders as well as cover crop and organic agriculture experts from multiple universities, non-profit organizations, private sector companies, and governmental agencies from across the U.S., collaborating with ten organic farmers to breed new varieties of hairy vetch (Vicia villosa), Austrian winter pea (Pisum sativum), and crimson clover (Trifolium incarnatum) through traditional, participatory, and marker-assisted methods. We began in 2015 to develop breeding programs in these species and have since expanded our work to include non-legume cover crop species such as small grains and brassicas. We focus on improving these cover crops for traits important to organic farmers, such as winter survival, early vigor, biomass production, nitrogen fixation, soft seed, and flowering time. We will report on the progress we have seen over several years of cover crop breeding, and highlight the participatory plant breeding activities undertaken with our farmer-breeder collaborators. As we move toward release of new cover crop cultivars, we will also discuss challenges and opportunities in organic cover crop seed production.

Harvesting and Marketing Native Prairie Plants for the Organic Market

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There are few options for organic seed for native species from the northern Great Plains. The seed available is primarily from conventional sources. Native plants are important to diversity and in some cases medicinal uses. Native Americans used native plants in several instances. Bringing the diversity back to the landscape or to the field is a slow process. Locating organic seed for native species may require finding the source on an organic location. One farmer has done just that by certifying native rangeland and harvesting seed for two species, Echinacea and the Prairie Turnip. The Prairie Turnip was and still is used as a food source for tribes of the Great Plains. A farmer will share their experience harvesting, growing, and marketing two species native to the northern Great Plains.

Food Gardens for a Changing World

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We need to figure out how to change our food system from one that drives the climate crisis, environmental degradation, chronic disease and social inequity, into a food system that supports equity and creates a stable climate, and healthy environments, people and communities. But how do we do it? We need courageous policies for our food system at global, national and state levels, but we can also do a lot in our own communities and backyards. We suggest five key ideas based on biological and social sciences as a powerful basis for thinking about food production, focusing on household, community, and school gardens. We give examples of how these ideas can be applied to create gardens supporting healthy people, communities, ecosystems and climates.

What Role for "Place" in Localized Seed Systems? Organic Vegetable Seed Production in Southern British Columbia

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A comprehensive look at British Columbia's organic vegetable seed grower community and its contribution to sustainable local food systems and how this community and its impact contrasts with similar communities and organic seed movements elsewhere in North America and across the world.

ECOBREED: Increasing the efficiency and competitiveness of organic crop breeding*

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The ECOBREED project is coordinated by the Agricultural Institute of Slovenia and is carried out in collaboration with 25 partner organizations representing 15 countries: AT, CN, CZ, DE, ES, GR, HU, IT, PL, RO, RS, SI, SK, UK and USA.

ECOBREED will improve the availability of seed and varieties suitable for organic and low input production. Activities will focus on four crop species, selected for their potential contribution to increase competitiveness of the organic sector: wheat (both common Triticum aestivum L. and durum Triticum durum L.), potato (Solanum tuberosum L.), soybean (Glycine max (L). Merr), and common buckwheat (Fagopyrum esculentum Moench.).

This project will develop (a) methods, strategies, and infrastructures for organic breeding; (b) varieties with improved stress resistance, resource use efficiency, and quality; and (c) improved methods for the production of high-quality organic seed. The objectives of the project are:

- To increase the availability of seeds and varieties for the organic and low-input sector
- To identify traits and combinations of traits suited to organic and low-input production environments, including high nutrient use efficiency and weed competitiveness/allelopathy
- To increase breeding activities for organic and low-input crop production.

ECOBREED will increase the competitiveness of the organic and low-input breeding and farming sectors by:

- Identifying genetic and phenotypic variation in morphological, abiotic/biotic tolerance/resistance, and nutritional quality traits that can be used in organic breeding
- Evaluation of the potential of genetic variation for enhanced nutrient acquisition

- Evaluation of the potential for increased weed competitiveness and control
- Optimization of seed production/multiplication via improved agronomic and seed treatment protocols
- Developing efficient, ready-to-use farmer participatory breeding systems
- Pre-breeding of elite varieties for improved agronomic performance, biotic/abiotic stress resistance/tolerance, and nutritional quality
- Development of training programs in (a) genomic tools/techniques, (b) PPB, and (c) use and application of improved phenotyping capabilities.
- Ensuring optimum and rapid utilization and exploitation of project deliverables and innovations by relevant industry and other user/stakeholder groups.

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Community Seed Sharing Programs: Getting Seeds into the Hands of the People

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This poster highlights the importance of community seed sharing programs, including why planting, saving, and sharing seeds is essential to the cultivation of sustainable neighborhoods and healthy communities. The poster highlights how to establish a community seed sharing program that will succeed for years to come. The traditional art of seed saving allows the grower to develop deeper relationships with the plants in their care while also preserving their history, cultural heritage, and genetic diversity.