

ORGANIC FRESH MARKET AND DRY BEAN PRODUCTION ON CALIFORNIA'S CENTRAL COAST: A Guide for Beginning Specialty Crop Growers



Introduction

Fresh market round and flat pod bush beans can be a productive and profitable market crop, as well as a beneficial rotational crop in diverse, small- to medium-scale, mixed specialty crop systems in California.

The primary advantages of beans include their relatively low cost of production until the time of harvest (which requires more labor), as well as a short production window that eliminates a significant amount of financial risk compared to most other vegetable crops. Bush beans can also be grown as shell or dry beans, adding another dimension to a specialty crop grower's product mix.

This guide describes the steps involved in growing bush beans organically with a focus on planting to moisture for weed control, and reviews options for planters to use at various scales.

Features of bush bean production

- Managed well, bean crops grow quickly, form a canopy, and incur little or no labor costs for weed management
- Relatively deep-rooted, efficient nutrient scavengers that require little or no supplemental fertility
- Minimal pest and disease pressures
- Self-pollinate; seed can be easily saved, reducing production costs
- Well suited to drip irrigation, which minimizes water use and reduces soil compaction from harvest crew
- Offers potential for multiple, staggered crops to take advantage of seasonal market prices
- Can be grown as dry beans (allowed to mature) to extend marketing opportunities
- Low crop residue facilitates easy seedbed preparation for subsequent crops or cover crops
- Good crop cover and weed management can significantly reduce weed seed bank and weed pressure in subsequent crops

SUMMARY OF PRODUCTION PRACTICES

Soil type

- Grow well on loamy sands to clay loams
- Sandy loam soils are optimal for maximum production and ease of management
- Soils with low CEC (e.g., loamy sands) may require supplemental fertility

Fertility requirements

- Fall/winter cover crop (bell beans, triticale, vetch)
- Compost, as needed (5–7 tons/acre)

Soil temperature

- Plant when soil temperatures reach 60° F minimum at planting depth

Plants per acre

- Roughly 130,000

Planting technique

- Direct seeded
- Planted to moisture

Bed spacing

- Single line on beds spaced 30–36" center to center for green bean harvest
- Double lines on 40" beds for combine-harvested dry beans

Plant spacing

- Optimum row spacing: 30–36" between seed lines
- Plant spacing: 1.5–2" apart in the seed line
- Single line configuration optimizes mechanical weed management and harvest efficiency.

Planting depth

- 1–1.5" depending on soil type, moisture levels and weather conditions.
- Can be planted deeper (up to 2") on lighter textured (sandier) soils

Irrigation

- Drip tape facilitates uniform water application, saves on water costs, and minimizes both weed and disease pressure

Days to maturity

- Most fresh market round and flat pod bean varieties take 50 days from planting to harvest.
- Dry beans take roughly 4–5 months from planting to harvest, depending on variety. Harvest timing is determined by a balance of maturity and dry down; harvest the beans before the pods start splitting open (shattering).

Harvest

- Irrigate prior to harvest to ensure green beans are turgid (juicy/snappy, not dry/limp)
- Harvest in the morning while temperatures are cool
- Avoid rough handling; pack gently to avoid bruising
- Remove all mature beans from a plant
- Cull (toss out) any broken or damaged beans, and those that have had soil contact

Post-harvest handling

- Avoid over-handling freshly harvested beans; bruising impacts market quality
- Keep harvested beans in a shaded spot to reduce respiration and maintain freshness
- As soon as possible after harvest (within 1 or 2 hours), cool beans with clean water to remove field heat and to keep them fresh and turgid.



PRODUCTION SEQUENCE – SUMMARY

(crop day -25*) In spring, mow cover crop to facilitate breakdown.



(crop day -25) Incorporate cover crop residue.



(crop day -11) Form beds with rolling cultivator or listing shovels.



(crop day -10) Pre-irrigate beds with overhead irrigation (1–1.5"). Wait for dry down and weed emergence.



(crop day -1) Work bed surface lightly with cultivator to terminate weeds, re-form beds, and create "dust mulch" to trap subsoil moisture.



(crop day 0) Direct seed bean seeds with a JD 71 planter (or equivalent).



(crop day 20) Cultivate for weed control using standard 3-bar cultivator with sweeps, knives, and disc hillers.



(crop day 20) Lay drip lines in seed lines.



(crop day 21–30) Cultivate with rolling cultivator when beans are greater than 12" in height to smother weeds in seed line and cover drip line.



Spot weed large flowering weeds.



(crop day ~60) Pick for market quality every 2–3 days, depending on weather and crop development**



Drill cover crop seed prior to fall/winter rains.



Plant successions of fresh market beans approximately every 10 days with a JD 71 planter.



**If growing for dry beans, harvest before seed pods begin to "shatter"

Numbers in parentheses refer to crop day, with crop day 0 = planting day, based on a typical season at the CASFS/ UC Santa Cruz Farm.

Production Practices — Additional Details

Timing

In cooler coastal production areas you can plant beans from April through August, and even into September, depending on the potential for early frost. Because production costs are low (cost of crop failure is not devastating), growers can risk early or late plantings to have beans in the market when supply is lower and prices are higher. Plant beans grown for harvest as dry beans by mid May on California's Central Coast.

In warmer inland valleys it is best to plant early (April and May) while daytime temperatures are relatively moderate. Avoid June and July plantings, since fresh market bean quality and quantity will be significantly reduced when daytime temperatures are much above 95°F (35°C). Beans can then be planted again in the late summer (August and September) to allow for good production until the first frost.

On soils with relatively good water holding capacity, large areas can be bedded, pre-irrigated, and then worked with a rolling cultivator following weed seed emergence. The cultivation will effectively hold soil moisture for 30 days or longer, allowing for successive plantings over time with minimal effort. To ensure harvest continuity for staggered plantings, plant the next round of beans when the prior planting is in the "crook" stage (see below), approximately every 10 days.



FIGURE 1. Planting bean seeds to moisture. Photo: Martha Brown

Planting

When produced on a commercial scale, beans should always be planted to moisture rather than irrigated up. If you plant beans into dry soils and then irrigate them to initiate germination, weed seeds will germinate at the same time as the newly planted beans. In most cases weeds will quickly outcompete the beans and compromise effective weed management. It is not possible to cover labor costs, through sale of the crop, for hand weeding when weed pressure is high. See the publication *Tillage, Bed Formation, and Planting to Moisture* in this **Grower Guide** series for additional details.

When planting to moisture, use a wide "Alabama" shovel mounted on the planter to run ahead and push off the dry dirt on top of the bed. Set the shovel so that it goes deep enough to get into the sub-surface moisture. When set correctly, the shovel leaves a flat "V" pattern down the center of the bed. On most soil types, as long as you can see some slight darkening of the soil that is exposed when the bed top is knocked off compared to the drier surface soil, there should be enough residual pre-irrigation (or rain) moisture in the soil at the bottom of the "V" to initiate germination of the newly planted bean seed. Plant beans at the low point in the middle of the bed to conserve moisture deeper in the soil (Figure 1).

In most cases 1–1.5" is a good planting depth for strong germination, although beans can emerge when planted 2" deep as long as the soil is "loose" and not compacted above the seed. Loose soil above the seed line also limits evaporative loss. When beans seeds all emerge at roughly the same time, you know you have done a good job of planting them.

Note that most bean planters are designed to drop seed into a small trench that is then covered with soil and firmed up with the planter press wheel. Avoid planting when the soil is too wet as the press wheel can create a compacted layer over the seed that dries into a firm crust, which can significantly impede successful bean seed emergence.

Planters

When choosing a tool-bar-mounted planter for larger-scale bean plantings (greater than 1/10 acre plots), select a planter that singulates the seed, has double disc openers that cut deep into the soil (4" minimum), and has a press/tamp wheel. Options include the Clean Seeder TP (www.suttonag.com/clean_seeder_tp.html), the John Deere 71 "flexi" planter (Figure 2;), and the International 185 planter (similar to the John Deere 71) planter. Note that on smaller farms, the cost of this type of planter can be a significant capital expense.

Although no longer available new, the John Deere 71 "flexi" planter is still one of the more common planters used on the Central Coast for planting beans (many parts are still available). It is called a "flexi" planter because it is designed to "flex" or "float" over heavy residue. This design feature makes it an ideal planter for planting beans (and many other large seeded crops) following cover crop incorporation in the spring.

The Clean Seeder TP and John Deere 71 planters have double disc openers that create a very narrow opening in the soil (Figure 2). The seed falls into the opening while the sides of the opening are being held open by the discs. The small trench created by the openers easily collapses once the disc openers pass. The press wheel on the planter firms the soil over the seed and helps to reestablish capillarity, which improves soil moisture movement from lower in the soil horizon. If you question whether there is adequate soil moisture, assess moisture early the next day after planting. Soil moisture typically improves overnight as a result of the light compaction (and improved capillarity) created by the press wheel.

The advantage of double disc openers (common on most grain drills) is that they can easily cut through or roll over residual cover crop or crop residue. In comparison, Planet Jr. planters use a fixed opener shoe, which gathers field trash when used to plant at depths greater than 1 inch. When residual crop residue wraps on a fixed shoe, it pushes soil away from the seed line, causing skips in planting and an uneven surface.

Plate planters such as the Clean Seeder TP-TB, John Deere 71, and International 185 do an excellent job of “singulation” of the bean seed. Driven by the press wheel, the seed plate rotates in the bottom of the seed hopper. The holes in the plate allow single seeds to drop into the hopper cells. The cells rotate over an opening in the bottom of the hopper, and with the help of a “knocker,” drop the seed at a selected spacing as the planter moves through the field.

Planting depth can be adjusted with a rotating cam on the side of the planter, which changes the angle of the press wheel in relation to the disc openers. Seed spacing is set based on the number of holes in the seed plate, as well as gearing, which is easily changed. Select seed plates carefully to match varieties, since bean varieties vary significantly in size and shape.

Germination

When beans germinate, they lift the two seed halves (cotyledons) above the soil surface. This is referred to as “epigeal” germination. The emerging beans will first push through the soil with the stem (hypocotyl) in a “crock” position and then



FIGURE 2. A John Deere 71 “flexi” planter set up for direct seeding bush beans. Photo: Jim Leap

the cotyledons will emerge, followed by the first true leaves as the hypocotyl straightens out following emergence. The early stage of germination when the stem first appears above ground is referred to as “in the crook” (Figure 3).

Emerging beans are very susceptible to heat damage at the soil surface as they push upward. When planting in late summer (August or September for fall production), farmers in warmer inland valleys of California commonly put a “soil cap” on the bean seed line with small disc hillers (Figure 4). The hillers are attached to, and run directly behind the planter to form a small mound of loose soil directly over the seed line. During times of high daytime temperatures, growers dig up the embibed seeds daily until they see uniform radical emergence. They then mechanically knock off the cap. If timing is good, the beans will emerge through the soil during the cool of the evening, thus avoiding the issue of stand loss due to high soil temperatures.

In cooler coastal production areas you do not need to cap the seed lines. However, a very light soil cap (which does not need to be removed) helps keep the soil loose and moist. This can improve ease of emergence and stand uniformity in both extremes—when the soil is either slightly too wet or too dry.



FIGURE 4. Disc hillers create a soil cap over the seed line.
Photo: Jim Leap

Weed control

When soil moisture is optimal, planting to moisture allows the beans to germinate but limits weed germination, as most weed seeds require more moisture to trigger germination compared to the large bean seed. The beans emerge in a small trench in the middle of the bed, where vigorously growing beans will easily outgrow most weeds (Figure 5).

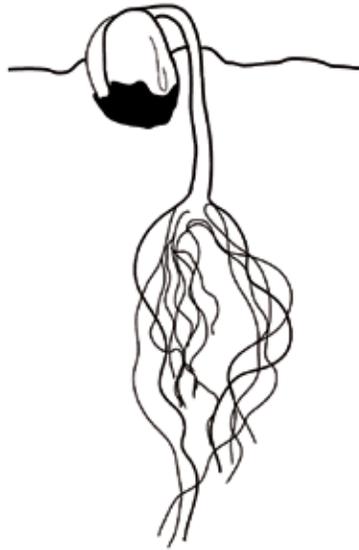


FIGURE 3. An emerging bean “in the crook.” Illustration: Laura Vollset

Let the beans grow as long as possible without irrigation to allow them to root deeply and to minimize weed competition. In most climate zones on soils with decent water-holding capacity, the beans can grow to full bloom before you need to irrigate (see Irrigation, next page).

Once beans are 5–6” tall, do a first cultivation. Use a standard 3-bar cultivator with a set of reverse disc hillers running along each side of the plant line, side knives along the sides of the beds, and sweeps in the furrows. Run small chisels behind the tractor tires to a depth of about 4” to break tractor tire compaction and facilitate subsequent cultivations. This first cultivation will effectively terminate most newly germinated weeds from seed line to seed line. Then lay drip tape along the seed line.

As the beans continue to elongate, use a rolling cultivator for the second—and most effective—cultivation. Properly set, the cultivator will gently return the dirt that was pushed off the bed top at time of planting to the middle of the bed (Figure 6). The bed should end up looking just like it did prior to planting. If bean stems are long enough, this “dirting” cultivation will effectively cover both the drip line and smother any weeds that have emerged in the seed line while covering only the lower stem of the bean plant. This last cultivation, or “dirting,” leading up to harvest is commonly practiced on large acreages of many agronomic crops that are planted to moisture in situations where herbicides are not used. To perform this cultivation successfully requires specific and tightly adjusted implements, and a significant level of tractor skill. As small farms scale-up to mid-sized farms and larger acreages, planting to moisture and dirting can significantly reduce the labor required for weed control.



FIGURE 5. Newly emerged beans in trench.



FIGURE 6. A rolling cultivator re-forms planting beds and “dirts” growing beans, burying the drip lines and any weeds.

Other options for planting and weed management

On small plots (100 bed-feet or fewer), you can easily plant beans to moisture by hand. Pre-irrigate your beds, and use hand tools to take out the newly germinated weeds. Push the bean seed into the deeper moisture by hand. Any subsequent weed growth can be handled with a wheel hoe or hula hoe.

On larger plots (greater than 100 feet), plant beans to moisture with simple tools. Use a rototiller (either walk behind or three-point, mounted behind a small tractor) following pre-irrigation to terminate weeds and form a soil or “dust” mulch. Form a planting trench with a small furrowing shovel mounted on a wheel hoe to access deeper soil moisture. Plant with a Planet Junior push seeder using the general purpose “deep” shoe, or the Jang (clean seeder) large seed push seeder (Figure 7). On this scale, weeds can be managed using hand tools or wheel hoes.

Irrigation

Time the first post-emergence irrigation based on subtle signs of water stress in the bean plants during warmer days—especially later in the day. Pay attention to slight changes in the color of the bean plants: a plant with adequate soil moisture appears dark green; when stressed, the green color shows hints of gray. Following emergence of the first true leaves, water stress will be very evident as a stressed plant tends to push the first true leaves together and upright. These stress symptoms typically show up on field edges where pre-irrigation coverage may not have been adequate, or where soil is more compacted.

Monitor stress daily and (although this can be challenging for many growers) wait as long as possible before the first irrigation to allow for deep rooting, promote early and uniform flowering, and inhibit weed competition.

Apply about an inch of water with the first drip irrigation. Subsequent irrigations should be scheduled using evapotranspiration (Et) data from your local CIMIS station or another sources (cimis.water.ca.gov), and based on the percent canopy of the bean plants at time of irrigation.

Harvest

Fresh market beans are at their best when the seeds inside the pod are still very small and the bean is still tender. Bean pods form quickly; the harvest must be timed well to avoid harvesting any beans that are “over-mature.” On many fresh market “round pod” bean varieties, you shouldn’t be able to see bumps in the pod indicating seed development. Open random beans to check for over-maturation. Another good field test to determine market quality is to break the beans in half—they should break easily (snap) and not bend.

Harvest in the morning when the temperature is cooler. Harvest efficiency is related to the picker’s ability to grab as many beans as possible in a single handful and pull them off the plant with enough care not to break any beans at the stem end. Efficient bean harvest is a fine art that takes a strong back, practice, and fast hands. A good bean picker is able to pick 50 lbs., or roughly two 5-gallon buckets per hour. This rate is only possible when the beans are heavily laden with evenly mature green beans. Sorting beans when harvesting is simply not economically viable.

Depending on variety and uniformity of maturation, a stand of beans can be harvested one, two, or three times. The longer the planting is harvested the greater the likelihood of missing over-mature pods during the prior pick. The over-mature pods from extended harvest need to be sorted out, and this task is simply not economical. When the next succession is ready to go it is time to walk away from the last planting.

Dry Beans

Small scale harvesting and processing of dry beans (.25 acres or less)

Dry bean harvesting for direct market sales (\$4–\$6 per pound) can be easily and economically accomplished with minimal capital investment. The most common method used on the Central Coast to harvest small dry bean plots is to hand cut the entire plant when pods are mature (dry), but not yet shattering (Figure 8), and place them on tarps fully exposed to sun to allow them to continue to dry to the point of shatter.



FIGURE 7. Push seeder.



FIGURE 8. Dry beans ready for harvest. Photo: Elizabeth Birnbaum

Once the pods begin to shatter easily they can be “threshed” by either walking on them or by rolling over them with anything heavy enough to shatter the pod but not so heavy that it breaks the bean seed. Some growers on the Central Coast put the bean plants in burlap bags and drive over them with a light vehicle, such as small field utility “gator.”

Once the beans are threshed, remove the bean plant residue with a pitchfork and collect the beans on the tarp. Sort the beans from the remaining small plant residue by screening (to remove rocks and small dirt clods), and winnowing in the wind or in front of a fan. Simple technologies to streamline this process may include multiple screen sizes in frames that fit over a wheelbarrow. For larger-scale dry bean production (greater than .25 acres), use a small combine or fanning mill-type seed cleaner.

Pests and Diseases

Before you select varieties and plant your bean 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 bean arthropod pests in the Central Coast region are:

- Aphids: Cowpea aphid, *Aphis craccivora*; Black bean aphid, *Aphis fabae*; Pea aphid, *Acyrtosiphon pisum*; Green peach aphid, *Myzus persicae*: suck plant juices, weaken and distort crops, can transmit viruses, may make crop unmarketable.
- Cucumber beetle: Western spotted cucumber beetle: *Diabrotica undecimpunctata undecimpunctata*, Western striped cucumber beetle: *Acalymma trivittatum*: damage can make beans unmarketable.

The main bean diseases in the Central Coast region are:

- Damping off caused by *Pythium* spp., *Fusarium* spp., *Rhizoctonia solani*, and *Thielaviopsis basicola*: causes pre-emergent rot of whole seed, emerging plant, or first true leaves.
- Powdery mildew caused by *Erysiphe polygoni*: severe infestation reduces yield, shortens productive life of plants.

Please see *Organic Management of Select Specialty Crop Pests and Diseases* in this **Grower Guide** series for information on the pests and diseases listed here, and suggestions for their control in beans.

ADDITIONAL RESOURCES

Common dry bean production in California, by Rachel Long et al, 2010. University of California Agriculture and Natural Resources, Publication 8402. anrcatalog.ucanr.edu/pdf/8402.pdf (not an organic guide, but lots of useful information)

How to manage pests: Dry beans
UC IPM, Statewide Integrated Pest Management Program. ipm.ucanr.edu/PMG/selectnewpest.beans.html

Introduction to weed management in a small scale organic production system (video). Produced by the Center for

Agroecology & Sustainable Food Systems. www.youtube.com/user/casfsvideo

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

Organic Bush Bean 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 Martha Brown and Ann Baier.

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Photos, p. 1: Left, Martha Brown; top right, CASFS, bottom right, Fifth Crow Farm. Icon illustrations, p. 3, Laura Vollset.

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