Seed Aid for Seed Security

ADVICE FOR PRACTITIONERS

Vegetable Seed Supply and Selection in Humanitarian Response

Vegetable seeds are increasingly used to advance nutrition and income goals in humanitarian response. Understanding crop choice and how seeds are sourced and supplied can support these interventions.[1]

Diverse vegetables demand quite diverse seed management practices. Farmers can easily save seed from some vegetable types, while other types are more reliably sourced from commercial suppliers.

Seed Supply: Commercial

Worldwide, commercial vegetable seed supply is narrow, with few primary producers servicing a large downstream distribution network. Seed traders frequently experience this effect. For example, a crop failure for one major pepper seed producer can cascade into a worldwide supply shortage (and price spike) for all pepper seed across multiple years.

Producing vegetable seed to commercial specifications is technically challenging. Compared with cereal and legume seed, worldwide demand for vegetable seed is lower. Commercial vegetable seed production is slow to emerge in the developing world. As a result, beyond the seed saved by small-scale farmers themselves, vegetable seed is more likely (than cereal or legume seed) to originate from imported sources, either before or after its final packaging.

For this reason, when local seed production, saving, and/or commerce have been disrupted by crisis, the nearest sales outposts of vegetable seed companies with global or countrywide reach may be willing to engage with crisis relief work. Potentially, such companies could offer technical support or engage with small-scale commerce. National labs, as well as organizations like the World Vegetable Center (AVRDC), ECHO, and Seed Programs International (SPI) may be able to offer crisis-appropriate seed options at varying quantities, selections, and prices.

Even in remote locations, vegetable seed may be seen in all kinds of small shops and from markets, not just agro-dealers. Restoring this type of trade, if damaged by crisis, can be one goal of crisis response, alongside efforts to foster renewed vegetable seed production and saving by farmers.

Seed Saving and Storage: Local Production

In an attempt to build resilience at the household level, local seed saving and production can also be highlighted as an end goal for seed provision. Know from the start that seed selection, saving, and processing techniques across the range of common vegetables can be a lot to master, especially in the humid tropics and especially during crisis recovery. On the positive side, seed for fresh vegetables tends to be small (in seed size but more so in volume saved to plant a crop) and therefore easier in storage to tuck away from insect pests and other damaging factors. But, as a group, vegetable seed is more susceptible to death by humidity and heat damage than maize or legume seed.

Techniques can be learned to save seed effectively if training is budgeted and deployed. Training themes might include successful variety isolation, selection, saving, and storage of seed. As all these activities do add labor requirement to what are an already time-intensive

[1] This brief was prepared by Peter Marks (Seed Programs International), with inputs from Julie March (USAID US/OFDA), Louise Sperling (CIAT), and Anne Turner (CRS). Special thanks to Julian Hoyle for providing much of the information in Table 1.

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CIAT International Center for Tropical Agriculture Since 1967 / Science to cultivate change
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set of crops, do factor in 'labor added' when planning seed saving projects, and especially in crisis situations when farmer resources might already be stretched.

The ease or difficulty of saving seed varies greatly by crop type with some specific advice given in Table 1. Seed of crops such as peppers, squashes, many local greens are fairly easy to save. However, a few types of vegetable seed cannot readily be produced in the tropics at all. Carrots, for example, are a biennial crop (producing seed their second year) with a vernalization requirement (an uninterrupted period of cold triggers seed production).

Also, remember that crops many evolve in their traits over time, whether through unintentional farmer selection, outcrossing in the field, or crop failure. Hence, seed saving

TABLE 1
Ease of Saving Seed from Some Vegetable Crops

Crop	Ease of saving seed	Instructions for saving seed
Beet	Difficult	Roots need a period of cold weather for growth to stop and for flowering and seed production to start. Not recommended for tropical countries.
Broccoli, Cabbage, Chinese Cabbage	Difficult	Plants require cold weather conditions to cause plant to flower and produce seed. Some tropical varieties may flower if left to mature completely. If seed production is attempted for cabbage, the head must be cut open carefully to expose the growing point and produce flowers. After flowering, allow the pods to dry, then remove seed.
Cantaloupe	Easy	Allow plants to mature completely, and fruits are past normal market stage. Extract seeds, wash in clean water, and dry well in shade.
Carrot	Difficult	Roots need a period of cold weather for growth to stop and for flowering and seed production to start. Not recommended for tropical countries.
Cucumber / Gourd	Easy	Allow plants to grow well past normal market stage, and fruits turn a yellowish color, and plant is no longer growing. Harvest fruits, extract seed, wash in clean water, and dry in shade. If seeds are encased in heavy pulp, fermentation will help separate them.
Lettuce	Moderate	Plants will start flowering under hot conditions, but head lettuce needs to have heads cut open when young to allow flower stalk to grow up. For all lettuce types, do not select seed from early flowering plants. Harvest seed when flowers appear white and fluffy.
Mustard	Easy	Most plants will flower and produce seed. After flowering, allow the pods to dry, then remove seed.
Okra	Easy	Harvest pods when fully mature (brown) but before shattering. Remove seed.
Onion	Difficult	Bulbs need a period of cold weather for growth to stop and for flowering and seed production to start. Not recommended for tropical countries.
Pepper	Easy	Will cross in the field if not isolated. Allow plant to grow to full maturity and final color. Cut open fruits, extract seed, and dry in shade.
Radish	Easy	Most small red radish varieties will flower easily and produce seeds. When seed pods are dry, remove seed. Some Asian varieties, especially daikon, require cold weather to cause plants to flower. These are difficult to produce in tropical countries.
Regionally Important Greens	Easy	Food plants such as amaranth, jute, and Malabar spinach tend to have short seasons and readily go to seed. Techniques vary with species but are generally easily learned.
Squash/"Pumpkin"	Easy	Allow plants to grow well past normal market stage, and fruits turn a yellowish color, and plant is no longer growing. Harvest fruits, extract seed, wash in clean water, and dry in shade.
Tomato/Eggplant	Difficult, or Moderate with traning	Allow fruits to ripen to full color. Extract seed into a container – drier eggplant may require soaking – and allow to sit in a cool place for 24–48 hours for natural fermentation to take place. Wash seed with clean water, strain, and dry in shade.
Watermelon	Easy	Allow fruits to mature to full market stage. Open fruit and extract seed. Wash with clean water, and dry in shade.

Source: Dr. Julian Hoyle, manuscript.

TABLE 2
Vegetable Seed Supply and What it Means for Crisis Response Practitioners

Seed Supply Factor	Action considerations
Global supply is narrow for commercial vegetable seed in particular.	Local sourcing of appropriate seed may be difficult post-crisis for a key set of vegetables.
Supply may be imported in the first place as opposed to available from locally-produced sources.	Concern about impact on local economy may be reduced. The importance of the "informal retail" sector in seed distribution may be increased.
Seed saving for vegetables, as a group, can pose challenges especially in the humid tropics.	Bridging informal local distribution networks with formal (global) seed commerce should be considered as one path to vegetable seed security. Assess whether seed saving training is feasible within the context of crisis intervention.
In contrast with cereals and legumes, "seed" and "food" are not interchangeable for most vegetable crops in a crisis.	Farmer seed self-insurance options are reduced for the vegetable crops. Crisis seed aid may therefore be a greater need for these crops.

cannot not be seen as 100% reliable for maintaining original genetic traits. Within seed saving programs, it is wise, then, to plan for a way that farmers can renew original seed stock periodically as needed.

Seed vs. Food

Vegetable seed security is also driven by harvest timing in relation to seed production by the plant. Most vegetable species as defined for this brief are consumed or sold before the plant has produced mature seed, or even – as for leafy greens – before the plant has begun to produce seed at all. For most cereal and legume crops, seed and food are readily interchanged in the informal sector, even in normal times. Then, in a crisis, "seed" may become "food" and vice versa, each providing insurance against loss of the other. Vegetables eaten as leaves, roots, stems, or immature fruits offer no such automatic development of seed. For vegetables, it may be the practice in normal times to let part of a crop mature to seed after the harvest of food. This practice may be interrupted by crisis.

Table 2 summarizes how the above factors may impact program design and feasibility decisions, especially in contrast with staple crops.

Selecting Vegetable Seeds for Use in Relief and Recovery

Beyond crop type, there are other key issues associated with selecting among types of vegetable seeds in relief and recovery periods. As a baseline, there should be prior evidence that any varieties selected are adapted to the agro-ecological zones, using farmers' known management practices, and, that they will have a good degree of farmer acceptability. Select other issues are listed below.

Hybrid vs. Open Pollinated

Open-pollinated (OP) seed is desirable where seed saving is a goal. Assuming plants are not allowed to cross with other cultivars in the garden, offspring will be genetically similar to parent plants. Almost all commercially-available OP vegetable seed is highly inbred (very similar genetics in all plants), allowing the saving of seed to yield predictable results.

Hybrid seed is the result of a controlled cross between parent plants. The parent plants are chosen for their desirable and often divergent characteristics; many hybrid varieties include genetic material from wild ancestors of food crops. The disease and stress resistance found in these wild lines was often lost in early human efforts to breed larger, more flavorful plants for gardening. Seed cannot be saved with predictable results from hybrid plants, but if a project's main concern is reliable production in the first season, hybrids can be a superior choice. Hybrid seed is much more expensive than open-pollinated seed due to the laborious work of crossing the parent plants.

Commercial hybrid varieties produce genetically uniform crops. Because OP seed is inbred, plants grown from commercial OP seed are also quite genetically uniform. From a risk management perspective, arguably both of these seed types are an inferior product of the commercial age. Traditionally, farmers maintained wide genetic diversity in any one field and would save seed from the whole set together – this is what is known as a landrace. For example, one plot of okra would contain plants able to persist through different types of stress mixed with plants that have the highest yield or best flavor. In contrast with a uniform plot of a high-yielding variety, this mixed plot could yield much less in a favorable year, but much more in a year challenged by weather, pests, disease, or low farmer resources. The only way to replicate this smart strategy with either OP or hybrid commercial seed is to grow multiple varieties. Local sourcing and voucher programs can turn up landrace seed for vegetables.

GMO vs. Not

Commercialization of GMO varieties has been extremely limited for the common annual vegetables described here (i.e., excluding staple crops like maize). A few GM summer squash varieties are in commerce since 1995 for their virus resistant qualities. Otherwise, as of this writing, those identifying vegetable seed sources for crisis response are unlikely to encounter GM seed.

Seed Treatment

For commercial, non-organic planting purposes, much seed worldwide is treated. Treatments contain fungicide, bactericide, inoculant, and/or an inert coating meant to

make the shape of the seed more smooth or uniform for commercial planting equipment. Extension of seed distribution infrastructure into the developing world is largely to serve business needs and less so the small-scale farmer. Therefore, untreated seed may be less prevalent than it is in places like the U.S. and Europe. Some countries, like Honduras, may require treatment of almost all imported seed.

Global standards call for bright coloring to be added to seed treatments so that the added chemicals are evident. But this system is not guaranteed to be in place. Humanitarian aid programs should consider any requirements for clear labeling to avoid consumption of treated seed and ensure that they are in line with requirements in terms of use of pesticides, herbicides and fungicides. Training on treated seed should accompany its distribution, especially when eating seed is a concern, when farmers sow by mouth, and where hand-washing capacity is limited. Projects that expect to train seed aid recipients in strictly organic growing methods will also want to avoid treated seed. Conversely, if a setting faces impact from fungal diseases and/or insects during the germination stage, project planners may consider seed treatment desirable.

Seed Viability Standards/Maintaining Quality

Seed "quality" is multi-faceted when suitability for local conditions and culture is considered. But the basic viability of seed to grow at all remains a key issue. An essential resource is FAO's 2010 publication *Seeds in Emergencies: A Technical Handbook*. Here, FAO gives detailed instructions for sampling and testing seed along with sourcing advice. FAO gives a general standard of 70%+ germination if sourced locally and 80%+ if sourced internationally.

In understanding seed viability, a key concept is that any seed is a living organism. Poor germination indicates (most often) that some of the seed is simply dead, or else so compromised in its internal resources that it dies shortly upon first sprouting. Extreme high heat and humidity can kill seed quickly no matter how new or old it is, and no matter how long seed of that species "should" last.

Many types of vegetables may be appropriate in humanitarian response. Reflect closely on crop choice.

Ideal storage conditions rarely exist in the field. Humidity is the biggest enemy of seed – small, light vegetable seed can absorb a harmful level of water from the air in short order, then heat can cook the living organism inside. Moisture invites damaging organisms and starts physiological processes in seed that deplete reserves and decrease germination.

Given these dangers, consider the Key Pointers in Box 1.

BOX 1 Key Pointers for Sourcing, Storing, and Delivering Vegetable Seed

- **In response to natural disasters, many seed vendors or producers may hold supply with compromised quality. Assess this prior to sourcing seeds locally or approving vendors for receipt of vouchers. If organizing a seed fair, consider a quality testing program to certify suppliers in advance. Visual seed inspection on fair day is helpful but does not tell the whole story, especially for vegetable seed. Seed can even be faked, such as by saving and drying the seed from foods over the course of time and resealing commercial packets with these contents.**
- **Vegetable seed is small and planted intensively, so does not face the same storage and transport issues as grain and legume seed – seed to grow a lot of vegetables can fit in a small space. A project element could be to identify key buildings (such as medical clinics) in targeted regions or communities where electricity and/or climate control is most dependable. Then, form alliances or agreements establishing these facilities as seed storage and distribution points.**
- **If seed sourced is in an airtight package or container, keep it sealed until as close to planting time as possible. Hermetically sealed individual garden-sized packets are increasingly available and coming down in price.**
- **Train seed recipients and intermediary distributors in basic seed testing, storage principles, and appropriate technologies. For example, seed in an airtight container can be buried to protect against excess heat. If distributing seed, source it in packages sized for final recipients to begin with. The more times seed gets unpacked and repacked in varying conditions, the higher the risk.**
- **Provide access to seed packets with instructions as to plant spacing, days to harvest, days to germination, and other key details. Information should be in local or national languages or provided graphically. Watch out for seed packets that give misleading planting dates and seasons specific to Europe, Asia, or other locations.**
- **Expiration dates can be lost when seed is repackaged, or absent when bought from informal sources. Work to include dates, but also train that they are only a guideline – seed may last much shorter or longer than dates shown – and that farmers should instead rely on their own germination testing when quality is in doubt.**
- **Provide small quantities or vouchers at multiple time points, if logistics allow, so that those with highest capacity to store seeds are primary holders over time. For some vegetables there are two to four planting seasons per year (with staggered planting possible within each).**

Which Vegetables?

Beyond issues of seed per se, different vegetables have very distinct advantages or raise quite specific concerns. Table 3 suggests some of the specific issues to consider in focusing on which vegetables to promote.[2,3]

[2] For the tropics, an additional highly-recommended resource is the text and charts found in Martin, 2012. This resource covers climactic tolerances for all major vegetables along with perennial food plants, some cash crops, and staples. As Dr. Martin states, any crop-selection advice provided globally should only be used as a rough screen with the real decisions made at a locally-specific level.

[3] Underutilized traditional vegetables also comprise a vast and important topic. Such traditional vegetables can be diverse. In one Thailand study (Bates et al., 2012), 95 species were collected in just three village clusters. We cannot give this topic its due attention here and set it aside as needing further exploration through the lens of crisis relief.

TABLE 3
Discussion of Vegetable Species: Advantages, Suggestions, and Concerns

Vegetable type	Advantages	Suggestions/examples/concerns
Carrots	**Carrots produce slightly more edible calories per hectare per day than maize and potatoes, with greater micronutrients. Widely consumed and sold.**	**High heat resistance in many modern hybrids. Stump-rooted Asian Kuroda types do well in heavy soils and stress conditions – but steady moisture and weed control help all carrots.**
Onions	**Widely consumed and marketable. Strong nutritional benefits tend to be less-known than for some other vegetables.**	**Be aware of day length requirements for onions. Slow to grow from seed unless harvested in scallion stage. May prefer to grow from sets or transplants if quick harvest is the goal. Cultivars vary widely in storage potential. Seed is short-lived.**
Peppers	**Widely consumed and marketable. Nutritious, especially when ripe.**	**Disease and excess water can be a problem for plants. Slower to harvest than most vegetables listed. Shorter seed life than some.**
Tomatoes and Eggplants	**Especially good choices for marketing in peri-urban areas with a post-crisis goal of livelihood restoration.**	**What westerners know as processing tomatoes may be best choice for stress conditions. If growing these solanaceous crops in wet conditions, get expert seed selection help. Eggplant shape and species preferences vary by continent.**
Common Brassica Greens	**Fast to harvest. Nutritious and known in many cultures.**	**Examples: mustard, collard, kale. Kale is a cooler-weather crop but there are pockets of interest and familiarity in tropical highland zones.**
Cabbage	**Widely consumed and marketable. Transports well and storable in some conditions.**	**As is also true of broccoli and cauliflower, there exist tropically-adapted varieties. Success depends on selecting the right types for the setting.**
Asian Greens	**Growing in familiarity and popularity outside of Asia – consider among your choices in any setting. Often extremely fast to harvest with good nutrition.**	**Examples: pak choi, choysum, chrysanthemum, napa. There are heat tolerant varieties. But all can lose quality quickly after harvest. If seed saving is a goal, get expert help in selecting types.**
Lettuce	**Fast to harvest. Marketable if quality can be maintained.**	**Can lose quality quickly after harvest. Some leafy types have good heat resistance.**
Regionally-Important Greens	**These plants tend to "grow like a weed" in their native ranges, have high nutritional value, and knowledge of preparation is usually in place.**	**Examples: amaranth, convolvulus (morning glory), spinach, water spinach, malabar spinach, jute mallow, cleome.**
Regionally-Important Legumes	**Often multi-purpose plants, e.g. forage, green vegetable, green manure, stored dry seed/food.**	**Examples: chickpea, pigeon pea, cowpea, lablab bean, groundnut, rice bean, winged bean. If locally prevalent, seed availability is not likely to be impacted by most crises.**

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TABLE 3 *(continued from previous page)*

Discussion of Vegetable Species: Advantages, Suggestions, and Concerns

Squash/"Pumpkin"	**Leaves are cooked and eaten in some cultures and are highly nutritious. Seeds are a protein source. Hard squashes store well. Among the easiest for seed saving (but will cross). Some types are among the few annual vegetables that thrive in humid and monsoon tropics.**	**There are at least four major species of squash (C. pepo, maxima, moschata, mixta) with differing profiles as to regional preference and disease/pest-resistance. Consult horticultural and cultural expertise. Most require large growing space and tropically-adapted pumpkins may require 100+ days to maturity.**
Watermelon & other melons	**Cantaloupe in particular is very nutritious. Seeds are a protein source consumed in some cultures. Among easiest to save seeds (but do readily cross).**	**Choose modern commercial types if ease of transport and disease resistance are goals. May be challenging in humid tropical conditions. Watermelon may be more adaptable to most stress. Require large growing space (and longer time to harvest) compared with much of list.**
Regionally-Important Cucurbits	**Where they are eaten they are often dietary staples and due to ease of saving, seed may be locally available with only access issues in crisis recovery.**	**Examples: bitter melon, winter melon, snake gourd.**
Quick-Growing Roots, e.g. Radish, Beet, Turnip	**Multi-purpose plants (greens can be eaten) and roots are stored/transported more readily than some.**	**Favor cooler weather although heat-tolerant varieties are available.**
Okra	**Consider use where extreme heat and uneven water would make other crops dubious. Transports well. Widely consumed and preserved by drying. Seed readily saved (and edible).**	**Some will want to grow as a perennial, some annual-consider this in variety selection. The hibiscus family, of which okra is a member, includes other edible crops of regional importance.**

Exit Strategies

If valid supply chains are identified as working in normal times, utilizing those vendors in intervention (such as engaging them as pick-up points for distributed seeds or as approved voucher recipients) can help ease the transition out of the aid paradigm. If such supply chains are broken by the crisis, restoring them could be part of the planned intervention.

Widespread seed saving is often positioned as an exit strategy from seed aid; for this reason relief interventions often focus on open-pollinated vegetables. Remember, however, that even in the temperate-climate developed world where conditions make most seed-saving easier, vegetable farmers at all scales don't always save seed. When farmers have both access to and availability of seed, their preference is often to turn to the local markets. Consider, then, how to make good links to local commerce as part of a sustainable intervention strategy.

One advantage of voucher or cash programs is that by design the likelihood is good that seeds similar to those selected by farmers are still available once the program is over. For direct seed distribution programs, there is no such guarantee. If distributing seed, use the following methods to aim for seed system continuity after intervention:

- Select seed for distribution that is similar to what is locally available.
- Build local supply chains for similar seed as part of the intervention. For example, develop a public/private partnership that entices a commercial seed company to establish links to lower wealth communities.
- Support local micro-entrepreneurs who can distribute seed and increase community seed system self-reliance.

If we have made farmers dependent on crop or seed choices no longer available to them, we lose the possibility of a transition from the crisis response. Remember: a good deal of vegetable seed is imported, and a large portion is bought retail. So, if populations are able to exit crisis with restored livelihood, and if communities have restored commerce, then traffic in vegetable seed may return of its own accord – as long as we get out of the way and let it do so.

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