OREGON STATE UNIVERSITY EXTENSION SERVICE

Photo by Lynn Ketchum, © Oregon State University

Dry Farming in the Maritime Pacific Northwest

Intro to Dry Farming Organic Vegetables

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Before the rise of dams and aquifer pumping, dry farming was mainstream agriculture for millennia in much of the American West. Dry farming is not a yield maximization strategy, so it has not gotten much attention from industry and academia. Therefore, knowledge about it hasn't been well documented.

Dry-farming techniques for vegetable crops in the maritime Pacific Northwest have mainly been passed down from farmer to farmer over the past century, so dry farming vegetable crops is not widely known or understood by the maritime Pacific Northwest farming community. (Dryland farming of grains is well documented in the Pacific Northwest's rainfed, semi-arid, and sub-humid zones east of the Cascades.) In recent decades, very few farmers have experimented with dry farming, and even fewer have extensive experience in dry-farming practices.

To clarify, unirrigated does not necessarily mean dry farmed. Crops that grow primarily during a rainy season are not "dry-farmed," whether it be fava beans and garlic overwintered west of the Cascades or grains harvested in the summer east of the Cascades. Dry-farmed crops grow primarily during a dry season.

Contents

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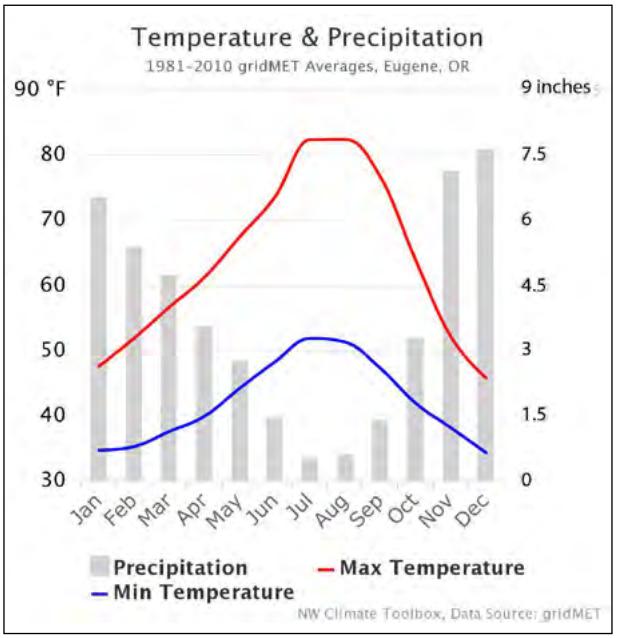
From 2015 to 2019, the OSU Extension Dry Farm Project has focused on small-scale, organic production of spring-planted, summer vegetables (for example, tomatoes, potatoes, winter squash, zucchini, melons, flour corn, dry beans) and aims to explore, revive, and expand awareness of dry farming. This publication is not a comprehensive manual on how to dry farm, but it does provide an overview of dry farming, describe some of the management practices that support growing organic vegetable crops without supplemental irrigation in this region, and offer some additional resources.

What is dry farming?

Dry farming is crop production without irrigation during a dry season, usually in a region that receives at least 20 inches of annual rainfall and utilizes the moisture stored in the soil from the rainy season. The Willamette Valley receives about 40 inches of precipitation per year, often with less than 2 inches of rain falling during July and August combined (see graph below). This seasonal drought coincides with the greatest period of transpiration for plants. Dry farmers work to conserve soil moisture during these long, dry periods through a combination of management strategies that could provide an alternative to irrigated vegetable crop production on some sites in the maritime Pacific Northwest.



Example of average temperature and precipitation in Eugene, Oregon, illustrating the dry summers in our maritime Pacific Northwest climate. To see average temperatures and precipitation for other locations, visit The Northwest Climate Toolbox at https://climatetoolbox.org/tool/historical-climate-normals

Why dry farming?

Water scarcity

Commercial and non-commercial farmers in the western United States are already facing challenges from increasing weather variability and a changing climate. Reduced snowmelt, higher temperatures, and drought directly impact water supply for growers. For example, during the drought in the 2015 growing season, many Oregon vegetable farmers using surface water for irrigation were cut off early, some as early as June.

Therefore, it is critical to increase our knowledge and awareness of drought mitigation tools and develop strategies for growing with little or no irrigation. While dry farming may not be a good fit for every farm, it could offer greater crop security for some in times of uncertain water supply.

Also, many new farmers have trouble finding land with adequate irrigation rights. Dry farming may also offer a way to get started in crop production on a piece of land while saving money for an irrigation system or other infrastructure.

Reduced inputs

Dry farming is not a yield maximization strategy. Rather, it works with nature to produce food more sustainably using fewer inputs, such as irrigation water, fertilizer, and labor. Since the yield is often much lower for dry-farmed crops compared to irrigated crops (25 to 50 percent less in some cases), commercial growers should factor this into their bottom line.

In our region there are many non-commercial farms (or homesteads) and commercial farms that are not reliant on their farm for their sole income. They have plenty of space to grow food on their land but no access to irrigation. On some of these sites, dry farming may make a lot of sense.

Farmers new to dry farming are often surprised by a plant's ability to produce with less water and realize that they have been overwatering many crops. In addition to conserving resources, using less water can also reduce fertilizer demand, protect carbon reserves in the soil, and lessen weed pressure.

Although perennial weeds such as bindweed and Canada thistle may persist in a dry-farmed system, many dry farmers report that without irrigation they have fewer annual weeds to manage. In a field with little to no perennial weed pressure, much of the work would happen in the spring—preparing the soil, planting, and managing annual weeds until rains stop. Typically, in late June to late July, there is a window of minimal crop management until harvest begins, which could result in some downtime for the farmer.

Improved produce quality

Dry farming is a much more accepted practice in the wine grape industry. It is known for yielding higher quality fruit for wine. In some wine grape growing regions in Europe, dry farming is even obligatory, and irrigation is not allowed. However, the impact of dry farming on the quality of vegetable crops is not as well known or documented.

To begin to address this, the OSU Dry Farming Project has held sensory evaluations of dry-farmed versus irrigated tomatoes and melons at many field days and events. These experiential learning opportunities have provided some preliminary data on participants' preferences.

For instance, in September 2018, in a blind taste comparison of dry-farmed and irrigated 'Desert King' and 'Christmas' watermelons at the Corvallis Farmers Market, 67 to 100 percent of the 60 participants ranked the dry-farmed 'Desert King' and 'Christmas' watermelons higher in the categories of color, texture, and sweetness.

Dry-farmed Early Girl tomatoes harvested at Gathering Together Farm on August 24, 2016. Photo by Amy Garrett, © Oregon State University

The Dry Farming Collaborative participated in the 2017 Variety Showcase, put on by the Culinary Breeding Network, in an exhibit organized by Fran McManus on the impact of farming practices on flavor. Taste comparisons of dry-farmed and irrigated tomatoes, melons, and winter squash were offered. Photos by Amy Garrett, © Oregon State University

As customer awareness and interest in dry-farmed produce increases, niche-marketing opportunities arise. Some farms with plenty of access to irrigation have expanded their production of dry-farmed tomatoes, for example, because of customer demand and interest in flavor as well as values held about natural resource conservation.

Watch this short video featuring several Willamette Valley farmers sharing their reasons for dry farming select vegetable crops.

Adapting to a Changing Climate: Conserving Water with Dry Farming Management Practices
https://www.youtube.com/watch?v=FRjDf7x9Tro

Dry-farmed winter squash at Oregon State University Vegetable Research Farm. Photo by Lynn Ketchum, © Oregon State University.

How does dry farming work?

There is more to dry farming than simply turning off the irrigation. Dry farmers use a variety of management strategies to store water from winter rain in the soil to support summer crop growth without supplemental irrigation. Successful dry farming requires favorable soils that can store moisture, adapted crops that can withstand the climatic extremes, and innovative farmers who can tailor a management system to fit their local environment. There isn't a precise recipe for how to dry farm, and what works on one site may not work on another.

Following are some of the key practices and considerations for dry farming organic vegetables in the maritime Pacific Northwest.

Site assessment and selection

A site with deep soil and good water-holding capacity is a good place to start. Soil is a great and inexpensive place to store water! Growers on marginal, shallow, sandy, and/or rocky soils might still be able to dry farm some crops but will likely have less yield. In these cases, building soil quality over time through cover cropping and organic matter supplementation may help increase soil water-holding capacity and crop productivity.

The following are key factors for assessing and selecting a site.

Know your soil!

- *Online soil maps and surveys*. Check out your soil types online and look at key characteristics such as texture, available water-holding capacity, depth to restrictive feature(s), and depth to water table to understand what your crop roots are accessing (or not) below ground. For example, see SoilWeb Apps (https://casoilresource.lawr.ucdavis.edu/soilweb-apps/) and NRCS Web Soil Survey (https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm)
- *Experiential.* Because dry-farmed crops root deeper than irrigated crops, pull a 5-foot soil core with a soil auger or dig a hole to get a sense of what your dry-farmed crop roots will be experiencing in terms of soil depth, texture, and moisture.

Andy Gallagher of Red Hill Soils and student interns assessing a 5-foot soil core pulled at Gathering Together Farm in 2016. Photo by Amy Garrett, © Oregon State University

If you need assistance to determine your soil type(s), contact your local Extension office or Soil and Water Conservation District.

Oregon

OSU Extension Service (https://extension.oregonstate.edu/find-us)

Oregon Association of Conservation Districts (https://oacd.org/oacdpress/about-us/who-we-are/directory)

Washington

WSU Extension Service (http://pubs.cahnrs.wsu.edu/locations/)

Washington Association of Conservation Districts (http://www.wadistricts.org/partnership-directory-4.html)

Water-holding capacity

- *Soil health and organic matter.* Improving soil health (https://soilhealthinstitute.org/) and adding organic matter (compost, cover crops, etc.) translates into more water held by the soil and more drought resilience.
- Silty and loamy soils with some clay content have more water-holding capacity than sandy soils. To learn more about estimating the available water-holding capacity of your soil, see *Estimating Soil Moisture by Feel and Appearance* https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_051845.pdf

Soil depth

- Four feet of moisture-retentive soil is recommended, and more is better. However, you can adapt the site you have with the suite of management practices highlighted in this publication. Shallow soils may require wider plant spacing and be less productive.

Proximity to other plants

- Minimize competition for water by selecting a site that has no neighboring trees or shrubs with lateral roots extending into the area to be dry-farmed. Also, root depth and lateral root distance vary between crops. Vining annual crops like squash and tomato have vast root systems and require more space per plant than dry beans and potatoes.

Slope and aspect

- In general, a slope may lose more water to drainage than a flat site. Steep slopes tend to have shallow soil with reduced water-holding capacity and an increased risk of erosion, especially when cultivated. Terraces and swales may enable some crops to be cultivated on sloped sites.

  In the maritime Pacific Northwest, south-facing slopes get more sun and heat units and therefore lose more water through evaporation than north-facing slopes. However, with our short summer growing season, sun exposure and heat units are important for ripening vegetable crops.

Wind

- Water loss through evapotranspiration increases significantly on a windy site. Crop evapotranspiration can be reduced by 10 to 40 percent with a windbreak, depending on the height and porosity of the windbreak as well as its distance from the crop.

Plants as indicators

- Are there any places on your land where unirrigated plants, such as blackberries, still look green in August? Their lushness and color are a good sign that the plants are accessing soil moisture late in the growing season. This could indicate a good location for dry farming summer crops.

Soil and bed preparation

- ***Timing is key!*** Start as early as possible, or as soon as the soil is dry enough to work or to get a tractor onto the field. This period can range anywhere from February to April in western Oregon (Table 1, page 6). For each particular site, it will also depend on the frost dates and growing degree-days, which can vary greatly due to factors like altitude and aspect.

- ***Organic matter.*** Adding organic matter, such as cover crops and compost, can increase soil water-holding capacity. Cover crops are killed and incorporated earlier for dry farming than in irrigated summer annual cropping systems because the cover crop utilizes more and more moisture as it grows, which is the same moisture summer crop growth will rely on.
- ***Bed preparation.*** Raised beds dry out faster than level beds, and sunken beds retain moisture better than level beds.
- ***Amendments.*** Amending soil right before planting may burn roots in an unirrigated system, so many dry farmers amend in the early spring or previous fall.
- ***Plow pan.*** Dry farmers often use a chisel plow or a broadfork for hand-scale operations to break through the plow pan. This helps ensure that crop root growth is not restricted and helps incorporate organic matter and other applied amendments deeper into the soil profile. For example, most tillers work the soil to a depth of 6 to 8 inches. The chisel plow and broadfork penetrate the soil to a depth of about 18 inches, creating a pocket for amendments to fall into. Learn more about the plow pan and subsoil compaction in Building Soils for Better Crops (see "For more information," page 10.
- ***Cover crops.*** Cover crop roots can penetrate soil deeper than most equipment and be a very effective and economical way of incorporating organic matter deep into the soil. This may help dry-farmed crops to access water and nutrients later in the growing season.
- ***Pre-plant cultivation*** is done after initial soil preparation to prevent the soil surface from crusting and cracking and to manage weeds, conserving soil moisture for summer crop growth.

Table 1. For the OSU Dry Farming Demonstration in Corvallis, the soil type was Woodburn Silt Loam, and soil preparation timing varied from 2015 to 2018.

	Date(s) of soil preparation activities					Planting date(s)		
Year	Flail mowed cover crop	Incorporate cover crop	Amend with compost and lime	Chisel plowed or broadforked	Pre-plant cultivation	Potato	Dry bean	Tomato transplants, corn, cucurbits
2015	3/17	3/17	3/30	4/1	4/10, 4/20, 5/5, 5/25, 5/27	5/5	5/5–5/7	5/25–5/27
2016	4/1	4/8	4/20	4/21	4/29, 5/9	4/29	N/A	5/9–5/12
2017	4/24	5/1	5/9	5/20	5/23, 5/26	N/A	5/23	5/23–5/26
2018	4/10	4/24	N/A	N/A	5/24	N/A	5/24	5/24

Planting timing and technique

- ***Moisture.*** Plant when and where there is moisture. For the dry-farm trials in Corvallis from 2015 to 2018, planting was done between late April and late May (Table 1, page 6). The key is: Do not wait until the soil dries out to plant! Put the seed in contact with moist soil, which may be a little below the depth recommended on the seed packet.

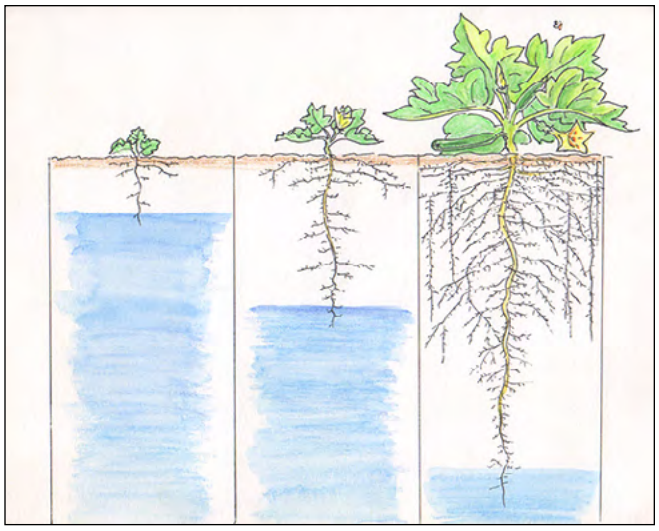
  Some growers, who have the ability to irrigate and need to plant late in drier soil, do one long overhead irrigation right after planting to get plants established. Then they pull the pipe and do not irrigate the rest of the season.

- ***Soil temperature*** is another important factor affecting germination. For example, squash, melons, and zucchini often require soil temperature to be at least 65°F to 75°F for germination. Determining the right time to plant in the spring is a dance with soil moisture and temperature.

- ***Dry conditions.*** If conditions are extremely dry when it is time to plant tomatoes (for example), you could prune off all the lower leaves of the transplant, leaving the top three or four. Dig a hole deep enough so that just the top leaves you left will be above ground. Fewer leaves means less transpiration and less water demand. Also, you could fill the hole with water and let it percolate into the soil before planting. This is also known as "mudding in" the transplant.

- ***Pre-soaking the large seeds*** of crops like corn, beans, squash, and melon 24 hours before planting may help seedlings germinate and get established more quickly, especially in drier conditions.

- ***Lower planting density*** is also key for dry farming. Giving each plant more space minimizes competition for water stored in the soil. Optimal plant spacing will vary from site to site based on soil water-holding capacity and equipment (see the next bullet point). A good starting point is to double the spacing you would normally use for irrigated crops. A density trial might be a useful way to fine-tune spacing for a specific location.



Stylized illustration of dry-farmed 'Dark Star' zucchini plant extending roots deep into the soil as the water table recedes from spring into the dry summer. Drawing by Moria Peters, used by permission.

- ***Seeding.*** Many small-scale farmers, both in irrigated and dry systems, use seeders (for example, Jang, Planet Jr., Earthway) to direct seed and thin plants to the desired density.

- ***Thinning.*** In the case of a severe drought, you could eliminate every other plant so that remaining plants have a better chance at surviving and being productive.

- ***Create good seed-to-soil contact*** by pressing in the soil around the seed or transplant. This is important in both irrigated and dry farmed systems. Helping the seedlings get established quickly in the spring, while moisture is more abundant at the soil surface for them to access, is especially important for dry farming.

Moisture conservation

- ***Dirt or "dust mulch,"*** as it has been called historically, is the most traditional approach used by dry farmers to conserve soil moisture for summer crop growth. This involves cultivation to loosen the top few inches of soil. Organic farmers often already do this to manage weeds instead of applying herbicides. Compared to those growing irrigated crops, dry farmers are more mindful about timing and cultivate shortly after rain to prevent the soil surface from crusting and cracking, which can cause the soil to dry out faster.

- ***Decrease moisture loss*** by working the ground early in the morning when there is still dew on the ground and before direct sun hits the area.
- ***Organic mulches.*** Deep mulches, such as leaves, wood chips, or straw, may be a viable and economical option for conserving soil moisture for home gardens and small farms where weeds are pulled by hand or managed with hand tools. Some farms grow a winter cover crop that is then cut and used as mulch for the main crop. Others take in organic debris, like leaves, that might be delivered for free by their city or town. Larger-scale mulching may be feasible with some creativity. Some important considerations when experimenting with mulches are:
  - Soil temperatures are cooler under deep mulch, which may inhibit germination of some direct-seeded crops like squash and melon.
  - Mulch may also provide habitat for slugs and rodents.
- ***Synthetic mulches.*** Some dry farmers use synthetic mulches, like weed fabric or plastic, to warm soil, hold in soil moisture, and suppress weeds. This approach may be especially useful on sites with perennial weed pressure, such as bindweed and Canada thistle. However, these mulches may also provide voles and gophers a safe haven from birds of prey.

Crop varietal selection

- Some of the most commonly dry-farmed, warm-season vegetable crops are indeterminant tomatoes (which grow and produce fruit until killed by frost), potato, winter squash, zucchini, melon, dry beans, and corn (sweet and flour). These spring-planted crops that are summer harvested were the focus of the OSU Dry Farming Project from 2015 to 2018.
- There is a longer list of more commonly grown vegetable crops that are often *unirrigated* in our region, such as garlic, fava beans, root crops, and many leafy greens. These often fall-planted crops are rainfed and grow during our rainy season, adding to the palette of year-round food production possibilities without irrigation.
- Other vegetable crops may be dry farmed in our region on some sites, within the limitations of the soil and the creativity of the grower.
- According to Steve Solomon, beets, chard, kale, leeks, and rutabagas are good at finding water and are semi-drought resistant, so it is possible to grow them without irrigation in the maritime Pacific Northwest. However, all do better with some irrigation. Celery, Chinese cabbage, spring-planted bulb onions, and summer and fall crops of lettuce, radishes, and scallions require irrigation in most situations in order to be productive.

Dry-farmed tomatoes at New Moon Organics in Shively, California in August 2015. Photo by Amy Garrett, © Oregon State University.

Dry-farmed dry beans at Warren Creek Farm in northern California in August 2015. Photo by Amy Garrett, © Oregon State University.

- Drought-tolerant, early-maturing, or dry-farmed vegetable varieties are often preferred. Varieties that germinate quickly in cool, wet, spring conditions are desirable given our short growing season. Plant breeders and farmers can make selections and save seed from dry-farmed crops that perform well on their site. Saving seed is a useful long-term strategy for developing drought-tolerant varieties specific to each farmer's location and management system. For resources on organic seed-saving and production, visit https://seedalliance.org/all-publications/.

The western United States is getting drier and is predicted to get more so, according to climate change projections. As aquifers dry up and drought is more prevalent, interest in this old way of farming has increased and become very relevant to the sustainability of our food system, including the future of many farms.

Quick summary of essential points

Dry-farmed summer vegetable crop production in our maritime climate can be facilitated and enhanced with the following conditions:

- Plants are given adequate space with minimal competition from other plants for water stored in soil.
- The soil going in to the growing season is fully saturated to a considerable depth.
- Weeds are meticulously managed and eliminated.
- The soil surface is cultivated or protected to prevent crusting and cracking, which can accelerate soil moisture loss.
- The site has deep soil with good water-holding characteristics.
- Soil quality is improved over time with cover cropping, adding organic matter, and minimizing soil disturbance.
- Drought-tolerant, early-maturing, or dry-farmed vegetable varieties are grown.

There is no precise recipe for how to dry farm organic vegetables on every site. This publication provides an overview of some of the key practices and considerations for your exploration of dry farming. There is always room for innovation. If you are new to dry farming, experiment! Start small, expand on your successes, and share what you learn with others.

Areas for further research

Some areas of interest amongst growers in the maritime Pacific Northwest are:

- Strategies for dry farming organically to preserve soil health with less soil disturbance and fewer fossil fuels, such as no-till and minimal tillage techniques
- Production and management practices for dry-farmed perennial systems, such as berries and orchard crops
- Effects of different mulches on the productivity of various dry-farmed crops
- Best practices for nutrient management in dry-farmed vegetable systems
- Efficacy of fungal inoculants in assisting with drought tolerance (for example, Bioensure)
- Developing and selecting annual crop varieties as well as rootstocks for orchard crops in dry-farmed systems
- Use of soil amendments, such as biochar, to increase water-holding capacity in more-marginal, less-productive soil types
- Economics of dry farming and how reduced inputs and reduced yield really affect the bottom line

For more information

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For more information and resources on dry farming, visit: https://centerforsmallfarms.oregonstate.edu/dryfarm

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