The Grower's Guide to Conducting On-farm Variety Trials

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PREFACE

On-farm variety trials help farmers manage risk by identifying optimal genetics for a grower's unique environmental and market conditions. The authors of this guide hope it will serve as a useful tool for farmers, as well as for research, extension and non-profit programs looking to train farmers as co-researchers when conducting on-farm trials. This publication is part of a larger project that includes webinars, on-farm workshops and an online toolkit for managing on-farm trials (http://articles.extension.org/pages/74613). The guide, online resources, and related outreach events of this project are delivered in partnership between the USDA's Risk Management Agency (RMA), Organic Seed Alliance (OSA), University of Wisconsin-Madison, Oregon State University, eOrganic and the Midwest Organic and Sustainable Education Services (MOSES). This publication is funded by USDA's Risk Management Agency under award #RM17RMEPP522C027.

Co-authors of this publication include: Micaela Colley, Program Director at Organic Seed Alliance; Dr. Julie Dawson, Associate Professor of Horticulture at University of Wisconsin-Madison; Jared Zystro, Assistant Director of Research and Education at Organic Seed Alliance; Kitt Healy, Midwest Research and Education Associate at Organic Seed Alliance; Dr. James Myers, Professor of Vegetable Breeding and Genetics at Oregon State University; Harriet Behar, National Organic Standards Board Member and Associate Outreach Specialist in Organic and Sustainable Systems at University of Wisconsin-Madison; and Kat Becker, variety trial veteran and proprietor of Cattail Organics.

Introduction

Farming can feel like one gamble after another, but successful farmers know that good risk management strategies can increase farm stability and profitability. Choice of variety and seed source are just as critical to farm management as selecting the right implement to work the field or irrigate your crop. Seed choices influence a grower's ability to manage weeds, insect pests, and disease pressures, as well as cope with climate uncertainty. Identifying and using appropriate crop varieties is particularly crucial for organic farmers who have fewer "quick fix" tools than conventional producers who often rely on agrochemicals to mitigate crop stresses. Variety trials can highlight crop traits well-suited to a grower's unique environment, market and management realities, while contributing to the sense of wonder and tradition of innovation that draws many to farming in the first place.

The goal of this publication is to provide farmers with the fundamental skills to conduct on-farm variety trials that reflect their particular goals and farming operations. The guide presents scientific principles in an accessible way, and walks readers through the process of planning, implementing, evaluating and interpreting a variety trial. Readers will be able to apply what they learn immediately to their own farms, and benefit from reliable information about what thrives in their unique agroecological system.

For readers already familiar with variety trials, it may be useful to begin with the Variety Trialing Worksheet in Appendix A, and to refer back to the main body of the text for additional details on any topics that are still unclear. The primary target audience is organic vegetable and grain producers and these crops serve as applied examples throughout the guide, but the basic principles apply to many crops and farming systems.

Why do variety trials?

For busy farmers, variety trials may seem like another item on a never-ending list of things to do. In the long run, however, incorporating trials into an annual farm plan can help growers optimize their operation to avoid a number of common production pitfalls. The benefits of variety trials are extensive, but here are a few of the key potential positive impacts and reasons to incorporate variety trials into your annual farm plans.

Optimizing organic systems

Organic producers have fewer allowable inputs for mitigating crop stresses than their conventional counterparts and instead rely on agroecological practices. Crop genetics well-suited to organic production systems are thus all the more crucial for success. A growing body of research suggests that the varieties that perform best on organic farms may not be the same as on conventional farms, and that organic farmers may benefit from using varieties bred specifically for organic systems. Variety trials are particularly useful for farmers transitioning to organic production, seeking varieties bred for low-input operations, or looking to replace conventional varieties or seed sources.

Finding varieties to fill market niches or seasonal needs

Identifying novel, interesting crops or varieties of a crop you already produce can be a way to differentiate yourself in the marketplace and attract new customers. Farmers market customers, chefs, and specialty distributors are intrigued by unusual or exceptional varieties, varieties with a story, superior flavor, unique colors, and varieties available early or late in the season. Conducting an on-farm variety trial prior to expanding production of new, unknown varieties prevents the difficult lesson of losing a crop. Many colored carrots, for example, evolved in climates with milder winters than farmers encounter in most of the US; therefore, some varieties may bolt readily if planted too soon under cool spring conditions. Likewise, a head lettuce that performs exceptionally in May, may be the first variety to succumb to disease in a late-summer planting. Testing new varieties in trials throughout the season can ensure they are adapted to your growing conditions and seasonal needs.

Replacing a dropped variety or reducing dependence

Losing a standard variety when it is dropped by seed catalogs is a frustrating experience that is especially common among organic farmers. Variety trials can help growers identify alternative varieties with similar or superior qualities to the dropped standard. Many growers undertake this type of trial preemptively, identifying crops for which they rely too heavily on one variety, and using the trial to identify other viable options. This type of strategic redundancy reduces risk in any farming system. Trial results can also be communicated to seed companies as encouragement to retain high-performing varieties.

ADDRESSING THE ORGANIC RESEARCH GAP

Investments in public organic plant breeding and seed research increased by $22 million between 2011-2016 according to OSA's *State of Organic Seed* report (www.stateoforganicseed.org). While this rise in public research funding is encouraging, the level still pales in comparison with investments in conventional breeding programs, leaving funding gaps in public plant breeding and variety trials to address the diverse needs of organic agriculture. The vast majority of seed industry and public breeding programs are still conducted and managed in nonorganic systems. This means the onus is essentially on farmers to seek out organic varieties and verify their performance. On-farm variety trial information can be shared with other local farmers facing similar market and environmental considerations, and with plant breeders and seed companies to help determine priorities for future organic seed breeding. Contributing to the general body of information about organic variety performance helps ensure that more and better organic varieties will continue to come to market.

Complying with organic certification requirements

In order to maintain organic certification, growers must be in compliance with the National Organic Program's organic seed rule, which states: "The producer must use organically grown seeds, annual seedlings, and planting stock: *Except*, that: Nonorganically produced, untreated seeds and planting stock may be used to produce an organic crop when an equivalent organically produced variety is not commercially available."

As the quality, quantity, and diversity of commercially available organic seed increases, organic certifiers are increasing scrutiny of nonorganic seed use on certified organic farms. There are many reasons to trial and use organic seed besides fulfilling a regulatory requirement. Nonetheless, variety trials can help ensure compliance by identifying organic varieties and seed sources equivalent in quality, productivity and purpose to conventional varieties in a grower's particular system. Even a variety trial indicating no suitable organic alternative to a nonorganic variety indicates a market gap and demonstrates that the farmer is acting in good faith to comply with certification requirements.

Variety trials can help identify novel varieties for niche markets while assessing unknown varieties' adaptation to local growing conditions.

Addressing climatic challenges

Individual plants and crop varieties vary in their response to environmental stresses. On-farm trials can highlight varieties able to withstand stresses on your farm. Sometimes these stresses are regional in nature. A lettuce recommended for bolt tolerance, for example, may resist bolting more or less under various environments due to different heat and daylength conditions and thus perform differently in certain regions than others. A cherished tomato variety might be tolerant to the disease Septoria in the Mid-Atlantic (where the seed is marketed), but susceptible to the different pathogen races or the timing of infection commonly experienced in other regions of the US. Unpredictable weather patterns due to global climate change may present growers with new environmental challenges, rendering old varieties less reliable than they once were. Conducting variety trials as part of your annual farm plan can help your operation adapt to more extreme conditions by helping you find varieties well-suited to the changing climate of your particular area.

From a Certifier's Perspective

Consider using a worksheet like the one in Appendix G to document your efforts to find organic replacements for conventional varieties and for communicating these findings to your certifier. Variety trialing tips from an organic certifier can be found throughout this guide in the side bars labeled: "From a Certifier's Perspective."

ORGANIC SEED CAN HELP

Why Choose Organic Seed? Farmers choosing to use organic seed support investments in a seed system responsive to the needs of organic growers. As organic plant breeding and seed usage continue to grow, seed companies are encouraged to offer a greater selection of varieties well-adapted to organic systems. Using organic seed also supports a healthier environment, since pesticide regulations often allow higher applications of chemicals on non-edible crops including seed. Farmers using organic seed reduce the chemical footprint that conventional seed production creates.

Planning the Trial

Identifying trial goals

Clearly articulated goals will help ensure that the time and attention spent conducting your trial yields useful information. For example, the goals will inform decisions about when the trial should be planted, how the crop should be managed, how large the plot size should be, when to evaluate the trial, what data will be collected, and how to interpret trial results. A variety trial may incorporate several goals in one season, but considering which qualities are most important will ensure that trial outcomes are as useful as possible for the grower.

Example trial goals include:

- Identifying a variety that resists a specific pest or disease
- Replacing a variety that has been taken off the market, or that is only available in nonorganic seed
- Identifying a variety with superior culinary qualities, exceptional nutrition, or distinctive visual appearance
- Identifying a variety with particular agronomic characteristics, such as improved yield, early vigor, weed competitiveness, or drought tolerance
- Identifying a variety for a specific harvest window, such as early or late plantings for season extension

Conducting trials in a hoop house or high tunnel can help identify varieties particularly well-suited to this production system, as well as those suited to an early or late-season harvest window. Photo credit: Julie Dawson

Prioritizing crops

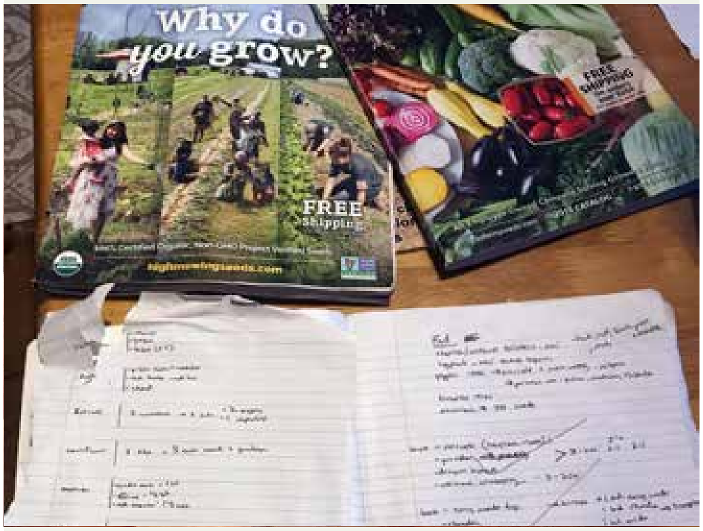
Since trials of every crop are usually impractical, prioritize your efforts. Identifying a superior variety of an economically significant crop may yield obvious returns, but trialing a new or unique specialty crop may open new market opportunities or production possibilities. Integrating annual trials into your long-term plan will help refine the overall farming system by continuously improving the choice of crops and varieties for production.

TIPS ON PRIORITIZING CROPS FROM CATTAIL ORGANICS

Kat Becker runs Cattail Organics, a community supported agriculture (CSA) and wholesale vegetable farm in Athens, Wisconsin. Kat integrates variety trials into her long-term farm plan to ensure that she is always discovering the best varieties for her farm and markets, and to indulge her curiosity about the diversity available within common crops.

Kat decides which crops to trial based on five priorities:

1. Key economic crops, especially if an important variety is at risk of disappearing, or if she is overly reliant on one variety
2. Staple crops she has difficulty growing, like cauliflower for her CSA shares
3. Crops with a seasonal weakness, such as a summer baby lettuce or spring broccoli
4. Changes in management practices that require new traits from certain crops, such as a carrot that withstands mechanical harvest
5. Novel varieties to fill potential market niches, like radicchio for local chefs



Seed catalogs and seed company websites are a great place to begin your search for trial varieties. Keep in mind, however, that seed catalogs will use glowing language to describe varieties, so don't let this distract you from your trial criteria. Photo credit: Kat Becker, Cattail Organics

Choosing trial varieties and acquiring seed

Before seeking out varieties, create a full description of ideal crop characteristics or desired traits. This description will help you articulate what you are looking for when sourcing seed, and serve as your criteria for evaluating the trial. For example, you may want to be the first grower with tomatoes at the farmers market, but you also want a variety that fits your market and production system. So your description might be a red, flavorful, salad-size tomato that is determinate (to minimize trellising) and requires fewer than 75 days to maturity.

Seed catalogs and seed company representatives are a good place to start when seeking variety recommendations. Keep in mind that seed companies are in the business of selling seed, so resist the temptation of pretty pictures and rosy descriptions, and focus on your trial criteria (days to maturity, disease resistance, a certain market quality, etc.). Some companies offer free seed or other compensation in exchange for conducting on-farm variety trials if you share results with them. Appendix B includes a list of resources for finding organic seed sources.

From a Certifier's Perspective

Many farmers have long-standing relationships with nonorganic seed suppliers, or the buyer of their crop may mandate the use of a nonorganic variety. Nonetheless, certifiers require growers to include seed companies offering organic seed in their seed search, even if those companies are unfamiliar. As you trial new organic varieties, and identify options that work well in your system, be sure to communicate your findings to your nonorganic seed representatives. This may encourage them to consider expanding their organic offerings in the future.

Some university research programs and county cooperative extension agencies conduct regional varieties trials and make their results publicly available. Even if trials are not conducted in your immediate vicinity, the trial reports may introduce you to unfamiliar varieties aligned with your trial goals. Appendix D includes information on public variety trialing programs. Networking with other growers through regional conferences, farmers markets, or seed exchanges may also yield interesting information about potential trial varieties, while also providing a foundation for potential collaborative trialing efforts. More information on planning and conducting collaborative variety trials is available in Appendix C.

Irrespective of the source, seed selected for your variety trial should reflect the goals of the trial and your farm management approach. If the best variety for your trial is not organically available, consider producing your own seed or approaching your favorite seed company and asking if they would consider carrying it.

Including a check variety

Always include your farm's standard variety in your trial, also called a "check" or "benchmark" variety. Your check variety is a familiar point of comparison for all other varieties in the trial. Including a check variety is important to:

1. *Compare the conditions of the season to "normal" conditions* – If you know your standard variety does not usually get disease, but it did this year, then you would be able to recognize that the disease pressure is higher than normal and may be influencing other varieties in the trial more than it would under a low disease pressure season.
2. *Compare the performance of the trial varieties to your standard variety* – This helps determine whether you should switch your standard variety to a new one.
3. *Communicate results to others* – If the standard variety is well known then you may use it as a point of reference for explaining results of the trial to others, such as co-workers, seed company representatives, and researchers. For example, "This tomato produced ripe fruit three weeks earlier than 'Early Girl'!"

Research station variety trial reports are often made public and can be a good source of information. Appendix D lists public variety trial programs.

TRIAL PLANNING TIPS FROM CATTAIL ORGANICS

Kat Becker's five tips for variety trial planning

1. **Talk to your seed company representatives.** You'll be impressed by how willing they are to suggest trial varieties from other companies, or pre-release varieties, when appropriate.
2. **Don't do a variety trial on a crop you've never grown before.** Learning how to manage a new crop is a project in itself, so give yourself the benefit of growing only a well-known, reliable variety or two in your first season of trying a new crop. Save the variety trials for subsequent years, when you have a better understanding of how the crop generally performs in your system.
3. **Conduct multi-window trials for crops that are planted in succession or heavily influenced by seasonal changes.** This can help highlight varieties that work well in certain times of the season, but not in others. If you only trial lettuce in the spring, for example, you may miss observing an important disease resistance or susceptibility that is not apparent until July.
4. **Trial goals can be very simple.** One of my most successful trials had the simple goal of finding a tomato that tasted as good and was as productive as 'Sungold'. I discovered 'Yellow Mini' and never looked back.
5. **Trial things for fun…within reason.** My kids and I have made some wonderful discoveries trialing weird varieties we weren't sure would be commercially viable, like various bull horn peppers and 'Papa Cacho' potatoes. But focusing too much time and energy on experimenting with novel varieties can distract from more immediate trial priorities.

Creating the plan

When creating a plan, carefully consider how much time you can give the trials and when. If you prioritize variety traits that must be evaluated during the busiest time of the season, collecting all data will be challenging. Consider starting small – with one crop, a few varieties, and maybe a screening trial rather than a replicated trial (as described in the "Designing the Trial" section) — and choosing a trial that can be conducted during a quiet a part of the season. You can then scale up as you become more comfortable with trialing methods.

Your specific plan should include details of where on your farm you will plant the trial, what the field looks like, how you will lay out the plots, when you will plant, what type of data you will take, when you will collect data, and how data will be documented and stored. Having your systems set up in advance will save you the headache of trying to keep track of loose data or management details during the busy season. Try to fit your trials into your existing workflow and crop management calendar. The more unusual a trial is in terms of what it requires you to do, the less likely you are to follow through with it.

A worksheet to aid trial planning is included in Appendix A, and Appendix G includes sample datasheets to be modified or used as is. The "Designing the Trial" section includes more detail on how to design your trial.

Lettuce is an example of a crop often planted in multiple phases throughout the season. It may be useful to plant sequential trials of a crop like lettuce so you can properly observe a variety that performs well in the spring, for example, but poorly in the fall.

Designing the Trial

The goal of a variety trial is to determine if certain varieties work better for your production system, climate and markets than others. **To achieve this goal, the trial must be designed to emphasize differences in varieties, rather than differences in the field or management conditions.** Completely eliminating field variability is difficult, so trials must be designed to take environmental variability into account, and to highlight differences between varieties despite imperfect field conditions. This section describes different approaches to trial design to ensure that your trial yields reliable information aligned with your goals.

By the end of this section, you will be able to answer the following questions about trial design:

- Where and when will I plant my trial?
- What are the sources of variation in my field?
- Based on trial goals, will I choose a replicated trial design or a screening trial design?
- Based on my crop and trial goals, how many plants will I put in each plot?
- How will I randomize plot locations to ensure the trial is unbiased?
- How will I manage the trial to most accurately reflect how the trial crop is generally managed on my farm?

Replication and field variation

Replicating varieties in multiple plots across the field helps account for land variation when comparing varieties. When varieties are grown and evaluated in only one plot on the farm (unreplicated), this is considered a "**screening trial**." When varieties are planted in multiple plots at the same time following a replicated experimental design, this is considered a "**replicated trial**." Replicated trials require more attention and effort, but provide greater assurance that the results are accurate. The ideal experimental design for your farm will ultimately depend on the type of information you are interested in obtaining from the trial, as well as the practical realities of your operation and available time. No one template can be perfectly exported from one farm to another, but common considerations can help you design a trial well-suited to your goals and operation.

__Plot:__ The plot is the fundamental experimental unit. The term plot refers to a single location of the field planted with one variety. Each plot usually includes several plants of the variety. Each **block** includes one plot of each variety.

EXAMPLES OF FIELD VARIATION

Field Effects
The "field effect" refers to the influence that variable field conditions have on the performance of the plants in the field. Common field effects may include:

Slope
- Variation in soil moisture or drainage
- Variation in soil type, pH or quality
- Sun or wind direction
- Pest, weed or disease pressure
- Temperature (e.g., cold pockets)
- Pollution
- Irrigation variability

Experimental design: screening trials

The need for replication in your trial will depend on how uniform your field is and what type of information you want to get out of the trial. For traits like yield or disease resistance, where field variation can have a large impact, replication is important, even when your field appears quite uniform. For more qualitative information, such as determining which carrot variety has the deepest color, a screening trial may be appropriate since the trait you will evaluate is less dependent on environmental variability. Screening trials

Pressure differences in an irrigation line could contribute to field variation that could skew trial results. Being aware of variable conditions in your field is the first step towards designing a trial that accounts for those conditions. Photo credit: Shawn Linehan

are also set up to compare a larger number of varieties in a more preliminary way – to see what's out there or to determine which varieties are worth including in a future replicated trial.

In a screening trial, in general, one variety is replicated across the field and the rest of the varieties are only planted once. This allows you to compare each variety to the "check" (or replicated) variety, and to make observations about whether varieties are promising for your markets, climate and management practices. Once you have completed a screening trial, you may want to conduct a replicated trial with a smaller number of the best varieties if you are interested in a trait like yield, which is hard to measure accurately in a screening trial.

Screening trials are useful for:

- Evaluating whether a variety merits consideration for a replicated trial
- Checking for trueness-of-type or other seed quality concerns, and evaluating the overall composition, or uniformity, of an adequately large population
- Identifying potential strengths or weaknesses of a variety. This sort of information gains strength when replicated over time, over multiple locations, or is followed up with a replicated trial.
- Experiments with a core question that is less likely to be influenced significantly by inevitable field variation (e.g., does this variety sell well at market?).
- Observing a larger number of varieties than is practical in a replicated trial.

Accounting for field variation in a screening trial

Because a screening trial does not rely on replication to account for field variation, it is especially important to pay attention to field conditions and ensure that the field and management are as uniform as possible. You probably have a good idea of which parts of your field are "problems" due to slope, compaction, changing soil type, irrigation line pressure, or other factors. You should use this knowledge of your field when setting up the trial. Avoid any localized problem areas. Locating a trial in an area with a dip in the middle that collects water, or on the far end of an irrigation line that never gets quite enough pressure is not a good idea. Try to ensure that field conditions are as uniform as possible in the trial location, and that it has been managed uniformly the previous year. If possible, locate your trial in the middle of your production crop planting to ensure that the management of the trial is consistent with your production management.

Screening trials are set up with a replicated "check" variety and single plots of the "test" varieties. The check variety should be distributed across the field two to four times so you can get a sense of how uniform your field actually is (see an example plot map in Figure 1). Your check should be a variety you are familiar with, whether it is your standard variety or the variety you are trying to replace. When evaluating the trial, you will use the plots of this variety as a point of comparison for all the test varieties in the trial.

To create a planting map, you should first distribute the check plots as evenly as possible across the trial area. For the test varieties, you can pull the names out of a hat or use an online random number generator to decide where they will go. Avoid planting test varieties in a non-random order, such as by company, because this can result in all the varieties from one company (which may be genetically related as well) going into the better or worst part of the field. Planting a border row and planning for consistent management within your field are very important for a screening trial, and are discussed in more detail below.

Screening trials can be very useful, especially if field variability is minimized, but their limitations should be kept in mind. Because conditions such as soil type, sun exposure, or irrigation may vary across the field there is a risk that differences in performance of varieties are due to variable field conditions rather than genetic or seed quality differences. Sometimes these conditions cannot be anticipated at the beginning of the season, so you cannot account for them in your field map. Replication helps account for this sort of variability.

Experimental design: replicated variety trials

If you have done a screening trial and have a few varieties that seem promising, you may want to conduct a replicated trial to determine which one is best. Replicated trials are also useful for teasing out differences in complex traits such as yield or disease resistance, especially when these traits are expressed unevenly across the field. For example, if a disease usually comes in on the prevailing wind, one edge of the field might have more severe disease pressure than the other side. Replication can help account for these differences in your field, so you can be sure your trial results reflect actual differences in trial varieties.

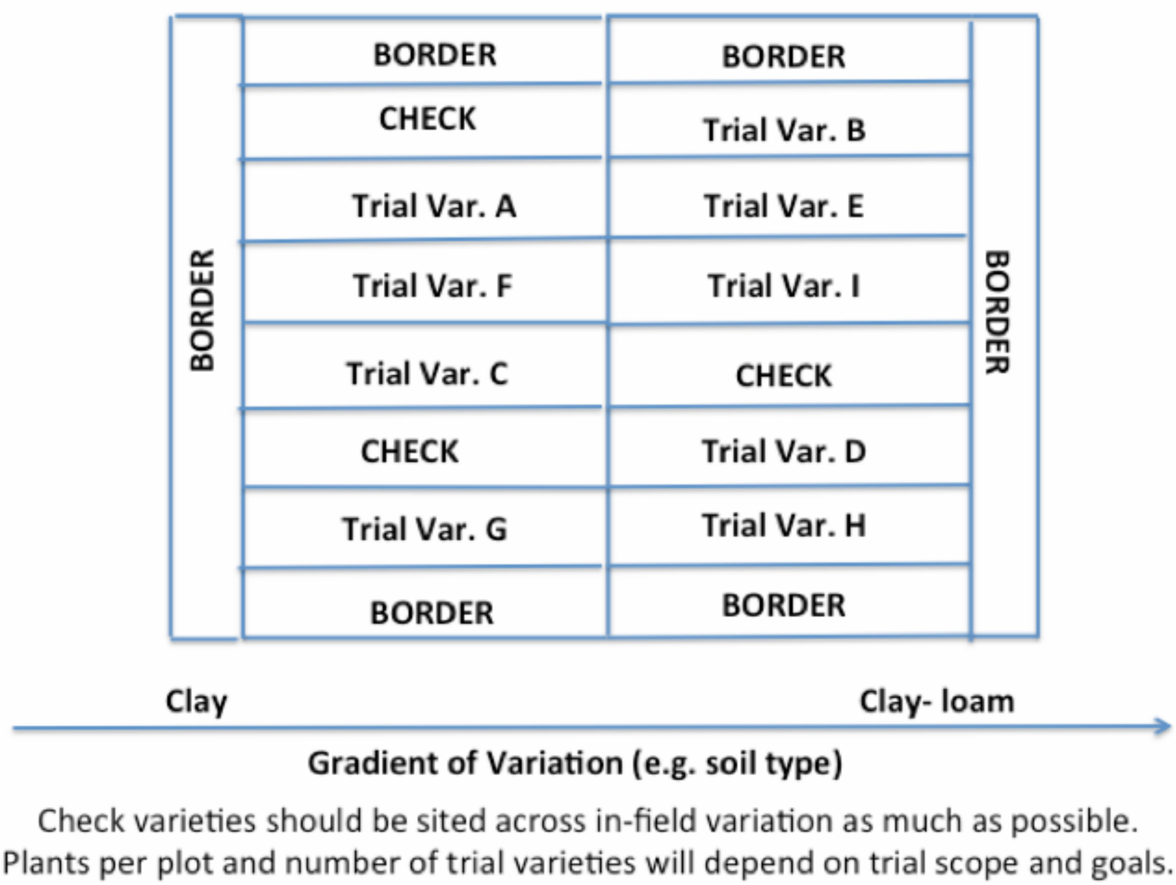


Figure 1. A sample screening trial plot map

Replicated variety trials are useful for:

- Evaluating traits likely to be influenced by environmental variation such as yield or disease resistance
- Detecting subtle differences between varieties
- Obtaining highly reliable information from your trial

When designing a replicated trial, remember that the purpose of replication is to account for differences due to environmental variation in your field. Typically this requires dividing the field into “blocks” rather than completely randomizing the different plots of all the entries (see figure 2). This is called a Randomized Complete Block Design and it is the most common design for replicated variety trials.

The layout of the blocks is where your knowledge of the field comes in. Site the blocks so that they are as uniform as possible, and any gradient of variation across the field is mostly going to create differences *between* blocks rather than *within* blocks (see Figure 2). This will allow you to account for the difference between blocks when comparing varieties, ensuring that environmental variation in your field has less of an effect on your results. Even with replication and statistical analysis, it isn’t possible to perfectly account for variation in the field, so choosing as uniform a site as possible is important when designing a replicated trial.

Typically one plot of each trial variety is planted within each block. So if you have three blocks, you will end up with three plots of each trial variety. Once you have laid

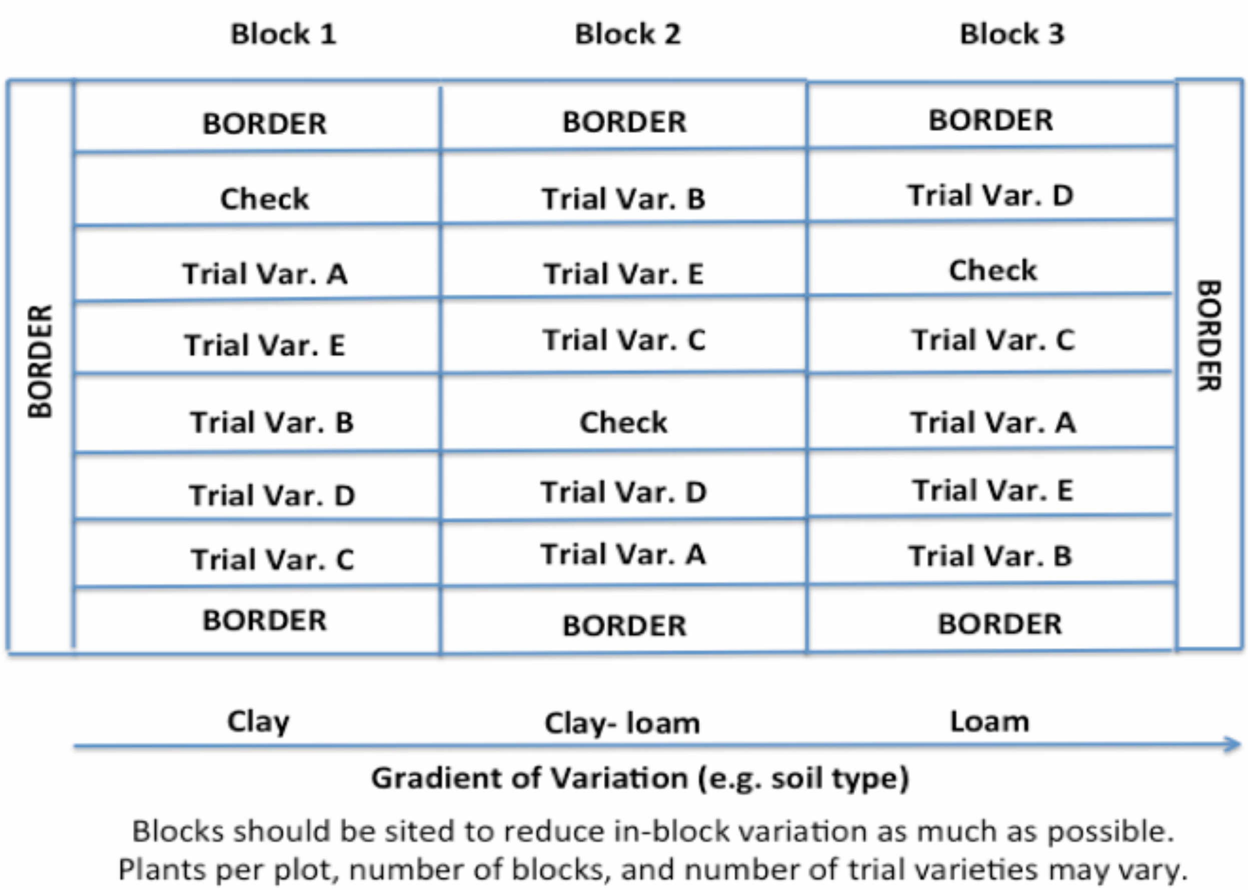


Figure 2. A sample replicated trial plot map

out the blocks in your field, you should randomize the varieties within each block. One option is to mark all of the plant stakes for each block and then mix them up and walk the block inserting whichever stake comes to hand first to mark the first plot and continue down the row marking plots in this manner. Then do the same for the second and third blocks. Another option is to randomize your variety list in a spreadsheet for each block and then create a map of the field prior to planting. Including a check variety in addition to your test varieties is important, just as it is for a screening trial. This check variety will be replicated and randomized within each block, the same as the test varieties, and will provide a point of comparison when interpreting the results from your trials. If you have extra space, you may choose to replicate the check variety more than once within each block, but this is not necessary.

When deciding whether or not to conduct a replicated trial, make sure you consider the time commitment required for the trial. If you plant a replicated trial and then only take notes or measurements on the first block, you won't gain anything by replicating.

Marking and mapping the trial

Before laying out a screening or replicated trial, create a map of the field that diagrams any sources of variability. Aerial photographs, if available, are also useful to view field variability. Mark on your map or aerial photo any differences in soil type, irrigation type, disease or pest pockets that you are aware of, wind and sun direction, and temperature gradients, such as cold air drainages on a hill slope. The map is a tool for you to decide where to site a screening trial or place each trial block of a replicated trial to minimize the effects of field variability.

Once the trial site and block areas are identified you are ready to lay out and mark the trial. You must decide on your plot size and then use flags or stakes to mark each plot in the field, ensuring sufficient space for equal sized plots of each variety within the field and, for replicated trials, within each block.

From an aerial view, it is easy to see variability in soil type, vegetation, and field edge effects – important considerations in deciding where to establish your trial.

Common farm materials may be used as plot markers, including plastic or wire irrigation flags or survey stakes. Wooden stakes or even paint stirring sticks make good markers, are relatively low cost, and are biodegradable in case one gets demolished in the field. Use permanent marker or horticultural marker (more expensive but more weather-proof) to write variety codes on stakes or flags. Since these markings can fade in the sun, remember to rewrite them midway through the season using your field map as a guide. Labels can also be printed on weather-proof label paper and placed on small plastic stakes.

Once the labels are placed in the field, *create a field map*. Stakes are easily lost, stepped on, run over by a tractor, or faded in the sun. Now that you have set up the trial, make a map of where you planted everything. Put the map in a safe place to ensure all your effort isn't wasted, as the plot map is essential for evaluating the trial.

Plot layout

The size of plots in the trial should be large enough to represent the typical traits of the variety. Larger numbers of plants provide a more accurate idea of how the variety will perform, but are more difficult to manage than small plots. Small plots are more susceptible to freak accidents,

REDUCING BIAS IN YOUR TRIAL

Ideally you should conduct what is called a "blind trial." In a blind trial a letter or number (or series of letters or numbers) is assigned to each variety rather than listing the variety name on each stake. This helps eliminate bias when evaluating varieties. It is crucial, however, to not lose the code for which variety each letter or number represents. If that happens, the trial loses its entire value.

Wooden survey stakes and irrigation flags are useful for marking a trial, and a long tape measure is handy for evenly spacing plots. A best practice is to establish the trial in the middle of the field under uniform conditions to avoid edge effects.

like a leak in the irrigation line or a mistake in cultivation. In general, when evaluating F1 hybrids and purelines of self-pollinated crops, fewer plants are necessary to get a representative sampling compared to open-pollinated varieties of cross-pollinated crops due to the generally greater inherent genetic variability in cross-pollinated populations. For field crops, you want to ensure that the plot size is large enough that you can plant with your standard spacing. For small grains in particular, yield is not measured on an individual plant basis because it is so dependent on plant spacing, so you will need a population large enough to be representative of both the variety and your management strategy (see Table 1).

Table 1 lists recommendations for minimum numbers of plants per plot for different plant families. These numbers are based on the authors' understanding of plant reproductive physiology and the amount of functional genetic diversity one would expect to observe in a population of each crop. Of course, none of these numbers are set in stone, and you may find yourself weighing the option of reducing the number of plants per plot to, for example, accommodate more trial varieties, or to fit the trial in a confined space, such as a hoop house. Or you may opt for more plants per plot to ensure a representative sample of a diverse population. Though following these recommended minimums will improve the accuracy of your trial, adjusting them to make your trial work in your circumstances will not invalidate your results.

Table 1. Recommended minimum number plants per plot in a replicated variety trial to evaluate population

Crop	Min. # of plants
Corn	30
Brassicas	30
Carrots	50
Radishes	50
Tomatoes/Peppers	10
Squash/Cucumbers	10
Beans (bush varieties)	30
Beans (pole varieties)	10
Lettuce (heading varieties)	10
Lettuce (leaf varieties)	25
Spinach	25
Peas	30
Small Grains	5 m^2

Ideally plots should be large enough to be managed as you would normally manage the crop in production. If you normally plant your cabbage on 36-inch centers and field cultivate with a tractor, then a small garden trial with 24-inch spacing and hand hoeing may result in some varieties performing differently than they would under your "normal" conditions. **For best results, include your variety trial within your production field of that crop so that all production practices are the same as for commercial production.**

Edge effects and inter-plot competition

Border rows around your experimental plots will minimize edge effects. Plots without borders tend to be more productive because they lack competing plants around them, but edge plots can also suffer from increased wind, sun, herbivore and airborne disease exposure. Data from un-bordered plots around the outside of the trial may reflect these influences, obscuring the variety effect that you hope to observe. Border rows should be planted not only on the sides of the trial, but at the top and bottom of the field as well.

Another variable to consider in determining plot size is the number of rows to include per plot. Single row plots may be appropriate for some crops, but may give more variable results because of potential competition between varieties in adjacent rows. With three or four rows per plot, the center one or two rows can be evaluated to reduce inter-plot competition. As with plot length, the minimum number of rows may also be determined by equipment. For example, your planter may only plant six rows at a time.

Trial plots should be managed as similarly to your commercial production field as possible.

TIPS FOR GRAIN GROWERS

If you normally combine harvest your grains you may want to replicate plots as full passes in the field to harvest and evaluate yields on a larger scale, while ensuring that trial management mirrors how you manage your commercial crop. Alternatively, you may want to plant smaller plots of grain crops (~5 m2) and harvest by hand to include more varieties in your trial. Either way, be certain to include your standard variety as a check and then extrapolate relative yields based on that year's yield for the standard variety in production.

Field crop producers may find it difficult to make small plot trials, which often require planting and weeding by hand, relevant to their production system. Growing trials at a larger scale to accommodate standard production practices may be beneficial in these circumstances.

CASE STUDY IN EXPERIMENTAL DESIGN

Jamie Kitzrow of Springhill Farm is conducting a fennel variety trial. He has been planting the variety 'Orion', but he wants to see if there are any other varieties available that perform better on his farm.

To do this, he sources five fennel varieties: four new varieties plus his standard variety, 'Orion'. Jamie first numbers each variety for the trial: A = 'Zefa fino', B = 'Perfection', C = 'Fino', D = 'Orbit', E = 'Orion', and F = an unreleased variety from a trusted seed company. He then starts one flat of each variety (172 cell plug tray) and plans for 50 plants per plot.

When it comes time to lay out the trial, Jamie chooses a relatively uniform area without any noticeable wet spots or slopes. He does know, however, that the trial site has a gradient of soil composition — the south end of the field has more clay and the north end is more loamy. To collect useful data from his trial, Jamie decides to plant three blocks along this gradient in soil (see Figure 2). Each block will include one plot of each trial variety with 50 plants per plot. Jamie prepares three beds for the trial, which are surrounded by his larger fennel production field, to minimize edge effects and standardize management. He randomizes the order of the varieties in each block using the =RAND function in Microsoft Excel. Then he labels stakes with the variety number and the block number. For example, variety A in the first block would be labeled A-1, variety B in the first block would be B-1, and variety D in the third block would be D-3. After marking the plots, putting in the labeled stakes, and planting 50 fennel plants in each plot (300 per block), Jamie makes a map of his field and stores it in a secure location.

Repeating the trial across years

For both screening and replicated trials, it is important to repeat the trial for more than one year. If a variety completely fails, you can drop it, but promising varieties should be tested more than once before planting them on larger acreage. Every season is different, and it is important to make sure that a new variety holds up under the range of environmental conditions your farm experiences.

Consistency in management

Consistency in management is important for both screening and replicated trials. The varieties and the blocks in the trial should all receive the same management inputs and practices (i.e., seedbed preparation, fertilization, cultivation, etc.) as your commercial plantings of that crop. If practices are inconsistent, differences in performance may be the result of unequal treatments as opposed to genetic differences in varieties.

Field conditions for the trial should be managed the same as a production crop, including spacing, fertilization, and weeding.

Evaluating the Trial

How you evaluate your variety trial will depend on the goals you have identified. Evaluation criteria can be extensive or focused depending on the intent of the trial and amount of time available. Because farmers are very busy, it is best to narrow the list of evaluation criteria to those that are most important (five or six at most). **Evaluation criteria should align with the key traits identified in the trial planning and variety selection process** (see "Planning the Trial").

By the end of this section, you will be able to answer the following questions about trial evaluation:

- What are my evaluation criteria/traits to be evaluated?
- For each trait to be evaluated, is a qualitative or quantitative evaluation more appropriate?
- For quantitative evaluations, will I use a measurement, rating, or ranking approach?
- When will I perform evaluations?
- Will anyone else perform evaluations, and if so, how will we standardize data collection?
- What will my data sheet look like and where will it be stored?

Evaluation timing and logistics

Variety evaluation can occur throughout the season to capture important traits at different stages of growth. If you want to evaluate emergence in spring carrot varieties, your first evaluation may occur just a week or two after planting. Seedling vigor, for example, is a trait particularly important in organic production that can be evaluated early in the season before the demands of harvest reduce the time available for evaluations. Commonly, each variety is evaluated at harvest maturity, to ensure that the data collected represents the variety accurately. Often all of the varieties in the trial will be mature at the same time, allowing evaluation of the entire trial on a given date. However, in some cases varieties may differ in maturity dates and the trial will require multiple evaluations. Evaluating some crops at multiple growth stages will be useful if each stage may be harvested for a different market. Plan to evaluate disease incidence two to three times during the season to see which varieties stay healthy the longest.

Sample data collection and evaluation sheets are available in **Appendix G** and online at www.seedalliance.org.

The trial evaluation should be a combination of data collection and notes. Collecting data, including measurements and scored traits, is a useful tool for developing a clear picture and detailed record of individual traits. Field notes give context to measured data, integrating overall impressions, and providing a record of unavoidable weather events or management decisions that may influence results. Both elements should be used in concert in the final analysis and variety selection decisions. If possible, it is also important to have the same person or team of people collecting data or taking notes throughout the season. This will ensure that information based on perception (like a 1-5 rating of plant height) or any short-hand in the notes are consistent throughout the data collection period.

Evaluation criteria should align with the key traits identified in the trial planning and variety selection process. If possible, have the same person or team of people collect data or take notes throughout the season for consistency.

Evaluation criteria to consider

Evaluation criteria should reflect the goals of the trial and the priority traits articulated in the trial plan. The traits you choose to evaluate may address market demands, such as flavor and uniformity, as well as production constraints like yield and storage capacity. Some traits, such as seedling vigor and pest resistance, may be particularly important to organic growers.

Potential evaluation traits include:

- Flavor
- Yield
- Length of productivity (i.e., first and final harvest dates)
- Seedling vigor
- Weed competitiveness
- Plant stature or lodging resistance
- Uniformity
- Rate of pest or disease infection
- Bolting sensitivity
- Holding and storage qualities

EFFICIENCY TIP

If evaluating the trial throughout the season is too time-consuming to plan, then just monitor the trial for full maturity and set aside time to capture key evaluation criteria at harvest time. The quality of data is more important than quantity of data.

From a Certifier's Perspective

A clear description of the crop characteristics you seek, and documentation of whether they are present in variety trials, are invaluable elements of your Organic Systems Plan, and will demonstrate to your certifier that you are actively researching organic equivalents. A worksheet for identifying important traits and documenting trial activities for your organic certifier is included in Appendix G.

Quantitative vs. qualitative evaluation

In addition to deciding on the most important traits to evaluate, you also need to decide how you will evaluate these traits. Most traits have different ways they could be assessed, and there is often a tradeoff between the precision of the assessment and the length of time it takes to capture. **In general, you should choose the evaluation method that gives you enough precision to make a decision, but remains manageable in terms of time, so that you will be able to follow through.**

Trial evaluators use a few general categories of assessment methods. One is measurement, in which you quantify the trait for each plot, such as measuring plant height in inches (or cm) or measuring yield in pounds (or kg) per plant. This is quite precise, but also quite time consuming. Another option is to score each plot for that particular trait, often on a 1-5 or 1-9 rating scale. This simple way of quantifying a trait can be analyzed using statistical methods, but is less precise than actually measuring that trait. It is usually much faster, however, and can be quite accurate with enough practice. For some crops and traits, rating the plot as a whole is the best method; for others it makes more sense to rate each individual plant and then take a plot average. Rating scales are commonly used in plant breeding programs as a way of generating a rapid numeric evaluation of important traits that take too much time to measure exactly.

A third category of assessment methods is ranking. With this method, the plots are ranked from best to worst. So the most productive plot in a block would get a 1 while the least productive plot would be ranked last. This is easily interpreted if you have consistent ranks between the replications of a variety across a trial. It can also be analyzed using statistical methods, although the analysis is a little more complex than with measurements or rating scales.

Measuring top height on carrots is an example of collecting quantitative data that may be evaluated by statistical methods

A simple way to collect qualitative data is to have your farm crew, CSA members, neighbors or broader community identify the varieties they prefer and explain why.

A final method of assessing traits is a qualitative evaluation. This can be descriptive text, such as "exceptional yield" or "poor yield." If conducted consistently across the trial, qualitative evaluations can be very informative and also very rapid. An example of a qualitative score sheet is provided as a worksheet in Appendix G. Qualitative descriptions can also capture important details relevant to your trial or changes in traits over time. For example, a qualitative assessment of a purple carrot trial might read, "Trial variety A had a beautiful dark purple color with concentric yellow rings early in the season, but the color faded in storage."

For both rating scales and qualitative evaluations, care must be taken to avoid grouping everything under one or two scores, or very similar text. If all the plots look the same, the scores should of course be the same, but the tendency for inexperienced raters is to avoid the extremes of the scale (not scoring anything a 1 or a 5 for example on a 5 point scale), resulting in scores that prevent you from differentiating between varieties with any confidence. Similarly, if you evaluate everything as "pretty good color" you will have no record of subtle differences between the varieties when you review your notes at the end of the season. This is less of an issue with measurements or ranking, where the rater is forced to rank varieties from best to worst.

From a Certifier's Perspective

Both qualitative and quantitative evaluations are useful in communicating trial results to your organic certifier. For quantitative information, be sure to explain how measurements were taken, and how ratings and rankings were assigned.

A useful scale developed by the International Center for Tropical Agriculture uses nine points and is easy to translate into a verbal scale. Rating is as follows: 1=poor, 3=fair, 5=average, 7=good, 9=excellent. The even numbers can be used to achieve finer differentiation. Other researchers including pathologists commonly use a 1-5 scale in which case half numbers can be used for finer differentiation. Which ever scale you choose we recommend including all numbers in the scale and comparing performance to other varieties in the current trial rather than performance in a different trial. If fewer numbers are used then ratings will often fall in the middle and distinctions between varieties can be lost.

EFFICIENCY TIP

Score traits rather than measuring or counting to save time. (See *Qualitative vs. quantitative traits* above.)

Data collection

Though the process of data collection will vary by trial and by farm, these general data collection steps will help ensure that your data is reliable and thorough. Repeating measurements is frustrating and time consuming. Getting it right the first time is very worthwhile!

1. Begin the evaluation process by first walking the trial to observe the plots, gaining a feeling for the breadth of traits within the field.
2. Every plot should be individually evaluated. Do not pool the three replicated plots for the evaluation or the intent of replicating will be lost.
3. Start with the list of all the traits to be measured or scored. Walk the field and evaluate each plot for a single trait. Then starting back with the first plot, repeat the process for each trait, one trait at a time. So, for example, all plots are evaluated for uniformity, then all plots are evaluated for vigor, and then all plots are evaluated for color until the evaluation of all desired traits are recorded.
4. Take notes on each plot individually. Notes might include an overall assessment or notable details that were not captured in the data collection or even comparisons of one plot to the next (e.g., variety #3 is much more productive than variety #4).
5. After the evaluation process, some evaluators find it useful to rank each variety overall to capture final impressions before leaving the field. You may want to rank them from top to bottom in order of performance, or it may be useful to assign a number according to future use, such as: 1 = grow next year, 2 = continue to evaluate, or 3 = drop from consideration. Note that the exercise of collecting data, plot by plot, and taking detailed notes helps you notice more detail and gain a holistic impression of each variety by the end of the evaluation process.
6. Evaluate all of the plants in a plot as a whole rather than just assessing the best or worst individuals in the population. This applies to both assigning a score and measuring a trait. When measuring, it is best to assess all of the plants in the plot and compute an average. If the plot is too large to measure the whole population, then randomly select a sub-sample to measure and compute an average for that plot.
7. Make sure your data sheet is labeled with the date and the name of the evaluator. Try to evaluate the entire trial on the same day and store completed data sheets in a safe location where they can be easily found again at the end of the season.

Begin your evaluation by walking the trial field, observing differences between plots and between blocks.

EFFICIENCY TIP

Keep one notebook, legal pad or folder exclusively for data collection and/or trial notes. Give it a home in your barn, office or truck, and be sure to return it to that home after each evaluation.

Sensory Evaluation

Plant breeders and farmers are increasingly interested in evaluating flavor and other sensory traits to ensure that crops are not only productive but also highly appealing to customers. Sensory evaluation can be as simple as tasting or "bite-testing" a random fruit, root or leaf from each plot as you move through the field, or it can be more involved, including ratings or descriptions of distinct flavor or visual characteristics. Involving the farm crew, CSA members, market customers or local chefs in sensory evaluation can be a great way to incorporate multiple perspectives into your data collection, while providing a valuable outreach and education opportunity. Growers who specialize in food-grade grains or other processing crops may choose to do a bread, sauce or beer evaluation in collaboration with their customers. Culinary professionals and the general public are often surprised and delighted by the diversity available within crop species, and love identifying their own favorite varieties. Consider including taste tests as part of a farm open house or CSA pick-up.

Sensory evaluation can be as simple as a "bite-test" in the field.

Hedonic vs. descriptive analysis

In the food science field, sensory evaluation is often conducted in controlled laboratory environments with highly trained panels of taste-test specialists. This level of standardization is not possible or necessary on your farm. One element of sensory analysis science that is important to consider, however, is the difference between hedonic and descriptive analysis. Hedonic analysis assesses the tasters' preferences, asking, for example, how much the taster likes the flavor of a certain sample. Descriptive analysis asks the taster to put their preferences out of mind, and focus on objectively characterizing the traits in question. If you would like to include both hedonic and descriptive questions in your sensory evaluation, plan to keep those questions separate. Once a taster identifies a sample as one they like or don't like, this may skew the way they describe the sample or vice versa. A sample sensory evaluation sheet is available in Appendix G.

To evaluate the culinary quality of trial varieties, try preparing each sample in a few different ways. This delicata squash is presented roasted and raw for tasting. Photo credit: Shawn Linehan

Tips for taste testing

Taste testing is the most common form of sensory evaluation. Designing a taste test and analyzing results can be straightforward, but the following tips will also ensure that your results are reliable.

1. Taste crops at peak maturity. If the time to maturity among trial varieties is variable, try to find a window in which all varieties will have at least some fully mature fruit, leaves or tubers.
2. Be aware of environmental effects. The flavor of some crops is heavily affected by rain events or temperature changes. Be aware how these might affect your trial crop and plan to taste all varieties on the same day (if possible) to minimize the influence of variable weather.
3. Get a representative sample from the plot. Just tasting one fruit or leaf from each plot may skew your perception of a variety's overall performance. A better practice is to rate each plant individually and then take an average, or, if the varieties are pretty uniform, take a bulk sample from multiple randomly selected plants within each plot. Avoid tasting samples that clearly do not represent the variety, such as blemished or under-ripe fruit.
4. Be aware of health and safety. Depending on the crop, it may be unsafe to taste crops without washing them first. Also, if you prepare a taste test ahead of time, be aware of risk factors associated with leaving food unrefrigerated for extended periods.
5. Discourage evaluators from communicating with one another. Tasters can easily skew each others' opinions by talking about their impressions. Providing earplugs to tasters can be one way to discourage them from influencing each other.

After you have collected data on your trial, you may feel like you have a pretty good impression of how the different varieties compare to each other and to your check. You may consider skipping the data analysis and instead refer back to the raw numbers when you need to. Much can be learned by simply internalizing your impressions of the trial, but analyzing your data allows you to check your impressions against your actual observations, yielding concrete information to guide decision making.

Taste evaluators rating kale varieties for flavor and texture with score cards.

Making Sense of the Data

Once data are collected the task remains of assessing the results. The first step is to review your trial goals. Was the goal to identify a single variety that out-yielded your current standard variety or the most disease-resistant variety available? Or was the goal to identify several new and interesting varieties to expand your offerings? Depending on your goals the data assessment may be approached from different angles. The type of data you collected will also influence how you are able to analyze it.

Analyzing qualitative vs. quantitative data

For qualitative evaluations, typically you will summarize observations for each trait. If you conducted a replicated trial, summarize your findings for each variety by synthesizing your notes from the three replications. For a screening trial, summarize your notes for each plot compared to the check variety. Look to see if your notes were consistent for the replications of each variety and for the replicated check in a screening trial. If one replication stands out as being less productive or otherwise different from the other replications — or if your check variety performed unexpectedly — this indicates an environmental effect that should be kept in mind when distilling results. Once you have summarized your observations, you can rank varieties based on each trait you evaluated and pick the top 2-3 to grow again next year. Qualitative evaluations are typically easy to understand and act on as long as they are detailed enough so that you can differentiate varieties.

For more quantitative data, such as measurements, rating scales or rankings, much can be learned from simply looking over the data without using statistical methods. Statistics are an additional tool that can be used to assess the effects of natural variability between plots and the likelihood that the differences measured are due to true genetic differences between varieties rather than to differences in field conditions.

Viewing the data

Entering the collected data into a Microsoft Excel spreadsheet makes it easy to look at and to calculate averages. This will also facilitate entering data into statistical formulas if you choose. Each plot should be entered separately into a chart of the traits evaluated, the varieties, and replication (see table below). Each trait evaluated should be considered separately and then compared to identify the best varieties overall. Let's consider the following example.

Figure 3. Sample table of yield scores

	Yield (scale of 1-9)			
Variety	**Rep 1**	**Rep 2**	**Rep 3**	**Average**
Var A	7	6	7	6.67
Var B	8	9	2	6.33
Var C	3	4	3	3.33

We can learn a lot by looking at all three replications along with average scores. From an assessment of the averages we would conclude that variety A was the highest yielding variety, but by comparing individual replications we can see that variety B actually scored higher in two out of three replications. We might consider what happened to variety B in the third replication. Did the irrigation fail? Or was the soil compacted in that plot? Did it get eaten by a rabbit? We can confidently conclude that variety C was the lowest yielding, but we might consider other traits besides yield

Yield, a common quantitative trait in variety trials, can be measured (e.g., by weight), rated (e.g., on a 0-9 scale), or ranked relative to other trial varieties.

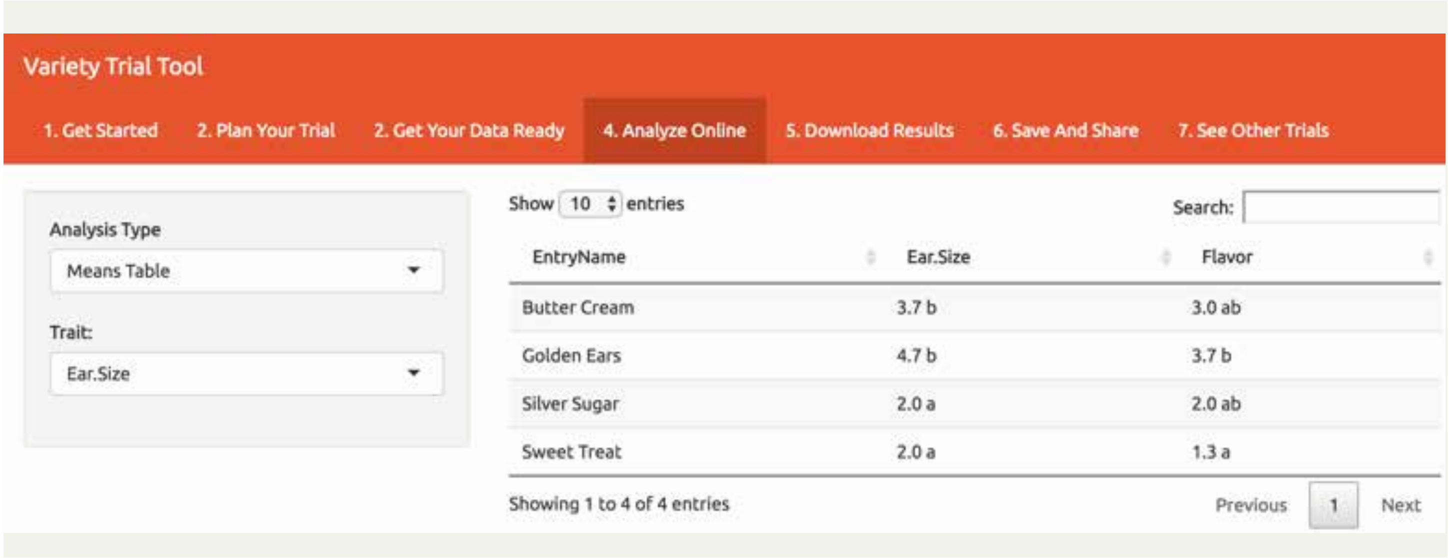
for A and B before deciding which performed best. If the trial had not been replicated and Variety B had only been planted in the location of the third replication then you might have dropped it from the trial based on poor performance in that location. This illustrates the reasons for replicating.

In some trials, you may choose to look at a certain trait, like yield or disease resistance, over time. With tomatoes, for example, it may not be useful to simply do one foliar disease rating in early August when the plants are still lush. You may want to add a late August rating and a late September rating. This type of sequential information can expose varieties that come on strong but go down quickly, or varieties that reach their peak right at an important time for your markets. One easy way to look at data collected over time is by creating a line graph. You can do this on paper, by creating X and Y axes, marking the dates you measure the trait of interest on the X axis and the measurements on the Y axis, and then connecting the dots. Microsoft Excel also has some easy templates for creating graphs and charts, though they always depend on having your data entered in a systematic way (see Figure 3).

Statistics

Replicated trials can also be analyzed with statistical methods that account for the variability between blocks or replications. Organic Seed Alliance has developed a variety trial analysis tool available at https://seedalliace.org/varietytrialtool. This tool allows growers to design trials and use statistical and visual applications to analyze the results. Below is a snapshot from this tool of a sweet corn trial showing the average ratings for ear size and the average rankings for flavor.

Here the tool shows only the averages of ratings and rankings for the three replications. Notice the lower case letters ("a," "b," and "ab") next to the averages for flavor and ("a" and "b") next to the average for ear size. Those letters are a shorthand way of showing whether the different varieties have trait averages that are statistically different from one another (see the section on statistics below). If the score for two varieties share a letter then their scores are not statistically different. Using the example above, even though 'Golden Ears' had an ear size rating of 4.7 and 'Butter Cream' had an ear size rating of 3.7, they both have b's next to their averages, which indicates that the different sized ears may be due to variation from replication to replication rather than variety differences. On the other hand, both 'Golden Ears' and 'Butter Cream' had ears that were statistically larger than either 'Silver Sugar' or 'Sweet Treat.'



EntryName	Ear.Size	Flavor
Butter Cream	3.7 b	3.0 ab
Golden Ears	4.7 b	3.7 b
Silver Sugar	2.0 a	2.0 ab
Sweet Treat	2.0 a	1.3 a

STATISTICAL TERMS

Mean – The sum of the measurements divided by the number of measurements: the average.

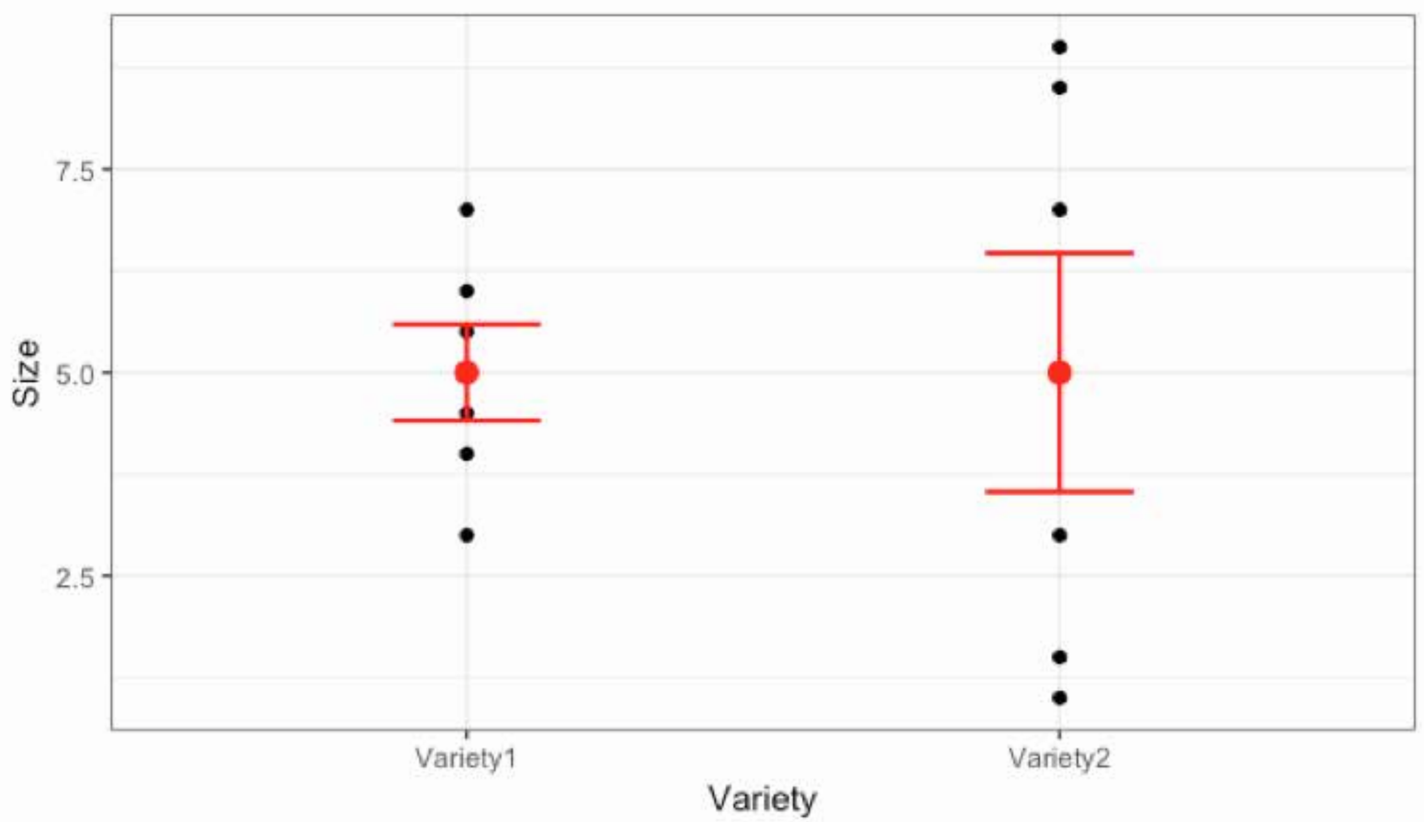
Standard error – A measure of the amount of variation in the data. If a variety has a measurement with a large standard error that means the measurements varied a lot from replication to replication. See the example below, which shows two varieties with the same mean (red dot) but different standard errors (red lines). For the mathematically inclined, the standard error is calculated as:

$$\sqrt{\frac{\sum(x_i - \bar{x})}{N(N-1)}}$$

where x_i are the individual measurements, $\bar{x}$ is the average, and N is the number of measurements.

Least significant difference (LSD) – The minimum difference between treatment averages that is required to be considered a real difference rather a difference due to chance.

P-value – The probability that the observed difference between varieties could occur by chance. For example a p-value of 0.05 means that there is only a 5% chance that the varieties were truly the same and the observed difference was actually due to chance. There is a 95% chance that the varieties are actually different.



Example of sizes (black dots) of two varieties with the same average size of 5 (large red dot), but different standard errors (red lines extending above and below average)

Identifying the winners

After looking over all of the traits evaluated you should have a feeling for which varieties performed the best. Having a clear understanding about which traits are most important to you will help in this process. Creating an overall rating scale allows you to sort out the varieties and make decisions about how to proceed in the future. If the goal is to pick the top variety then you might consider ranking all of the varieties in order of overall performance based on your identified priority traits. So number 1 would be the best variety (in this case, variety A in figure 3 above) and you might decide to grow it next year. If the top varieties are indistinguishable you might decide to keep the top two or three and trial them again the following year to compare a second season.

Taking photos of each trial variety at harvest can provide context for the numbers and notes collected during the season, and aid in identifying trial "winners."

If the goal of the trial is to identify multiple good varieties, potentially for different production or market niches, then it may be more useful to create an overall ranking that separates the varieties into classes of performance. For example: 1 = best performing, ready for production; 2 = medium performing, continue to evaluate; 3 = poorly performing, drop from the trial. In this case each variety would be assigned an overall score of 1, 2, or 3, which would indicate how to proceed the following year. This type of scoring is also useful in the event that the top variety is dropped from availability. Then you may return to your trial data and choose among the other varieties that ranked #1 overall.

For multiple year trials, consider variety performance over time in comparison to the standard check variety. For example, variety A may outperform the standard check in two out of three years or in 66% of the trials. In a single year trial, consider how the performance of each variety offered an advantage or disadvantage over your standard variety. For example, variety A had a 10% yield increase over the standard variety. This sort of comparison helps put into perspective the potential benefit of replacing the standard variety with a better performing variety.

Seed cost

Although cost is not a trait that is evaluated in the field it may be an important factor in deciding which variety to grow. Once the data is analyzed and overall scores are assigned it may be useful to evaluate the relative cost of each variety. For example, if one variety out-yielded another by 10%, but the seed cost twice as much it may not be worth the yield increase. In most cases, depending on the crop, the cost of seed is a small portion of the overall production expense and improved yield or quality may easily outweigh the additional cost of seed even if the increase is only 10% improvement in crop productivity.

From a Certifier's Perspective

Though some organic seeds are more expensive than nonorganic seeds, price is not listed as a reason why an organic variety may be unsuitable as a "commercially available equivalent" for a nonorganic variety. Only performance characteristics (like those demonstrated in a variety trial) can be used to compare a standard variety with a potential organic substitute.

Conclusion

Conducting and analyzing a variety trial can be a time consuming but rewarding process. As with any process that begins with a question, you will likely expect a conclusive answer at the end. Often, however, a successful variety trial will leave you with a handful of new favorites, each standing out for different reasons, as well as a whole new set of questions about what trait combinations are possible for your target crop. Variety trials are sometimes a gateway to on-farm plant breeding or seed production. So even though your trial may end with the season, an exciting new project may be just beginning.

Appendix A: Variety Trial Planning Worksheet

Envisioning the trial

Trial crop:

Trial goals:

Desired variety traits:
List in order of importance

1. ___________________________________

2. ___________________________________

3. ___________________________________

4. ___________________________________

5. ___________________________________

Circle the traits you plan to evaluate as part of the trial

Check variety:
This could be a common industry standard, a variety you'd like to replace, or one you know has key desired traits for comparison.

Trial varieties:
Selected according to your goals and desired variety traits

Potential seed sources:
Seed companies, plant breeders, university or extension researchers, other farmers

Designing the trial

<u>Replicated or screening trial:</u>
Based on trial goals, complexity of assessing target traits, expected influence of field variation, level of accuracy desired in trial results. See "Designing the Trial" section of this guide.

<u>If replicated, number of replications (blocks):</u>
At least 3 are recommended

<u>Plants per plot:</u>
Plan on one plot of each variety in a screening trial (2-4 of the check), and one plot of each variety in each replication (block) of a replicated trial. See "Plot layout" in the "Designing the Trial" section of this guide for minimum plant per plot and square footage recommendations by crop.

Implementing the trial

<u>Ideal planting date:</u>
Based on crop, trial goals, and traits you plan to evaluate

<u>Planting location:</u>
It is best to site the trial in a uniform area, where it can be easily managed along with your commercial planting of the same or similar crop(s).

<u>Known sources of field variation:</u>
Describe or diagram field conditions, such as slope, wind direction, or differences in soil quality that may influence trial crops in certain parts of the field.

Laying out the blocks (replications):

Describe or diagram where in the field the blocks (replications) will be placed based on variation in field conditions. The goal is to minimize variation within blocks. You may choose to add on to the previous diagram.

Plot layout and randomization:

Describe how you will randomize plot locations within each block or within an unreplicated trial. You may choose to add randomized plot locations to your previous diagram.

Border rows:

Describe how you will reduce edge effects in your trial.

Checklist for planting:

- ☐ Flags or stakes to mark trial area
- ☐ Codes to disguise variety names (see "Designing the Trial" section of this guide)
- ☐ Stakes for each plot, labeled with codes
- ☐ Field map
- ☐ Pens and markers
- ☐ Normal planting supplies

Notes on planting and management:

This is especially important if you plan to repeat the trial in subsequent years.

Trial Evaluation

Evaluation Criteria

For each trait that you plan to evaluate, list an approximate date (or set of dates for traits evaluated more than once) for when you plan to evaluate and your method of evaluation (e.g., weighing yield, rating flavor, ranking disease resistance, overall notes).

Trait	Evaluation timing	Evaluation method

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

Who will participate in data collection?

It's best to have one person or a small group of people conducting evaluations so measurement, rating, ranking or note-taking styles are consistent.

Checklist for data collection:

☐ Data sheets (sample data sheets are available in Appendix of G)

☐ Clipboard

☐ Pens/pencils

☐ Tools needed for measurement

☐ Colored tape or flags for marking unusual plants or plots

☐ Field map in case plot stakes are unreadable

Data Analysis

How will you enter and store data so you can easily find it again?

How will you summarize or analyze information collected?

For more information on data analysis options, see the "Making Sense of the Data" section of this guide.

Appendix B: Organic Seed Sourcing

Agriculture Technology Transfer for Rural Areas (ATTRA)

ATTRA maintains a searchable database of organic seed suppliers, provides background on the organic certification regulations, and offers additional organic grower resources. This database can be searched by seed company and by state, but not by crop type or by variety.
https://attra.ncat.org/attra-pub/organic_seed

ATTRA also provides a list of regional sources of bin-run organic grain seed for organic grain producers.
http://attra.ncat.org/attra-pub/summaries/marketingorganicgrains.html

Association of Official Seed Certifying Agencies (AOSCA)

AOSCA hosts the Organic Seed Finder website. Searches are conducted by crop type and yield specific variety information. The website also features a list of seed companies selling organic seed, but it isn't comprehensive.
http://www.organicseedfinder.org

Off-grid Heirloom Seed List

This independent website maintains a list of heirloom seed sources from around the country, as well as contact information for seed providers. The list cannot be searched by crop type or variety.
http://www.off-grid.info/food-independence/heirloom-seed-suppliers.html

Pickacarrot.com

This independent search engine indexes catalogs from over 60 seed companies, mostly focused on horticultural crops. Searches are conducted by crop type and results are listed by variety and seed company. Searches can be restricted to include only certified organic seed in results.
https://www.pickacarrot.com

Appendix C: Collaborative Trials with Other Farmers and Researchers

You may choose to do trials collaboratively with a group of farmers rather than on your farm only to explore how varieties perform in multiple locations. If the other farms are similar to your own, working with a group provides additional information that you can use to make decisions about varieties. For example, your trialing collective could all do a screening trial with the same check variety and overlapping test varieties and compare results. Or you could coordinate a replicated trial, in which each farmer plants at a different time of the season to look for varieties that thrive in particular windows. Standardizing management as much as possible across sites is important, but has to be weighed against the practicalities of each farmer's system. If your farms are close enough together you could help each other with trial planting and harvests.

Another type of trial model with multiple farms, called a mother-baby or regional-satellite trial, is often done in conjunction with university, extension or non-profit researchers. In this model, the researchers conduct a replicated trial measuring things like yield and disease resistance, and farmers each plant a screening trial with the same check and test varieties. This model has the benefit of producing replicated, reliable results on complex traits, and also being grounded in farmers' expertise and evaluations of the same varieties. These trials exist in different regions of the country for different crops, so you may be able to join an existing trial network if this type of trial is of interest to you. Or you can organize a group of farmers and ask your state extension service or university to help you set up a collaborative trialing program. Resources for existing trial networks and contact information are available in Appendix D.

Appendix D: Public Vegetable Variety Trials and Organic Small Grains Trials

In 2014, the Carolina Farm Stewardship Association compiled results from variety trials across the Southeastern US and made them available on their website: https://www.carolinafarmstewards.org/southeast-organic-seed-and-variety-trials-report

Carrot Improvement for Organic Agriculture (CIOA) is a long-term collaborative breeding and trialling project focused on orange and novel-colored carrots with improved traits for organic production systems: https://eorganic.info/carrotimprovement

Colorado State University's College of Agricultural Sciences conducts specialty crop evaluations for regional adaptation to organic production as part of Dr. Mark Uchanski's research program: http://specialtycrops.agsci.colostate.edu/research-and-projects

Cornell University conducts trials of small grains in organic systems and posts their trial results online. They also do vegetable trials as part of their breeding programs and make some of the results available: https://plbrgen.cals.cornell.edu/research-extension/small-grains/cultivar-testing

Experimental Farm Network engages researchers, farmers and citizen scientists around the country in participatory plant breeding variety trialing projects: https://www.experimentalfarmnetwork.org

The Northern Organic Vegetable Improvement Collaborative (NOVIC) conducts trials on a variety of crops at sites across the northern US. Trial results from NOVIC are available on e-organic: https://varietytrials.eorganic.info.

Oregon State University's Department of Horticulture conducts organic vegetable variety trials and vegetable breeding for organic systems in the Pacific Northwest. More information is available at: http://oregonstate.edu/dept/NWREC/programs/vegetables
Evaluation results are available from Dr. Jim Myers and Deborah Kean: http://extension.oregonstate.edu/catalog/details.php?sortnum=0624&name=Vegetables&num_results1=31&s=12&num_pages=3&sort=snumbera

Organic Seed Alliance conducts variety trials in partnership with universities and organic farmers. Trial results, along with other trialing and breeding resources, are available online: https://seedalliance.org/all-publications

University of British Columbia partners with the Bauta Family Initiative on Canadian Seed Security to identify varieties that are well-adapted to local organic farming conditions: http://ubcfarm.ubc.ca/bc-seed-trials

University of Wisconsin–Madison's Department of Horticulture conducts organic variety trials on a variety of vegetable crops at three research stations and on over 60 farms in the Upper Midwest. Trial results and program information are available at: https://dawson.horticulture.wisc.edu/chef-farmer-plant-breeder-collaboration

USDA's Sustainable Agriculture Research and Education Program (SARE) maintains a database of all previous project reports. Searching for variety trialing projects, especially for specific crops, can yield useful results: https://projects.sare.org/search-projects

The Vegetable Research and Extension Program at Washington State University–Mt. Vernon evaluates vegetable varieties and breeding lines for suitability for production in Western Washington: http://vegetables.wsu.edu

Appendix E: Variety Trials for Plant Breeding

A growing number of organic farms are engaged in on-farm seed production and plant breeding, either for on-farm use or as a diversified commercial crop. Variety trials are a critical first step in ensuring success in any seed project unless you are intimately familiar with the performance of the seed you choose to plant. Seed that is planted for a seed crop is called *stock seed* and seed used in breeding projects are referred to as *breeding material*. If your goal is to create a new or improved variety then it is critical that the stock seed or breeding material hold all the genetic qualities desired in the resulting variety. Seed of the same variety can also differ dramatically from one seed source to another. For these reasons trials are a critical first step to select the best genetic material to start with and ensure the investment of time and resources will lead to success. Your favorite varieties from a trial may be a good source of new parents for breeding projects, as long as you check the intellectual property of the variety and ensure it is not patented in a manner that prohibits it's use in breeding. The following are additional recommended resources for sourcing seed for potential breeding projects.

National Plant Germplasm System

The US Department of Agriculture's National Plant Germplasm System (NPGS) curates crop varieties at about a dozen locations around the US and territories. The collections house both wild and cultivated species. Plant accessions are cataloged in GRIN (the Germplasm Resource Information Network), which is a searchable database at https://npgsweb.ars-grin.gov/gringlobal/search.aspx. Small quantities of seed can be requested for research purposes. While some crop collections are quite extensive (for example, there are over 12,000 accessions of Phaseolus beans), many accessions are not adapted to North American climates. In particular, many tropical varieties flower and fruit under short days, but are inhibited by the long days found during our normal growing season. As such, these varieties will not begin to flower until September, an insufficient growing season to produce a mature crop. Seed quantities from NPGS are typically small and you are expected to maintain the variety once you receive it. When using this resource, it is important to use all information available and choose varieties carefully.

Open Source Seed Initiative (OSSI)

OSSI is a national nonprofit that encourages plant breeders to release varieties under an "open source pledge" intended to keep varieties and breeding material in the public domain. Any seed listed on the OSSI website (or marketed under the OSSI pledge) are available for use by any farmer or plant breeder interested in breeding with, selecting from, or simply saving seed of that variety. https://osseeds.org

Seed Savers Exchange

Seed Savers Exchange is a nonprofit organization of gardeners who save and exchange heirloom seed. They also have a seed catalog business. Additionally they publish a garden seed inventory and are a good place to research and source small quantities of seed that may not be commercially available. www.seedsavers.org

Appendix F: Variety Trial Case Studies

These sample trial plans use the worksheet from Appendix A to demonstrate how a grower might set up a trial. The first example comes from a diversified vegetable farm and the second from an organic grain farm.

Sample trial #1: Greentree Naturals

Diane and Thom of Greentree Naturals in Sandpoint, Idaho, have been saving their own pea seed of a variety they like for several years. Peas fill an important niche for the farm as they are a good early spring crop during a time of year when little produce is available at the market. However, they regularly experience hot, dry spells during June at which time their pea production drops off. They want to conduct a variety trial to see if there are any other sugar snap peas that tolerate the climatic conditions better than the one they currently use but also possess the good eating quality of their current variety. As an organic farm, identifying good organic seed sources is also of interest to Diane and Thom. However, since they plan to save their own seed, which will then be organic, this is not the top priority.

Envisioning the trial

Trial crop: Sugar snap peas

Trial goals: To identify varieties of sugar snap peas that produce well, have desirable traits, and tolerate the warm, dry spells that occur in mid-June.

Desired variety traits:

1. Productivity overall and window of productivity (do they last into June?)

2. Lack of stringy-ness

3. Large pod size

4. Good flavor

5. Seedling vigor

Circle the traits you plan to evaluate as part of the trial
All but #3

Check variety:
Greentree Naturals farm-saved seed

Trial varieties:
From organic sources: Sugar Daddy, Cascadia, and Sugar Ann
From non-organic sources: Sugar Snap, Super Sugar Snap, Sugar Sprint, and Sugar Star

Potential seed sources:
Local and national seed companies

Designing the trial

Replicated or screening trial: Replicated

If replicated, number of replications (blocks): 3

Plants and/or rows per plot: 10 row feet per plot

Peas are a self-pollinated crop. In general, varieties of self-pollinated crops don't tend to have as much genetic variability in the population as cross-pollinated crops. Therefore smaller plot sizes are needed to get a good evaluation of the population.

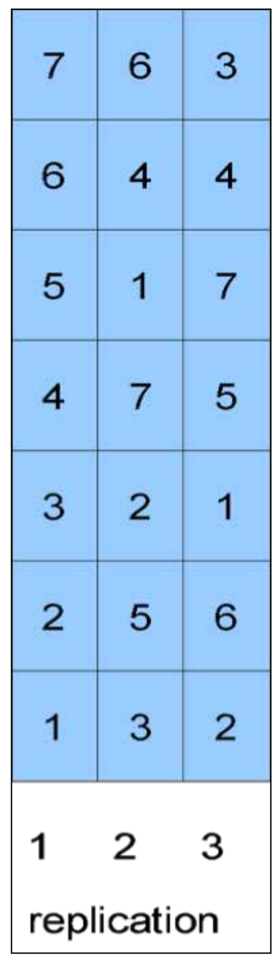
Implementing the trial

Ideal planting date: Normal planting time of early to mid-April as soon as the soil is workable and warm enough to plant.

Planting location: In three 100 foot rows within commercial pea field, southwest part of the farm

Known sources of field variation: Greentree Naturals is a small, two-acre farm nestled in the valley between the Cabinet and Selkirk mountain ranges in Northern Idaho. The farmland is fairly flat but the soil texture varies from a sandy loam to loam across the farm. The weather and prevailing winds usually come from the north through the valley. Trees along one side of the farm shade some of the eastern side of the field in the morning. Because they use drip irrigation the watering is fairly consistent but can sometimes be slightly heavier at the beginning of the row and lighter at the ends.

Laying out the blocks (replications): The three rows (blocks) for the trial will be placed in a flat area of the field where the soil type is consistent and away from barriers like trees to avoid shading part of the plot or blocking it from the wind. This ensures that all plots in the field will be similarly exposed to the sunny, hot, windy conditions of concern in June. The three rows are in an area with consistent soil conditions. No significant differences are expected within or between rows (see diagram at right).



Plot layout and randomization: There are seven trial varieties, each is assigned a number. Each number in the diagram at left represents a ten-foot plot of peas of that numbered variety. Each variety is in each replication (block) in a random order.

Border rows: The trial is surrounded by a commercial planting of peas, serving as a border.

Checklist for planting:

- ☐ Flags or stakes to mark trial area
- ☐ Codes to disguise variety names (see "Designing the Trial" section of this guide)
- ☐ Stakes for each plot, labeled with codes
- ☐ Field map
- ☐ Pens and markers
- ☐ Normal planting supplies

Notes on planting and management: The peas will be grown in the same manner that they always follow on their farm: single rows on a trellis with drip irrigation. All plots will be watered, weeded, and fertilized equally.

Trial Evaluation

Evaluation Criteria

Trait	Evaluation timing	Evaluation method
1. Seedling vigor	3 weeks after planting	1-9 rating scale (1=lowest vigor)
2. Yield	Each weekly harvest	weigh lbs. harvested on each date
3. Length of harvest window	First and last harvest	record first and last harvest dates
4. Stringy-ness	2 dates: one early season, one late	in field bite test, 1-9 rating scale (1=most stringy, 9=least)
5. Overall eating quality	2 dates: one early season, one late	in field bite test, 1-9 rating scale (1=least favorite, 9=best overall)

Who will participate in data collection? Diane will perform all non-sensory data collection. Diane and Thom will do eating quality evaluations.

Checklist for data collection:

- ☐ Data sheets (sample data sheets are available in the Appendix of G this guide)
- ☐ Clipboard
- ☐ Pens/pencils
- ☐ Tools needed for measurement
- ☐ Colored tape or flags for marking unusual plants or plots
- ☐ Field map in case plot stakes are unreadable

Data Analysis

How will you enter and store data so you can easily find it again? After each data collection day, data will be entered into an excel spreadsheet and saved.

How will you summarize or analyze information collected? Diane and Thom will look at average ratings and yield measurements for each variety. They will create line graphs to look at yield over time for each variety. Using this data and general field notes, they will rank varieties in order of overall performance. Any varieties that consistently out-perform their check will be considered for production.

Sample trial #2: Nash's Organic Farm

Nash's Organic Farm is a diversified grain, vegetable and livestock operation on the Olympic Peninsula of Washington State. The farm saves some of their own seed and seeks varieties adapted to the mild maritime climate. They grow wheat for direct market at their farm store and to bakeries in the region. They own their own mill for processing the wheat and seek varieties with good baking qualities. The farm experiences damp, cool spring conditions, dry long summers, and occasional episodes of fall rains during harvest season. They grow both winter and spring varieties of hard red and white types and are seeking the best varieties for their local climate to save their own seed on farm and use in production. The farm is working to move toward more winter varieties to avoid the need for preparing wet fields in the spring, less dependence on irrigation, and an earlier harvest window to avoid wet, fall conditions. The farm works closely with Washington State University (WSU) and is collaborating with the WSU wheat breeders to source commercial varieties and evaluate new breeding populations in an on-farm trial.

Envisioning the trial

<u>Trial crop:</u> Hard red winter wheat

<u>Trial goals:</u> To identify wheat varieties with good baking qualities and high yield that establish quickly from a fall planting, overwinter reliably, resist disease, and mature early enough in the fall to avoid fall rains.

<u>Desired variety traits:</u>
1. Good stand establishment from fall sowing.

2. Moderate stature with strong stalks to avoid lodging.

4. Resistance to stripe rust, a major grain disease in the area.

5. High yield of cleaned seed.

6. High protein content and good baking quality

<u>Circle the traits you plan to evaluate as part of the trial.</u> All traits will be evaluated in the trial.

<u>Check variety:</u> Their current variety Espresso is the farm standard and popular among organic farms. They save their own seed and will include this variety as the standard check to compare new varieties.

<u>Trial varieties:</u>
4 breeding populations from WSU, numbered varieties, not commercially available.
2 Organic hard red wheat varieties from an organic grain seed company based in the Upper Midwest.
1 Heirloom - Red Fife, an older variety he received from a Canadian wheat grower.
1 Check variety - Espresso, from farm saved seed.

<u>Potential seed sources:</u> Regional seed company, national organic seed company, state university breeding program

Designing the trial

<u>Replicated or screening trial:</u> Replicated

<u>If replicated, number of replications (blocks):</u> 3

Plants and/or rows per plot: Nash will plant small plots for the first year since the amount of seed available from the WSU breeding program is too small to plant with the seed drill and combine harvest. He will seed plots by hand in 4 ft wide x 10 ft long plots with a 1 ft gap between plots. In row spacing will be 6 inches to mirror production field conditions. Nash has a small scale push seeder used for vegetable seed that is designed to plant several rows in close spacing at once. He will use this seeder to establish the grain plots.

Implementing the trial

Ideal planting date: Mid-October timing the planting date with the weather predictions when fall rains are consistent enough to irrigate the crop.

Planting location: Swath in the center of a flat field of Espresso winter wheat crop so that the trial plots will be managed the same as the surrounding wheat crop.

Known sources of field variation: There is a soil gradation from one side of the field to the other. The field is bordered by tall trees. One area of the field has a dip that tends to collect water in the rainy winter months.

Laying out the blocks (replications): The trial will be placed in part of the field with the greatest uniformity in soil type, but there is still a potential gradient in one direction so blocks will be placed across the direction of the greatest potential difference in texture. The blocks will avoid the area of the field with the drainage dip and be placed where the field is as flat.

Plot layout and randomization: There are nine trial varieties, each is assigned a number. Each number in the diagram at left represents a ten-foot plot of wheat of that numbered variety. Each variety is in each replication (block) in a random order.

Border rows: The trial is surrounded by a production field of Expresso wheat serving as a border.

Checklist for planting:

☐ Flags or stakes to mark trial area

☐ Codes to disguise variety names (see "Designing the Trial" section of this guide)

☐ Stakes for each plot, labeled with codes

☐ Field map

☐ Pens and markers

☐ Normal planting supplies

Notes on planting and management: The wheat will be seeded in rows with a push seeder since the plot sizes are small and the main field is also drilled into rows. Nash will test all varieties for percentage germination in advance and then the amount of seed for each plot be All plots will be watered, weeded, and fertilized equally.

Trial Evaluation

Evaluation Criteria

Trait	Evaluation Timing	Evaluation Method
1. Stand establishment	Early winter after fall planting and again in March after over-wintering; June lodging score	Record heading dates; Rate plant height on a 1-9 scale (1= lowest stand); Lodging score on a 1-9 scale (1= no lodging)
2. Stripe rust resistance	Begin monitoring every other week in late April, begin scoring when disease is present	Rating scale of 1-5 (1=no disease, 5=highest incidence)
3. Timing of maturity	Monitor maturity from July 20 onward by harvesting a few heads by hand and assessing moisture content in the field by bite test. If all varieties are close then harvest all varieties on one date. If some varieties are much earlier or later then harvest plots on separate dates when dry enough to thresh in field post harvest. Harvest each plot individually.	Record harvest dates
4. Yield	Harvest each plot individually with a hand sickle and bundle, thresh bundle from each plot individually. Clean threshed seed with fan and screens.	Weigh final clean weight
5. Moisture content	After harvest and cleaning, test each plot for percent moisture	Using a portable grain moisture meter
6. Standard grain quality measures	After harvest test: protein content, test weight (weight/volume seed), falling number, DON toxin content, thousand kernel weight.	Send samples from each plot to WSU lab for testing
7. Baking quality	Late fall, combine seed from all three plots of each variety and mill by variety. Share flour of each variety with local baker to make small leaves of each.	Evaluate baking quality with a local baker. Conduct taste evaluations of baked loaves with baker and solicit feedback on qualities.

<u>Who will participate in data collection?</u> Nash's lead farm manager will monitor field traits and harvest timing. WSU will participate in evaluation of protein content. Nash will process harvested seed and evaluate yield and moisture and then mill the flour for the baker. The baker and farm crew will participate in taste evaluation.

<u>Checklist for data collection:</u>

☐ Data sheets (sample data sheets are available in the Appendix G of this guide)

☐ Clipboard

☐ Pens/ pencils

☐ Tools needed for measurement

☐ Colored tape or flags for marking unusual plants or plots

☐ Field map in case plot stakes are unreadable

Data Analysis

How will you enter and store data so you can easily find it again? After each data collection day, data will be entered into a spreadsheet and saved.

How will you summarize or analyze information collected? Nash and his farm manager will review the field data and any notes on field performance together and discuss which varieties worked best in production. They will also review the yield and moisture content after harvest and discuss pros and cons of yields and the need for additional drying post-harvest. The farm has a grain dryer that can be used to dry prior to storage, but the more a variety needs drying the more energy and limited dryer space needed. Baking quality is very important for Nash's customers so any varieties that had particularly poor baking quality would be dropped from future trials. The top varieties would likely be evaluated again the following year(s).

Appendix G: Sample Evaluation Sheets

Sample evaluation sheets are included in the following pages. Descriptions about each are below.

Trial Management Sheet, Seed to Kitchen Collaborative

The Seed to Kitchen Collaborative (SKC) developed this management data sheet to help keep track of management practices in trials, both so different farms participating can see what each farms' management was, and so that farmers can keep track of how trials were managed over time. You can also use this sheet to record any unusual weather events or problems that occurred during the season.

Variety Sheet, Seed to Kitchen Collaborative

This data sheet was developed with participating farmers in the SKC on-farm trials, based on what they would like to know about varieties from other farmers. SKC also collects quantitative trait information in research station trials. The data collected from the on-farm trials is also used to help breeders focus on key issues identified by farmers.

Chef Evaluation Form, Seed to Kitchen Collaborative

The participating chefs in the SKC use this form to evaluate flavor and culinary characteristics of different varieties. Certain questions are particular to chefs, but most can be used with any group of tasters.

Tasting Template, Seed to Kitchen Collaborative

Intensity scales are used by the farm crew to taste all varieties in the SKC project. The varieties are given three letter codes and are generally tasted in sets of about six. Information from these tastings is used to select varieties to bring to the chefs.

Trial Management Information

	CROP SPECIES				
FIELD	soil type				
	prior crop				
	cover crop				
	bed preparation				
PLANTING	planting method				
	planting date				
	plant spacing				
MANAGEMENT	fertilizer				
	mulch				
	irrigation				
	pest or disease treatments				
	trellising method				
	pruning method				
	standard varieties				
	Unusual weather events or problems				

Organic Seed Alliance
Variety Trial Evaluation

Date:
Location:
Farm:
Evaluator:

Evaluation: ______________________________

Crop type: ______________________________

*for blind test, fill in variety name after evaluation

Traits (fill in traits to be evaluated)

Var #	Rep #	Variety*								

Comments:

Comments:

Comments:

Comments:

Comments:

Comments:

Comments:

Comments:

Comments:

Comments:

Variety Sheet

Organic seed trial work-sheet – used to determine equivalency, or not, with non-organic seed	Days to Harvest-Maturation	Nutrient utilization/ fertility requirements	Day length requirements	Canopy potential	Seed emergence potential	Disease resistance-list types	Pest tolerance-list types	Drought Tolerance	Heat or cold tolerant	Seedling and plant vigor	Uniformity	Bolting sensitivity	Length of productivity	Flavor	Yield	Holding and storage qualities
Non-organic seed variety name																
Organic seed trialed name																
Organic seed trialed name																
Organic seed trialed name																
Non-organic seed variety name																
Organic seed trialed name																
Organic seed trialed name																
Organic seed trialed name																
Non-organic seed variety name																
Organic seed trialed name																
Organic seed trialed name																
Organic seed trialed name																

Name:

Crop: Please plant in the order on the sheet, with two plots of the check variety, one on each end of the trial

SKC

Seed to Kitchen Collaborative

Variety	Would you grow this again?	How marketable is it?	What did you think of the flavor?	What did you think of the productivity?

Datasheet continues on reverse!

Variety	Any disease/ insect/ stress problems?	Strongest point	Major flaws	Which variety was the best/worst?	General Notes

Name: ______________________________

Crop:

SKC

Seed to Kitchen Collaborative

Variety number	Flavor Intensity (1-9, 9=high)	Description of flavor characteristics	Description of an interesting appearance charactersitics	Description of any interesting texture charactersitics	Flavor like/dislike (1-5, 1= strong dislike 5= strong like)	Ease of Preparation	Strongest attribute	Weakest attribute	Would you buy it for your restaurant? (y/n)	Notes

Date ________________

CROP ________________

Taster ________________

SKC

Seed to Kitchen Collaborative

Instructions

Use a 1-5 score for each category below:

Sweetness, acidity, bitterness, umami, intensity:

1= low 2= moderately low 3= moderate 4= moderately high 5= high

Appearance, texture, overall:

1= poor 2= fair 3= moderate 4= good 5= excellent

1) For appearance, rate how appealing each variety looks: what is the likelihood you would purchase this variety at a market?
2) For overall category, give your global appreciation (1-5) of the flavor of each variety, excluding the appearance category
3) For unusual flavors, note any particularly strong flavors or anything that tastes "off" in words

Variety Code:	**NVM**	**PSJ**	**IDP**	**JXE**	**HKJ**	**XQM**
Appearance						
Texture						
Sweetness						
Acidity						
Bitterness						
Umami (savory flavor)						
Intensity						
Overall flavor						
Unusual or off – flavors (text)						

Additional Resources

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We thank the following for contributions and review of this publication:

John Foster, Oregon Tilth
Dr. Carol Miles, Washington State University
Nick Andrews, Oregon State University
Dr. Cinda Williams, University of Idaho
Dr. Roseanne Leiner, University of Alaska
Erin Mirrett, WSDA Organic Foods Program
Brian Andersen, Brian Andersen Farms
River & Sarah Bean, Arctic Organics
Anthony Boutard, Ayers Creek Farm
Diane Green, Greentree Naturals Farm
Jamie Kitzrow, Springhill Farm
Tim Terpstra, Ralph's Greenhouse
Connie Karr, Oregon Tilth
Nash Huber, Nash's Organic Produce
Anders Gurda, Pipeline Foods
John Wepking, Meadowlark Organics

Educational Materials