Landrace Gardening: A Compilation of Articles by Joseph Lofthouse

Joseph Lofthouse grows vegetables in a cold mountain valley where he practices the art of landrace gardening in order to feed his community more effectively.

Vocabulary

Landrace: a domesticated, locally adapted, traditional variety of a species of animal or plant that has developed over time, through adaptation to its natural and cultural environment and due to isolation from other populations of the species.
A crop cultivar or animal breed that has been developed through traditional farming practices for many years in a particular locale without influence from modern agricultural science. Derived from Danish, from land "country" (going back to Old Danish, going back to Germanic *landa-) and race "breed, race," borrowed from French. So literally a race, breed, or species of plant or animal genetically adapted naturally to a locale and by farmer preference—Georgic.

Cultivar: A race or variety of a plant that has been created or selected intentionally and maintained through cultivation. a variety of a plant developed from a natural species and maintained under cultivation.

Out Breeding: Out-crossing or out-breeding is the technique of crossing between different plant varieties with no common ancestors. This is the practice of introducing unrelated genetic material into a breeding line. It increases genetic diversity, thus reducing the probability of an individual being subject to disease or genetic abnormalities. Outcrossing is believed to be the "norm" in the wild. Outcrossing in plants is usually enforced by self-incompatibility.

P**henotype:** The physical appearance of an organism as distinguished from its genetic makeup. The phenotype of an organism depends on which genes are dominant and on the interaction between genes and environment. Phenotype is the term used in genetics for the composite observable characteristics or traits of an organism. The term covers the organism's morphology or physical form and structure, its developmental processes, its biochemical and physiological properties, its behavior, and the products of behavior.

Hybrid: The offspring of genetically dissimilar parents or stock, especially the offspring produced by breeding plants or animals of different varieties, species, or races especially as produced through human manipulation for specific genetic characteristics. Hybrids generally can not reproduce.

Inbreeding Depression: is the reduced biological fitness in a given population as a result of inbreeding, or breeding of related individuals. Population biological fitness refers to an organism's ability to survive and perpetuate its genetic material. Inbreeding depression is often the result of a population bottleneck.

Genotype: The genetic makeup, as distinguished from the physical appearance, of an organism or a group of organisms with reference to a single trait, a set of traits, or an entire complex of traits.

Survival of the Fittest

6/12/2013

Landrace gardening is a traditional method of growing food in which the seeds to be planted next year result from the survival of the fittest in a particular garden in previous years. Landrace varieties become attached to a region, and thrive in that region. Landrace varieties are genetically variable so that as conditions change from year to year the population can adapt to the changes.

The first landrace crop that I grew was Astronomy Domine sweet corn. It was the product of a breeding project by Alan Bishop of Bishop's Homegrown in Pekin, Indiana. The essence of the project was to throw as many cultivars of sweet corn as possible into a field, let them cross pollinate, and see what survived and how the descendants fared. Around 200 cultivars contributed their diversity to the gene pool. Some plants grew vigorously, many grew decent, and some struggled to survive. I saved seed from the parents that thrived and that did okay, and replanted the next year. The results were fantastic! I was hooked on growing genetically diverse crops and saving seeds from them.

My version of Astronomy Domine had diverged from the original version. My population is about ten days shorter season than the original. That is to be expected because in my cold mountain valley a crop has to produce quickly and thrive in cool nights if I am to get a harvest.

After the stunning success of the sweet corn project, I determined that I wanted to explore growing other varieties of localized landrace crops.

Melons seemed like a good test project, because they have traditionally done poorly in my valley, and because they are highly popular. Melons are an out-breeding crop, so they cross-pollinate readily, and can produce huge numbers of genetically unique individuals. Generating lots of variety is one of the key principals of landrace gardening. More diversity provides more opportunities to find family groups that thrive in any particular garden.

To start the cantaloupe project, I gathered together the seeds from the few melons that had produced a fruit the previous year, and I added to them as many varieties as I could obtain: from local farm stands, from the Internet, from seed catalogs, from the grocery store. I planted a packet of seeds per row until I had planted a large patch of melons. Then I sat back and watched one melon disaster after another. Some varieties didn't germinate. Some varieties were eaten by bugs within days of emerging. Others just sat there and shivered in the cold. Some individuals shrugged off the adverse growing conditions and grew robustly. The two best growing plants produced more fruit than the rest of the patch combined.

Here are photos that demonstrate the differences. Each seed was planted on the same day, a few feet from each other in the garden. The photos were taken a few minutes apart. The first photo shows what an average cantaloupe from a seed packet grows like in my garden. The second photo shows what a well

adapted cantaloupe grows like in my garden (after only one year of selection).

I collected the seed from the best growing melons and replanted it. Oh my heck!!! I was used to trying to grow maladapted cantaloupes. I never imagined that cantaloupes might actually produce an abundant harvest for me: I was harvesting a hundred pounds of fruit at a time!

Early in the process of developing a locally adapted cantaloupe population, I was contacted by a grower who grows in the same mountain valley as my farm. Since that time, we have shared seeds liberally with each other. I trust her seeds implicitly, because we share the same climate, the same soil, the same altitude, the same bugs, and the same philosophy towards diversity. Her seeds thrive in my garden because our gardens are so similar. I love our collaboration. It

is nice to see the grandchildren of my seeds coming back home to grow among their cousins. Half of the watermelon and cantaloupe seeds that I planted this spring were grown by her. She provided most of my sweet pepper seed. I am coming to favor the yellow watermelons that are emerging from the collaboration. They taste excellent and grow well in our valley. When did anyone ever say that before about watermelons in our valley?

The watermelon project included collaborators from around the world. We have shared seeds liberally among all participants. The most reliable imports into my garden have consistently come from the collaborator in my valley. To start the watermelon project, I planted around 700 seeds: A few seeds each from as many varieties as we could get our hands on. The first planting included the promiscuously pollinated hybrid offspring of hundreds of varieties. I harvested about 5 fruits the first year. That is great odds for a survival of the fittest plant breeding program. One of those fruits was from the variety of watermelon that my daddy has preserved for decades in our valley.

Because of my success with cantaloupes, I decided to convert all of my crops to locally-adapted survival-of-the-fittest landraces. Spinach was among the first crops that I converted. It was the simplest for me. I planted a number of varieties of spinach next

to each other and weeded out the plants that were slow growing, or quick to bolt. About 4 of the 12 varieties were suitable for my garden. I allowed them to cross pollinate and set seed. This spring someone gave me a packet of spinach seeds so I thought I'd plant it next to my locally-adapted landrace to compare them. See that little speck of green that I marked with a red dot? That is the imported spinach: Already gone to seed. I pulled it and laid it next to my landrace spinach to demonstrate the huge difference in growth. They were planted on the same day a few feet from each other. Sometimes when I start adapting a new crop to my garden, I import hundreds of varieties to trial. Other times I take a slow and steady approach, by growing one new cultivar in the row next to my crop.

If the new variety does well then I save seeds from it and add them to the landrace. If the new variety does poorly, then it might contribute some pollen. I do not try to keep varieties pure, other than basic things like keeping hot peppers separate from sweet peppers, and sweet corn separate from

popcorn. Turnips are a crop that I approached by the slow and steady method. They already grew well for me, so there wasn't any reason to search far and wide for something that would do better. I plant another packet of seed every few years, and may include a couple of roots from the new strain among the seed-parents the following year.

The dry bean landrace has been fun for me because it is tremendously colorful. It draws lots of attention at the farmer's market. I started it by planting beans, all jumbled up together from as many species and cultivars as I could acquire. I think that there were around 12 species, many of which I had never grown before. I planted them in hot weather, not knowing that some of them are cool-weather species. I didn't know if they were bush beans or pole beans. Nevertheless, some of them grew very well and produced a harvest in my short growing season. I collected the seeds of the survivors and planted them a couple weeks ago. This year I am expecting them to do great, because I selected (mostly) for bush types whose parents thrived in my garden. I tend to give my crops names that describe the plant or its use, such as "dry bush bean landrace". "Dry bean" describes what the crop is used for, "bush" describes how it grows, and "landrace" implies that it is genetically diverse and has been localized to my garden by passing the survival of the fittest test. Some crops can achieve

the landrace label in my garden in one growing season, other crops may take many years before I could say that they are thriving in my garden.

I could write and write about how successful landrace gardening has been for me, but it would just be more of the same: the locally adapted plants thriving, and the imports from far away struggling to survive. I hope that this post has helped show in photos why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Naming The New Varieties

6/18/2013

When I started landrace gardening, I had to relearn how to name the plants in my garden. I was used to keeping varieties separate, and to taking great pains to insure that they remained pure. I was pretty much of the mindset that a variety has one name that it carries with it forever. As a landrace gardener, names have become more fleeting. These days, in my garden, plants are more likely to be called something like “Dry Beans”, or “That Dry Bean With The Pretty Purple Flowers."

Mega-farms which grow seed for the mass-market use a naming strategy in which each cultivar is distinct and separate from every other cultivar. The seed is highly inbred, and measures are taken to keep in that way. Fixed names and unchanging genetics are important when growing commercial seed to be sold in a national or international market. Farmers should be able to trust that the “Bodacious Sweet Corn” that they purchased last year is the same as what they are purchasing this year.

The naming strategy used by landrace gardeners is more flexible. Landrace gardeners tend to lump seeds together into groups of similar type, and then name only the family groups. To people that are saving their

own seeds, and localizing them to their own gardens, the history and specific genetics of a variety don’t matter much. What matters more is that the current population has been localized to grow well in each particular garden.

As an example, with moschata squash, I separate the patch into early fruiting, which I save for seed, and later fruiting which I send to the farmer's market. Earliness is an important trait to me because I can't harvest a fruit that fails to mature. The first year of my moschata squash trials about 75 percent of the varieties grown did not produce fruits. The moschata landrace contains butternuts, and necked squash, and pumpkins. I lump the seed together and call them by their species name. The distinguishing trait is that they are squash. They look like squash. They grow like squash. They taste like squash.

In some cases it makes sense to separate the seeds a bit more, mostly for practical considerations. For example, with butternut squash, people frequently asked me for smaller fruits, so I divided the landrace into a small/ medium fruited landrace, and into an extra-large fruited landrace. I grow them in separate fields so that they don’t cross.

In the early years of a landrace development project I like to plant seeds fruit-to-row. By that, I mean that the seeds from one fruit are planted together in a row by themselves. The row might only be 3 feet long, or I might plant a hill of melons all from the same mother. This allows me to see how the offspring of a particular mother compare to the offspring of other mothers. I might not know anything about the pollen donor, but I can learn a lot about the mother by watching how a sibling group grows. Because earliness to harvest is of great importance to me in melons, I typically name fruits based on the day that they were harvested, followed by a letter to distinguish the different fruits that were harvested on the same day. For example, this photo shows how I label cantaloupes as they are coming out

of the garden. On these melons I also added a designation of which field they came from. I planted different populations in different fields, so that also tells me something about the family history of the fruit.

I add other details to the fermentation vat and final seed packet such as “yellow flesh”, or “tastes great”, or “10 percent sugar." Then before planting I can use those notes to decide what to plant. Offspring tend to resemble their mother.

When I am harvesting popcorn, I label the baskets with the date harvested. I pop each cob separately. I label great cobs with the date harvested, expansion ratio, number of old-maids, and unique traits, such as easy shelling or great taste. Then before planting time, I sort the seed packets to decide what traits I’d like to carry through to next year. I only keep plants separate that have some trait that I'd like to emphasize. Average cobs with average traits are saved and planted in bulk.

I do not typically label plants when they are planted. I am most interested in how the plants grow. I am not much interested in their history. Even if I could keep perfect records, there is unavoidable chaos when saving seeds. For example, one day my brother threw kitchen scraps into the fermentation bucket for my tomato landrace! So my tomato seed included seeds from tomatillos, peppers, and unselected tomatoes. The tomatillo that my brother helped me save was very nice.

I take copious photos or videos while planting, and during growth and harvest. If something interesting shows up I might be able to learn more about it from the images.

I often put a ribbon of surveyor's tape around a plant that has desirable traits, and write a note on the tape. Then the note is carried along with the vegetable at harvest, and becomes part of the name/description of the plant.

Once I get to a well developed landrace, I use names that describe the phenotype of the crop, along with a description of the location to which it is well adapted: So I grow “Joseph’s Best Cantaloupe landrace." It is the best growing cantaloupe in Joseph’s garden. I grow “Paradise Sugary Enhanced Landrace Sweet Corn." Paradise is the name of the village where the corn was developed. “Sugary Enhanced Sweet Corn" describes what the corn is used for, and “Landrace” implies that it is genetically diverse and has been localized to my garden by passing the survival of the fittest test.

Next week I will write about how landrace gardening promotes hybrid vigor and avoids inbreeding depression by encouraging promiscuous pollination.

Don’t Worry About Plant Purity

6/25/2013

This week I’m discussing three inter-related topics. Landrace gardeners do not worry much about plant purity because we believe that mixing varieties can promote hybrid vigor and eliminate inbreeding depression. We consider cross pollination to be desirable because it can create more vigorous plants. It may be prudent to grow different populations of the same species as distinct landraces if there are big differences in how they are used.

Heirlooms typically grow poorly in my garden. I believe this is because heirloom seed is often highly inbred. The term “inbreeding depression” describes a general lack of vigor which arises when a cultivar pollinates itself over and over again. Heirlooms typically have little genetic diversity because they have been inbred for up to 50 or 100 generations.

The large seed companies also offer highly inbred seed, but they partially solve the inbreeding depression problem by making

hybrids. Then they market the seed as having “hybrid vigor”, which is characterized by the plants growing more robustly than the inbred parents.

The term “open pollinated” is another synonym for highly inbred, because a variety can only “breed true” if it has been significantly inbred. The intense inbreeding makes it possible to offer nearly identical seed year after year.

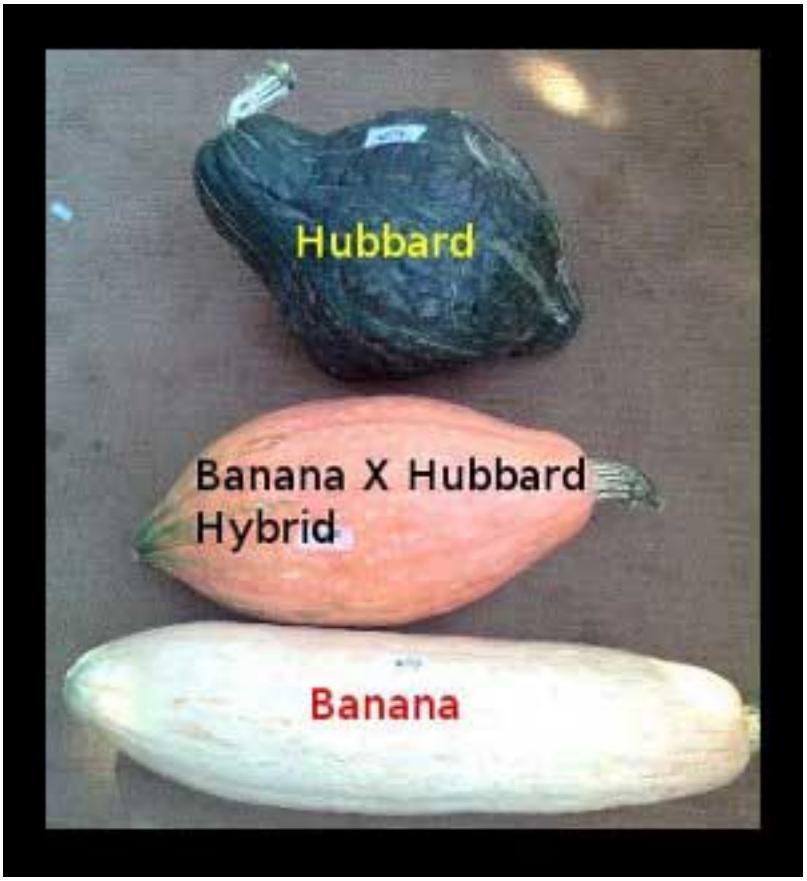
The plants in a landrace population avoid inbreeding depression because they are genetically diverse and are allowed to cross pollinate. The crossing between different family groups generates naturally occurring hybrid vigor in landraces. The new genetic combinations that arise with each new hybrid allow landrace gardeners to practice survival of the fittest selection. In my sweet corn crop I grow as many as ten thousand new genetically unique plants per year. An industrialized farm might only grow one genotype per year so the crop ends up being essentially a field of clones. So much can go wrong when a farm is only growing one cultivar. So much can go right when a farm is growing thousands of different varieties.

Some crops like tomatoes might only have a natural cross pollination rate of 5%. Other crops like spinach have a 100% cross pollination rate. Either way the principle of survival of the fittest plant selection can be used. I get faster results with higher cross pollination rates. It only takes a few crosses to create huge diversity among the second generation of offspring. At the top of the post I included a photo of the different types of peas that were generated by one manual cross.

There are occasions, even in a landrace garden, where it is desirable to keep varieties separate. I do not like hot peppers to get mixed up with sweet peppers. My sweet peppers can be any shape, or any size, or any color. They cannot be hot peppers! I also don’t like sweet corn and popcorn

to cross pollinate, because then the sweet corn gets tough kernels, and the popcorn stops popping.

With other crops I don't mind at all if they get mixed up with each other. Squash are a perfect example of this. As long as it grows like a squash, and cooks like a squash, and tastes like a squash I don't care about what color or shape it is.



Here's an example of a promiscuously pollinated squash. The fruit on the top and bottom are highly inbred. The fruit marked "Banana X Hubbard" is a naturally occurring hybrid. It was particularly tasty: better eating than either parent. I love the huge variety of flavors and textures that can arise in landrace vegetables.

I typically call my landraces "promiscuously pollinated", because there really is no telling who's the daddy. I like my landrace crops to be promiscuously pollinated because it leads to increased vigor, and provides more opportunities for survival of the fittest selection. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Getting What You Want

7/5/2013

I use promiscuous pollination among genetically diverse parents to get what I want from my garden. One of the most useful traits of landrace plant populations, is that addition to adapting to the climate, and the soil, and the pests, they also adapt to the gardener that is growing them and to the cultivation methods used. It has been a joy to use the processes of promiscuous pollination and local adaptation to tailor my plants to my specific way of doing things and to get what I want out of them.

Recently, I reviewed the business plan of a newly forming organic seed company. They are intending to sell seed localized to New England. Their marketing materials emphasize that they are growing their seed crops over plastic. That will tend to create a population of plants that are most well adapted to growing over plastic, and will lead to plants that are not as well adapted as they could be for the typical home garden and small scale farm which do not use plastic ground covers. If you are a New England grower that plants over plastic that might be a great source of seed adapted to that particular method of growing.

Reviewing how other growers care for their plants got me to thinking about how my habits affect the plants in my garden. One way that was immediately obvious was regarding water. I constantly hear people in damper climates say that they water their plants twice a day and they are still wilting. I live in a super arid climate, and I only water once a week by sprinkle irrigation. My plants don’t suffer from lack of water.

My neighbors also complain about their plants burning up. We have the same irrigation system, and the same soil and climate. I realized that the

difference is due to genetics. When I ask them where their seed was grown, if they know at all, it came from Oregon with its humid damp overcast weather and moderate temperatures. My seed has grown in my valley for generations and has become localized to the arid conditions, brilliant sunlight, and wide swings in temperature between night and day. It has adapted to thrive with weekly irrigation.

My goals for my plants tend to be a mix of pragmatic goals and artsy goals. First is that I want them to survive and produce a harvest. I want the food to be nutritious, and I want it to look pretty. One of my goals a few years ago was to improve the nutrition of my butternut squash by incorporating the extra carotenes from Libby's Pumpkin into the population. So I planted Libby's Pumpkin in my squash patch and let it promiscuously pollinate. Then each year I select for butternuts with the deepest orange color. It has been a great project that is both pragmatic and artsy. Food with higher nutrition looks better to me. I am doing a similar project to incorporate a corn into my sweet corn and popcorn that provides 10 times the vitamin A of regular yellow corn. It even shows up in the popped kernels. Woo Hoo! A naturally occurring yellow popcorn without added dyes.

To get what I want out of my garden, I plant genetically diverse plants, and encourage promiscuous pollination, and then select among the survivors

for those plants that are well adapted to my wants and to my way of doing things. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Genetically diverse landraces of plants can also be localized to deal better with weeds. I apologize in advance for the pun imbedded in the title of next week's post. I'll write about Landrace Gardening: Racing The Weeds.

Racing the Weeds

7/10/2013

The principles of landrace gardening can help us to grow plants that compete more effectively with weeds. By planting genetically diverse seeds and selecting via survival of the fittest, we can create plant populations that compete better against the local weeds that are common in any specific garden.

One of the earliest things I noticed when I started landrace gardening is that there are tremendous differences in how robustly plants of the same species grow in my garden. Some plants grow vigorously while other plants barely survive. Plants that grow vigorously have a huge advantage over weeds compared to slow growing plants, and that advantage accelerates during the growing season as the vigorous plant chokes out weeds, and the slow-growing plant gets overwhelmed. For example, see the photo of the watermelon plants. They were planted and photographed on the same day. They grew a few feet from each other. The plant in the red box would not compete well with weeds

Slow germination is another issue that can cause the weeds to get a head start over crops. As landrace gardeners we can select among genetically

diverse populations for genes that lead to quick germination. I'll again use watermelon as the example. This spring about 70% of my watermelon landrace germinated quickly. The 30% that germinated slowly are being eliminated. I drew a yellow box around a slow germinating seed. It was pulled immediately after taking the photo.

Another strategy that I use to select for plants that compete well with weeds is that I allow weeds to grow in my garden. [Not like I could stop them.] Plants that easily succumb to weeds do not survive long enough to produce offspring in my garden, so I am inadvertently selecting for plants that thrive in spite of the weeds. Here's a photo of a cantaloupe that is thriving among the weeds. I drew a red box around its kin that is not as well adjusted.

I'm enjoying writing these posts, because it gives me ideas about what I need to select for in order to improve my garden. It's obvious to me today

that I need to spend some effort on selecting among my carrots and parsnips for quick germination and early vigorous growth. These are the two crops that I am most likely to lose to weeds.

As a landrace gardener I have a variety of methods at my disposal to select among genetically diverse crops for plants that will thrive in spite of competition from the local weeds. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Photos by Joseph Lofthouse

Food Security Through Biodiversity

7/17/2013

The recent history of agriculture documents many examples of crop failures that resulted from a pest overcoming a plant's defenses and then spreading widely in a short period of time. This wildfire-like spread of plant pathogens is due to the genetic uniformity of the affected crops. Similar failures routinely happen due to weather. Landrace gardening largely avoids these problems by maintaining wide genetic diversity within species, and by growing many different species.

After the 1970 corn blight, the National Academy of Science warned that crops in the United States are impressively vulnerable to failure due to genetic uniformity. It seems to me that the trend towards uniformity has accelerated since that time. I expect the trend to continue in mega-agriculture due to the increasing mechanization of farming.

I have witnessed a counter-trend among small scale growers. The reasons given for seeking out genetically diverse crops varies among gardeners. Some are seeking a wider flavor palate. Others love the exciting colors. Some want higher nutritional content. I grow landrace crops primarily for the reliability: Genetically-diverse locally-adapted crops produce more reliably for me. I believe that the plants are less susceptible to total crop failure due to pests or weather. I also reap the benefit of my food not looking or tasting bland and boring. I harvest by hand, so I do not benefit from uniformity of ripening dates, or height of a cob of corn, or a consistent fruit shape.

I am expanding the biodiversity of crops in my garden by growing traditionally cloned crops from seeds instead of cloning. Nearly all potato varieties available on the market are sterile clones without the ability to

produce seeds. I trialed many varieties until I found some that produce fruit with viable seeds. Then I stopped growing the non-seeding varieties. The photo of potatoes shows what the offspring look like. Each basket of potatoes in the photo represents the offspring of one seed. By routinely growing potatoes from promiscuously pollinated seeds, I am hoping to eliminate the possibility of a potato famine affecting my valley. Those of us involved in this endeavor say that we are growing “True Potato Seed.”

My favorite current project is creating a landrace of garlic that reproduces via pollinated seeds. The photo is of a garlic flower. I’m planning a blog for about November to report the current year results for this project. The garlic genome has suffered even more than potatoes from monoculture cloning, but my collaborators and I have obtained wild ancestors from around the Tian Shan Mountains in central Asia which have retained the ability to make seeds. We are working with that germ plasm to create a landrace of promiscuously pollinated garlic. We say that we are attempting to create “True Garlic Seed.”

In addition to maintaining biodiversity within a species, we can also increase the diversity of our gardens by growing additional species. Instead of growing only common beans, I am growing fava beans, runner beans, Lupini beans, tepary beans, cowpeas, garbanzo beans, soybeans and a

couple of species that I can't name. It is unlikely for a disease, parasite, weed, insect or weather pattern to overcome all of those species at the same time.

Recently I read an article from MOTHER EARTH NEWS about edible dahlias. I am intending to start growing them. That will be a great addition to the sunroots and edible canna lilies that I am already growing. I am growing genetically diverse sunroots from seeds. It is commonly thought that sunroot flowers are sterile, but my sunroots are prolifically seeding because unrelated individuals are allowed to promiscuously pollinate each other. Sunroots are typically grown as clones, which are self-incompatible, and thus do not set seeds. A cross-pollinating crop can adapt to my garden. A clone is always a clone.

Growing a wide variety of genetically diverse crops decreases the possibility of total crop failure. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

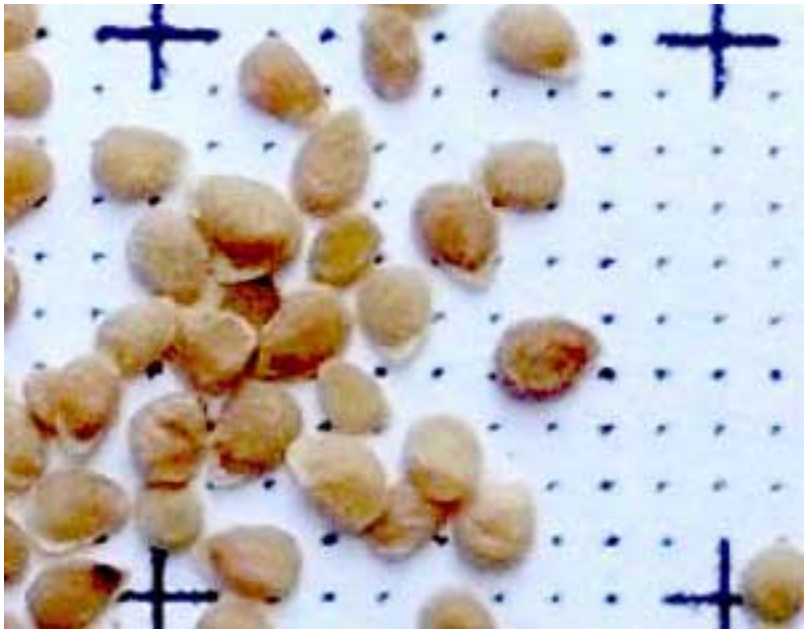
True Potato Seeds

7/24/2013

Potato seeds are harvested from potato fruits. The pollinated seeds are called "True Potato Seed" (TPS) to differentiate them from "seed potatoes" which are genetically identical clones of a tuber. I do not like growing a lot of clones in my garden because of the danger of total crop failure due to genetic uniformity. However potatoes are a crop that is easy to propagate by cloning, and during good times potato clones produce a lot of food.

I grow a combination of cloned potatoes and potato seedlings each growing season. By growing the clones, I am planting varieties that have grown well for me in the past. By growing true potato seeds, I am introducing genetic diversity into my potato patch, and adapting potatoes to my local conditions and way of doing things. Each year I select a few of the seedlings to grow as clones the following year. I aim for balance between the clones and the seedlings. I want to constantly refresh the gene-pool and search for new and better varieties while maintaining the varieties that have done well in the past.

As is typical with landrace gardening, lots of fun shapes, colors, and tastes show up among the offspring of true potato seeds.



Most potato varieties are unable to make fruits or produce seeds. I do not allow those varieties into my garden. If a potato plant does not make an abundance of fruit I do not replant it the next year. It seems important to me to only grow potatoes that can make lots of seeds so that I can plant the seeds to localize the population to my garden via survival of the fittest plant selection.

Potato seeds look and grow much like tomatoes, except that they are smaller. I grow them approximately the same way that I grow tomatoes. Due to the delicate nature of young stems, potato seedlings grow best in very bright light (direct sun or close to a grow light). I plant them outdoors after danger of frost is past. Potatoes may start forming tubers in the pots, so I recommend growing them in pots for no more than 8 weeks prior to transplanting. The delicate stems can benefit by transplanting a couple of times shortly after germination to bury the stems up to the first leaves.

To harvest potato seeds, I pick the berries which are like small green cherry tomatoes. I figure they are ripe when they get soft or turn slightly yellow. I often store them on the shelf for weeks or months after picking. To extract the seeds, I add one cup of berries to 6 cups of water and blend for 30 seconds in a blender on medium. The pulp floats and is discarded. The seeds sink and are collected and dried. Potato seeds remain viable for years and can be used to regenerate a crop even if every cloned tuber is lost. Potato seeds are less likely than clones to transmit diseases or pests to next year's crop.

By growing genetically diverse plants from true (pollinated) potato seeds I am developing a locally-adapted potato population, and I am reducing the risk associated with growing only clones. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Saving Landrace Seeds

7/31/2013

Seed saving is an integral part of landrace gardening. We can localize our gardens to our specific growing conditions and way of doing things by planting genetically diverse seed, allowing them to cross pollinate, and then saving and replanting the seeds.

Saving seeds doesn't have to be the complicated highly involved and technical process that some writers would have you believe. Before writing was developed, illiterate people were saving seeds, and they developed many of our most popular food crops. Plant seeds are resilient. It doesn't much matter what specific techniques we use to save seeds. We don't have to clean our seeds like machines do. Our seeds are likely to grow when planted. The important thing about landrace gardening is to be saving and replanting localized genetically diverse seeds.

The essential knowledge regarding seed saving is that plants produce seeds, and that seeds can be planted to grow a new plant. It's also good to know that offspring tend to resemble their parents. Even if we don't know for sure who the father is, we can know who the mother is, and siblings tend to have similar traits whether they are full siblings or half siblings.

As a landrace gardener I don't worry much about plant purity. A dry soup bean is a dry soup bean regardless of what color or size it is, or even what species. Once in a while I worry about things like keeping the hot peppers separate from the sweet peppers, but that is only because it makes things easier in the kitchen.

I hear over and over again that home gardeners shouldn't save seeds because they might not breed true. To me, that is a great reason to save seeds. I don't want functional clones of the mother plant. I want to grow a genetically diverse family so that the offspring can become localized to my garden. Saving seeds as a landrace gardener alleviates many of the isolation issues that are so difficult for people that are trying to maintain purity in highly inbred cultivars. I want my plants to be promiscuously cross pollinating.

Humans are social creatures. We thrive by sharing and cooperating with each other. Even if I am not able to grow every species of crop seed that I need for my farm, I have developed a collaboration network of nearby growers that share seeds amongst ourselves. I love my network, because while the seed might not be exactly tailored to my garden, it is well adapted to my valley. And if my local network doesn't have genetically diverse landrace seed, chances are that some of my collaborators from further away have non-locally adapted landrace seed with enough genetic diversity that when I import it to my garden some family groups will do well.

By saving my own seeds, and sourcing seeds grown by nearby neighbors, I am able to grow locally adapted plants that thrive in my garden. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Maintaining a Landrace

8/7/2013

I consider it my duty as a farmer to maintain healthy and thriving landrace populations for the crops that are most desired by the people whom I feed. My protocol for doing so is:

- Add small amounts of new genetics to the gene pool from time to time.
- Include small amounts of older seed in each year's planting.
- Be liberal during selection of seed parents.
- Swap seeds with the neighbors to enhance local adaptability.
- Grow a sufficiently large population to maintain genetic diversity

I add a small amount of new varieties to my landrace vegetables from time to time. I call them foreign varieties because they are not from this area. There might be something in the new material that is just what my garden needs. If they do well, I may save seeds from them. If they do poorly they may contribute pollen. I figure that I can plant up to about 10 percent non-locally adapted seed each year and not worry about it dramatically affecting my landraces.

Each year I include seeds from several previous years in my plantings. I do this to avoid having the genetic balance of the population thrown seriously out of kilter by a single odd growing season. That helps me to retain plants that do well in hotter or cooler growing seasons, and in wetter or drier seasons. This seed contributes about 10 to 30 percent of my crop.

I am liberal during selection, for example, by saving carrot roots of different sizes, shapes, colors, textures, flavors and maturity dates. I save lots of seed from great-growing plants, and less seed from plants that struggle in my garden. I save more seed from plants that produce great-tasting food than from plants that are less flavorful, but as long as the food is edible it's a candidate for seed saving. This allows the population to become localized to my garden while preserving lots of genetic diversity so that the seed may adapt to the changing climate, bugs, soil and practices of the farmer.

I frequently swap seeds with the neighbors. This lets me take advantage of the localization that they have done to our valley. I am more familiar with the practices of some neighbors than others. Some neighbors have been long-term collaborators and I trust their seed completely and plant it in large quantity. Other neighbors are almost unknown to me so I treat their seed as if it was foreign seed and plant it in limited quantities.

These practices are designed to maintain a large genetic base for my landraces and avoid inbreeding depression. The effective population of my landraces includes the plants grown in my garden for the past two to five years and in the gardens of my close collaborators during that same time, and in the gardens of those who provided foreign seed. This protocol allows me to preserve and enhance my existing landraces while allowing them to continuously adapt to local conditions. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Fertilizing Landraces

8/14/2013

Landrace gardening allows us to minimize the cost and labor of adding fertilizer to our gardens by selecting for plants that thrive in the pre-existing soil.

Mega-agriculture generally takes the approach of growing highly inbred cultivars, and then conducting tests and applying fertilizers to modify the surface of the soil to provide the exact nutrients required by each clone. As a landrace gardener I have chosen a different path. I accept my soil as it is and do not try to modify it. Then I plant a wide variety of genetically diverse crops and select among them for those plants that thrive in my soil. I localize my plants to my garden. I do not modify my garden to fit the plants.

Here's a photo of what my popcorn crop looked like about ten days ago. It was grown without fertilizer in a field that has not been fertilized in 5 years. It was just starting to tassel, and since that time it has shot up even taller. Many of the cobs are at eye level which makes them very resistant to pheasants, raccoons, skunks, and other corn eating animals.

It has been my experience that a well-adapted localized landrace grows better without fertilizer than a non-adapted off-the-shelf variety grows with fertilizer.

Plant roots penetrate very deeply into the soil. Any fertilizers or amendments that I apply to the soil are surface applications that do little to change the deeper structure of the soil. I figure that it's better to select for plants that do well with whatever the deep soil happens to be.

I am careful to build healthy soil. Weeds and crop residues get returned to the field. They do not get gathered up and thrown away. They do not get fed to animals unless the manure returns to the field. Kitchen scraps and spoiled fruit are returned to the soil.

Landraces can also thrive in fertilized gardens. The key is to be consistent from year to year in what fertilizers you apply, and in the timing of the applications. Landrace crops become adapted to the gardener as well as to the soil.

By using the principles of landrace gardening we can select among genetically diverse crops for plants that thrive whether we grow with fertilizer or without. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Photo by Amber Christensen

Growing Popcorn

8/23/2013

Landrace popcorn requires care to preserve and enhance its ability to pop. I imported and planted three popcorns in recent years that had lost their ability to pop well because they had not been maintained in a manner that preserved their popability. In today's blog I'll write about my method of selecting for great popping ability. In next week's blog I'll write about how to prepare homegrown popcorn for popping.

In the 2009 growing season, I crossed a highly inbred popcorn with a genetically-diverse landrace of non-popping decorative corn. Since that time I have been selecting among the offspring to obtain a genetically-diverse localized landrace of popcorn that tastes great and pops completely. Last week's post contained a photo showing how well it grows for me.

There are two kinds of starch in popcorn. Clear-looking transparent starch is required for great popping. If the starch is white or milky looking it doesn't pop well.

Very small kernels don't produce much volume of popped corn and tend to have a crunchy unpalatable tip. Very large kernels tend to produce old-maids instead of popping. My crossed plants produced many different sizes of kernels. After years of selecting for best popping ability, the kernel size matches very closely to the plain old yellow popcorn sold in the grocery store. They have converged into mid-sized kernels that weigh about 0.18 grams and are about 6 millimeters in diameter.

If the seed coat of the popcorn kernels cracks while drying, then the cracks allow steam to escape so the kernel will not pop. A 20 power jeweler's loupe can facilitate seeing fine details.

The best popping corn has smooth kernels that form a great pressure chamber to hold the steam inside until it ruptures. Kernels with abrupt edges or that are flat from being squished together form weak pressure chambers that lead to poor popping. This difference is demonstrated in the photo containing two kernels of corn. The kernel on the left has an abrupt edge around the germ, and it is squished flat. Kernels like that don't pop well. The kernel on the right has a round top, and the germ is

imperceptible. Kernels like that pop well. Round kernels (which are called pearl) pop better than pointed kernels (which are called rice).

Considering all those traits of a great popcorn, my method for selecting cobs to plant next year is as follows. If the answer to any question is no then the cob is fed to the chickens.

- Do the kernels look glassy?
- Are the kernels about 6 millimeters in diameter?
- Are the seed coats free of cracks and ruptures?
- Are the kernels smooth and pearl-shaped?
- Is the germ imperceptible?

Once a cob has passed all of the above tests, then it is a candidate for test popping. I test each cob in order to determine which pop the best so that I can plant those cobs next year. My method is to take a tablespoon of kernels from one cob, and pop it in a microwave oven in a glass dish. I measure the total volume of popcorn produced, and the number of un-popped kernels. The key to maintaining a great popcorn landrace is that nearly every kernel pops. I write the volume and number of grannies on each cob so that after I have popped every cob I can make decisions about which to plant next year.

Sometimes I write a note on the cob like “easy shelling”, or “great taste.” These are traits that I want to show up more often in my popcorn. If they are associated with poor popping ability, then I might plant them anyway,

and de-tassel them to make a hybrid between plants with great taste and those with great popping ability. Next year I will re-select again. In addition to selecting entire cobs, individual kernels can also be selected that have great shapes.

I was able to take a non-popping decorative corn and turn it into a great popping and great-tasting popcorn by allowing it to promiscuously intercross with popcorn and then selecting among the genetically diverse offspring for great popping ability and glorious flavor. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

How to Prepare Homegrown Popcorn for Popping

8/30/2013

For best results from homegrown popcorn the moisture should be adjusted prior to popping. This blog details the procedures I use to achieve great popping results.

When I originally started working with popcorn I was disappointed with how poorly it popped. After doing research I realized that I needed to adjust the moisture for best popping ability. Either too little or too much water in the kernel can lead to poor popping. The difference is demonstrated by the photo of popped corn. One batch of popcorn contained 10% moisture and the other batch contained 14% moisture. The final volume was about twice as much in the batch with the proper moisture, and there were fewer old-maids.

To test the percentage of moisture in a batch of popcorn I use the following procedure:

1. Grind some popcorn

2. Weigh out a sample

3. Dry in Oven at 250 degrees Fahrenheit for 3 hours

4. Weigh again

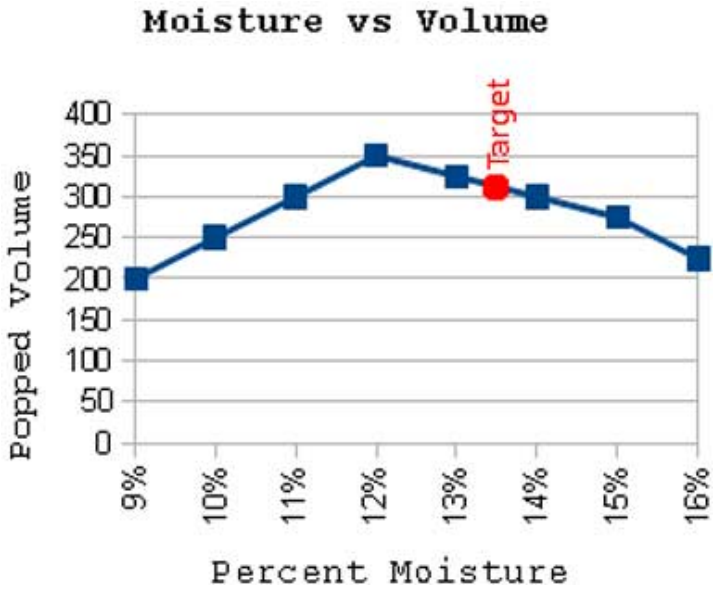
I use a sample size of about 20 grams because that fits the capacity of my scale, and allows me to use stainless steel condiment dishes. I have also used tuna cans or pieces of aluminum foil.

I calculate the moisture content of the bulk corn using this formula:

(Original Sample Weight) – (Dried Weight)

——————————————————— = Percent Moisture in Bulk Corn

Original Sample Weight



A few years ago I ran a series of popping tests to determine the optimal moisture content. I made this graph which shows the final volume of popcorn compared to the percentage of moisture in each batch. I have

settled on 13.5% moisture as my target. That provides a good balance between great popping ability, high quality, and good long-term storage. Too much moisture in popcorn can lead to mold.

The formula I use to figuring out how much water to add is:

Water to Add = (Weight of Bulk Seed * (1-%moisture in bulk popcorn) / (1-Target % moisture) – Weight of Bulk Seed

Sorry if your eyes just glazed over, mine sure did when writing that. No worries, here is a real world example: the most recent that I moisturized. I had a batch of popcorn seed weighing 3000 grams. It contained 8.7% moisture. I wanted to adjust the moisture to 13.5%.

Water to add = 3000 g * (1-0.087)/(1-0.135) – 3000 = 166 grams.

Here is a photo showing what it looked like in the real world. That sure seems like a lot of water to me, but I do live in a very arid climate!!! After adding the water, I shake the bottle occasionally so that the moisture gets evenly distributed. I wait 2 days after adding water before popping the corn. Once the moisture has been measured and/or adjusted I store the popcorn in airtight containers.

I have explained the scientific method for adjusting the moisture in popcorn. It could also be done by intuition and experience: For example,

storing the corn open to the air for about a week at room temperature and 70% humidity. Another example would be to arbitrarily add small amounts of water and test pop batches until it pops great. These methods are available to anyone who grows popcorn at home. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Replanting Hybrids

9/13/2013

Hybrid plants can be a valuable addition to a landrace garden if the right hybrids are incorporated. Hybrids have a mixed parentage, so there will be some level of diversity among the offspring. Saving seeds from well adapted plants among a genetically diverse population is one of the fundamental principles of landrace gardening.

Hybrids are often created from “elite germplasm”, so they may contain traits for more robust growth, higher yield, or resistance to pests and disease. These traits can be a valuable addition to a landrace.

My cantaloupe localization project included many commercial hybrids and, after the first year, many natural hybrids. I retain a lot of variability in the landrace regarding shape and size of fruit, and the texture of the skin. I save seeds from plants that have great taste, a wonderfully musky smell, and orange flesh. Occasionally I save seeds from a bad tasting fruit if it has some other trait that I want to explore. The bad tasters get planted in an out of the way spot where they won’t contribute much pollen to my main production beds. If some of their offspring produce great tasting fruit then I’ll add them back into the production beds. This week’s photos are of my

cantaloupe landrace: descendants of hybrids. Every fruit smells and tastes great regardless of what it looks like.

The first year a commercial hybrid is grown, the plants will be near clones of each other. If the seeds are saved and replanted a variety of different types of offspring are likely to show up. Plants tend to resemble their parents and their grandparents, and most of the plants will contain a mixture of traits that is like the mother of the hybrid, or like the father, or like some blend of traits that is midway between that of the mother and the father. We don't typically know the parents of a commercial hybrid, but they have been selected to produce great offspring when paired with each other. The grandchildren are also likely to be great plants. A lot of work went into identifying those traits. We might as well incorporate them into our landrace gardens.

If the seeds from a hybrid tomato are saved and replanted, they will always produce a tomato plant. If the seeds from a great hybrid are saved they are likely to produce great offspring. If the seeds from a mediocre hybrid are saved they are likely to produce mediocre offspring.

The drawback of using commercial hybrids in a landrace garden is that hybrids in some species are made using cytoplasmic male sterility. This type of sterility is a trait of the mother plant, and it is passed on to all of her descendants. That is valuable to a commercial seed production company because it greatly reduces the cost of producing hybrid seed. I don't like partially sterile plants in a landrace.

Commercial hybrids of the following species are generally made using cytoplasmic male sterility. I recommend that commercial hybrids of these species not be included in a landrace: Broccoli, cabbage, radish, onion, carrot, beet and sunflower.

Hybrids of brassicas can also be made using self incompatibility, so those hybrids would be safe to use in a landrace if the seed company disclosed what method of production they used, or if the flowers are examined for normal pollen production.

Hybrids of the following crops are generally free of cytoplasmic male sterility: tomato, cucumber, squash, corn, watermelon, melons and spinach.

Beans and peas are such radical in-breeders that commercial hybrids are not available.

Before I was aware of cytoplasmic male sterility, about 70% of my carrot landrace was male sterile. They grew fine. The fertile plants produced more than enough pollen for the whole patch. It seems undesirable to me to grow partially sterile plants, so each year I examine my carrot landrace and chop out any sterile plants. I am especially careful when I import new varieties into my garden. I intend to revisit the topic of male sterility in a future post and include more details about how to identify sterile plants.

Some crops, such as tomatoes, peas, and beans are mostly in-breeders and don’t produce many natural hybrids. I watch for the rare natural hybrids

among them and give any that I find a special place in the garden. I create hybrids by manual cross pollination. This year I grew the descendants of a naturally occurring bean hybrid named “Resilient Bean Breeder” which was discovered by Carol Deppe. I am very pleased with it. There is diversity in plant structure, productivity, and maturity dates. Planting the offspring of hybrids allows tremendous opportunities to find plants that really thrive in my garden.

A century ago, my great-great grandfather discovered a naturally occurring hybrid in his wheat field. He saved the seed from it. Eventually it became the most widely planted wheat in northern Utah and southern Idaho. Our family still grows “Lofthouse Wheat”, and we still reap the benefit of the good will that was generated because he replanted seeds from a hybrid and attached our name to the resulting landrace.

I love including the offspring of hybrids in my landraces. The segregating offspring of hybrids provide many opportunities to find the perfect combination of genes to localize a plant population to my garden and way of doing things. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Beautiful Crops

9/19/2013

Landrace vegetables are among the most beautiful foods that can be grown. My fall frosts are arriving in a few days, so I thought it would be appropriate to reflect upon the growing season and share photos of some of my favorite landrace crops.

Astronomy Domine sweet corn was my first landrace development project, and still holds a fond place in my heart. The beauty of the cobs amazes me every year. I can't wait to peek inside the cobs and see what beautiful colors and combinations of colors await my eager eyes. I love the nuances of taste and texture that are associated with the various colors and shapes of kernels. I picked the seed crop a few weeks ago. Our fall rains arrive about the time the corn starts getting dry, so I pick it for further drying under cover on the porch to prevent it from molding in the field.

My watermelon landrace development project has finally produced an abundant early harvest in the available growing season in spite of the adverse conditions. I have been working on this project for 4 years. It was an ongoing project before I became involved. Hundreds of varieties were planted and allowed to cross pollinate, most of them failed spectacularly in my garden and in the gardens of two collaborators in a similar climate to mine. Watermelons are so far out of their comfort zone in my garden that in one of the early years I harvested only 5 fruits from about 700 seeds that were planted. That is great odds to start localizing a species to a particular garden. I love the watermelon landrace!

The insides are yellow, or pink, or crimson, or orange. Some fruits contain swirls of yellow and red. They are a delight to cut open. Each color brings with it an associated flavor and texture. I really like the yellow fleshed melons. I select each year for sweeter taste, better texture, and earlier harvest so the population is becoming better and better. This year I am awarding the crop the title of landrace. I have previously called it a proto-landrace because while it was a genetically diverse population, it was not well localized to my garden. My soup bean landrace brings a lot of joy to people at the farmer's market. If I put a dish of them on the table, people

will stand and run their fingers through them over and over seeking out unusual colors and patterns. They cook up into a hearty flavorful soup. Some of the types quickly disintegrate forming a thick broth. Others hold their shape well regardless of how long they are cooked. They make a pleasantly delightful soup.

Last spring I imported a hybrid bean clade into my garden. It consisted of the descendants of a natural cross between two different types of beans. It grew wildly in my garden producing bush beans, and pole beans, and semi-vining beans. Some were too long season for my garden. I harvested the crop last week saving for myself the short-season bush beans. The suitable beans will be added to my pre-existing bean landrace. The seeds from the plants that are unsuitable for my garden will be used for food, or shared with people who have different climates and opinions about what makes a great bean.

Landrace crops are some of the most beautiful and tasty crops that can be grown. That makes growing and eating them a joyful experience. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Landrace Hybrid Squash

10/11/2013

When I tell people that I am growing landrace crops, and that I allow my plants to promiscuously cross pollinate, their replies are often tinged with fear. They worry about deformed franken-fruits, and about bad flavors, and about ugliness. My experience has been that those fears are not realized in my garden.

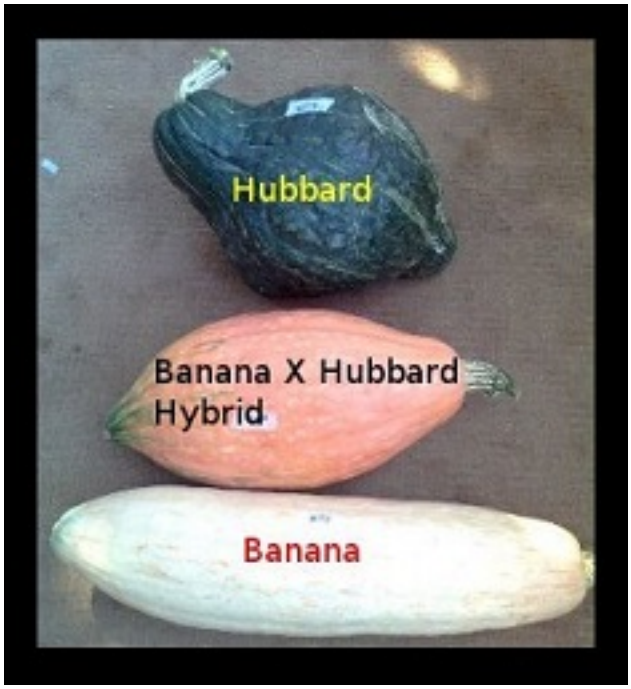
One of the nicest things about landrace gardening is that plants tend to resemble their parents and grandparents. So if I start out with great parents then due to family resemblances I am likely to end up with great descendants for many generations to come. Here is a photo demonstrating how family resemblances are retained. The great-grandparents of these squash were Buttercup (like the dark green squash in the photo) and Red Kuri (which resemble a tiny red Hubbard). The descendant squash have retained the basic buttercup shape and great taste, and have picked up beautiful colored skin from the Red Kuri. They are small fruited like their ancestors.

You may remember this photo from some months ago. It shows a hybrid squash which resulted from a cross between a Hubbard squash and a

Banana squash. The child squash was beautiful, and it tasted great. It was a blend between the traits of the two parents. The offspring have now matured. I harvested them prior to our recent frost-emergencies. [Sorry that I missed blogging for a couple weeks. I felt like harvesting the crops was more important than writing about harvesting. We had a very hard freeze this week that killed the frost sensitive species. I'm still harvesting cold hardy varieties, but I have the opportunity to blog again.]

Here's a photo of what the grandchildren of the Hubbard X Banana hybrid look like. These are the F2 generation. It is the generation that exhibits the most diversity when two different inbred cultivars are crossed. The traits have been scrambled so that the shape, and fruit color, and rind thickness have been interchanged between the different kinds. Despite cosmetic appearances, they have retained the general family characteristics. Eating quality is sweet and moist without strong flavors. No bitterness or stringiness appeared. Unfavorable traits have to come from somewhere, and since the grandparents didn't have them they are unlikely to show up in the grandchildren. The fruit size is very large as is typical of this particular family. I could continue to grow this squash as a complete family group, or I could select individual fruits as the ancestors of future generations to move the family in a direction I'd like it to go. Either way, I'll only replant seeds from parents that passed the survival-of-the-fittest test in my garden and

that taste great to me. Their children are likely to grow great and taste fantastic.



I have been working on my butternut squash landrace for five years. Each year I select for fruits that taste marvelous to me. This year I imported and grew other kinds of butternut squash to see how they compare to my landrace. Uugh: Too many gaggy butternut squash! I hadn't fully realized how thoroughly my landrace butternut squash have come to conform to my ideal of what a good tasting squash aught to be.

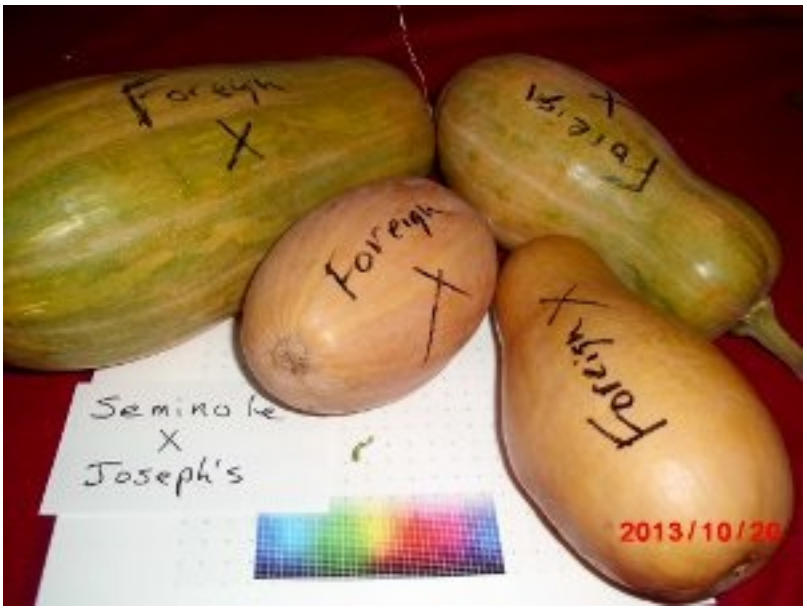
I believe that fears about Franken-fruits, and bad tastes, and ugliness in crossed plants are unfounded, because they don't typically manifest in my garden even though I allow a tremendous amount of promiscuous pollination. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Foreign Imports

10/23/2013

I am constantly working on projects to incorporate beauty, resilience, and higher nutrition into my landrace crops. I do this by paying attention to what is going on in my garden, and by importing seeds from other gardens. This week's blog documents some of this year's selection projects and explains why I am working on them.

Some years ago when I started my landrace moschata squash project, I included seeds from Seminole Pumpkin because they are a wild squash. They may be closely related to the ancestral squash from which butternuts were derived. It is likely that there are many useful genes in these squash that were lost during domestication. Alas, the Seminole Pumpkin is a native of Florida, so when I planted it in my garden it had not even started flowering when it was killed by frost. I can't do survival of the fittest selection among the offspring of a plant that fails to produce seeds or pollen in my garden, so my moschata squash landrace went forward without the Seminole Pumpkin. I have been sad about that for years.



I grow an abundance of seed, and share it widely. One of the collaborators with which I shared landrace moschata seed lives in a similar climate which has a longer frost-free growing season. He crossed my landrace squash with Seminole Pumpkins and returned the seed to me. I grew that seed this summer. Many of the resulting plants were still too long season for my garden and didn't mature fruit, but a few did. I am elated. Due to the generosity of a collaborator whom I have never met, I will be able to work with the genes from Seminole Pumpkins. I'm expecting to find some clever traits among the offspring.

I imported some South American corn composites into my garden. A composite is new mixed population containing many different varieties. Composites are similar to landraces, in being genetically diverse, but they have not yet been adapted to any particular garden. I grew the South American corn composites in a patch by themselves. The seed that I collected this year is a composite of composites: I call it a hybrid swarm because of the huge diversity that exists in this population. I am attempting to combine the South American and Caribbean corns into a population that is suitable for growing in my garden. A lot of the plants in the patch were not suited to my garden and didn't produce offspring, or had a very long season so they are only marginally useful to me. Overall they produced a lot of offspring which will be useful to me and contain traits which are not available in the North American corns that I have previously grown. It is my intention in a coming growing season to hybridize the South American population with my sweet corn, and with my popcorn. This should significantly increase the resilience and bio-diversity of my current crops.

This summer I also worked on projects to incorporate more color and nutrition into my popcorn landrace. I did this in several ways:

I selected white kernels and grew them in a separate patch. White is a recessive color which tends to be swamped out by other colors. Because it

looks really good to have a few mostly white cobs among the landrace popcorn I add a bit of white kerneled corn into the bulk seed before sharing so that the visual interest of the harvested crop remains high.

One of the ancestors in the South American composites produces extravagant amounts of beta-carotene I value that trait because of its high nutritional potential. I selected the high nutrition seeds from the composite based on deep orange color. They popped poorly, so I planted them in my popcorn patch to make a popcorn hybrid. Hybrids are used to combine the traits of two different varieties. Corn hybrids are made by removing the tassels from the mother plant before they release pollen. I missed de-tasseling it because I forgot to stake the row or the stake disappeared. Some of its seeds got pollinated by my popcorn. Some of its pollen for poor popping ability contaminated my popcorn. Because the South American corn represented less than 1% of the plants in my popcorn patch the damage will be minimal. I intend to grow the obviously hybridized seed in a separate patch for a few years until the high nutrition trait and great popping trait are combined and consistent. I also crossed this corn with my sweet corn so that I can develop a high nutrition sweet corn.

I made a hybrid cross between my popcorn and Glass Gem flint corn. Glass Gem contains beautiful blues, greens, and pinks which do not

currently exist in my popcorn, but it pops poorly. I figure that a cross will allow me to combine the traits of great popping ability and glorious colors into the same plant. I don't know what the nutritional value of all those different pigments are, but plant pigments tend to be antioxidants or meet other nutritional needs so I figure the more color the better.

It doesn't take much additional effort to incorporate beauty, resilience, and higher nutrition into landrace crops. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Landrace Gardening for the Casual Grower

11/4/2013

In today's blog I am writing about my hopes and dreams for the landrace seed movement and offering suggestions about how I think farmers, merchants, and casual growers could cooperate together to improve seed security by localizing our crops to specific eco-regions or towns.

When I was a young boy I gardened with my grandfather. He grew his own seed and replanted it from year to year. My father was more likely to buy commercial seed from a regional seed company. That trend towards less localized seed has continued, and today the typical method of obtaining seeds for most people is to order them from a mega-international seed company based only on a pretty photo and clever description.

It seems to me that the seed offered by the international seed companies is chosen by executives in far away places with little experience about what grows well in any particular region. Their seed appears to be selected for average commercial growers using a full spectrum of fertilizers and

pesticides. Casual home growers typically don't stick to the chemical application schedule and are often disappointed with the results. Additionally, there is no such thing as an average grower or an average climate. Each garden and each region has its own climate, bugs, soils, and way of doing things.

Despite the individual differences from garden to garden, there are a number of discernible eco-regions. Gardens within each region share many similar traits. If I could recommend only one change to the way that home gardeners and small scale farmers obtain their seed, I would recommend that they purchase seed that was grown in the same eco-region as their garden. My neighbors are constantly complaining about seed that they purchased from the Pacific Northwest maritime eco-region. It is about as opposite of growing conditions from our Desert Mountain eco-region as it is possible to get. The climate, soils, and pests are radically different. If my neighbors planted seed that was grown in a Desert Mountain eco-region I believe that their gardens would grow much better. My fondest dream would be for each gardener to grow their own localized seed that has been selected by survival-of-the-fittest for each specific garden. Next best would be for a few growers in each town to specialize in producing landrace seeds adapted to that town. I believe that even plain old open pollinated cultivars would do better for the casual grower if the seed was produced locally.

I am aware of two plant nurseries in my valley that carry seed that is grown in our eco-region. They also carry seed that is grown in other eco-regions. They do extensive trials and are constantly seeking feedback from growers to assure themselves that the varieties that they carry perform well in our area. I am very pleased with these two small stores. I highly recommend their offerings to local gardeners. For those of you that live outside my valley, I recommend finding nurseries that carry seeds that have been

grown in your eco-region. Ask for regional or local seed. If the seller can't tell you where the seed was grown it might be appropriate to find a different merchant.

I obtain locally-adapted seed from the farmer's market and from local produce stands. It has typically grown very well for me. Sometimes I tell the vendor that I am buying their produce for seed, sometimes I collect the seed surreptitiously. And now for my dream: I wish that more farmers would grow their own seeds and make that seed available to the local neighbors. I regularly offer 20 to 40 varieties of local landrace garden seeds for sale at the farmer's market. It sure would be nice if some of the other farmers offered their own varieties, whether landraces or cultivars. I think it would be clever if I could buy locally-adapted landrace seed from the nurseries in my valley that already carry regionally adapted seed.

When I was a small boy I often helped my grandfather harvest Scarlet Runner Beans. It is a fond memory for me. I have tried for years to find a variety that will produce a harvest in my garden. I haven't been able to locate a supplier of locally or regionally adapted runner beans. My plantings obtained from international seed companies have failed year after year. Last spring a collaborator in California sent me a landrace of runner beans. About 80% of them failed to produce seed in my garden. Most of the plants

that did set seed only produced one mature pod. There was one plant that produced eight pods. It was white flowered, and white seeded, so it's not a "scarlet" runner. Nevertheless, I'm super pleased to be growing runner beans again. While the landrace seeds that I received were not locally-adapted enough to thrive in my garden, there was enough genetic diversity among them that a few barely managed to reproduce. That's better than I can say about the commercial varieties I tried. The survivors are well on their way to becoming a locally-adapted survival-of-the-fittest landrace. I may never recover my grandfather's seed, but I might be able to come up with something substantially similar.

I hope to see more casual growers buying locally-adapted seeds from local farmers and nurseries. I'd like to see more farmers producing their own seed with enough excess to share with the community. I believe this would significantly increase the reliability of our food system. Buying localized seed is something that can be implemented by every grower and every farmer. The success I have seen from planting locally-adapted seed is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Sunroots

11/6/2013

Sunroots are the edible rhizomes that form under a species of sunflower. They are also called by other names such as Jerusalem Artichokes and Sunchokes. I do not use those names because they are not from Jerusalem, they are not artichokes, and I consider it bad marketing to choke the people I feed.

I prefer to eat sunroots raw. I grate them for adding to a coleslaw or salad. They also work well when added to a soup or stir-fry. Sunroots contain the prebiotic soluble fiber inulin which can cause gas or bloating if eaten in large quantities by people unaccustomed to eating prebiotic foods. I recommend soups, stir-fry, and salads because it is easy to add small amounts of sunroots to foods that are already familiar.

Sunroots seem like the perfect emergency survival food to me because they grow prolifically and the tubers are winter hardy allowing them to be stored in the ground until needed. The tubers are susceptible to dehydration, therefore, after digging, I recommend storing them in plastic in the refrigerator. If leaving the tubers in the ground overwinter I cut the stems off to avoid having the plants levered out of the ground by a winter

wind. I leave about a foot of stem attached so I can find them easily. I typically dig sunroots in late fall and early spring.

I am creating a survival-of-the-fittest landrace of sunroots for my garden. Sunroots have a reputation for being sterile and not producing seeds. That is because seeds only form if pollinated by an unrelated plant and since most people grow a single clone they do not get seeds. Harvesting seeds from sunroots can also be problematic because goldfinches are extremely effective predators of the seed. I bag the seed heads or harvest them shortly after petal drop. Sunroots growing in a genetically diverse population produce thousands of seeds per plant. I only have to bag a few heads in order to have an abundance of seed.

Sunroot seedlings are cold hardy. I plant them in early spring about the same time as carrots or beets. The seedlings produce rhizomes and seeds during the first growing season. I plant the seedlings about 18

inches apart. That gives enough space to evaluate each plant for properties that are important to me: productivity, shape, length of stolons (shorter is better), wind tolerance, color, etc. I replant tubers from the best plants into a new row so that they can cross-pollinate next year.

Sunroots readily propagate from rhizomes which can lead to weediness. If I were not selecting for a locally-adapted landrace I would plant sunroots into a perennial bed where they could resprout every year. No matter how carefully I harvest there are always some rhizomes that get missed.

Sunroots are a crop that is commonly grown as clones. They have great potential to become a locally-adapted survival-of-the-fittest landrace. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Fruit and Nut Trees From Seed

11/14/2013

When I was very young, it was unheard of to harvest nuts in my climate. This week I have been harvesting Carpathian walnuts. A friend in California called them the best tasting walnuts she has ever eaten. The tree was planted 31 years ago as a seedling that was grown by Les Shandrew, a childhood friend of my grandfather. Les is the boy shown in the photo irrigating the field with his father Sylvester. The irrigation ditches in my community were originally dug by hand and horsepower. The ditch crews developed a habit of planting the apple seeds from their lunches into the soil next to the canal. It has been 150 years since my village started digging canals. There are “wild” apple trees growing every few hundred yards along the entire length of our canal systems. The trees and/or their descendants are still providing an abundance of fruit for the community.

The apple trees are genetically diverse as expected from seed grown plants. There are early apples, and late apples. There are tart apples, and bland apples. Some of the fruits are highly attractive to apple maggots, some of them are immune. One of the trees is my favorite apple ever. It matures in early summer. It has blotchy red fruit that is super fragrant and very tasty: the perfect blend of sweet and tart. I really need to work on my

tree grafting skills. I tried three years to graft a scion from it onto other apple trees. This year I had many grafts take for other varieties, but alas not for my favorite. I expect to keep trying until one survives.

I am also growing a pear tree that was grown from a seed by Les. I had to learn how to use the pear appropriately because it has a bitter skin. The bitterness fades when the pears are super soft and ripe, but if I want to eat a semi-ripe pear I peel them because the bitterness is only skin deep. The really nice thing about the bitter skin is that it is repulsive to insects, so I can grow the fruits organically and not have insect blemishes on the fruits. The fruits fall from the tree when they are still green, so I pick them and ripen them on the countertop. The pear has become one of my favorite trees. It's not like every other pear. It has its own quirks. My caretaking skills have evolved to accommodate the quirky nature of the tree. It feels really good.

I have continued my community's tradition of growing fruit and nut trees from seeds. Volunteer walnut trees sprout prolifically in the yard. Instead of treating them as weeds, I treat them as a valuable source of genetically-diverse locally-adapted walnuts. I share the seeds and seedlings with the community for planting. Winter hardiness is an important trait for nut trees in my area because we are near the outer edge of the plants ability to survive. I am able to screen hundreds of volunteer trees per year for winter hardiness. It may be many years before we can evaluate nut quality. If any turn out bad we have the option of grafting.

I consider myself to be part of a multi-generational project to develop locally-adapted survival-of-the-fittest landraces of fruit and nut trees. There is a thriving sub-culture that continues the village tradition of growing fruit and nut trees from seeds. Each generation the offspring are selected for better growth, higher production, and increased winter hardiness.

When I was very young, it was unheard of to harvest nuts in my climate. This fall we harvested walnuts, hazels, and pistachios: All of them from genetically-diverse seed-grown plants that have become localized enough to have passed the survival-of-the fittest test for our valley. I expect that if the tradition continues - of growing landrace fruits and nuts from seeds - that my great-grandchildren will be harvesting many additional types of fruits and nuts that are currently unavailable to me. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Seed Swaps

11/26/2013

I use seed swaps as in inexpensive way to add lots of genetic diversity to my crops. I usually don't care much about the specific traits of specific cultivars, I am mostly seeking to add genetic diversity to my garden, and then I can do survival-of-the-fittest selection after the plants have cross-pollinated. I don't like to mix hot peppers with sweet peppers, but within broad guidelines like that pretty much any kind of seed is welcome to try to add it's genes to my landraces.

When I was buying industrialized seed, my seed bill was over $1000 per year. Last year, by growing my own seed, and using seed swaps as the primary source of new varieties, my seed bill was less than $100 including shipping. I acknowledge that seed swaps are time consuming, but what else is a vegetable farmer to do when the ground is covered with snow from November until March?

When I am starting a new landrace or adding diversity to an existing landrace I might only plant 10 seeds of each new variety. I might plant 5 to 100 varieties. I end up with lots of packets of leftover seed which are almost full. I often list the opened packets in seed swaps, and exchange them for something else that I'd like to trial. Sometimes what I get in swap are partially used seed packets that other people have trialed in their gardens. I also get a lot of home-grown seed. Sometimes they are listed as "might be cross pollinated". I love those kinds of exchanges! The more different kinds of parents there are in a seed packet the more opportunities I have to find a family group that thrives in my garden.

Another kind of swap that I really enjoy is trades with the local neighbors. I might swap one kind of dry bean for another. My daddy has grown Charleston Gray watermelon for decades. It thrives in his garden. I beg seeds from him every year because I don't have the proper isolation distance to keep it pure, and it's a family tradition, and my garden would feel lonely without it. I visit my regular trading partners each winter and take my seed stash with me. We compare notes and swap seeds. I usually take a seed-bank archive copy of my garden with me to the farmer's market. People often bring seeds from their gardens and trade for something I'm growing. I really like these kind of trades because I have found that the locally-adapted varieties that my neighbors have grown are often much better performing than seeds I obtain from far away growers.

I am currently participating in a seed swap that has many hundreds of species listed and lots of named cultivars: flowers, herbs, vegetables, medicinal plants, ornamentals, and trees. We call it The Hog Wild Seed Swap because we pig out on seeds. Many of my landraces contain a significant amount of ancestors that come from the Hoggy Swap. One year I even acquired lichens! I am inspired by William Woys Weaver's blog on Mother Earth News about Edible Dahlia Bulbs, so I am using the swap to

obtain many different kinds of dahlias that I can screen for edibility, for tuber productivity, and for the ability to set seeds prolifically. I'll watch for varieties that are highly attractive to pollinators so that I can get lots of cross-pollination going on which will give me more diversity to choose from. I participate in a variety of other seed swaps during the winter.

Seed swaps are an inexpensive way to add lots of biodiversity to a garden. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Survival Seed Banks, Part 1: What Seeds Are Available?

12/10/2013

Last winter I was kibitzing with my farmer friends about a typical seed bank. Today's blog is a summary of our observations and analysis. Next week's blog will detail my recommendations about what seeds I think the ideal survival seed bank would contain. The following week's post will discuss how to store a seed bank.

The idea behind the marketing of emergency seed banks is to put together a bunch of different kinds of seeds, and seal them in a container, and put them on the shelf so that you can grow a garden if food from the grocery stores becomes unavailable.

Philosophically I think that the better emergency food strategy is to be growing a garden as part of a day-to-day lifestyle, and saving seeds so that they can become locally adapted. Then if grocery store food ever becomes

scarce, we already have the knowledge, tools, soil fertility, gene pools, and manual skills to expand on existing gardens. I acknowledge that in today's world of inexpensive and readily available fuel, it's easier and less expensive to grow food in another hemisphere and import it into our local grocery stores. If that ever changes, then having a seed bank of maladapted highly-inbred varieties seems better than not having any seeds at all. I'd like to think that we can do better than that.

Comparing Seed Banks

While analyzing the seed bank, we did comparison shopping by making tentative orders from some of the more expensive online seed catalogs. If the sizes of seed didn't match the seed bank we bought the next larger packet size. Our bottom-line price ended up being 1/3 the cost of what the seed bank was asking, and we ended up with more seeds.

The seed banks are marketed as having special packaging materials and techniques which greatly prolong the life expectancy of the seeds. I believe that this is mostly hype. Longevity seems mostly about storing seeds dry, not exposing them to high temperatures, and avoiding bugs and animals. I store seeds in glass jars in the spare bedroom. If I lived in a damper environment I'd include a desiccant with the seeds before storing. I test germination once a year. Most varieties store well, and I believe those that don't would degrade about the same whether they are packaged in glass jars or in Mylar bags. If I had plenty of freezer space I'd store seeds in glass jars in the freezer. Life expectancy of frozen seeds is about 16 times that of seeds at room temperature. I'll write more about storing seeds in two weeks.

I am especially skeptical of seed banks that claim that their seed can plant an acre of land, especially when the container that holds the seeds is the size of a soda bottle. One of my fields is three-quarters of an acre, so I

have a good idea about how much seed is required to plant a field that size. It is much more than 20 or 30 small packets of seed. To put things in perspective to plant an acre takes approximately 14 pounds of sweet corn seed, or 5 pounds of squash seed, or 70 pounds of dry bean seed. That's around 7 gallons of beans!!! I would expect the seed bank that we analyzed to plant about one-tenth acre, even though it claimed to be enough seed to plant an acre.

Plan for 1/3-Acre Survival Garden

This week's photo shows the amount of seed that I would want if planting a bare-minimum, staples-only, 1/3 acre survival garden. It includes 13 ounces of landrace sweet corn, 21 ounces of landrace flour corn, 2 pounds of mixed dry beans, 14 ounces of peas, 2 ounces of beet seed, and 3 ounces of landrace squash seed. I took the photo to demonstrate that you aught to be aiming towards pounds or ounces of seed, and not packets. The bottle of beans all by itself is about the same size as the super deluxe seed bank that we reviewed.

In preparation for this article I reviewed the offerings of many survival seed banks. I was mostly dissatisfied with the quantity and types of seeds being offered. For example, one of the banks included 30,000 lettuce seeds and 20,000 celery seeds, but only 50 seeds each of beans, peas, and corn. They skimped on foods that store well and are easy to grow and have enough calories and nutrients to feed a family, and focused on watery low nutrition foods that are hard to grow and do not keep well. Additionally in my garden lettuce has a limited growing season. I can only harvest lettuce about 60 days per year, and my family wouldn't eat more than a head of lettuce per day even if it was the only food available. A couple hundred lettuce seeds would be more than sufficient. I'd want more like 4000 corn seeds, 2000 bean seeds, and 3000 pea seeds. I'll write more about that next week.

A common feature of the seed banks I reviewed was that they tended to include lots of tiny seeds for species that are not all that useful in a survival situation such as lettuce, celery, cauliflower, radish, basil, Brussels sprouts, spices, and eggplant. I think that even in good times, eggplant is not a food. Uugh! It makes great ad copy to state that the seed bank contains 100,000 seeds, but what's the point of including 30,000 lettuce seeds? Fifty corn seeds is less than the amount commonly believed necessary to avoid inbreeding depression.

The seed banks tended to be skimpy on large seeded items for crops that are most useful as staples. A staple crop is a food that is easy to grow in large quantities and that can be stored for a long time without refrigeration. Traditional staples in northern climates are corn, dry beans, soup peas, winter squash, turnips, cabbage, beets, sunroots, potatoes, and carrots. I consider wheat to be iffy as a staple crop because harvesting by hand provides a meager return on investment compared to harvesting corn or pulses.

Seed Bank Vegetable Variety Offerings

The choice of varieties in the seed banks I reviewed was also troubling to me. A lot of them included varieties of tomatoes like Beefsteak or Brandywine. These are fine tomatoes if you have a long growing season of near perfect growing conditions, but they are not as productive nor as reliable as varieties that produce smaller fruits more quickly. The first tomato harvested in my garden is always a cherry tomato. I would have liked to have seen more cherry tomatoes offered. The seed banks often included Roma tomatoes which are very susceptible to blossom end rot. Why include a variety like that when there are so many non-susceptible tomatoes to choose from? Some of the seed banks included things like decorative corn or jack-o-lantern pumpkins. I'm certainly not going to be growing decorations in the midst of a food emergency!

Only one of the seed banks that I reviewed mentioned regionally adapted seeds. They claimed that the varieties of seeds that they put into their bank are chosen based on the region that the buyer is located in. I was somewhat pleased with that approach. They didn't bother to mention what seeds are going to what regions, but at least they acknowledged that the problem exists. I am disappointed with the seed banks that were offering a one-size-fits-all collection of seeds for every garden in the world. In my ideal world, the seed bank manufactures would offer seed collections specific to each eco-region. In the USA there are 12 major eco-regions. I'd like to see each seed bank manufacturer offer at least 12 different versions of their seed bank with varieties selected specifically for each major eco-region. Those regions can be further subdivided into a multitude of smaller eco-regions.

I would have liked to have seen more varieties of each species rather than more seeds of a single inbred cultivar. Instead of one species of bean, I would have liked to have seen a dozen species. There's no telling whether a particular variety or species will perform well in any specific garden, especially if there are climatic, or social, or environmental issues which interfere with normal cultivation practices. It's much better in my opinion to throw 3 to 10 varieties of many different species into the ground. It seems like that is a more reliable way to find something that thrives. Then the second year we could grow seeds from the most productive and well adapted plants.

I really like the idea of mixed seed for an emergency seed bank. I was first exposed to the idea of packets of mixed seed about 20 years ago in the catalog of Pinetree Garden Seeds. I bought a packet of mixed radish seed. I loved it. Today many seed companies offer mixed seed. I think that they are one of the most useful and inexpensive ways to stock a survival seed bank.

I'd be perfectly happy including some types of hybrid seeds in a survival seed bank. For example, I would have included hybrid tomatoes. The reason that hybrid tomatoes have taken such a huge market share is because they tend to perform much better than highly inbred heirloom tomatoes. Even if the hybrids don't breed true, their offspring are likely to perform better than open pollinated varieties. They will turn into landrace or open pollinated varieties once we start saving seeds from them.

A Call for Locally Adapted Seed Banks

Overall, we were highly disappointed with the offerings of the survival seed bank marketers. I think that we'd get a better product if there were growers in each neighborhood that offered locally-adapted landrace seed banks specifically selected via survival-of-the-fittest for that neighborhood. This is part of the reason that I believe that landrace gardening is a path towards food security through the use of common sense and traditional methods.

Survival Seed Banks, Part 2: Types and Qualities of Seeds to Include

12/19/2013

Part one of the emergency seed bank article evaluated the offerings currently on the market and found them mostly unsatisfactory. Today's article, part two, details the quantities and varieties of seeds that I think should be included in an emergency seed bank. Part three will discuss long-term storage of seeds.

I recommend that the following quantities and types of seeds be included in an emergency seed bank suitable for planting a one acre garden. Emphasis is on staples: crops that provide a lot of food that can be stored long-term without refrigeration. I'd rather see lots of different varieties for each item in the list rather than only one variety per species. Genetically diverse varieties and mixed seed are preferred over highly inbred varieties or single cultivars. Hybrids are OK to use for some species. I believe that if the time ever comes when we are required to grow our own seed, we'll be

better of starting our survival-of-the-fittest gardens with a lot different kinds of genetically diverse parents.

Joseph's Survival Seed Bank Seed Variety Recommendations

Variety Name	# seeds	Joseph's Suggestions
Bean, Dry	4,000	One of the few sources of significant amounts of protein in a vegetable garden. They aught to be well represented. (Dry bean soup from the grocery store is an inexpensive source of mixed seed. Check germination before storing.) I think that many different species of beans should be included in an emergency seed bank. A disease, pest, or weather pattern is less likely to take out every species during the same growing season. Example of different bean species include common beans, tepary beans, runner beans, garbanzo beans, fava beans, soybeans, chickpeas, yard-long beans, mung beans, lentils, lima beans, lupinis, etc…
Bean, Green	100	I don't think green beans have a place in a survival garden. They don't have enough nutrients to justify the labor. However green beans turn into dry beans if left to dry on the vine.
Beet	3,000	Can provide both early edible greens and long lasting roots. No hybrids.
Broccoli	100	A very difficult crop for me to grow well because of bugs and hot arid days. A highly nutritious crop, so in an emergency I'd eat the bugs and put up with the sulfurous taste. Broccoli is not a staple, so no sense planting more than a row or two. No hybrids.
Cabbage	300	A traditional survival food. No hybrids.
Carrot	10,000	A good staple for a survival garden. Gotta keep up on weeding small plants but yield is great, and they store well. No hybrids.

Chard	100	More nutritious and longer season than lettuce. If the outer leaves are harvested a few plants will produce food all season long in my climate. No hybrids.
Corn, Sweet	4,000	Successive plantings about 10 days apart allow extended harvest. May be dried for addition to soups. Prefer the reliability of old-fashioned (su), rather than sugary enhanced (se), or super sweet (sh).
Corn, Flour	4,000	For making corn meal. Easier to grind than flint corns. Much easier grain to harvest and process than wheat.
Cucumber	100	Cucumbers don't seem like a survival food, but are nice for a change.
Eggplant	0	I believe that even in good times, eggplant is not a food.
Lettuce	0	I wouldn't include lettuce in a survival garden. Nutrient density is low.
Cantaloupe	50	Muskmelons don't store well. Nice to have something sweet for a couple weeks, but they are not a staple. Hybrids OK.
Onion	5,000	Onions store well and make other things taste better. No hybrids.
Parsnip	500	Can overwinter in the ground, and be harvested whenever the ground is not frozen. Life expectancy of the seed is short, thus the high numbers of seeds. No hybrids.
Peas	5,000	Another significant protein source. I'd prefer soup peas for a survival garden. That way they are more of a staple and less fleeting. Pea greens may be eaten as an early spring salad.
Pepper, Green	50	Again not a staple, but something to make the flavors more appealing.
Pepper, Hot	50	I wouldn't include hot peppers in a survival garden, but who cares if it's only 50 seeds? Will transfer hot gene to sweet peppers.

Potato	200	Pollinated potato seeds should be a component of every emergency seed stash. Even if all potato tubers are lost in storage they can be readily regenerated from true seeds. Yield of 2nd year tubers is greater than from first year seedlings. This amount of seed is intended as a safeguard to be able to generate enough tubers for replanting. I recommend only abundantly fruiting varieties for an emergency seed bank. That would allow survival-of-the-fittest selection to be practiced.
Radish	400	I don't think of radishes as a food. However they produce a quick crop that could be eaten if you were hungry enough. No hybrids.
Spinach	400	My favorite early spring green. Hybrids are great.
Squash	-	Winter squash should be one of the main staples in a survival garden. They store very well without refrigeration in a warm dry place. They dehydrate easily. It's an embarrassment to most survival seed banks that so few squash seeds are included. Often times even if seeds are included it’s only one of the four common species. Growers in hotter climates may consider including luffa and lagenaria summer squash. Hybrids are great.
Squash, Cushaw	100	They don’t grow well in my cold climate. They are included because I think it is best to include as much biodiversity as possible.
Squash, Maxima	100	Often susceptible to bugs. Good long-term storage (3 to 6 months). Hubbard, Banana, Buttercup, Lakota, Sweet Meat. I think the buttercups are the best tasting squash in existence. Hybrids and cross pollinated maxima squash are wonderful.

Squash, Moschata	200	The most bug resistant winter squash and longest keeping (up to 12 months). Butternuts, Black Futzu, Long of Naples, Pennsylvania Dutch Crookneck, Long-Necked Squash, Libby's Pumpkin, Long Island Cheese, Seminole Pumpkin. I have had wonderful success allowing the different varieties to cross-pollinate.
Squash, Zucchini	50	Pepo winter squash don't keep well (1 to 3 months). I think their flavor is horrid. I'd rather grow a pepo summer squash -- something like a zucchini or a crookneck, but only one type so that I can maintain a consistent type.
Sunroot	50	Can overwinter in the ground, and be harvested whenever the ground is not frozen. A great crop to plant in an out of the way place and forget about it until needed.
Tomato	200	It's better in my opinion to grow modern hybrid tomatoes instead of heirlooms. I have found that yields are better and they are more reliable. Seeds can be saved from hybrid tomatoes, and the offspring are likely to be more productive than highly inbred heirlooms. I recommend not including Roma tomatoes due to their susceptibility to Blossom End Rot.
Tomato, Cherry	50	Always the earliest tomatoes to produce fruit in my garden. Mixed varieties are wonderful. Hybrids are great.
Turnip	2,000	Produce larger harvests over a longer season than radishes, and can be stored both in the ground and in a root cellar. No hybrids.
Watermelon	50	Store better than muskmelons, and nice for a change. Not a staple. Hybrids OK.

Wheat, Winter	1,000	Wheat is extremely labor intensive to harvest in a home garden. Corn provides a much better return on investment. I recommend winter wheat because its winter growth habits make it more resistant to weeds, and in dry climates it does not need irrigation. I recommend varieties that are easily threshed by hand. Rye is an acceptable substitute. Rye typically grows taller and is even more resistant to weeds. This quantity of wheat seed will not feed a family the first year, but it would give you options later on.
Other Species		My list of varieties is customized for my northern temperate mountain garden and cultural norms about what foods are acceptable. Growers in warmer or damper climates or in lowlands would want to include additional or different species that grow better in their environment and that fit the local food customs. Spices could be included for planting in later years of a food emergency. I think the first year should focus on staples. A medicinal herb seed bank would be clever. I don't have the experience to recommend varieties. I did not include fruit and nut trees. I recommend that food trees be planted now. They can be left to grow feral until needed as food. Yes falling fruits and nuts make a mess in a carefully manicured lawn, but I believe that it's better to waste the food year after year than to not have any hope of a harvest because food trees were never planted.

I think that a seed bank containing approximately this quantity of seeds would make an excellent survival seed bank for a one acre garden if you started with genetically diverse seeds. They would turn into locally-adapted survival-of-the-fittest landraces once you started saving seed from them. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Survival Seed Banks, Part 3: Seed Storage Common Problems

1/3/2014

If we are going to go to the expense and trouble of assembling a stash of seeds for use in the future then it is important to store them in a manner that is likely to provide viable seeds when we are ready to plant.

A great seed storage strategy should take into account all of the ways that seeds are commonly lost. In my personal experience, seeds are most commonly lost or damaged in the following ways. My list is sorted from most common to least common for my personal seed losses. I have never experienced a disaster, but included it on the list for the sake of completeness: human foibles, animals, bugs, moisture, heat, decay, and disasters.

Human Foibles

From my observations, the most common way that seeds are lost is due to human foibles. Grandpa dies and the people cleaning the house don't realize that they are throwing away a box of seeds containing precious family heirloom landraces. People get divorced and the non-gardening spouse takes the seed stash. Seeds get misplaced. They get left in the

back of the truck during a rain storm. Thieves steal. Things get dropped or broken. The rent doesn't get paid on the storage unit.

I think that one of the best ways to avoid losing seeds to human foibles is to live a life of peaceful cooperation with others. Many times in my life I have lost a treasured variety due to absent-mindedness, or crop failure, or mice, or whatever. When my collaborators find out they say things like “You gave that variety to me 5 years ago and I love it! I've sent you a packet of seed.” I keep archive copies of my garden seeds at the homes of friends and relatives. If something bad happened to my main seed supply I'd still have backup seeds. I also send archive copies of my garden seeds to collaborators. They can stash the seeds, or plant them, or donate them away. More than a few times I've had seeds come back to me from the collaborator's stashes.

Animals

Twice in my life mice have gotten into my seed stash and eaten nearly every seed. Both occasions occurred after I moved and a box of seeds got left in the garage. The mice chewed into plastic totes, and cardboard boxes and ate the entire seed stash except for one bottle of seeds stored in a glass mason jar. I still have that jar of seeds today, 13 years after the first attack.

The two methods that I have found which reliably deter mice is to use either glass jars or steel cans. Sometimes I seal seeds into #10 steel cans. Around here the cans and sealer are available a few times per year at the LDS church meetinghouse. In other areas the canners are available by appointment at the Bishop's Storehouse.

My preferred storage method for seeds is glass jars with steel lids, because they are re-usable but steel cans are not. I use sizes from 4 ounces to one gallon. I could use larger sizes if they were readily available.

Once in a while I drop a bottle of seeds in the field and it breaks. These days I tend to transfer the amount of seeds I want to plant into a plastic bag and return the excess to the glass jar when I get home. I'll typically stuff lots of small packets of seed into gallon jars with wide mouths.

Bugs

Bugs are the next most common way that I lose seeds. They likewise chew through plastic, paper, and cardboard. They sneak through tiny little cracks. I often can't tell by looking at a packet of seeds if it contains bugs or baby bugs. There are lots of different species of bugs that attack seeds. Some get into my seed stash as eggs that are harvested with the seed. Others arrive during processing or storage.

Regardless of how bugs get into the seed, I have one strategy that has always worked for me: Freezing the seed kills the bugs. The seed should be dry and ready for storage before freezing, because freezing damp seed could damage the embryo. A couple of days in a typical home freezer is usually sufficient. Once in a while I'll run seeds through the freezer twice separated by about a week. This may catch the bugs at different stages of their life cycle when they are more susceptible to freezing. The seeds should be in a hermetically sealed waterproof container (for example plastic bag or glass jar) so that they do not absorb moisture after being removed from the freezer.

I have run germination tests on dry seeds both before and after freezing. I haven't observed detrimental effects on the varieties I've tested.

Vigorously shaking a bottle of seeds will mechanically crush many bugs and eggs. I shake seeds both before and after freezing.

Once the bugs on the seed are dead, then the seed needs to be protected from reinfection. Glass mason jars are my preferred method. They are inexpensive, readily available, and impervious to bugs. I have often wondered if steel ammo cans would be bug proof.

Many different kinds of seed eating bugs arrive in my home from the grocery store. I do not allow infestations to continue. A thorough cleaning of the pantry is done whenever I notice bugs. If I keep the population of bugs low then they are less likely to eat my seeds. When I have available freezer space I freeze incoming grain products to reduce the number of bugs arriving from the grocery store. Incoming seeds are always frozen before being put in the seed stash.

Moisture

Excess moisture during storage is detrimental to seeds because it reduces their life-expectancy or encourages growth of microorganisms. I use a couple of seat-of-the-pants methods to estimate how dry seeds are. I'll do a bite test. If the seed is still soft enough to bite then it is too moist to store. Another test I use is to put a glass jar or plastic bag of seeds outside in the sunlight. If moisture beads up on the inside of the container then they are too moist. Carol Deppe in `The Resilient Gardener` recommends hitting bean seeds with a hammer. She says that if they shatter they are dry enough. If they smash they are too damp.

In my super-arid climate seeds readily dry to low moisture. People that live in damper climates may need to take active steps to dry seeds. I like using a dehydrator set at 95°F. I also dry seeds by spreading them out on a tarp or cookie sheet exposed to the sun.

The moisture in seeds can be reduced by the use of desiccants. I like using white rice because it is readily available: Dry the rice in the oven at 225°F for about 4 hours. Cool. Place in airtight container such as a gallon sized glass jar. Add seeds in paper or fabric envelopes. Allow to dry for about a week. For large sized batches, equal weights of rice and seeds will reduce the moisture in the seeds by 50%.

Commercial seeds that are sold in paper envelopes typically have too much moisture in them for optimal storage, therefore I recommend drying them before storage. They can be dried paper envelope and all.

Once dry, the seeds need to be protected from atmospheric moisture. I prefer glass jars with steel lids.

Heat

Most species of dry seeds store very well for me at room temperature. The physical chemistry of biological systems roughly operates on the principle that for every 18°F increase in temperature the rate of reaction doubles. So a variety of seed that is expected to last 8 years at 70°F would only be expected to survive 4 years at 88°F, 2 years at 106°F, and 1 year at 124°F. So if you have a choice between storing your seeds in a warm place or a cool place, choose the cooler location.

Decay

In like manner, for every decrease in temperature of 18°F the rate of reaction is cut in half. So seeds that are expected to be viable for 8 years at room temperature can be expected to survive for 32 years in the refrigerator or 128 years in the freezer. Freezing dry seeds basically puts their life-expectancy on hold. If the power ever goes off, then their biological decay starts up again.

Disasters

I have never lost seeds to a disaster, but it is something that I plan for. I keep seed stashes in three different counties. One stash is quite susceptible to flood, wildfire, and theft. Two stashes are immune from flood but susceptible to earthquake. All stashes are susceptible to house fires. I figure that by spreading the seeds out that I am mitigating against all of them being destroyed at the same time. The shelves of my primary seed bank are bolted to the wall, and have a lip around them so that the seeds are less likely to be damaged by an earthquake. They are in glass jars. If I wanted an extra measure of security, I could put plastic bags inside the jars so that even if the jars break the seeds would still be contained. People in other areas should include plans for getting their seeds through their most likely disasters: For example burying seeds in Tornado Alley.

Summary

With careful forethought, it is possible to store seeds in a manner that will allow them to avoid or survive common seed destroying events. If genetically locally-adapted genetically-diverse seeds of many different species are stored then rebuilding of a local food system would be straight forward. This is part of the reason why I believe that Landrace gardening is a path towards food security through common sense and traditional methods.

Promiscuously Pollinated Tomatoes

1/22/2014

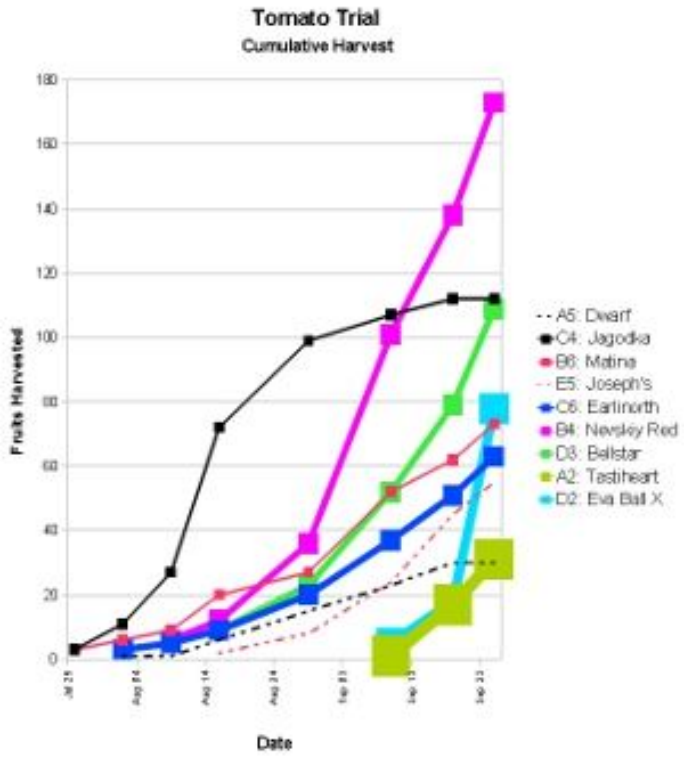
In previous blogs I have written about landrace development projects that I have been working on for years. Today I am describing a project that is just beginning. I would like to convert my tomato population into a promiscuously pollinated landrace. A freely cross-pollinating population of tomatoes would greatly simplify the process of survival-of-the-fittest selection for families of tomatoes that thrive in my garden.

Background

In their natural non-domesticated state, tomatoes are a promiscuously pollinated crop. During domestication they were converted into a highly inbreeding crop. I believe this is due partially to not taking the tomatoes natural pollinators with the plant when it left its native land, and partly due to the intense focus in the last century on preventing cross-pollination. Naturally cross-pollinated tomatoes are typically considered a liability in modern times both in mega-ag and among home growers so heavy selection pressure has been put on the species to eliminate traits that lead to higher cross-pollination rates. I intend to reverse that trend in my garden and to create a landrace of tomatoes that is promiscuously cross-pollinating.

What Triggered This Project?

During the 2013 growing season I conducted a cold/frost tolerance trial on tomatoes. That got me into the tomato patch regularly to take measurements and photos. While there I noticed that just about every time I was in the tomato patch that there were two plants, out of 50 varieties, which were highly attractive to bumblebees. At least 5 different species of



bumblebees visited the plants while I was watching. They spent around 10 seconds per flower. If the bees even visited other tomato plants they stayed for less than a second on any particular flower. Those two plants also happened to be the most productive plants in my garden. The varieties are named Jagodka and Nevskiy Red. I attribute the high productivity in part to the bumblebees doing a highly effective job of pollinating the flowers on those plants. I believe that more flowers got better pollinated leading to higher fruit set and larger tomatoes. That got me to thinking about what I really want out of my tomatoes. Do I want to continue trialing highly inbred varieties from far away that perform marginally? I decided that doesn't work for me any more. I want a locally-adapting population of tomatoes that is constantly generating lots of natural hybrids so that they can get more and more acclimated to growing in my garden with its unique pests, soil, climate, and farmer.

Where Do I Go From Here?

I have identified two varieties that are highly attractive to bumblebees, and that were very productive in my garden. They will form the basis of my new population. For the next few years the primary selection criteria for my tomatoes will be 'Highly attractive to pollinators'. Secondary selection criteria will include 'children of natural cross-pollination', productivity, and 'traits that might lead to higher cross pollination rates'.

Some of the older heirloom-type tomato varieties have retained traits that make cross-pollination more likely. I intend to gather some of those varieties together and allow them to cross-pollinate if they will, and select among the offspring for plants that are highly attractive to pollinators.

Possibly Useful Traits

Last summer I used a 20 X magnifying glass to carefully examine tomato flowers. I noticed a number of traits that might be useful in this project, especially if all of the traits could be combined into a single family. If a couple of years of natural pollination and observant selection don't lead to the combining of these traits I may attempt manual pollinations later on.

Simple Flowers: Some varieties of tomatoes have so many layers of petals that they prevent pollinators from reaching the interior of the flower. I will be selecting for simple flowers that allow easy access by insects.

Non-Fused Anther Cones: There was wide variation in how tightly the anthers were fused together. In some varieties they were loosely connected if at all, and in others the anthers were tightly fused together. I believe that a non-connected or marginally fused anther cone might lead to higher cross-pollination rates.

Loose Anther Cones: Some anther cones were tight against the style. This tight fit might prevent pollen from reaching the stigma or from leaving the anther cone, thus leading to lack of interest by pollinators and low cross pollination rates. Other anther cones fit very loosely around the style. I will be selecting for loose anther cones.

Extended Stigmas: Some varieties had stigmas that were totally inside the anther cone, others had stigmas that were outside the anther cone, and everywhere in between. I expect to be selecting for long styles that are outside of the anther cone so that they can rub up against a bees belly and collect some foreign pollen. That requires that pollinators are attracted to the flower in the first place.

Abundant Pollen: I attempted to extract pollen from many varieties of tomatoes this summer. The two varieties that were attractive to bumblebees were the only two varieties in my garden that released clouds of pollen for me when vibrated. Bees are not dummies. If a plant isn't feeding them then they are not going to hang around. The trait of attracting bumblebees might be a sufficient selection criteria to use for developing a locally-adapted survival-of-the-fittest promiscuously-pollinating tomato landrace in my garden.

Collaboration

I'd love feedback on this project. Have you noticed specific varieties of tomatoes in your garden that are highly attractive to bumblebees or other pollinators? Do you know of any varieties that readily release clouds of pollen or that are unusually susceptible to natural cross pollination? If you notice a variety during the coming growing season that the bees just won't leave alone, please tell me about it. I have a small amount of seed from Jagodka and Nevskiy Red which the bumblebees really liked this summer. If you'd like to collaborate on a grow out or in making manual crosses with something like Hillbilly let's correspond.

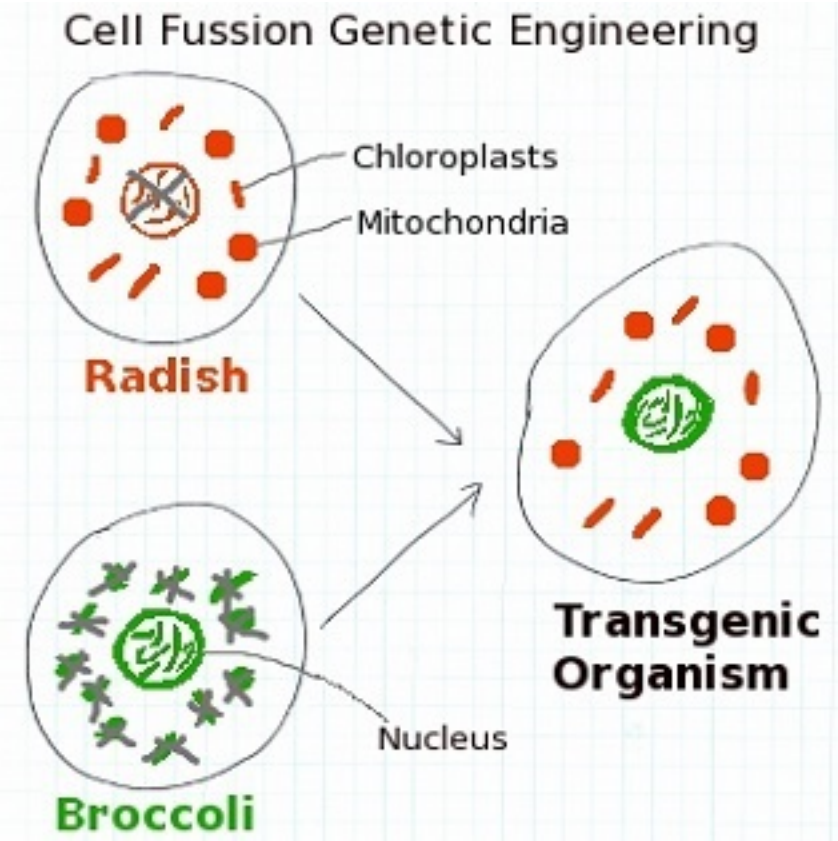
Conclusion

I believe that there is plenty of diversity available among commonly available tomato varieties to allow a group of observant plant breeders to return a population of tomatoes to their natural state of being promiscuously pollinating. I believe that it is easily possible to combine modern traits like large fruits with ancestral traits like being highly attractive to pollinators and very susceptible to cross pollination. A tomato landrace that combined the best of both worlds would constantly be regenerating lots of new hybrid vigor. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Genetic Engineering and Cell Fusion CMS

2/5/2014

This weekend I listened to the webinar broadcast of the Organic Seed Growers Conference 2014. One of the sessions was titled: 'Unpacking the Cell Fusion Debate'. I touched on this topic in a previous blog on landrace gardening, and promised to return to it at a later time. Seems like now would be appropriate.



What is Cell Fusion?

Cell fusion is a genetic engineering process in which the nucleus is removed from a plant cell and replaced by a nucleus from a different plant that might be from a different species or genera. This creates a new plant with mixed genetics. It contains the mitochondrial and chloroplast DNA from one cell and the nuclear DNA from a different one. This is typically done for the purpose of creating cytoplasmic male sterility (CMS), which allows hybrids to be created reliably and inexpensively, and prevents anyone other than the seed company from recreating the variety. This

process is also called somatic fusion or protoplast fusion. The plants created by using this technology are sometimes called transgenic cybrids.

Is Cell Fusion Compatible With Organic Standards?

The discussion at the conference centered around whether it is appropriate to use this sort of genetic engineering in Certified Organic production of fruits and vegetables, and how the industry might adapt if the standards are changed. Cell fusion technology is currently being used extensively in the production of both organic and conventional foods. I have been writing about this topic since 2011. Now that it has gained national attention at a major conference attended by many of the prominent players in the organic seed movement we can expect to see it become a common topic of conversation. It is likely that the USDA's National Organic Program will be asking for public comment on the issue.

Who is Affected?

As things currently stand, buyers of organic food, and of hybrid organic seed may not be able to determine whether or not the plants are derived from genetically engineered ancestors. Growing non-hybrid seed is currently the most reliable way to avoid growing plants created via cell fusion genetic engineering.

Seed companies that have signed the Safe Seed Pledge may want to re-evaluate their hybrid seed offerings to make sure that they are honoring their promises in light of the new understanding of this topic. I would like to see signers of the safe seed pledge providing details about how their hybrids were created: Especially regarding the brassicas, alliums, chenopods, and umbifers. Some of these types of hybrids may also be made using self-incompatibility. It would be nice to know which are which. I would like to see the release of a Safe Seed Pledge 2.0 which generally

bans the use of cytoplasmic male sterility and specifically bans cell fusion genetic engineering.

There may be disruptions in the availability of seed if the industry consensus determines that cell fusion technology does not belong in organic agriculture. Large-scale growers might want to start planning now in order to avoid uncertainty later on. Small-scale growers can avoid transgenic cybrids by not planting hybrids.

A Muddled Mess

Now for the part where it gets confusing. Cytoplasmic male sterility has been known for a long time. In some species it may be obtained by natural means. Onions are an example. Hybrid onions are grown extensively. The parent varieties were probably created using the naturally occurring sterility. But what if some hybrid onion varieties were created via genetic engineering? How would the average grower or even seed company be able to tell which is which? The seed companies haven't been forthcoming with that type of information. Cell fusion genetic engineering allowed the creation of hybrid broccoli (and other brassicas) by combining a broccoli nucleus with radish organelles. These types of genetically modified organisms are extremely common in the grocery stores, even in the organic aisle. The same type of sterility traits might be obtained by natural means or might only be obtainable by genetic engineering, with all sorts of in-between states.

My Stance

For my own purposes on my own farm I have determined that cytoplasmic male sterility is not compatible with organic standards regardless of whether it originated naturally or via genetic engineering. It seems wrong to me to intentionally grow defective plants if alternatives are readily available. I'm guessing that won't be a popular stance among regulators and large-

scale growers, but it's likely to be favored by small-scale growers and by end users of organic food and seeds. For now cell fusion GMO seeds are most easily avoided by not planting hybrid seeds.

Conclusion

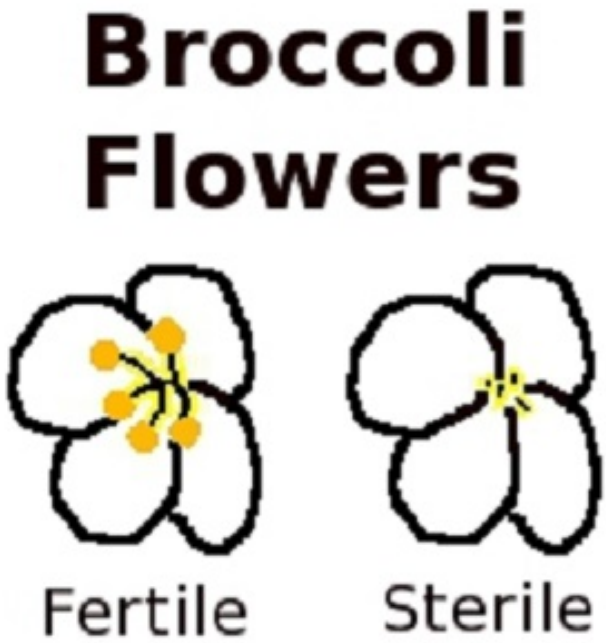
The organic food and seed industry is faced with a decision about whether to continue business as usual by using hybrids derived from cell fusion genetic engineering or to come clean, resolve mistakes made in the past, and get on with providing the kind of food and seeds that people expect from “Certified Organic” and the Safe Seed Pledge.

On my own farm I bypass this issue by constantly screening for cell fusion and naturally occurring male sterility and eliminating it. I make whatever sacrifices or investments necessary to create and maintain crops with perfectly functioning male and female flower parts. This allows my crops to become locally adapted through survival-of-the-fittest and farmer directed selection. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Dealing With Cytoplasmic Male Sterility

2/12/2014

Cytoplasmic male sterility (CMS) is widely used in both conventional and organic agriculture as a simple inexpensive method of creating hybrids and protecting seed company's trade secrets. Sterile plants are problematic for landrace gardeners and seed savers because they interfere with normal plant biology and seed saving practices.



Male sterility can be achieved by unusual natural means or by genetic engineering. Last week's blog defined cell fusion CMS and touched on the politics of using genetically engineered varieties in USDA organic seeds and food. This week's blog takes a pragmatic hands on approach to sterile plants and treats all male sterile plants the same whether they originated by natural means or in a genetic engineering laboratory. On my farm I have banned male sterility of both types in annual and biennial crops because I think that it is wrong to propagate defective plants.

How CMS Affected My Carrot Crop

Approximately 85% of the **USA** carrot crop are F1 hybrids that are male sterile. They do not produce pollen. What this means from a practical standpoint is that if a home gardener plants one of these carrot varieties and tries to save seed from it that their attempt will be unsuccessful. Either no seed will be produced, or some wild pollen from Queen Anne's Lace will pollinate the crop and the offspring end up reverting to wild forms, or the plant will be pollinated by other nearby carrot varieties.

When I started my carrot landrace I used a mix of hybrids and open pollinated carrots. After I became aware of cytoplasmic male sterility I screened my carrot crop and found that 70% of my plants were male sterile. I was crushed, and incredibly disillusioned with myself, with the seed industry, and with my trading partners that unknowingly provided the seed.

Review of the Seed Industry

This week I reviewed the seed offerings of 6 seed companies that were suggested to me as having low rates of cell fusion CMS. Half of the companies offered inventories that seem like they have a lot of male sterility. One of them claimed to be 100% organic and a signer of the safe seed pledge. It seems to me that about half of it's inventory on some species was made by cell fusion genetic engineering! One company didn't disclose whether or not the seed they are selling is hybrid but they are offering varieties with the same names that the other companies are calling F1 hybrids so they are likely the same varieties and made with cell fusion CMS.

Half of the companies I reviewed offered only open pollinated seeds. They are doing seed right for home gardeners. If I still bought seeds I would only buy from those companies.

The take away message for me is that I can't trust the seed industry and my swap partners to tell me whether or not the seed they are offering is male sterile. I figure that they either don't know what they are trading or they know and don't want to tell me. Fortunately I don't have to rely on other people to do the screening for me. If a plant fails to produce pollen it is often obvious by looking at the flowers with a magnifying glass or even with just my eyes.

How To Eliminate CMS

Male sterility takes many different visible forms depending on the species, but one thing that is fairly common among them is that the anthers are missing from the flower. This week's images show what that looks like in the cabbage family and in the carrot family.

Nowadays I routinely screen for male sterility and chop out every sterile plant that I find.

Male sterility is common among commercial hybrids in the carrot, beet, onion, sunflower, and cabbage families. I don't knowingly add hybrids from those families to my landraces. I think that last growing season I finally eliminated male sterility from my carrot patch. Healthy carrot flowers look fuzzy even from a distance because of many anthers poking up. Sterile carrot flowers look smooth because the anthers are missing. I have included photos in this blog of what that looks like.

Commercial hybrids of cabbage family plants are often made by cell fusion CMS. They are crops like broccoli, kale, turnips, radishes, bok choi, rutabaga, mustard, cabbage, Brussels sprouts, cauliflower, canola, and kohlrabi. A normal cabbage family flower has styles with anthers attached growing from the center of the flower. A common manifestation of male sterility is that the anthers and styles are missing. Look at the drawing of a broccoli flower to see what that looks like.

In onions, male sterility is often indicated by bulbils forming in the flower head. The flowers might produce anthers, but they don't release pollen. If I rub my fingers across a normal onion flower it will come away with pollen on it. Sterile plants don't produce pollen. Seed set is often low in male sterile onion flowers.

In potatoes with male sterility the pollen is often sticky. It is like a jelly instead of a fine dust. I can observe dusty pollen by flicking a flower with my finger on a sunny day. Pollen pours out of healthy flowers.

I don't know what male sterility looks like in beets or chard. I suppose that male sterile plants wouldn't release a cloud of pollen when shaken.

Another way that I commonly identify male sterile flowers is to pay attention to the pollinators. Flowers that are not producing pollen are less attractive to bees, flies, wasps, and other pollinators. What self respecting sweat bee is going to visit a pollen-less sunflower? Additionally male sterility often interferes with the nectaries of flowers causing them to produce little or no nectar. Another turn-off to pollinators.

Seed set is often much lower in male sterile plants than in plants with healthy flowers. In the case of a single variety being planted with no related healthy plants within pollination distance the variety might self-eliminate by failing to produce any seed at all.

Conclusion

In spite of contamination of the conventional and organic seed markets by genetically engineered cell fusion CMS, it is simple to participate in survival-of-the-fittest and farmer-directed selection in order to create healthy locally-adapted populations of food crops that are free of male sterility. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Egyptian Walking Onions

4/3/2014

I have started harvesting my first crop for the season: Egyptian Walking Onions. They grow under the snow during the winter and are ready for harvest about 3 weeks after our winter snow cover melts. My father calls them forever onions because they continue to produce food for my family until covered with snow in the fall. The strain I am growing was collected from my great-grandfather's garden.

How to Use Egyptian Walking Onions

I love the taste of walking onions. They are robustly flavored without the strong sting that is so disagreeable to me in some varieties of onion.

In my climate walking onions produce scallions (green onions) during

the entire growing season. In hotter climates they may form a dormant bulb during the hottest part of the summer. The bulbils may be eaten as well. The bulbils are small, so I like using them in dishes that don't require peeling such as pickles or roasted onion.

How to Grow Eqyptian Walking Onions

Walking onions are a hardy perennial. In my climate they can be planted or harvested any time of year except when the ground is frozen. If pulled, the roots and a small piece of bulb may be replanted. They'll grow a new plant. They may be propagated by planting the bulbils that form on top of the flower stalk, or by digging and dividing the mother clump. There are a few weeks after the flower stalk forms in which the stem becomes hard and undesirable. New bulbs form beside the flower stalk producing tender bulbs later in the season.

I typically keep a perennial mother clump to generate bulbils that I harvest and store in a dry area. I then replant the bulbils every few weeks as an annual to grow successive crops of green onions for market and to feed my family.

New Varieties

Egyptian onions are an inter-species hybrid between bulbing onions and bunching onions. The plants produce a few flowers, but as far as my plant breeding network has been able to determine, they may be sterile and produce few if any viable seeds. Oh no! One of those sterile plants that I was badmouthing the last couple of blogs. I did that deliberately to demonstrate that I'm willing to grow some sterile plants if fertile substitutes can't be found. I used to grow sterile potatoes, but successfully transitioned to only growing fecund potatoes that produce true pollinated seeds. I also grow garlic and seedless grapes which are both sterile. Eventually I'll

transition to only growing fertile garlic, but I can't foresee totally giving up my seedless grapes.

I have a small patch of onions in my garden in which is planted both bulbing onions and bunching onions. I allow them to flower together. I am hoping to eventually find some inter-species hybrids among the offspring. This will create more biodiversity among my tree onions and allow them to avoid the eventual fate of clones: a combination of pests, diseases, or weather that overcomes the plants defenses. My ancestor's clone has been going strong for more than 70 years, but it could meet it's demise any decade now.

I am also using pollen from both parent species to pollinate the top setting onion flowers. Perhaps that will be the kick they need to set seed.

Conclusion

Egyptian walking onions are a wonderful plant in the home garden because they can provide great onion taste any time of year that the ground isn't frozen. Even though they are grown as clones, I suspect that the creation of new clones may be within the skill set of the average landrace gardener. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Landrace Gardening: 2014 Progress Report

12/1/2014

Today I'm sharing stories about the successes and failures of this growing season. Sorry that it's been so long since I posted. I allowed a slow personal economy and a series of family troubles to distract me from writing.

Vigorous Carrots and Parsnips

In Racing the Weeds I suggested that it would be nice to select among the carrots and parsnips for seedlings that grow vigorously so that they can out-compete the weeds. I am content to say that was a stunning success this growing season! A patch of carrots was grown without weeding or thinning. They didn't grow as big or produce as abundantly as the patch that was weeded and thinned only one time, but both patches produced food for the table and roots to be grown for seed next year. The parsnips were also grown without weeding. They are still in the ground. The smaller plants can be culled in the spring before the patch flowers. The surviving carrots and parsnips have shown that they can handle the weeds. The photo of a recently weeded carrot row shows the huge differences in growth that can exist between strains. I don't see the value in keeping the slow growing plants. They would continue to grow slowly for the entire growing season.

Skunks Attack Corn!

Skunks ate 2-3/4 patches of sweet corn. My corn varieties were developed in fields that are not bothered by skunks, so when planted into a new field they were decimated by a new pest. No worries. A quarter of the plants in

one variety passed the survival-of-the-fittest test and overcame the skunk predation. They had stronger stalks, or higher cobs, or other traits that kept them from being eaten. I'll replant the survivors into the same field next year with the goal of developing a skunk-proof, or at least skunk-resistant, sweet corn.

Tomatoes Getting Frisky

Great progress was made on the project to develop Promiscuously Pollinated Tomatoes. A number of varieties were identified that have loose or open flowers. The shorter season specimens were combined into a new grex. Then F1 hybrids were created between them and my earliest tomato. The hybrids are currently growing indoors under lights in hopes that they'll produce F2 seed to plant

in the spring. The second generation after a cross is the most exciting. That is where the most diversity shows up.

Melons & Squash vs. the Rain

We had unusually long and repeated monsoonal rains this summer. The muskmelons and watermelons suffered. Ripening was delayed. Plenty of muskmelons were left in the field – or turned into wine – because they popped from absorbing too much water. There was mildew on the squash leaves! Out here in the desert we mostly forget that mildew even exists. Nevertheless, the squash produced abundantly, including about 9 different types of mixta squash. The total harvest of mixta squash in the previous 5 years of trying was one fruit. I am really looking forward to growing the mixta squash next year.

Named the Beans

This year the dry bean landrace was well enough adapted to my garden and way of doing things that it was given a name. It is consistently performing very well these days and not changing much, it seemed like it was time for a name. We watch for naturally occurring bean hybrids. They get trialed for a year or two. The best get added to the landrace. The rest get eaten. The new additions are about 10 percent or less per year.

Grew Some Trees

To continue the Fruit and Nut Trees From Seed Project, a few hundred hazelnut seeds were planted. About a dozen plants survived without being weeded. A half dozen pecan trees were grown from seed. Some of the more promising walnuts were identified for transplant into a slightly colder micro-climate. Scions from feral fruit and nut trees and friends yard's were grafted into existing trees. My grafting skills could definitely use some refinement.

Sunroots Get Award for Most Improved

The sunroot landrace showed remarkable improvement this growing season. Last year the feral sunroots were crossed with a commercial clone. The seeds were replanted. About 40 percent of them grew vigorously and survived the growing conditions and the farmers. Half of the plants were not agronomically pleasing and were culled. The others produced vigorous plants with pretty, easy to harvest tubers, and high productivity. They have been replanted into a seed-production and trail bed.

Steady As She Goes for Potatoes and Popcorn

The potatoes and popcorn continue on each year with a little bit of refinement here and there. A few nice cultivars among the potato seedlings were added to next year's seed crop. The popcorn is refined each year for better popping ability, easier shelling, and taste that is more pleasing to me. Popcorn hybrids were made to add more colors and more carotenes. I figure that more colors equals higher nutrition. Slow and steady is the working meme for these crops.

New Garlic Varieties

The project to produce true pollinated garlic seeds, and thus new varieties of garlic, produced 26 pollinated garlic seeds, and 9 new varieties of garlic. I'm intending to post on that topic this winter.

Other New Crops

In order to assure Food Security through Biodiversity, work continued on adapting new species to our growing conditions. I felt inspired by William Woys Weaver's blog post so I grew and ate dahlias this summer. They need some work, but there's lots of potential there. Respectable amounts of favas and garbanzos were harvested. I've only been working with them one or two years, so they are still in a rough draft stage. This was the third year of working on an okra landrace. The first year the plants grew to just above my ankle and 99 percent of the plants failed the survival-of-the-fittest test by not producing seed. The second year a few plants reached knee high and only 95 percent of the plants failed the survival-of-the-fittest test. One of the plants survived the first fall frosts. This year one of the survival-of-the-fittest tests was performed in the greenhouse by selecting for vigorous growth of seedlings. About 80 percent of the seeds were culled before setting out. This year one of the successful plants grew taller than the farmer, and there was an abundant enough harvest to share okra at the farmer's market. Some of the plants were still producing food when I tilled them under 52 days after the start of our fall frosty season. The third year of a landrace development project often seems magical to me. Frost tolerant okra grown in my cold mountain valley? How clever.

Conclusion

In spite of the complete neglect that some crops suffered, they nevertheless provided food for my people. They produced offspring that seem very capable of providing food next time there are economic or family

problems. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

True Garlic Seeds

12/8/2015

A cloned crop like garlic has limited potential to become localized to a particular garden. The glorious success of landrace gardening happens because genetically diverse crops are subjected to survival-of-the-fittest and farmer directed selection. After a while, the varieties get closely aligned to the local environment, the farmer's way of doing things, and the culinary habits of the community.

In the 2011 growing season I was chatting with a few other plant breeders. We decided that we should be growing garlic from pollinated seeds so that we can create new varieties of garlic that can be regionally adapted. It's a daunting task, because very few varieties of garlic make seeds any more.

What's Wrong With Garlic?

Garlic is a crop that has been grown primarily through cloning for perhaps ten thousand generations. When scientists did genetic analysis on garlic they found that plants with the

same genetics were being offered under many different names. This indicates that there are far fewer varieties of garlic being grown than it would appear by looking at a list.

Cloned crops create a food-security risk, because when a pest finally overcomes a variety's defenses, it overcomes the defenses of every clone of that variety. Entire crops can be lost in a single season. Genetically diverse seed grown crops are much less susceptible to crop failures.

As a result of being cloned for eons, the small amounts of normal chromosome damage – that are typically eliminated through sexual reproduction – have accumulated in garlic. The vast majority of varieties have accumulated so much damage that they have lost the ability to flower or to produce seeds.

Some people use the term “seed garlic” to describe the cloning process. They are dealing with bulbils or cloves: vegetative parts of the plant. When I use the term “true garlic seeds” I am referring to pollinated seeds in which a pollen grain fertilized an ova in a flower. Growing plants from seeds instead of cloning also tends to reduce virus contamination.

Finding Fertile Garlic

Before starting this project, I was already growing many types of garlic. My collaborators sent others. [1,2] Rather than removing the scapes I allowed them to attempt to flower. Then I screened them for the ability to set seed. I collected a total of three seeds from a couple thousand garlic plants. Germination rate of first generation garlic seeds is very low, so I didn't get any plants from those seeds.

Dr. Maria Jenderek helped us to identify and Barbara Hellier helped us to acquire accessions from the Agricultural Research Service that are known to produce at least a few seeds from time to time. These varieties were mostly collected in the USSR. They are from near the center of origin of garlic and have retained more of the ancestral traits including an ability to make a few seeds if conditions allow.

Ted Jordan Meredith and Avram Drucker [3] helped us to identify and acquire other varieties that have produced seeds in their gardens. Ivan W. Buddenhagen [4] shared pollinated seeds grown in his garden in Oregon.

We have had the most success with varieties that are classified as “purple striped” or “marbled purple striped”. Last growing season, a couple of growers reported stunning success with Chesnok Red.

Removing Bulbils

In a garlic scape, flowers form intermingled with bulbils. The bulbils tend to strangle the flower stems. A few seeds might be formed anyway on some varieties. We have found that more seeds form if we limit the competition by removing bulbils from the flower stalk. I do this with my fingernails by raking out the bulbils. Others prefer to use tweezers.

The ease of the process varies widely between varieties. Some have lots of little tiny bulbils. Some have a few larger bulbils. Whether small or large some are tightly held while others fall out easily. So far my most seedy variety, PI 540319, has large bulbils that are easy to remove. The best possible scenario.

Overcoming Fertility And Other Barriers

Some varieties of garlic are female sterile, and some produce sterile pollen, or only partially viable pollen. In an attempt to overcome these barriers I

plant different varieties close together, hoping that the pollinators will spread fertile pollen between plants. I am also weeding out varieties that completely fail to even go through the motions of flowering.

I never would have imagined when we started this project that the biggest obstacle to overcome would not be related to genetics, biology, or growing conditions. We have experienced widespread opposition to our efforts from government bureaucrats who have went so far as to confiscate plants and interdict shipments of seeds. The beautiful plant with 3-feet-long leaves shown in the photo growing in a pot was destroyed by a government bureaucrat.

I have sometimes thought of gardening as a subversive activity. It appears that growing new varieties of garlic is even more so. A word of caution to those joining our effort: Perhaps public posts about sharing seeds or bulbs isn't the most prudent activity. And people clamoring for seeds or bulbs may be doing so under false pretenses.

Germination

We have had good success sowing garlic seeds in mid-winter. Cold-frames or the Winter-Sown method have produced the best germination rates. I highly recommend sowing into weed-free potting mix, because garlic start off slowly and it's easy to loose the seedlings in a weedy soil.

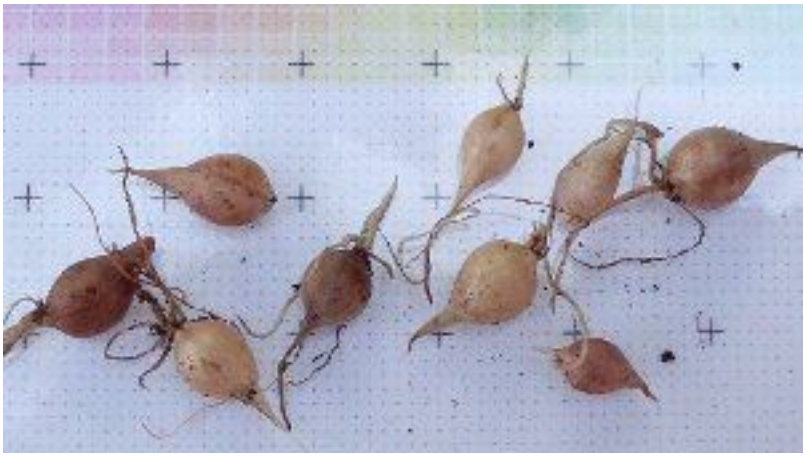
Success!

I managed to grow 8 new garlic varieties from pollinated seed. I collected 26 seeds. More than that were produced, but I dropped the bowl containing the seed into the lawn... Some collaborators are being even more successful.

It's a been a ton of work to obtain a few new varieties. But they are varieties that have never before been grown in the history of the world. That's something to smile about.

Conclusion

We have identified varieties that produce true garlic seeds, and we are learning and sharing methods for growing garlic from pollinated seed.



Eventually we expect to be creating hundreds or thousands of new garlic varieties per year. At that point, they can become l o c a l l y - a d a p t e d landraces. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

References

[1] HomeGrown Goodness Plant Breeding Forum: True Garlic Seed
[2] Seed Savers Exchange: Growing Garlic from True Seed
[3] Growing Garlic from True Seed, Meredith & Drucker
[4] Ivan's Garlics
[5] Links to Scientific Papers On My Web Site

Photos by R. Wagner, K. Edwards, J. Lofthouse

Do It for the Taste

4/27/2016 1:10:00 PM

I have been growing my own varieties of fruits and vegetables for years. They taste marvelous to me. Before saving seeds, I taste the crops to make sure that they taste good to me. I didn't start out to intentionally breed for great tasting vegetables, it happened mostly by chance as tastes, textures, smells, and colors that I find most pleasing have come to predominate in my varieties.

This afternoon, I had the pleasure of attending an open house at the home of a man that has been my friend since childhood. There was a beautiful spread of vegetables that looked glorious, but tasted nothing like the vegetables from my garden. The experience triggered the train of thought that lead to writing this blog.

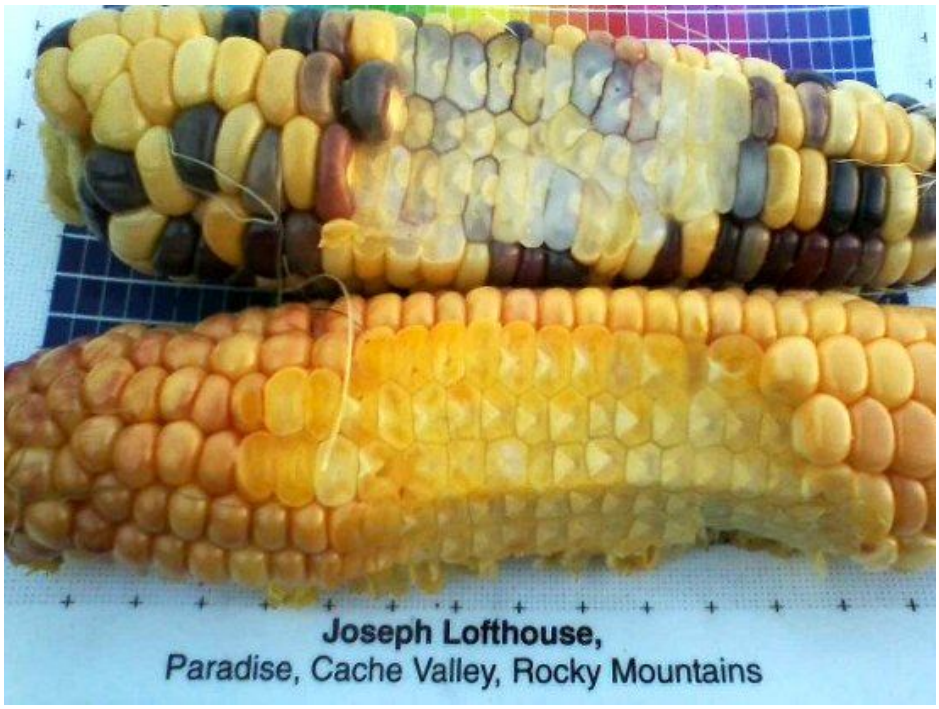
Industrialized Food

Last fall, I was invited to the capitol, for a week, where I was wined and dined on the finest food that industrialized agriculture has to offer. On more than a few occasions, I put a forkful of food into my mouth that I thought I

recognized, but the taste or texture was so off-putting, that I spit it out for fear that I had inadvertently put a non-food item into my mouth.

As an example, there was a dish of small thin snap beans that looked so young and tender that on my farm, I would have expected them to melt in my mouth. At the restaurant, they had the consistency of a bean stem. In a blind taste test, I would have considered them too fibrous to be edible. I was served fruits that looked like tomatoes or strawberries, but the texture and taste was more akin to eating Styrofoam packing peanuts with a bit of added food coloring.

I've heard some of my patrons use the term “cardboard tomatoes” to disparage tomatoes that are trucked in from far away. I had the opportunity to taste some of them. I have included a photo of an industrialized cantaloupe (above). I sure wouldn't want to eat that!



Localized Food

The experience last fall helped me to realize that I have been localizing the taste of my food to my own body and my own community. When I plant genetically diverse crops, and allow them to promiscuously pollinate, they are creating lots of variation in taste, texture,

color, and odor. When I save seeds from specific plants that taste best to me, I am moving the population in the direction of what tastes best to me.

I view myself as a thoroughly average human primate. So I think that when I select for varieties that taste great to me, I am tending to select for crops that taste great to my community. That is, borne out at the farmer's market, where some of my varieties have developed a following. People that look forward every year to my muskmelons, sweet corn, squash, or tomatoes. Sure, I might lose 20% of my fruit crops to bruising before I can get them to the farmer's market. But what survives is a joy to the mouth, nose, and eyes.

I have included a photo comparing a high carotene version of my sweet corn with normal sweet corn (above). Mmm. Mmm. Mmm.

Better Smelling Food

When I first started growing melons, I called them cantaloupes, because that's what the seed packets called them. Over the years, as I saved the melons that tasted best to me, they started to become sweeter and sweeter, and they got smelly. Not just a little smelly, they became odoriferous, and fragrant. I can't put a basket of them in the cab of the truck with me unless I roll down the window, and even that is pushing it.

The smell from a single melon on the dinner table is glorious. A couple baskets in a closed up truck creates an overwhelming odor. Therefore, these days I call them muskmelons, because their musky smell is one of their defining characteristics.

Higher Nutrition

Another melon trait has developed to please my taste buds. My muskmelons are deep orange due to high carotenes. I love the taste of carotenes in my food. So as I have been selecting for great taste, I have also been inadvertently selecting for higher carotene content and more brilliant color. I have noticed a similar trend in other crops such as squash, and sweet corn.

It seems to me that as I select for great taste, I am also selecting for more nutritious crops with higher levels of vitamins, anti-oxidants, and phytonutrients which are often brightly colored. My fruits and vegetables look great, and they taste great. I'm coming to believe that our bodies are not simple black boxes that take in any purported food and give any output. The more involved I become in saving seeds for better tasting food, the more I am convinced that foods taste better to our bodies when they have more of the nutrients that a body needs.

I've included a photo of my butternut squash. *My, how orange!*

Conclusion

When I plant genetically diverse crops, and allow them to promiscuously pollinate, they are creating lots of variation in taste, texture, color, and odor. When I save seeds from specific plants that taste best to me, I am moving the population in the direction of what tastes best to me and to my community. This is part of the reason why I believe that landrace gardening is a path towards food security through common sense and traditional methods.

Compiled and edited by Dr. Shanon Brooks-Monticello College 2021