FUNDAMENTALS OF COMMERCIAL SEED PRODUCTION IN WEST VIRGINIA

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1. COMMERCIAL SEED PRODUCTION IN WEST VIRGINIA

It is known that small scale commercial seed production was sporadically practiced by very few farmers in West Virginia in the past. Since we moved our seed company, Two Seeds in a Pod, to Reedsville (hardiness zone 6) in 2019, we have evaluated and grown seeds for hundreds of culturally significant seeds of Turkey and the Appalachian Region on our farm. Since then, I also have been closely working with farmers on growing commercial seeds here and other states across the country for our seed catalog.

Based on my own experience growing seeds in Preston County and working with other farmers, I will share some place-based insights and tips about commercial seed production in this document. In addition, in 2022, I worked with partner farmers from Monongalia, Fayette and Summers counties as part of a project funded by Northeast SARE to better understand the viability of growing seeds for small farmers in West Virginia. In this document, you will also find details from our collective work.

In my experience working with more than 50 food crops, I can say that the majority of these crops, including peanuts and artichoke (overwintered), can be successfully grown in field conditions in Preston County with varying levels of challenges. When possible, I personally prefer to grow seeds in field conditions to better understand the adaptation capacity of these seeds to the climate we are in and to the changing climate conditions year after year. However, certain crops are either prone to pest damage to grow in summer or not cold hardy enough to complete their seed cycle in our climate which means that we need additional storage infrastructure. In addition, our growing season may get humid especially toward the end of summer when certain seeds mature, and this alone may reduce seed quality and yield. Hence, growing certain seed crops in high tunnel is a beneficial practice for us in Preston County. In Table 1, I tried to summarize the seeds for their doability in field vs high tunnel on our farm. Note that one significant limitation here is whether a given seed crop is annual or biennial. Biennial seed crops such as cabbages, collard greens and artichoke cannot survive winter in without protection from extreme low temperatures in winter.

Crop	Field	High Tunnel
Artichoke	No	Yes
Arugula	Yes	Yes
Bean, Common	Yes	Yes
Bean, Yard Long	Yes	Yes
Cabbage	Yes	Yes
Carrot	Yes	Yes
Celeriac	Yes	Yes
Chickpea	Depends on the season	Yes
Collard Greens	No	Yes
Cucumber	Yes	Yes
Eggplant	No	Yes
Garlic	Yes	No
Gourd	Yes	Yes
Kale	Yes	Yes
Leek	Yes	Yes
Lettuce	No	Yes
Melon	Yes	Yes
Okra	Yes	No
Onion, Bulb	No	Yes to re-plant the mature bulbs after storage
Onion, Green	Yes	Yes
Parsley	Yes	Yes
Pea, Black Eye	Yes	Yes
Pea, Garden	Yes	Yes
Pepper	Yes	Yes
Radish	Yes to re-plant the mature roots after storage	No
Squash, Summer	Yes	No
Squash, Winter	Yes	No
Sunflower	Yes	Yes
Tomato	Yes	Yes
Watermelon	Yes	Yes

Table 1. Preferred and/or acceptable settings to grow seed crops in West Virginia.

1.1. General Tips for Seed Production and Seed Contracts

In this section, I will list practical tips for growing seed crops, based on my past experience and mistakes. These tips would apply to seed production regardless where you are located.

- If you have a high tunnel on your farm, your crop plan probably aims to maximize your income per square foot, and you know that it is not necessarily a great idea to plant vining plants such as summer or winter squash or gourds for farmers'

market in your high tunnel because they can easily take over other profitable rows around them. This logic works for seed crops as well. Don't plant any vining plants next to rows with seed crops such as lettuce or beans which mostly grow vertically and can be trellised.

- As you know, some crops can be both transplanted and direct-seeded. When possible, start your seeds in your high tunnel or in a room with ideal germination conditions to transplant your seedlings after the last frost rather than direct-seeding because direct-seeded plants often bolt earlier than transplanted plants. Especially in conditions where seedlings have to compete with each other because they don't have enough root space to grow vigorously, they will tend to bolt and produce seeds. It isn't good practice to save seeds from plants that didn't reach their full size and maturity, and bolting early decreases seed yields, hence, income you can make from that seed crop. I tried to summarize which seed crops I prefer to transplant and/or direct-seed in Table 2.

Crop	Transplant	Direct-seed
Artichoke	Yes	No
Arugula	No	Yes
Bean, Common	Yes	Yes
Bean, Yard Long	Yes	Yes
Cabbage	Yes	No
Chickpea	No	Yes
Collard Greens	Yes	No
Cucumber	Yes	Yes
Eggplant	Yes	No
Gourd	Yes	Yes
Lettuce	Yes	No
Melon	Yes	Yes
Okra	Yes	Yes
Onion, Bulb	Yes	No
Onion, Green	Yes	No
Pea, Black Eye	Yes	Yes
Pea, Garden	No	Yes
Pepper	Yes	Yes
Squash, Summer	Yes	Yes
Squash, Winter	Yes	Yes
Sunflower	No	Yes
Tomato	Yes	No
Watermelon	Yes	Yes

Table 2. Transplanting vs direct-seeding seed crops.

- In my experience, varieties planted in smaller populations and tended closely may produce better seed yields than those planted in larger quantities.
- Even after the danger of frost passed later in spring, if direct-seeded, soil temperature may not be warm enough for cucurbit seeds (e.g. squash, cucumbers) to sprout since these seeds would prefer a soil temperature above 70F. If soil temperature drops down to below 50F and the soil is wet, seeds may rot or the germination may be spotty. Hence, I prefer to start seeds for cucurbits indoors a few weeks before the last frost so I don't risk losing seeds and time. After all, we especially need squash fruits to have enough time on the vine on the tail-end of the season to reach full maturity for better seed quality and viability. This requires 4-5 weeks after the fruits' edible maturity. In Preston County, we usually have our first frost mid-October, meaning that we need to plant our squash seedlings in ground mid-May through early June.
- Growing methods you use will greatly affect your seed yield. Seed crops overwhelmed by weeds, poor soil fertility, overhead watering, excessive watering and pests are some of the factors that reduce seed yield. Weed regularly and space out your seedlings generously but also in a space-efficient way, especially if your farming scale is less than 2 acres, and growing seeds isn't your only practice.
- Don't leave sunflower (i.e. mature seedheads), okra pods, seed-mature squash fruits or corn, dry bean pods or any other produce you will harvest seeds from unattended for a long period of time in a place where humidity fluctuates. We experienced in the past that doing so significantly drops viability of seeds. If you can't guarantee low humidity, process the seeds immediately after harvest. Make sure that all seeds are bone dry before packing them in a ziploc bag or containers.
- If you have no or little experience in growing seeds for a seed company, I encourage you to closely work with that company to understand how seed pricing per weight works and what seed yield you can expect from the seed crops you will grow for them. Communicate openly about the the price range that works for you, and only grow the seeds that would financially work for you. Finding the balance that works for you to decide which crops you would like to grow takes more than one season, and would be dependent on a variety of issues, including improving seed yield for the same crop per given area or given row length of production. To help you evaluate the finances of commercial seed production, I provided a seed economic matrix in Appendix B.
- For many farmers, it is ideal to utilize their high tunnel space effectively to maximize the income from market produce they grow. High tunnel is a semi-controlled environment in terms of climate conditions and may be misleading for how a seed performs in a certain hardiness zone. Hence, unless you need to grow

a seed crop in high tunnel because of its specific needs, I recommend you to grow all your seeds outside to make accurate observations about that seed's adaptability to or performance in climate conditions of your hardiness zone.
- Two very important issues about fulfilling a seed contract are following the deadlines given in the contract and timely communication about any problems you observe in the field and asking any questions you may have at the time of harvesting and processing seeds to the seed company representatives. Be timely, effective and clear in your communication with them.
- Seed growing can be a profitable farming practice with you if you closely track the supply/equipment cost, labor hours and seed yield you harvest from your seed crops because this is when you can decide which crops would be the most beneficial for you to grow.

1.1.1. Crop-specific Tips for West Virginia Growers

You can find general seed saving guidelines for commercially common seed crops in Appendix A. In this section I will only list tips based on my personal experience for the seed crops that may require specific arrangements in our hardiness zone 6.

Some content in this section is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, through the Northeast Sustainable Agriculture Research and Education program under subaward number ONE21-403-35383.

Please note that, seeds are undervalued just like nutritious food. If your growing scale is 1-2 acres and you would like to practice producing commercial seeds in addition to growing vegetables for farmers' market, I recommend you to begin working with small seed companies that focus on culturally significant crops that are willing to pay higher prices for per weight of seeds you grow.

<u>Artichoke</u>

All artichoke varieties are perennial, most artichoke varieties are biennial in terms of producing artichoke flowers, meaning that they produce artichokes in their second year in ground while others can produce artichoke in their first year. In other words, artichoke plants require their permanent space on your farm and can provide seeds in their second yeara and after that.

Artichoke can be overwintered in hardiness zones 7-11. Hence, while certain varieties are more cold-hardy than others, it is risky to try to overwinter artichoke in our hardiness zone. On the other hand, in early 2023, I was pleasantly surprised to see that I was able to overwinter some of our artichoke plants outside by mulching the plants with pine shavings and covering them with multiple layers of Agribon row cover. Considering the challenges involved with overwintering plants, you can grow artichoke in your high

tunnel. However, note that these plants will stay in their spots year after year, and you will need to have a specific arrangement with a seed company so that you can justify growing artichoke seeds.

Arugula

Arugula is an annual seed crop, and although flea beetle can give damage to this crop at early seedling stage, it can be successfully grown in West Virginia in open field conditions. If planted early enough in spring, seed pods can mature before the end of summer which may get humid in West Virginia.

Leaving dry pods with mature seeds in them unattended on the plants through dry and wet periods may cause mold and decrease seed quality. When the seed pods are full and semi-dry, pick a few pods to break into them to see the seed color and hardness (you can chew the seeds to test hardness). At this point, seeds should be semi-hard and turning color to a range of dark purple and black once chewed. If these conditions are met and you are worried about seed quality, you can pull the plants with roots intact and lay them on a tarp for the pods to mature further. Ideally, plants need to be left in ground until seed pods are crunchy. Gently cut the plants above ground level to shake the seeds into a bucket.

Black-eye Peas, Lima Beans and Yard-long Beans

It is possible to successfully grow all of these crops in our hardiness zone. They all love and need heat when they mature their seeds. Hence, they need to be planted early in growing season so that there is ample time to produce high seed yield in our hardiness zone.

Cabbages

Cabbage is a biennial crop that needs to be overwintered to produce seeds in its second year. I recommend you to grow cabbage in your high tunnel, if you have one. This plant can survive light frost without receiving damage to heads but it is risky to grow it in our hardiness zone through winter without rotting even when the plants are covered.

Plants need to reach full edible maturity before December so that you can identify the cabbages that best represent the variety you grow. At that point, cut the heads above the stem and at the cabbage's base the same way you harvest cabbages for farmers' market. Pull the unwanted plants. Finally, using hoops and row cover, cover the remaining plants, and keep them covered through winter.

If you have storage space, you can pull the stems without damaging roots and bury them in moist peat moss where climate is controlled and freezing temperatures don't exist. You can re-plant the plants in early spring outside or in high tunnel. Keep the plants covered and add more layers if you don't have a high tunnel, until danger of hard frost passes.

Carrots

Carrot is very cold hardy and can be overwintered outside in our hardiness zone when heavily mulched to protect the roots. Foliage may die off but it will come back once the soil temperature is warmer in spring. Carrots, especially purple and yellow varieties, can be very profitable to grow if you have an arrangement to grow them for a seed company.

Celeriac

Celeriac is a winter hardy, biennial seed crop and in my experience, it can also be overwintered in our hardiness zone. However, you need to make sure that the roots reach full maturity before the coldest months of winter arrive. I would also strongly advise you to cover the plants with a few layers of row cover to minimize cold damage on the plants.

Chickpeas

Although it is a culturally very significant crop for me and I love growing it, chickpea is an inconsistent seed crop for me in our hardiness zone. Plants grew very well for me in some seasons while they didn't do well when we had a wet period on the tail end of summer. They need well-drained, light soil and a dry period at the time of seed maturity.

This crop can also be grown in high tunnel but profit margin from selling the seeds to a big seed company may not be as high as growing other crops such as beans for market in the same tunnel space. If you are interested in growing chickpeas, I would advise you to work with small seed companies that offer culturally significant seeds in their catalogs. They usually pay more per weight of specialty crop seeds.

Collard Greens

Collard greens are cold hardy down to 15-20F and should not be risked to be grown outside as a seed crop in hardiness zone 6 because temperatures here can very well drop down to below 0F in winter. This plant's seed cycle is biennial and it should be overwintered to produce seeds.

Collards can be successfully overwintered in our high tunnel if the plants are covered with row cover (we use Agribon). I keep the cover on the plants throughout the coldest months of winter, December through February.

Make sure to plant collards early enough (late summer/early fall) so that they reach full edible maturity before they become dormant in growth through winter. This will ensure higher seed yield and quality in summer following year.

Common Beans

Common beans grow vigorously and can provide a high seed yield in our hardiness zone. However, in the past, we also had successive growing seasons in which bean beetle,

Epilachna varivestis, made it impossible for us to harvest viable seeds with high seed quality from this crop. If winter following the growing season is mild, eggs of this pest may survive in ground and the beetle can be a problem again in the following growing season.

Crop rotation, hence planting bean in a different location on your farm may be a good solution to this problem. However, please note that if your growing scale is less than 2 acres, there is only so much space for you to keep your bean crop away from where the beetle population made a peak in the previous season. If this is the case, you may want to skip growing beans that year. Alternatively, you may release predators, such as parasitic wasps, where you grow beans to combat bean beetle. In my experience, if the beetle population is exploding, using organic pesticides such as Spinosad isn't an effective solution to get rid of this pest.

Cucumbers, Melons and Squash

Cucumber beetle, *Diabrotica undecimpunctata*, can give significant damage to young seedlings of these cucurbit crops. Plants need to be covered for at least 4-5 weeks and until they get established to be able to absorb and survive pest damage before setting flowers.

Eggplant

Eggplant can be grown as a seed crop in West Virginia; however, young seedlings are subject to flea beetle (*Altica spp*) damage in open field conditions. Hence, growers who would like to grow a successful eggplant seed crop with high seed yield and viability have two choices:

One is to use expensive but very effective insect cover (there is a product named Proteknet) that can be recycled through successive seasons and that is used to cover seedlings until they are mature enough to be able to absorb and survive pest damage. At flowering stage, plants can be uncovered and left open for the fruits to mature. Good quality eggplant seed requires warm temperatures to mature for 5-6 weeks after the fruits are ready to harvest for eating. This period corresponds to the tail end of the growing season in our hardiness zone. Hence, it would be ideal if you can plant your seedlings early enough in late spring so that by the time season begins winding down and you uncover the plants, plants already have fruits on them. With this method, I recommend you to use 76" wire support hoops and 10' wide Proteknet since eggplant gets tall, overgrows and stretches the net later in the season.

The cost-effective way to grow eggplant seed in our hardiness zone is to grow the plants in our high tunnel without a need to cover the plants. Flea beetle damage is minimal or non-existent for eggplant in tunnel conditions, and high tunnel extends the season especially when I keep the tunnel's plastic down and doors closed in early fall, when eggplant seeds mature. This ensures high seed quality and increases seed yield.

Garlic

If you have an arrangement with a seed company to sell the bulbs, seed garlic can be a very profitable crop in late summer/early fall especially because it doesn't require a lot of resources or labor except for when you plant, harvest and clean the bulbs. It is also very cold hardy, and in my experience it doesn't necessarily benefit from mulching which is additional cost, if used. In addition, mulching may cause stems and bulbs rot especially if you have heavy soil with poor drainage. Try growing garlic without mulching and see if you will have good results. I do.

If you have space limitations, I would recommend you to begin with porcelain and softneck varieties as well as varieties such as Chesnok Red or German Red that can yield large bulbs.

Green Onion

Green onion is cold hardy and can survive winter in our hardiness zone; however, I advise you to make sure that the plants reach their fully edible stage before ground freezes for better seed quality and yield in spring and to cover the plants with 3-4 layers of row cover for added frost protection. In addition, I also mulch the plants with pine shavings for added cold protection.

Gourds

Gourds thrive in hardiness zones with long growing seasons. While growing seasons in West Virginia are in the range of 140-150 days and long enough to grow gourds, it would be wise to seed gourds earlier than winter squash so that your plants have ample time to mature seeds on the tail end of the season.

Kale

Especially cold-hardy kale varieties such as Russian Red can survive temperatures down to -10F. Hence, in hardiness zone 6 of West Virginia, this crop can be grown outside with multiple layers of row cover. Kale is easy to grow as a seed crop in high tunnel in our zone as well. Make sure that the plants reach full maturity before the coldest months of winter arrive so that you have better seed quality and yield in the following year.

Leeks

Leek is another winter-hardy biennial seed crop and can be successfully overwintered outside in our hardiness zone. I would still recommend you to cover the plants with row cover through winter.

Lettuce

I think that maximizing yield of and growing high quality lettuce seeds in field conditions isn't possible in our hardiness zone because of rainstorms we have in late summer. This

is typically when lettuce seed also matures. Seed quality significantly drops with high humidity in late summer. Hence, I strongly recommend you to grow lettuce seed crops in your high tunnel. I would also encourage you to experiment with planting lettuce early in spring for a seed harvest in mid-summer when humidity is lower. Choosing traditional seed varieties which were not necessarily bred for bolt resistance may be an alternative solution to grow lettuce seed outside before the rainy season arrives.

Multiple varieties of lettuce seed can be successfully grown simultanouesly in high tunnel since lettuce is an inbreeding plant with perfect flowers.

Okra

Another heat loving plant, okra is easy to grow and can be a profitable seed crop in our hardiness zone. While transplanting seedlings is the preferred way, okra can definitely be grown by direct-seeding as long as the seeds are planted no later than May. Otherwise, pods won't have enough time to reach full seed maturity or your seed yield will be lower than ideal.

Okra is easy to grow and can be a profitable seed crop.

Parsley

Parsley can be overwintered both outside and in high tunnel in our hardiness zone. I prefer to grow parsley in high tunnel because the plants are protected from weather elements at the time of seed maturity. On the other hand, seeds mature early/mid season which usually takes place before the humid period of late summer. Hence, I do think that high quality parsley seed can also be grown in field conditions in Preston County.

Radishes

Radish is cold hardy but not winter hardy and wouldn't be able to survive our winter temperatures outside. This crop can potentially be overwintered in high tunnel by heavily mulching and with multiple layers of row cover on it. However, keep in mind that, you may not be able to harvest a meaningful quantity of seeds if you are growing radishes in only a small section of the tunnel. Hence, it may be more profitable for you to grow fresh produce of radishes for market in the same space than growing its seeds.

Shallots

In my experience, shallots do better in spring in our hardiness zone. Shallots may also go to seed but once grown from seed in the following season, bulbs won't be as consistent as growing this crop from bulbs. I pull the plants that go to seed in summer and select the bulbs that suit my selection criteria (e.g. bulb size, shape, flavor) and the typical traits of a specific variety, to keep growing them season after season.

Sunflower

Plant sunflower, especially late varieties, as early as possible in hardiness zone 6. We typically need to plant our sunflower around mid-May. When the hulls are full and mature for color and pattern in fall, harvest the flowers. Later in summer, we receive a lot of rain here in Preston County which may lock moisture in the flowers. Don't keep the flowers unattended without removing the seeds. Otherwise, you will end up with moldy seeds.

2. Economics of Growing Seeds

Seed companies pay growers based on a pre-identified set of seed prices per weight of each seed variety. In Table 3, you can find the seed prices paid by Reedsville (Preston County) based Two Seeds in a Pod seed company to the seed growers for a variety of seed crops. You can also consult with Appendix C to have insight about seed yield of a variety of seed crops which eventually helps you plan your field for the crop that you would like to grow. When combined, yield data and seed prices could give you an idea about the potential income you can make from each seed crop.

Yield data given in Appendix C is partly based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, through the Northeast Sustainable Agriculture Research and Education program under subaward number ONE21-403-35383.

Some payment methods practiced by seed companies to pay their growers are listed below:

- **One-time payment.** Total amount is paid after the delivery of seeds once seed germination tests are done, for the weight of delivered seeds based on the prices identified in the contract. Financially, this is probably the most preferrable method for seed growers.
- **Hybrid model.** Seed company has a special arrangement with the seed grower to pay them for the weight and price of the seeds both of which are identified in the contract. In addition, the company pays the grower a commission per sale of that seed. In this method, commission is paid once every meaningful amount of sales is reached, and that amount is based on a mutual agreement between the company and grower. We are following this model in 2023 to pay a plant breeder for the weight of the seeds of their breeding efforts in addition to a 25% commission for each seed packet of that seed we sell.
- **Commission-based model.** The company only pays the grower a commission after they make a certain amount of sales of the seed that the grower delivered. Unless you have a specific arrangement with the company you grow seeds for and you know that the company doesn't have financial worries, I strongly

recommend you to not accept a commission-based model since this model can easily become a way of labor and resource extraction.

Seed Crop	Weight Unit	Price ($)
Beans	lb	22
Black-eye Peas	lb	28
Cabbage	lb	200
Calendula	lb	100
Chickpea	lb	28
Collard Greens	lb	200
Cucumber	lb	75
Eggplant	oz	45
Garlic (small bulbs)	lb	12
Gourds	lb	70
Lettuce	lb	110-115
Melon	lb	75
Nigella	lb	200
Okra	lb	65
Peas	lb	28
Peppers	oz	45
Summer Squash	lb	75
Sunflower	lb	45
Tomatoes	oz	45
Watercress	lb	50
Watermelon	lb	75
Winter Squash	lb	75
Zinnia	lb	125

Table 3. Two Seeds in a Pod seed company's 2023 seed prices.

APPENDICES

APPENDIX A: SEED SAVING AND ISOLATION GUIDELINES

1. Isolation Distances

Following information and recommendations are compiled based on Suzanne Ashworth's Seed to Seed, Suzanne Ashworth's Seed to Seed: Seed Saving and Growing Techniques for Vegetable Growers and John Navazio's The Organic Seed Grower: A Farmer's Guide to Vegetable Seed Production, and our experiences and knowledge of growing seed crops. Please keep in mind that all this is textbook information and perhaps some of the most boring part of this document because people in Turkey have been saving seeds from crops they domesticated since 12,000 years ago, and none of the information given in contemporary books on the subject matter is new.

Please also keep in mind that seed company campuses that have actual fields where they grow seeds also hand-pollinate and use physical barriers and/or isolation materials such as cages, isolation tents, blossom bags for saving seeds, and they isolate plants by timing through staggered planting of different varieties of the same species. In other words, you can substantially reduce the isolation distance requirements given below by using any or a combination of various tools and methods.

Bean (green and dry), common (*Phaseolus vulgaris*): Common beans have self-pollinating, closed and perfect flowers, and it is recommended to keep 10-20 ft of isolation distance between different varieties of seed crops. It is also known and was experienced by me that due to environmental conditions and perhaps heavy bees, a small fraction of bean seeds that are grown within close proximity in the same field can still cross with other beans. Depending on the number of bean varieties grown in close proximity, cross-pollination may occur in %10-15 of the bean population. As an example, it is easier to rogue these crossed bean seeds following year if the original seed has a specific pattern while it may be more challenging to identify "pure" seed if the parent beans are both white.

Cabbage (*Brassica oleracea L.*): Cabbages are outbreeding plants, their flowers get pollinated by insects, they can easily cross-pollinate with other cabbage varieties and other members of cole crops (i.e. cauliflower, Brussels sprouts, heading and sprouting broccoli, kale and collards, and kohlrabi), and it is recommended to keep 0.5-2.0 mi of isolation distance between different varieties of cole crops. You can also apply a rotation plan and grow a different biennial cole crop for seed every year.

Carrot (*Daucus carota L.*): Carrots are outbreeding plants, their flowers get pollinated by insects, they can easily cross-pollinate with wild carrot or Queen Anne's Lace (*Daucus carota var. carota*), and it is recommended to keep 0.5-2 mi of isolation distance between different varieties of carrots. I recommend growing carrots in isolation cages to eliminate the possibility of crossing between your carrot seed crop with wild carrot.

Collard (*Brassica oleracea L.*): Collards are outbreeding plants, their flowers get pollinated by insects, they can easily cross-pollinate with other collard varieties and other members of cole crops (i.e. cabbage, cauliflower, Brussels sprouts, heading and sprouting broccoli, kale, and kohlrabi), and it is recommended to keep 0.5-2.0 mi of isolation distance between different varieties of cole crops.

Cucumber (*Cucumis sativus*): Cucumbers are outbreeding plants, their flowers get pollinated by insects, and it is recommended to keep 0.5-2.0 mi of isolation distance between different varieties of cucumbers.

Eggplant (*Solanum melongena*): Eggplant has self-pollinating, closed and perfect flowers, and we recommend you to keep 20-30 ft of isolation distance between different varieties of eggplant seed crops.

Lettuce (*Lactuca sativa*): Lettuce is an inbreeding plant with closed and perfect flowers, and it is usually recommended to isolate different varieties of lettuce seed crops 10 ft apart.

Melon (*Cucumis melo*): Melons are insect-pollinated plants, and different varieties of melons need to be isolated by 0.5-2.0 mi.

Okra (*Abelmoschus esculentus*): Okra flowers are self-pollinating; however, they can get attractive to bees because of their large size, and isolation requirement may be as high as 0.2 mi but in our experience, 300-400 ft usually suffice to isolate different varieties from each other.

Pea (*Pisum sativum*): Peas have self-pollinating, perfect flowers, and it is recommended to keep 10-20 ft of isolation distance between different varieties of pea seed crops.

Pepper (*Capsicum spp.*): Pepper flowers are largely self-pollinating; however, risk of cross-pollination increases in hot peppers due to their flower structure, and it is recommended to keep 75-300 ft of isolation distance between different varieties of seed crops. That being said, we had great results by using breathable plant covers on each varietal population throughout a given growing season while keeping substantially smaller distances between each variety but we also vigorously test our seeds against crossing.

Radish (*Raphanus sativus*): Radishes are outbreeding plants which are insect-pollinated, and any two radish varieties must be separated by 0.5 mi from each other.

Squash (Cucurbita spp.): Squash is insect-pollinated and it is recommended that different varieties of the same species of squash need to be isolated by 0.5-2.0 mi while *Cucurbita pepo* (i.e. main species for commercial summer squash), *Cucurbita maxima* and *Cucurbita moschata* (i.e. main species for commercial winter squash) don't readily cross with each other (i.e. chances are extremely low), and it is acceptable to plant one variety of each of these species together in most cases.

Tomato (*Solanum lycopersicum*): Tomatoes are self-pollinating plants, and it is recommended to separate tomato varieties by 20-30 ft while potato-leaf varieties (oftentimes these are old heirlooms) require more isolation.

Watermelon (*Citrullus lanatus*): Watermelon is an outbreeding plant, all varieties of watermelons will cross with each other, and 0.5-2.0 mi of isolation is recommended to maintain seed purity unless the crops are hand-pollinated. Melon and watermelon flowers are small and more challenging to hand-pollinate; however, cotton swaps and organza bags can be used to increase the chances of successful hand-pollination.

In light of the information provided in this section, you can also use **Table 3.1.** to have a general idea whether you can grow multiple varieties of one seed crop in the same season in your field or garden under reduced isolation conditions.

Seed Crop	Multiple Varieties in the Same Field
Beans	Doable
Beet	**No**
Black-eye Peas	Doable
Cabbage	**No**
Carrots	**No**
Cauliflower	**No**
Collard Greens	**No**
Corn	**No**
Cucumbers	**No**
Eggplant	Doable
Gourds	**No**
Lettuce	Doable
Melon	**No**
Okra	**No**
Peas	Doable
Peppers	Doable
Radishes	**No**
Soybeans	Doable
Summer Squash	**No**
Sunflower	**No**
Tomatoes	Doable
Watermelon	**No**
Winter Squash	**No**

Table 3.1. Growing arrangements for certain seed crops.

In **Table 3.2.**, you can find the minimum isolation distances and ranges I recommend you to keep when you grow more than one variety of the same species. Please note that, in my experience, crops in the list can be kept true to their type by using distance-based isolation without a need for further isolation methods although there is still a chance to end up with accidental crosses. In our experience, crossing occurs more frequently than

thought with common beans, black-eye peas, and yard-long beans; however, it is possible to detect and rogue these crossed seeds in the following year's planting than to do so for a crop such as squash.

If you are growing two or more varieties for the crops that are not listed in **Table 3.2.**, you need to hand-pollinate the fruits to prevent cross-pollination.

Seed Crop	Isolation Distance (ft)
Beans	10-20
Black-eye Peas	≥ 100
Chickpea	10-20
Eggplant	20-30
Lettuce	10-20
Okra	250
Peas	≥ 20
Pepper, Hot	300
Pepper, Sweet	200
Soybeans	10-20
Tomatoes	30-40
Yard-long bean	≥ 100

Table 3.2. Isolation distances for the crops that don't require hand-pollination.

2.1. Seed Harvest and Processing

2.1.1. Dry seed harvest. This category covers the crops of which seeds mature in a pod and are dried on a surface.

Bean, black-eye pea and garden pea. Cut the plant when the majority of the pods turns tan color and becomes leathery. Dry the pods for a week, out of direct sun, on a flat surface with good air circulation until seeds rattle in the pods. Thresh the pods to release the seeds without applying too much pressure. Winnow the chaff with fan. Avoid waiting until the pods turn dark brown before harvesting, as you may end up with shattered seeds. Black-eye peas may need a few more days than beans and garden peas to dry.

Brassicas. Cabbage, collard greens, Brussels sprouts, cauliflower and kale need to be over-wintered to encourage flower production. If in your climate zone, temperatures don't go below 20F, you can let the plants over-winter in the field. If you are in a colder area, pull the cabbage plants with heads and roots intact, trim the roots down to a foot. Store the plants at 35-38F and mild to high relative humidity in mold-free, clean wooden totes made from slotted planks to allow air and humidity flow. Cover the plants with wood shavings.

Re-plant in spring. Eventually, flower stalks emerge to form seeds. If the heads are too tight, stalks can also be encouraged to emerge by gently slicing an X on top of the heads. Make sure that the slice is shallow.

Harvest seed pods when they turn brown. Thresh by rubbing the pods to release the seeds, and winnow. Be careful not to apply too much pressure while rubbing pods, otherwise seeds may get damaged.

Kale, collard greens, Brussels sprouts and cauliflower can be processed for seeds in similar ways to cabbage while storage steps may be different or not needed.

In our experience, it is good practice to make sure the plants reach full edible stage by the end of fall, to be able to harvest good quality seeds from *Brassica* family plants in the following spring/early summer.

Carrot. Carrot is a biennial crop and needs to be over-wintered to flower. If your climate gets too cold to over-winter your carrot crop in the field, then dig up the roots and select them based on the variety's typical characteristics for size, shape, flavor etc. Trim the tops to 1 inch. Store the roots either in wooden totes mentioned earlier or in your root cellar, if any. Make sure that the roots don't touch each other before you cover them with woodchips.

Re-plant the roots in spring. At seed maturity, seeds will turn brown. Umbels that first form seeds on a plant offer the best quality seeds. To improve the seed quality, cut and discard the later umbels. When the majority of the seeds turn brown, cut the stems and lay them on a tarp for a few days to let them dry. Seeds can be easily detached from the umbels so keep the umbels away from wind and rain.

Please note that, even if the ground freezes, certain mature carrots can perfectly overwinter in ground. If you decide to leave the roots in ground, you may apply groundcover to keep soil temperature warmer throughout winter.

Corn. Let the ears completely dry on the stalks. Leave the shucks on the ears, and dry the ears for about 2 more weeks before removing seeds. Before storing, make sure that seeds are completely dry because corn can easily ferment in sealed buckets even if some level of moisture is left behind. Alternatively, you can use a grain moisture tester to test the moisture level left in the corn seed and other grains before storing them.

Lettuce. Lettuce seeds mature about 2 weeks after the plants flower. If the majority of the flowers on a single plant develop a "feather" look, then you can dig the plants with the roots intact and let 1) the mature seeds dry completely, and 2) almost-mature seeds mature on a tarp for around a week. Cut the rootballs at the time of seed harvest, and knock the seeds off either on a tarp or into a bucket. Try to harvest all the seeds from one batch of planting at once.

Okra. Allow the seed pods mature until they turn brown and split. Put gloves on and cut the pods. Let the pods dry for around a week and harvest the seeds with a glove on since okra pods may develop spines.

Onion, Bulb. Onion is a biennial crop, and needs to be over-wintered. Pull the plants at the time of bulb maturity, and select the roots to over-winter. Follow the steps described in the carrot section for storage details.

Re-plant bulbs in spring, and let the plants flower. Halving the bulbs sideways before planting may encourage stalk and flower production. Cut the umbels, leaving a few inches of stem attached to them, and lay them on greenhouse tables covered with landscape fabric or tarp to dry, making sure that good airflow is maintained.

2.1.2. Wet seed harvest. Methods in this category are used to harvest seeds from crops that produce wet flesh at seed maturity.

Fermentation method is very effective for removing the gel layer around the seed that acts as a germination inhibitor; a process that may help seeds germinate faster. The method delivers clean seeds by removing the pulp around them and is known to minimize disease-related problems.

Cucumber. Cucumbers are usually ready to process for seeds, 4-6 weeks after the fresh-produce quality stage on the vine is reached. At seed maturity, fruits are usually 2-3 times larger than the fresh cucumbers on a specific plant. Fruits with mature seeds also turn a pale yellow or brown color, another indication to help initiate the seed harvesting process. If possible, cure the fruits you pick at room temperature, away from rodents, for two weeks. Slice the fruits, and scoop the flesh into a plastic container. Let the mixture ferment for 36-48 hours. Stir the mixture twice a day to aerate. Rinse and spread the seeds on a surface with good air circulation, and let them dry for 2-3 weeks.

Eggplant. Eggplant seeds mature about 4 weeks after the fruits are ready to eat but please note that once this this stage is reached, you need to have a good number of warm days to ensure high seed quality and germination rates. We especially experienced this to be a problem when we moved to West Virginia because fall season here isn't as warm as in Florida, and this is a time when eggplant seeds mature. Early planting may help solve this problem. Please also note that in Florida flea beetle isn't an eggplant pest while in West Virginia we can't grow eggplant in open field without covering our crop to minimize pest damage.

Purple eggplant varieties usually turn dull brown while the white ones turn yellow at seed maturity. Soaking cut fruits in water about a day in water makes it easier to separate the seeds from flesh. Pick the fruits when you observe the color change, and cut them into smaller chunks, add water, and blend in a food processor. Make sure to have either a dull metal or plastic blade to not damage the seeds as you grind the flesh.

Once the flesh is blended evenly, transfer the mix to a bowl filled with water and remove the big chunks as well as the floating plant material. Decant the seeds into a colander, rinse and spread them on a surface with good air circulation. Let the seeds dry for a week.

Melon. Pick the melons at eating stage to cut them open and scrape the seeds out. Rinse the seeds thoroughly and let them dry for 2-3 weeks. If there is no sign of disease at the time of fruit maturity, you can leave them in the field until the rind softens, to improve the seed quality.

Pepper. While majority of pepper varieties turn red when the seeds are mature, flesh color may vary at seed maturity. We recommend you to only harvest the seeds from fully ripe fruits, and harvest the seeds right after picking those fruits. Take the seeds out on a surface that won't stick to the seeds, and let them dry for 2 weeks. When you harvest hot pepper seeds, make sure to wear gloves during harvest, and wash your hands thoroughly once you are done, before you touch any body parts. While, in my experience, letting pods ripen on the plant delivers the best quality seeds, if you observe any decay on fruits at pod maturity stage, pick them immediately.

Fermentation method is widely used to harvest pepper seeds. This method involves chopping the fruits without damaging the seeds and tossing them in a clean container or barrel to let fermentation process separate flesh from seeds. However, I highly recommend you to not use this method to produce commercial seeds since in my personal experience and experience from working with other growers. This method, depending on the environmental conditions where you conduct it, can make your pepper seed lot end up with low germination rates which makes the seed unmarketable, especially if the fermentation batch is left unattended longer than ideal.

Squash, Summer. Seeds of summer squash mature about 6 weeks later than the fruit's edible stage. At seed maturity, fruits become very large, rind becomes hard, and the fruit stems dry up. At this stage, you can pick the fruits, scrape the seeds and rinse them to dry for 2-3 weeks. If there is no sign of disease, you can also keep the fruits on the vine until the plants completely die or before the frost kills the plants and damages fruits.

Squash, Winter. At full fruit maturity, if the fruits don't show any sign of disease, store the fruits at around 70F for 2 months for improved seed quality. After storage, cut the fruits open, scrape the seeds out, and let them dry for 2-3 weeks. If you don't have proper storage conditions or if the fruits show sign of disease, harvest the seeds immediately once the fruits are ripe.

Tomato. Scoop the seeds and the pulp into a plastic container to ferment. Alternatively, you can also crush the whole tomatoes into a container to ferment. Let the container sit at room temperature. Stir the mixture twice a day to aerate. Fermentation process usually takes 36-48 hours. Seeds are usually ready to harvest when a layer of white mold

forms on mixture surface. You can also occasionally take seeds out of the container and rub them gently between your fingers to check whether they still feel slimy (i.e. whether the gel layer is removed or not). If not, fermentation is finished. If you find sprouted seeds in the mixture, this means that your seed batch has been over-fermented and is damaged. Paste tomatoes are usually meaty and have less juice than fresh-eating tomatoes, making the mixture thick. In this case, you can add an equal volume of water to the crushed tomatoes to initiate the fermentation. When fermentation process is complete, rinse the seeds. Spread the seeds and let them dry for a week in a room with good air circulation, preferably with a fan pointing at drying seeds and run at low speed.

Watermelon. Harvest the fruits at full ripeness, scoop their flesh out into a container and let the mixture sit for 6-10 hours. Rinse the seeds and let them dry for 2-3 weeks. If there is no disease pressure present, you can leave the fruits on the vine longer to improve the seed quality. If there is any sign of decay on the fruits, harvest them immediately.

Crop, Open Field Greenhouse

Seed Crop	Weight Unit	Price ($)
Beans	lb	22
Black-eye Peas	lb	28
Cabbage	lb	200
Calendula	lb	100
Chickpea	lb	28
Collard Greens	lb	200
Cucumber	lb	75
Eggplant	oz	45
Garlic (small bulbs)	lb	12
Gourds	lb	70
Lettuce	lb	110-115
Melon	lb	75
Nigella	lb	200
Okra	lb	65
Peas	lb	28
Peppers	oz	45
Summer Squash	lb	75
Sunflower	lb	45
Tomatoes	oz	45
Watercress	lb	50
Watermelon	lb	75
Winter Squash	lb	75
Zinnia	lb	125

2.2. Seed Harvest and Processing

2.2.1. Dry seed harvest.

This category covers the crops of which seeds mature in a pod and are dried on a surface.

Bean, black-eye pea and garden pea. Cut the plant when the majority of the pods turns tan color and becomes leathery. Dry the pods for a week, out of direct sun, on a flat surface with good air circulation until seeds rattle in the pods. Thresh the pods to release the seeds without applying too much pressure. Winnow the chaff with fan. Avoid waiting until the pods turn dark brown before harvesting, as you may end up with shattered seeds. Black-eye peas may need a few more days than beans and garden peas to dry.

Brassicas. Cabbage, collard greens, Brussels sprouts, cauliflower and kale need to be over-wintered to encourage flower production. If in your climate zone, temperatures don't go below 20F, you can let the plants over-winter in the field. If you are in a colder area, pull the cabbage plants with heads and roots intact, trim the roots down to a foot. Store the plants at 35-38F and mild to high relative humidity in mold-free, clean wooden totes made from slotted planks to allow air and humidity flow. Cover the plants with wood shavings.

Re-plant in spring. Eventually, flower stalks emerge to form seeds. If the heads are too tight, stalks can also be encouraged to emerge by gently slicing an X on top of the heads. Make sure that the slice is shallow.

Harvest seed pods when they turn brown. Thresh by rubbing the pods to release the seeds, and winnow. Be careful not to apply too much pressure while rubbing pods, otherwise seeds may get damaged.

Kale, collard greens, Brussels sprouts and cauliflower can be processed for seeds in similar ways to cabbage while storage steps may be different or not needed.

In our experience, it is good practice to make sure the plants reach full edible stage by the end of fall, to be able to harvest good quality seeds from *Brassica* family plants in the following spring/early summer.

Carrot. Carrot is a biennial crop and needs to be over-wintered to flower. If your climate gets too cold to over-winter your carrot crop in the field, then dig up the roots and select them based on the variety's typical characteristics for size, shape, flavor etc. Trim the tops to 1 inch. Store the roots either in wooden totes mentioned earlier or in your root cellar, if any. Make sure that the roots don't touch each other before you cover them with woodchips.

Re-plant the roots in spring. At seed maturity, seeds will turn brown. Umbels that first form seeds on a plant offer the best quality seeds. To improve the seed quality, cut and discard the later umbels. When the majority of the seeds turn brown, cut the stems and

lay them on a tarp for a few days to let them dry. Seeds can be easily detached from the umbels so keep the umbels away from wind and rain.

Please note that, even if the ground freezes, certain mature carrots can perfectly overwinter in ground. If you decide to leave the roots in ground, you may apply groundcover to keep soil temperature warmer throughout winter.

Corn. Let the ears completely dry on the stalks. Leave the shucks on the ears, and dry the ears for about 2 more weeks before removing seeds. Before storing, make sure that seeds are completely dry because corn can easily ferment in sealed buckets even if some level of moisture is left behind. Alternatively, you can use a grain moisture tester to test the moisture level left in the corn seed and other grains before storing them.

Lettuce. Lettuce seeds mature about 2 weeks after the plants flower. If the majority of the flowers on a single plant develop a "feather" look, then you can dig the plants with the roots intact and let 1) the mature seeds dry completely, and 2) almost-mature seeds mature on a tarp for around a week. Cut the rootballs at the time of seed harvest, and knock the seeds off either on a tarp or into a bucket. Try to harvest all the seeds from one batch of planting at once.

Okra. Allow the seed pods mature until they turn brown and split. Put gloves on and cut the pods. Let the pods dry for around a week and harvest the seeds with a glove on since okra pods may develop spines.

Onion. Onion is a biennial crop, and needs to be over-wintered. Pull the plants at the time of bulb maturity, and select the roots to over-winter. Follow the steps described in the carrot section for storage details.

Re-plant bulbs in spring, and let the plants flower. Halving the bulbs sideways before planting may encourage stalk and flower production. Cut the umbels, leaving a few inches of stem attached to them, and lay them on greenhouse tables covered with landscape fabric or tarp to dry, making sure that good airflow is maintained.

Pepper. While majority of pepper varieties turn red when the seeds are mature, flesh color may vary at seed maturity. We recommend you to only harvest the seeds from fully ripe fruits, and harvest the seeds right after picking those fruits. Take the seeds out on a surface that won't stick to the seeds, and let them dry for 2 weeks. When you harvest hot pepper seeds, make sure to wear gloves during harvest, and wash your hands thoroughly once you are done, before you touch any body parts. While, in my experience, letting pods ripen on the plant delivers the best quality seeds, if you observe any decay on fruits at ripening stage, pick them immediately. Please note that if you harvested a significant volume of fruits, you can also chop the fruits without damaging the seeds and toss them in a clean container or barrel to let fermentation process separate flesh from seeds.

Unless you are familiar with it, I recommend you to not use fermentation method to process your entire lot of pepper seeds since this method can make your seed lot end up with low germination rates which makes the seed unmarketable, especially if the fermentation batch is left unattended longer than ideal. Test this method with small quantities of peppers and test germination rates once you are done with the method to assess how you did with the method.

2.2.2. Wet seed harvest. Methods in this category are used to harvest seeds from crops that produce wet flesh at seed maturity.

Fermentation method is very effective for removing the gel layer around the seed that acts as a germination inhibitor; a process that may help seeds germinate faster. The method delivers clean seeds by removing the pulp around them and is known to minimize disease-related problems.

Cucumber. Cucumbers are usually ready to process for seeds, 4-6 weeks after the fresh-produce quality stage on the vine is reached. At seed maturity, fruits are usually 2-3 times larger than the fresh cucumbers on a specific plant. Fruits with mature seeds also turn a pale yellow or brown color, another indication to help initiate the seed harvesting process. If possible, cure the fruits you pick at room temperature, away from rodents, for two weeks. Slice the fruits, and scoop the flesh into a plastic container. Let the mixture ferment for 36-48 hours. Stir the mixture twice a day to aerate. Rinse and spread the seeds on a surface with good air circulation, and let them dry for 2-3 weeks.

Eggplant. Eggplant seeds mature about 4 weeks after the fruits are ready to eat but please note that once this this stage is reached, you need to have a good number of warm days to ensure high seed quality and germination rates. We especially experienced this to be a problem when we moved to West Virginia because fall season here isn't as warm as in Florida, and this is a time when eggplant seeds mature. Early planting may help solve this problem. Please also note that in Florida flea beetle isn't an eggplant pest while in West Virginia we can't grow eggplant in open field without covering our crop to minimize pest damage.

Purple eggplant varieties usually turn dull brown while the white ones turn yellow at seed maturity. Soaking cut fruits in water about a day in water makes it easier to separate the seeds from flesh. Pick the fruits when you observe the color change, and cut them into smaller chunks, add water, and blend in a food processor. Make sure to have either a dull metal or plastic blade to not damage the seeds as you grind the flesh. Once the flesh is blended evenly, transfer the mix to a bowl filled with water and remove the big chunks as well as the floating plant material. Decant the seeds into a colander, rinse and spread them on a surface with good air circulation. Let the seeds dry for a week.

Melon. Pick the melons at eating stage to cut them open and scrape the seeds out. Rinse the seeds thoroughly and let them dry for 2-3 weeks. If there is no sign of disease at the time of fruit maturity, you can leave them in the field until the rind softens, to improve the seed quality.

Squash, Summer. Seeds of summer squash mature about 6 weeks later than the fruit's edible stage. At seed maturity, fruits become very large, rind becomes hard, and the fruit stems dry up. At this stage, you can pick the fruits, scrape the seeds and rinse them to dry for 2-3 weeks. If there is no sign of disease, you can also keep the fruits on the vine until the plants completely die or before the frost kills the plants and damages fruits.

Squash, Winter. At full fruit maturity, if the fruits don't show any sign of disease, store the fruits at around 70F for 2 months for improved seed quality. After storage, cut the fruits open, scrape the seeds out, and let them dry for 2-3 weeks. If you don't have proper storage conditions or if the fruits show sign of disease, harvest the seeds immediately once the fruits are ripe.

Tomato. Scoop the seeds and the pulp into a plastic container to ferment. Alternatively, you can also crush the whole tomatoes into a container to ferment. Let the container sit at room temperature. Stir the mixture twice a day to aerate. Fermentation process usually takes 36-48 hours. Seeds are usually ready to harvest when a layer of white mold forms on mixture surface. You can also occasionally take seeds out of the container and rub them gently between your fingers to check whether they still feel slimy (i.e. whether the gel layer is removed or not). If not, fermentation is finished. If you find sprouted seeds in the mixture, this means that your seed batch has been over-fermented and is damaged. Paste tomatoes are usually meaty and have less juice than fresh-eating tomatoes, making the mixture thick. In this case, you can add an equal volume of water to the crushed tomatoes to initiate the fermentation. When fermentation process is complete, rinse the seeds. Spread the seeds and let them dry for a week in a room with good air circulation, preferably with a fan pointing at drying seeds and run at low speed.

Watermelon. Harvest the fruits at full ripeness, scoop their flesh out into a container and let the mixture sit for 6-10 hours. Rinse the seeds and let them dry for 2-3 weeks. If there is no disease pressure present, you can leave the fruits on the vine longer to improve the seed quality. If there is any sign of decay on the fruits, harvest them immediately.

APPENDIX B: SEED PRODUCTION ECONOMIC ANALYSIS CHART (MODIFIED AFTER STEINER)

Seed Production Economic Analysis Chart

Expenses	**Cost ($)**	
Land		
	# hr	**Cost/hr ($)**
Labor: planning		
Labor: field work		
Labor: seed harvest and cleaning		
Seed (planting stock)		
Fertilizer/Soil Amendments		
Pest Management		
Water		
Certification Fees		
Equipment (e.g. rentals, repair)		
Indirect costs (e.g. insurance)		

Total Cost ($)		**Cost per Net Seed Yield ($)**	

Sales	**oz**	**Sales/oz ($)**	**lb**	**Sales/lb ($)**	**Total Sales ($)**
Net Seed Yield (weight after cleaning)					

Profit ($)	
Net Profit (Total Sales-Total Cost)	
Profit per Seed Yield	

APPENDIX C: ESTIMATED SEED YİELDS FOR MAJOR SEED CROPS (MODIFIED AFTER STEINER AND MAYNARD & HOCHMUTH)

The list given below is a composite of Small-scale Organic Seed Production, prepared by Patrick Steiner and Knott's Handbook for Vegetable Growers, written by Donal N. Maynard and George J. Hochmuth. Unfortunately, year and location data aren't provided in this list. Please note that the yield data in this list was extrapolated by me to 100 ft of seed crops, and these values will inevitably include an estimation error. Beginning in 2022, raw data will be provided without extrapolation.

In addition, this list includes data from my own seed harvest and data I collect from seed growers I work with.

Crop	Variety	Year	Location-Hardiness Zone	Row ft/No of Plants	Seed Yield
Arugula	Common	2022	WV-6	96 ft	2 lb 9 oz
Bean, Common	Ayaş Barbunyası (Pole)	2020	WV-6	100 ft	10 lb
Bean, Common	Boşnak Arşın (Bush)	2022	WV-6	70 ft	4 lb 2 oz
Bean, Common	Dermason (Bush Kidney)	2020	WV-6	100 ft	14 lb
Bean, Common	Elmalı Sarı (Bush Wax)	2020	WV-6	100 ft	13 lb
Bean, Common	Endeze (Pole)	2020	WV-6	100 ft	20 lb
Bean, Common	Hanımeli (Bush)	2022	WA-8	150 ft	10.8 lb
Bean, Common	NT Half-runner	2022	WV-6	100 ft	6 lb 3 oz
Bean, Common	Sarıkız	2022	WA-8	150 ft	8.6 lb
Bean, Common	Sazova (Bush)	2022	WA-8	150 ft	12.5 lb
Bean, Yard-long	Çanakkale Black-seeded	2022	NC-7	150 plants	10 lb
Corn, Dent	Bloody Butcher	2022	WV-6	300 plants	58.4 lb
Dill	Gönen 10	2022	WV-6	100 ft	0.75 lb
Okra	Bornova Kınalı	2021	WV-6	206 ft	13 lb 3.5 oz
Pea, Black-eye	Lolaz	2021	WV-6	174 ft	9 lb 15.5 oz lb
Pepper, Hot	Acı Kıl	2021	WV-6	62 plants	16.1 oz
Pepper, Hot	Balık	2021	OR-8	69 plants	2.9 lb
Pepper, Hot	Pul Biberlik Maraş	2020	IA-4	100 plants	5 lb
Pepper, Sweet	Kandil	2021	WV-6	64 plants	13.7 oz
Pepper, Sweet	Bağcı Çarliston	2022	WV-6	49 ft	8.4 oz
Pepper, Sweet	Mehmet's Sweet Turkish	-	FL-9	100 ft	2.1 lb
Pepper, Sweet	Tatlı Kıl	2020	IA-4	100 plants	2.9 lb
Pepper, Sweet	Yaglik 29	2022	WV-6	100 ft	7.8 oz
Squash, Summer	Kars Egg (small seeds)	2020	IA-4	100 plants	13.5 lb
Squash, Summer	Kolsuz Sakız	2020	IA-4	100 plants	37 lb
Squash, Summer	Ürgüp Sivrisi	2022	WV-6	143 ft	3 lb 15 oz
Squash, Winter	Armut	2022	NC-7	80 ft	4.3 lb
Squash, Winter	Waltham Butternut	2022	WV-6	141 ft	10 lb
Tomato	Cindy's West Virginia	2021	WV-6	48 plants	12.1 oz
Tomato	Mortgage Lifter (Radiator Charlie's)	2021	WV-6	48 plants	14.9 oz
Tomato	Mountain Princess	2021	WV-6	30 plants	9 oz
Tomato	Turkey	2021	WV-6	100 ft	8 oz
Tomato	West Virginia Pepper	2022	WV-6	86 ft	5.1 oz
Tomato	Yalova Heart	2022	WV-6	83 ft	4.9 oz
Watermelon	Çekirdeği Oyalı (Orange Flesh)	2020	IA-4	100 plants	20 lb
Watermelon	Çekirdeği Oyalı (White Flesh)	2021	IA-4	100 plants	13 lb
Herb	Savory, Summer	2021	WV-6	100 ft	2.3 lb

APPENDIX C: ESTIMATED SEED YİELDS FOR MAJOR SEED CROPS (MODIFIED AFTER STEINER AND MAYNARD & HOCHMUTH) cont'd

Crop	Variety	Year	Location-Hardiness Zone	Row ft/No of Plants	Seed Yield
Bean, Fava	Broad Windsor	-	-	100 ft	13.5
Bean, Soy	Common commercial variety average	-	-	100 ft	12 lb
Beet	Detroit Dark Red	-	-	100 ft	13.3 lb
Cucumber	Boothby's Blonde	-	-	100 ft	3.2 lb
Brussels Sprouts	Common commercial variety average	-	-	100 ft	10 lb
Burdock	Common commercial variety average	-	-	100 ft	9 lb
Cantaloupe	Small, seedy varieties	-	-	100 ft	0.7 lb
Carrot	Long Orange Improved	-	-	100 ft	1.5 lb
Carrot	Conventional	-	-	100 ft	7.5 lb
Cucumber	Boothby's Blonde	-	-	100 ft	3.2 lb
Cucumber	Pickling Cucumber Average	-	-	100 ft	11.1 lb
Eggplant	Rosa Bianca	-	-	100 ft	1.3 lb
Greens	Cress	-	-	100 ft	2.5 lb
Greens	Kale	-	-	100 ft	4.2 lb
Greens	Mizuna	-	-	100 ft	5.3 lb
Greens	Giant Red	-	-	100 ft	3.2 lb
Greens	Southern Curled	-	-	100 ft	1.7 lb
Greens	Tatsoi	-	-	100 ft	1.7 lb
Kohlrabi	Average	-	-	100 ft	5.0 lb
Leek	Average	-	-	100 ft	4.0 lb
Leek	Durabel	-	-	100 ft	1.9 lb
Lettuce	Average	-	-	100 ft	1.3 lb
Onion	Early Yellow Globe	-	-	100 ft	3.7 lb
Onion	Southport White Globe	-	-	100 ft	4.9 lb
Pea	Average	-	-	100 ft	6.7 lb
Pepper, Hot	Ancho	-	-	100 ft	1.8 lb
Radish	Misato Rose (large roots)	-	-	100 ft	5.4 lb
Radish	Pink Beauty (mid-size roots)	-	-	100 ft	0.9 lb
Radish	Rat Tail	-	-	100 ft	19.7 lb
Spinach	Bloomsdale Savoy	-	-	100 ft	16.2 lb
Squash, Winter	Blue Hubbard	-	-	100 plants	13.5 lb
Squash, Winter	Long Pie	-	-	100 ft	5.1 lb
Squash, Winter	Table Queen	-	-	100 ft	8.1 lb
Turnip	Shogone	-	-	100 ft	15 lb
Flower	Calendula	-	-	100 ft	6.2 lb
Flower	Marigold, French	-	-	100 ft	0.7 lb
Flower	Morning Glory	-	-	100 ft	1.7 lb
Herb	Basil, Lemon	-	-	100 ft	6.8 lb
Herb	Cilantro, Santo	-	-	100 ft	5.6 lb