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Organic Dry-Farmed Tomato Production on California's Central Coast: A Guide for Beginning Specialty Crop Growers

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ORGANIC DRY-FARMED TOMATO PRODUCTION ON CALIFORNIA'S CENTRAL COAST: A Guide for Beginning Specialty Crop Growers



Introduction

Where appropriate climate and soil conditions exist, growing dry-farmed tomatoes can be a good option for specialty crops growers. Dry farming generates an intensely flavored crop much prized by consumers and retailers.

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

This guide describes the steps involved in growing dry-farmed tomatoes organically on the Central Coast of California, with a focus on proper soil preparation, planting, and weed control.

Features of dry-farmed tomato production

- Heightens the intensity of crop flavors
- Produces a desirable specialty crop that can command a good price
- Creates options for value-added products
- Maintains production in areas where water is limited
- Minimizes weed seed development
- Makes it easier to deal with problem weeds
- Facilitates the extraction of nutrients that have leached below the root zone of most irrigated crops by forcing deep rooting

PRODUCTION PRACTICES – SUMMARY

Appropriate conditions

- Minimum 20" winter rain.
- Early morning fog, mild afternoon temperatures (max to mid 80's F).
- Evapotranspiration (Et) rate approximately .15"/day.

Soil type

- Relatively high clay content (works best).
- Sandy loam soils or loam soils that overlay deeper clay soils also work well (see sidebar, page 4).

Crop placement

- Plant tomatoes in isolation from potatoes and other solanums to minimize potential for spread of late blight (*Phytophthora infestans*) from potato foliage.

Fertility requirements

- Fall/winter cover crop: single species legume or primarily legume mix.
- Fall-applied compost.

Recommended timing of planting / Successions

- Plant when soil warms to approximately 60°F at 8" depth and incorporated cover crop has decomposed (residues brown, leaves no longer recognizable).
- Successional plantings can extend the harvest season. Depending on climate, growing season and markets, successions can be planted 2–3 weeks or 4–6 weeks apart.
- Warmer soil conditions promote the rapid growth rates and deep root development essential for successful dry-farmed tomato production.
- Early and late plantings face lower soil temperatures, cool and moist weather, risk of rain or frost, have slower growth rate and vigor, and increased susceptibility to pests and diseases.
- Early or late plantings that succeed have the potential to mature during market windows when there is less crop

availability and therefore may command higher prices (*there are rarely any guarantees about pricing!*).

Plant and row spacing

- 18"–24" between plants; 6' between rows.
- Lower winter rainfall may necessitate wider spacing.

Planting technique

- Transplant starts in furrows formed in the bed middles.
- When planting to moisture, plant well-hardened plants that are at least 12" tall.
- Ensure that root ball is surrounded by moist (darker) soil; if necessary, hand dig into deeper moisture to get the roots as deep as possible into moist soil.
- Firm the soil around the roots to re-establish capillarity.

Days to maturity

- Fruit matures approximately 90 days after transplanting; earlier in hot weather.

Harvest tips

- Harvest at full ripeness (uniform deep red color) for maximum flavor.
- Ensure that tomatoes are still firm, not soft.
- Harvest thick-skinned varieties into 5-gallon buckets; handle fruit gently.
- Harvest with calyx intact to improve appearance for immediate direct sales.

Post-harvest handling

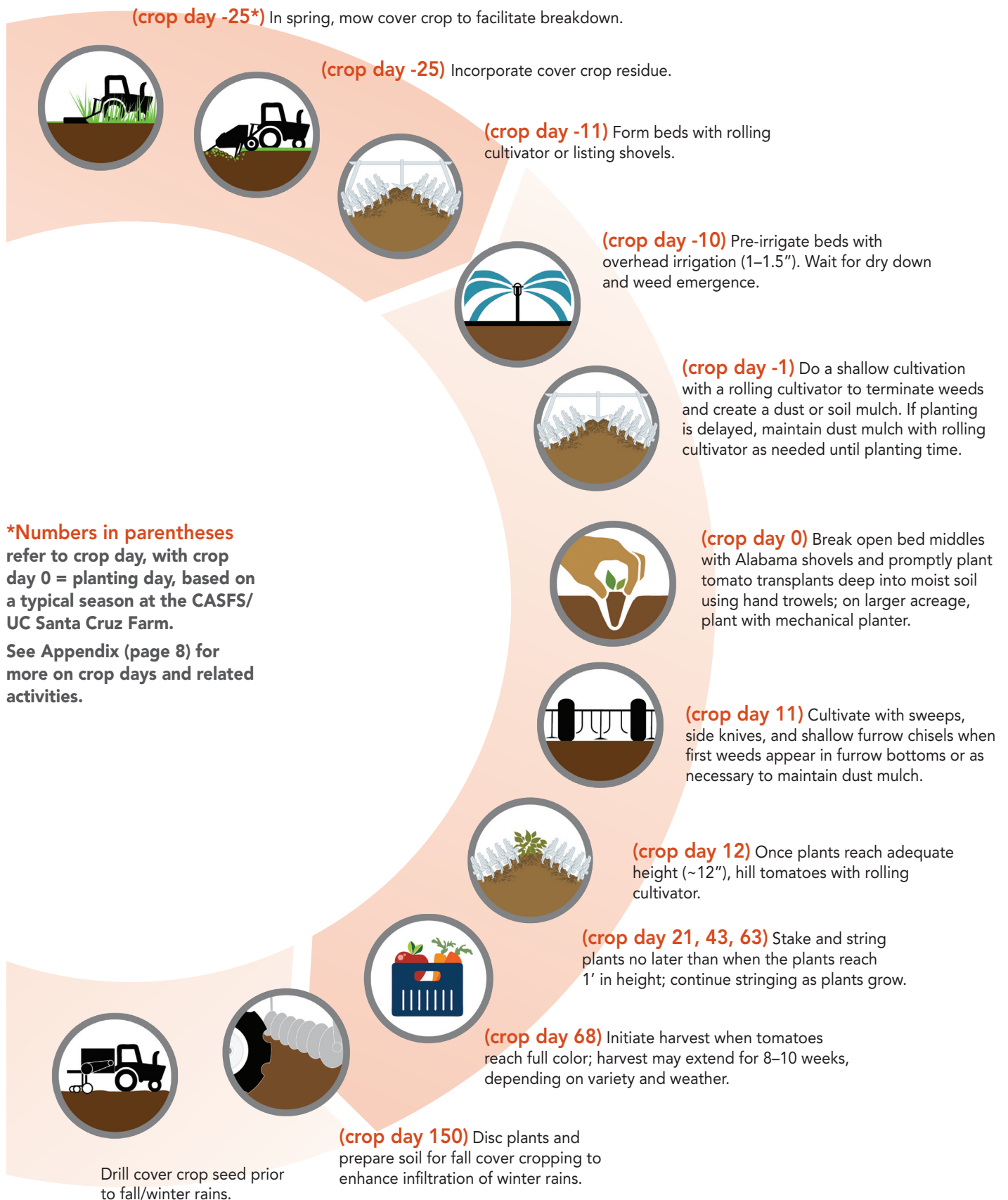
- Sort and pack in the shade.
- Store in cool, shady location to hold up to a week without refrigeration.

Crop rotation

- Rotate crops (plant different plant families) to break disease cycles.



PRODUCTION SEQUENCE – OVERVIEW



Production Practices — Additional Details

Soil amendments

Dry-farmed tomatoes will extend roots up to 8' deep or more to access moisture. Because there is no irrigation to carry solubilized nutrients to the root zone, dry-farmed tomatoes can be considered a “scavenger” crop in terms of nutrient uptake and demand.

Plant a winter cover crop ahead of a dry-farmed tomato crop to keep the soil covered over the winter, minimize soil erosion and nutrient leaching, fix nitrogen and build soil organic matter, stimulate microbial activity, improve water infiltration deep into the root zone, and enhance overall soil conditions. Use either a single species legume or primarily legume mix to grow a low-lignin cover crop whose residues break down quickly to facilitate earlier spring planting and maximize use of winter rains.

Because dry-farmed tomatoes are so deeply rooted, the crop will benefit from a fall application of compost prior to planting a cover crop. Compost applied at the time of cover crop incorporation would not benefit the dry-farmed tomato crop, although slow-release of nutrients would benefit subsequent irrigated crops.

Soil preparation and weed control

Soil preparation to conserve or “trap” winter rainfall is critical for successful dry farming. To maintain the winter moisture bank, follow this two-step process:

• Step 1: Incorporate the cover crop

Mow and incorporate the winter cover crop early to minimize water loss from the soil through transpiration from the cover

ASSESSING YOUR SOIL FOR DRY FARMING

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. 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.

If you are considering dry farming, bore numerous holes up to 4' deep throughout the production area using a 2" slide hammer soil probe or a soil auger to obtain soil “plugs.” Soils that are suitable for dry farming will exhibit continuity within the different horizons and a loam or sandy loam upper horizon with clay directly below it.

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. Although conditions vary from year to year, and management practices may be refined, it is less risky to experiment with dry farming (or any substantially new practice) on a small scale. If the small plot does well, you can expand it in future years.



FIGURE 1: Control newly emerged weeds (bottom left and right) with timely cultivation. Photos: Jim Clark

crop. Specific timing of incorporation is linked to your particular soil type and stage of cover crop maturation. Ideally, it will take place during a spring break in the weather that allows entry into the field with tillage equipment without undue soil compaction, and allows for subsequent decomposition of the cover crop.

To determine the optimum time to incorporate the cover crop, use a shovel or probe to assess the soil at various depths. Incorporate the cover crop and till when the soil is at about ~70% field capacity. This is on the wetter side of what is normally considered ideal; you will need to take care to prevent compaction.

• Step 2: Create a “dust mulch”

Once the cover crop is incorporated and adequately decomposed (this may take 10–20 days depending on the type of cover crop, its maturity, and soil conditions at the time it is worked in), list up beds in the field with a rolling cultivator. In the absence of adequate spring rainfall or if soil moisture is low, pre-irrigate beds with 1–1.5" of water using overhead irrigation to facilitate further breakdown of the cover crop; when spring rains are adequate (>1" after listing the beds) this step is unnecessary.

Wait for weed flush, then cultivate the weeds when they are at the pre-emergent “white thread” stage or still small (see Figure 1) and create a dust mulch. Use relatively shallow (4–6") mechanical soil tillage tools such as a rolling cultivator, rototillers, or disc harrows, often followed by secondary tillage implements such as spring tooth harrows. The loose soil created by this cultivation pass is referred to as a dust mulch or soil mulch. Because of the loose aggregation of the soil, the capillary action that would normally wick soil moisture to the surface is broken. Thus, the dust mulch provides an effective barrier to evaporative loss of moisture held within the root zone of the soon-to-be-planted dry-farmed crop.

Timing is critical for creating the initial dust mulch: you must trap as much rain moisture in the soil as possible, yet avoid working the soil when it is too wet. Tractor operations on wet soils, especially “heavier” soils high in clay content, can cause clod formation and compaction.

Similarly, it is 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.

Maintain the dust mulch and control weeds with light and fairly frequent tillage operations (every two or three weeks) from the time of initial tilling until the crops are too large to cultivate effectively.

Varietal recommendations

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 moisture.

Growers in the Central Coast region have trialed literally hundreds of varieties of heirloom, open pollinated, and hybrid tomatoes. To date, none has compared to the hybrid 'Early Girl' in its ability to set deep roots and consistently produce a good 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, but produces lower yields.

Some newer varieties have been bred with the pollen parents of 'Early Girl' yet (unlike 'Early Girl') claim to be resistant to spotted wilt virus, but these are not yet commercially available.

Seedlings

Depending on your farm's greenhouse facilities, tomato seedlings can either be grown on site or purchased from an organic seedling supplier. Plant well-hardened, "tall" plants (at least 12" tall) so that the seedlings can be planted deep to ensure root contact with moist soil.

Pre-irrigation

As noted above, dry spring conditions may make it necessary to pre-irrigate the beds before planting, with either overhead irrigation or drip lines, to establish an optimal stand. This pre-irrigation should always be followed by a cultivation to take advantage of planting to moisture, which gives the tomatoes a jump start on weeds (please see the publication *Tillage, Bed Formation, and Planting to Moisture* in this **Grower Guide** series for additional details).

On a garden scale, you may need to hand water the newly planted starts to ensure rooting and uniform establishment.

Plant spacing and planting technique

A typical spacing for dry-farmed tomatoes (depending on soil type and rainfall amounts) is 6' between rows and 2' between plants. Some growers use a closer spacing to further "stress" the plants for increased flavor; however, closer spacing will likely limit harvest windows, making additional successions necessary to increase overall yield (see page 2 for successional planting information).



FIGURE 2. Alabama shovels open planting furrows. Photos: Carolyn Lagattuta

Note that the recommendations below assume that you are planting into beds that have been prepared with a rolling cultivator and that the moisture is fairly close to the surface.

On the day of planting, set up a tractor-mounted tool bar with a wide Alabama shovel and open the middle of the bed to be planted (Figure 2). This pass with the shovel should remove the dry soil on the bed top and form a "V" down the length of the bed middle, allowing for easy access to deeper soil moisture in the bed middle and providing a "guide" for planting and follow-up cultivation.



FIGURE 3

Water the starts so they are well hydrated prior to planting, and do not allow them to dry out before planting into moist soil.

Plant seedlings at the desired spacing, as deep as possible, either by hand or with a mechanical transplanter. Plant vertically and ensure that the roots are in contact with moist soil (Figures 3 and 4).

Check plants following transplanting to make sure the roots have good contact with soil moisture. If you notice uniform wilting in the early morning on the day following transplanting you may need to "water in" the transplants to ensure survival. Slight wilting in the late afternoon—especially

during warm weather—is common during the first week following transplanting. Tomatoes are aggressive rooters and will survive and root with very limited soil moisture as long as daytime temperatures are not extreme (>85°F).

To minimize weed pressure and maintain a soil mulch, cultivate the soil frequently (every 2–3 weeks) following planting. The first cultivation will typically focus on furrow bottom weed management using a three bar cultivator running sweeps, side knives, reverse disc hillers, and shallow furrow chisels. Once the crop's stems have lengthened enough, use a rolling cultivator to throw dirt into the planted line to smother any



FIGURE 4. Plant tomato start deep into moist soil. Photo: Carolyn Lagattuta



FIGURE 5. Use a rolling cultivator to “hill” or “dirt” tomato plants.
Photos: Martha Brown

newly emerged weeds there (Figure 5). Unless high clearance cultivating tractors are available this cultivation will be the last.

Support system options

Although dry-farmed tomatoes may be grown without support, most Central Coast growers stake and tie their crop in order to increase crop yields, minimize fruit contact with the soil, and make harvest easier.

The following system is used at the UCSC Farm (see Figure 6):

- Once plants reach 1' in height, place untreated 5' wooden stakes a foot deep every 4' (every 2 plants) within the plant row, using a metal t-post every 4th spot for stability.
- Place a t-post at either end of the row at an angle as an anchor.
- Wrap string lines around the stakes starting at 8" above the ground, with a second line placed a foot above the first, and a third a foot above the second.
- Use a “basket weave” system to train the plants between the strings (for a similar system, see www.youtube.com/watch?v=XSf3aSj46jo).

Harvest and post-harvest considerations

Growing ‘Early Girl’ or similar thick-skinned varieties makes harvest easier since the tomatoes resist bruising or damage from handling. Tomatoes can be harvested into 5-gallon buckets; fruit at the bottom of the bucket will hold up under the weight of the tomatoes above them as long as the bucket is handled gently and the tomatoes aren’t overly ripe.



FIGURE 6. A basket weave system using metal t-posts and wooden stakes. Illustration: Laura Vollset

If you grow and harvest heirloom tomato varieties grown in a dry-farmed system, use extreme care during handling since these fruit are generally much more delicate than thicker-skinned varieties. The rest of the discussion below assumes production of small, thick-skinned, red tomato varieties. If you are growing heirloom varieties, please disregard those parts of this discussion that are not applicable to your crop.

For the best eating quality and flavor for direct market sales, harvest mature fruit just at the point where it develops a uniform color on the plant. Orange fruit will ripen to red post-harvest, but the fruit will taste much better when left to mature on the plant.

When harvesting, leave the calyx attached by carefully breaking off the tomato at the abscission zone just above the calyx. This takes some practice but will provide a more pleasing product at the point of sale (see Figure 7). When stacking in the bucket at time of harvest, place the tomatoes so that the stem will not puncture tomatoes as they are added.



FIGURE 7. Dry-farmed tomatoes at UCSC’s farm stand. Photo: CASFS

Transport tomatoes from the field to a shaded packing area for sorting and packing into suitable boxes for transport to market. Never refrigerate tomatoes! They lose flavor quickly at lower temperatures. Tomatoes will hold for up to a week after harvest without refrigeration in a cool, shady place.

For best quality and appearance tomatoes should be sold within a week of harvest. If you need to store them longer prior to sale, remove the calyx at harvest time as it will dry out and reduce the visual quality of the fruit.

‘Early Girl’ tomatoes will hold on the plant for up to a week after ripening even in warm weather, so harvest intervals can be as long as a week; however, every two or three days is optimal once fruit ripens.

Pests and Diseases

Before you select varieties and plant your dry-farmed tomato crop, look up common pests and diseases that affect the crop in your area. Learn about pest and disease life cycles, preventive practices, and possible treatments using resources such as the UC IPM website (ucipm.edu), your county Cooperative Extension offices, ATTRA's Biorationals: Ecological Pest Management Database (www.ncat.org/attra-pub/biorationals), neighboring farmers, and other knowledgeable professionals.

The main tomato arthropod pests in the Central Coast region are:

- Green peach aphid, *Myzus persicae*. Potato aphid, *Macrosiphum euphorbiae*: both green peach and potato aphids spread viruses that severely affect tomato plants.
- Tomato russet mite, *Aculops lycopersici*: mite nymphs suck the life out of plant cells, causing leaves and stems to bronze, dry up, and die.
- Stink bugs. Conspense stink bug, *Euschistus conspersus*. Redshouldered stink bug, *Thyanta pallidovirens* (= *T. accerra*). Sayi stink bug complex, *Chlorochroa sayi* and *Chlorochroa uhleri*. Southern green stink bug, *Nezara viridula*: several stink bugs feed on and damage tomatoes.

The main tomato diseases in the Central Coast region are:

- Late blight, *Phytophthora infestans*: a serious disease that develops rapidly and can destroy an entire tomato field in a few weeks' time.
- Tomato spotted wilt virus (TSWV) in the tospovirus group, spread by Western flower thrip: plants infected with TSWV do not usually produce marketable fruit.

Please see *Organic Pest and Disease Management in Selected Crops on California's Central Coast* in this **Grower Guide** series for additional information on the pests and diseases listed here, and suggestions for their control in dry farmed tomatoes.

ON CALIFORNIA'S CENTRAL COAST,

'Early Girl' and/or 'New Girl' are currently the best tomato varieties for dry farming. 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; this is exacerbated when water is limited or irregular. The symptom is a brown or 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.



FIGURE 8. Advanced damage caused by blossom end rot.

ADDITIONAL RESOURCES

Common misconceptions and key points about dry farming: Case study of dry farmer with more than 40 years experience, by Amy Garrett. Small Farms Program, Oregon State University, 2014. smallfarms.oregonstate.edu/sfn/su14dryfarming

Dry farming. California Ag Water Stewardship Initiative. agwaterstewards.org/practices/dry_farming/

Organic Dry-Farmed Tomato Production on California's Central Coast: A Guide for Beginning Specialty Crop Growers by Jim Leap, Darryl Wong, and Kirstin Yogg-Comerchero, with contributions from Ann Baier and Doug O'Brien. Edited by and Martha Brown and Ann Baier.

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Photo, p.1, left: Carolyn Lagattuta; p. 2: Elizabeth Birnbaum. Icon illustrations, p. 3, Laura Vollset.

Dry farming at Molino Creek Farming Collective. The Water Stewardship Project, Ecological Farming Association. agwater.wordpress.com/dry-farming/

Knock weeds out at critical times, by Mark Schonbeck. eOrganic, 2010. articles.extension.org/pages/18882/knock-weeds-out-at-critical-times

Organic tomato production, by Steve Diver et al. NCAT IP439, 1995, revised

2012. attra.ncat.org/attra-pub/summaries/summary.php?pub=33

Overview of dry farming on the Central California Coast, by Jim Leap. Supplement 4, Unit 1.5: Irrigation, principles and practices in Teaching organic farming and gardening: Resources for instructors. Santa Cruz, CA: Center for Agroecology and Sustainable Food Systems, 2016. casfs.ucsc.edu/about/publications/Teaching-Organic-Farming/part-1.html

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APPENDIX: PRODUCTION SCHEDULE, ECONOMIC DATA

Crop day	# beds (1 bed = .02ac)	Action	work rate (hr/ac)	fixed rate (hrs)	Total labor cost @ \$16.10/hr	Total machine cost @ \$21.70/hr	Harvest Week	% total harvest	Harvest Amt.	Harvest Value	
-25	10	Flail Mow:heavy	2.5	0.2		\$15.19					
-25	10	Spade	4.8	0.2		\$25.17					
-11	10	Mark Lines	2	0.2		\$13.02					
-11	10	List	1.25	0.2		\$9.77					
-11	10	Overhead Ir:set up	3.75		\$12.08						
-10	10	Overhead Ir:run		0.5	\$8.05						
-1	10	Light cultivation	1.25	0.2		\$9.77					
-1	10	Shape/JD 71 Seed/Furrow	2	0.2		\$13.02					
0	5	Transplant:1 line	58	0.5	\$101.43						
11	10	Cultivate	2	0.2		\$13.02					
12	10	Hill	1.25	0.2		\$9.77					
21	5	Trellis:stakes		0.5	\$85.97						
21	5	Trellis:tie up	48.4	0.5	\$85.97						
42	5	Trellis:tie up	48.4	0.5	\$85.97						
63	5	Trellis:tie up	48.4	0.5	\$85.97						
68	10	Harvest x 2 @ 75#/hr	259	1	\$42.50		1	5%	194	\$388.40	
75	10	Harvest x 2 @ 75#/hr	259	1	\$57.80		2	5%	194	\$388.40	
82	10	Harvest x 2 @ 75#/hr	259	1	\$141.20		3	15%	583	\$1,165.20	
89	10	Harvest x 2 @ 75#/hr	259	1	\$182.90		4	20%	777	\$1,553.60	
96	10	Harvest x 2 @ 75#/hr	259	1	\$182.90		5	20%	777	\$1,553.60	
103	10	Harvest x 2 @ 75#/hr	259	1	\$141.20		6	15%	583	\$1,165.20	
110	10	Harvest x 2 @ 75#/hr	259	1	\$99.50		7	10%	388	\$776.80	
117	10	Harvest x 2 @ 75#/hr	259	1	\$57.80		8	5%	194	\$388.40	
124	10	Harvest x 2 @ 75#/hr	259	1	\$57.80		9	5%	194	\$388.40	
150	10	Discx1	0.5	0.2		\$6.51					
-	10	Drill/Cover Crop	1.6	0.2		\$11.28					
				Sub-total:	\$1,429.04	\$126.51			3,884	\$7,768.00	
				Labor + Machine Cost (\$)			Yield				
				Per Block (.2 Acres):			Per Block (.2 Acres):		3,496	\$7,768.00	

Harvest Assumptions	
Harvest (#/acre)	19420
Harvest (#/row')	2,675
Harvest Rate (#/hr)	75
Price (\$/#)	2

Item	Cost per unit	Cost per acre	Notes
Tomato Starts	\$.025/plant	\$90.75	1 line/bed; every other bed; 7260 row/ac
Tomato Stakes	\$3/stake	\$4,356.00	5' grade stakes, 1 stake/5row';
T-posts	\$5/stake	\$1,815.00	6' (every 20'); 363/acre
Twine	\$.002/ft	\$87.12	
Boxes	\$.98/box	\$1,274.00	.98/box; 1300bx/ac
Total Expenses (per acre):			\$7,622.87

Per Acre Totals	
Income:	\$38,840.00
Labor + Machine Cost:	-\$7,777.74
Expenses:	-\$7,622.87
Production Profit:	\$23,362.92

Data reflect direct field production costs and do not include other potential overhead (e.g., water, electricity, land rent).