SUPPLEMENT 4

Overview of Dry Farming on the Central California Coast

"Dry farming" is a term that growers and consumers on California's Central Coast use to describe summer- and fall-harvested orchard, vineyard, and vegetable crops grown without supplemental irrigation following planting. Rather than rely on irrigation, dry-farmed crops draw on a reserve of soil moisture "captured" by the grower following winter and early spring rains.

A limited number of geographic regions are suited to dry farming, which requires adequate winter rainfall and, in the case of annual crops, a summertime marine influence that generates cool mornings and warm afternoons. These conditions, combined with careful soil preparation, appropriate variety selection, adequate plant spacing, and vigilant weed control are all required for successful dry farming.

A Note About Dry Land Farming

"Dry land farming" is another term commonly used in agricultural production. The term typically refers to winter grain production on non-irrigated cropland. Dry land grain is planted in fall and harvested in spring/early summer, relying on winter rainfall for growth and development. A dry land grain crop usually requires between 10 and 15 inches of annual precipitation for economic yields. In areas where rainfall is less than 10 inches, with careful soil management, grain can be produced every other year.

The important distinction between dry farming and dry land grain production is that the grain crop is "rain irrigated" during most of its growth cycle. In contrast, dry-farmed crops experience little or no rainfall during the growth cycle of the crop. In this supplement we are specifically referring to "dry farming."

Criteria for Successful Dry Farming

MEDITERRANEAN CLIMATE

Central California's Mediterranean climate creates the conditions that make dry farming possible. In normal years Central Coast rainfall is generated by storms that develop in the Gulf of Alaska and sweep south and then east, moving from the Pacific Ocean across the region from November through February and into March. High pressure then dominates the region from April through September and often into October, pushing rainfall to the north during the Central Coast's long "summer drought." Thus the region rarely receives significant rainfall from May through September.

Rainfall amounts vary considerably across the Central Coast, influenced in large part by the location, height, and orientation of the area's numerous mountain ranges. Steeper ranges parallel to the coast can cause significant orographic (mountain-induced) lifting of moisture-laden air, resulting in high rainfall amounts on the west side of these slopes. These ranges also create rain shadows on the east (inland) sides, reducing rainfall in these areas. From San Luis Obispo County in the south to San Mateo County in the north, rainfall amounts vary from approximately 8 inches up to approximately 35 inches per year depending on the effects of the mountain ranges and specific storm dynamics.

ADEQUATE WINTER RAINFALL

A minimum of 20 inches of rainfall during the rainy season is required to create an adequate reserve of soil moisture for growing most dry-farmed crops. The challenge for the dry-farm grower is to capture and hold as much of this precipitation in the soil as possible so that the spring-planted dry-farmed crops can access this "stored" moisture during the dry summer months.

MARITIME INFLUENCE

The valleys along the coast in Central California that receive significant summer time marine influence in the form of early morning fog and mild afternoon high temperatures (highs in the mid 80°s) and evapotranspiration (ET) rates in the range of .15 inches per day are ideal for dry farm production.

Higher afternoon temperatures and ET rates in the range of .33 inches per day, typically encountered in the more inland valleys with less marine influence, are much less suited to dry farming, especially of tomatoes, since it can be difficult for the plants to access deeper moisture quickly enough to maintain turgidity during periods of high evapotranspiration. However, some crops can be successfully dry farmed in inland valleys: although not within the scope of this article, wine grapes, olives, and apricots are successfully dry farmed in California on small acreages in areas with little or no maritime influence.

SOIL TYPE

The best soils for dry farming have relatively high clay content. Sandy loam soils or loam soils that overlay deeper clay soils also work well for dry farming. Soils higher in sand content do not hold soil moisture as well as clay and clay loam soils and therefore are typically not used for dry farming. And because organic matter increases the soil's porosity, it does not improve conditions for dry farming.

A grower considering dry farming should bore numerous holes up to 4 feet deep throughout the production area using a 2-inch slide hammer and soil probe to obtain soil "plugs": soils suitable for dry farming will exhibit continuity within the different horizons and a loam or sandy loam upper horizon going directly to clay. Horizons with a larger particle size, e.g., containing sand or gravel, will impede water's ability to be drawn upward to the plant's root zone, thus making dry farming less feasible. Preparing and planting a small area of the field is the best way to determine whether the site and conditions are suited to dry farming.

Soil Preparation

Soil preparation that conserves or "traps" winter rainfall is critical for successful dry farming. In the spring, prior to planting, residual rain moisture is typically lost from the root zone as water percolates down through the soil horizon with the help of gravity. High clay content in the soil, and to a lesser extent soil organic matter (humus), greatly facilitates the soil's ability to hold water in the root zone against the pull of gravity.

As the weather warms, soil moisture is also lost through surface evaporation. Evaporation occurs as water is drawn upward via small channels between soil particles; these channels can be thought of as capillaries within the soil horizon. Polar bonds between water molecules and the forces of cohesion facilitate water's upward movement through the soil: as water near the soil surface evaporates, water lower in the soil is pulled nearer the surface, much like liquid being drawn through a straw. Thus in fields destined for dry farming it is critical to break up the capillaries near the surface to minimize the evaporative loss of residual rain moisture during late spring and summer.

This breaking of capillaries is typically accomplished with relatively shallow (8"–10") mechanical soil tillage. Commonly used tillage tools include rototillers and disc harrows, often followed by secondary tillage implements such as spring tooth harrows. The resultant tilled zone is called a "dust mulch." This dust mulch provides an effective barrier to the potential evaporative loss of residual rain moisture held within the root zone of the soon-to-be-planted dry-farmed crop.

When creating the initial dust mulch, timing is critical: the grower must trap as much rain moisture in the soil as possible, yet avoid working the soil when it is too wet. Wet soils, especially "heavier" soils high in clay content, are subject to clod formation and compaction caused by tractor operations.

It is also important to minimize tillage depth when preparing soil for planting annual dry-farmed crops, since deeper tillage could disrupt the lower soil capillaries that are critical for soil water movement below the tilled zone. The dust mulch needs to be maintained with fairly frequent and light tillage operations (every two or three weeks) from the time of initial tilling until the crops are too large to cultivate effectively.

Although dry farming relies on winter rainfall, several scenarios can necessitate irrigation prior to planting. During dry springs it is sometimes necessary to pre-irrigate the beds before planting using either overhead irrigation or drip lines in order to establish an optimal stand. When a mechanical spader is used to incorporate a high residue cover crop prior to dry farming it is often necessary, in the absence of post-tillage rain events, to pre-irrigate with overhead sprinklers to facilitate the cover crop's breakdown. On a garden scale, you may need to hand water the newly planted plants to assist in rooting and uniform establishment.

The typical springtime dry farm tillage and crop culture sequence at the UCSC Farm is as follows:

1. Flail mow cover crop
2. Incorporate cover crop residue with mechanical spader
3. Form beds with rolling cultivator
4. In the absence of rain, pre-irrigate beds with over head irrigation at a rate of 1.5 inches per acre (when spring rains are adequate this step is unnecessary)
5. Wait for weed flush and create dust mulch with rolling cultivator
6. Maintain dust mulch with rolling cultivator as needed until planting time
7. At time of planting break open bed middles with Alabama shovels and plant tomato transplants deeply into moisture using hand trowels
8. Cultivate with sweeps and side knives when first weeds appear in furrow bottoms or as necessary to maintain dust mulch
9. Once plants reach adequate height, reform beds by throwing dirt into bed middles with rolling cultivator —when timed well this last cultivation pass will also effectively smother weeds starting to establish within the plant line

Variety Selection

In any dry farming system, variety selection is absolutely critical. Varieties that do well as dry-farmed crops typically have an aggressive root system capable of reaching deep into the soil horizon to tap the stored rain moisture.

It is interesting to note that growers in the Central Coast region have trialed literally hundreds of varieties of heirloom, open pollinated and hybrid tomatoes and, to date, none have compared to 'Early Girl' in their ability to set roots deep and consistently produce a high yield of high quality, flavorful, and marketable fruits with no irrigation. 'New Girl', a recently introduced variety, is closely related to 'Early Girl' and appears to have many of the same favorable characteristics.

Plant Spacing and Weed Control

Dry-farmed crops with extensive root systems can effectively extract deep residual rain moisture from a fairly large area within their roots' grasp. Competition from other nearby crop plants or weeds can result in water-stressed plants that produce very little fruit and remain stunted. For this reason it is critical to plant out dry-farmed crops in a much wider spacing than is typically used for irrigated crops of the same type. Good weed management in a dry farm system is also critical, since most weeds have aggressive root systems capable of outcompeting most crop plants for both water and nutrients.

As an example of plant spacing, irrigated tomatoes are commonly spaced 2 feet apart within the row with rows spaced 4 feet apart, a density of roughly 5,400 plants per acre. A typical spacing for dry-farmed tomatoes (depending on soil type and rainfall amounts) would be 6 feet between rows and 6 feet between plants, for a total plant population of 1210 plants per acre. As you can see from this example a significant yield reduction can be expected from most dry-farmed crops simply based on per acre plant populations. A higher price premium for dry-farmed tomatoes will often make up for the yield loss related to wider spacing.

Crops Suitable for Dry Farming

Tomatoes are the most notable dry-farmed crop produced in the Central Coast region. Dry-farmed tomatoes are typically transplanted into the field from May through June. It is advantageous to plant the tomatoes as deep as possible into the residual rain moisture after the dust mulch has been created and when soil temperatures are adequate for strong growth (>55 ºF). Growers often plant several successions spaced 2 to 3 weeks apart to provide an extended fall harvest period. Some growers stake and tie the tomatoes for ease of harvest and to enhance fruit quality, while others let the plants vine out on the ground without support.

'Early Girl' and/or 'New Girl' are currently the tomato varieties of choice. The fruits are easy to handle, they don't crack, and the flavor is remarkable. However, when grown without irrigation, these varieties are prone to a physiological condition known as blossom end rot. Blossom end rot is related to the plant's inability to move calcium to the blossom end of the fruit, which is exacerbated when water is limited. The symptom is a black sunken spot on the blossom end of the fruit that—depending on the severity of the symptom—is prone to rot. Although the condition often becomes less prevalent as the season progresses, it may affect 10–20% of the crop. Fruit showing symptoms of blossom end rot are not marketable.

Other annual vegetable crops that have been successfully dry farmed in the Central Coast region include dry corn, dry beans, and winter squash, all of which are direct seeded into residual rain moisture after the creation of the dust mulch. In a trial conducted at the UCSC Farm in the mid 1990s we showed no significant difference in yield between irrigated and dry-farmed Red Curry, Butternut, and Spaghetti winter squashes.

Advantages of Dry Farming

As a rotation within a diverse irrigated cropping system, dry farming has many advantages. The lack of irrigation in a dry-farmed production block can lead to improved soil tilth, since dry surface soil is not prone to compaction or clod formation from both foot traffic associated with harvest and tractor compaction from cultivation operations. Problem weeds are much easier to deal with when irrigation is eliminated for a season and weed seed development is easily minimized in a dry-farmed block. If water is a limited resource on a farm then dry farming makes perfect sense as a means of maintaining production while eliminating the need for irrigation. Forcing deep rooting of dry-farmed crops can also facilitate the extraction of nutrients that have leached below the root zone of most irrigated crops through excessive rainfall or irrigation.

Dry farming also heightens the intensity of crop flavors. This is particularly true of tomatoes, which are highly sought after by savvy consumers and the Central Coast region's chefs. As a result, the production and sale of dry-farmed tomatoes has become an important and economically viable niche market for small-scale organic specialty crop growers on the Central Coast.

Finally, although dry farming may not be appropriate for every cropping system and region, understanding the basic principles of dry farming can lead to a greater knowledge of the complexities of water and soil dynamics, tillage, weed management, and fertility management. This knowledge can in turn lead to a greater understanding of your particular production system. In regions where conserving water is critical, applying dry farming principles to irrigated systems can result in improved water use efficiencies, better weed management, and improved soil tilth and productivity.