

## Cover Crop Decision Guide for Perennial Cropping Systems

Cover cropping has been found to be an excellent agricultural practice for providing benefits associated with soil health, nutrient cycling and increasing beneficial insects, as well as for solving problems associated with poor field conditions (compaction, runoff, erosion). Most cover crops in California agriculture are grown between tree-rows and vine-rows during the winter months while perennial crops are dormant. Cover crops can then be primarily irrigated by winter rains while also helping to keep valuable precipitation where it falls.

When deciding if a winter cover crop would be a good idea, and how best to implement the practice, it's important to think about a number of factors specific to your situation, including the reasons why you would plant a cover crop. Identifying these key considerations will help you navigate the process of choosing a cover crop that is well suited for your field and management system. To identify your reasons and goals, look through the cover crop decision making table (pgs 2 & 3) for a list of problems that cover crops can help solve, as well as benefits that they can provide. While you'll find growing a cover crop has many co-benefits, we recommend focusing on a maximum of three reasons.

### Thinking through cover cropping in perennial production systems

When planting a winter cover crop in a perennial system, there are a number of options depending on the key considerations listed above as well as your management preferences. The most common cover crops planted in perennial systems fall into two categories:

#### Examples

🌿 Winter **annual green manure mixes**, which are generally planted every year in the fall and terminated in the spring with mowing and/or tillage.



#### Key Considerations

Reason(s) for cover crop *(see table on pages 2 & 3)*

Management challenges: compaction, drainage, weeds, pests, soil health, excess nitrogen

Cropping system

Ground management: tillage or no-till

Irrigation system: drip, furrow or sprinkler

Soil type and characteristics

Local climate: annual rainfall, frost risk

Planting equipment

🌿 Winter **annual re-seeding cover crops**, which consist of clovers, medics and some grasses, and are planted in the fall and managed with mowing (e.g., high mows of alternate rows) into the spring and summer, ideally in a way that allows the cover crop to set seed.

## Why plant a mix?

Over the years, many growers and cover crop experts have found that planting a mix is a great way to hedge your bets and ensure that you'll get a reasonable stand of cover crop, despite seasonal fluxes in weather, differences in soil type, drainage throughout the field, etc. By planting several different species, you'll find that some species will do well one year, and others will thrive the next. Researchers have found that aboveground plant diversity will encourage below ground diversity of soil biology which will enhance nutrient cycling and contribute to soil health. A mix can also encourage a healthier population of beneficial insects, and help to optimize decomposition of the cover crop to ensure that the nutrients are available for the trees or vines to take up. Choosing a mix of multiple cover crop species rather

than just one takes advantage of the different benefits each species can provide in a complementary way. For example, brassicas, which tend to have large taproots, are typically a good choice to reduce compaction, while legumes like bell beans and vetch are excellent for providing nitrogen. Additionally, taking into consideration different growth patterns of cover crop species can lend diversity to a mix that complements rather than competes. For example, upright species such as oats can act as a trellis for vining species like peas or vetch, allowing for both types of plants to contribute significantly to the biomass of a good cover crop stand.

## Tips for getting your cover crop in the ground

- 🌿 **Seed:** Buy the appropriate mix and quantity for the selected planting area, taking into account whether you are planting with a drill or a broadcaster. When ordering your mix, note that the seed weight and proportions will differ based on species and seed size. Consult with your seed dealer to make sure you have the right amount of seed to plant at the recommended rate.
- 🌿 **Inoculant (for legumes only):** This will only be necessary when planting larger-seed legumes. Ask your seed dealer or ag retailer for the appropriate inoculant for the legumes you'll be planting.
- 🌿 **Planting Equipment:** Be sure that you have access to planting equipment to sow your cover crop seed, such as a drill or broadcaster. If you rent equipment, reserve it well ahead of time. Calibrate the equipment for the right seeding rate over your field.
- 🌿 **Timing:** Plant winter cover crops in Northern California between early October and the middle of November. Legumes typically do best if planted by mid-October. Early planting dates are favorable for good germination, but may require more irrigation if fall rains are late.
- 🌿 **Irrigation:** To ensure the cover crop germinates well and creates a good stand, a light irrigation (~2 acre-inches) in perennial crop fall planting is recommended after sowing unless fall rains will occur soon after planting.
- 🌿 **Labor and Management:** Make sure that planting and managing a cover crop is included in your management plan and calendar. Estimate the labor, equipment, fuel use, etc. needed for ground prep, planting and mowing/tillage. Ideally several of these can line up with regular operations.



## I want my cover crop to... solve problems

Goals	Plant Characteristics	Possible Species*	Considerations
<b>Improve infiltration</b>	Plants with deep roots (brassicas, and some legumes) and fibrous root systems (grasses)	<b>Green Manure:</b> triticale, common vetch, mustards. <b>Annual Re-seeding:</b> white sweetclovers, sub clovers, crimson clover, bur medic, 'Blando' brome.	Cover crops improve infiltration by protecting the soil, reducing surface crusting, improving soil structure and providing channels for water to enter the soil. They are especially effective when cover crops are planted densely and managed with mowing.
<b>Reduce compaction</b>	Plants with large taproots and fibrous root systems (brassicas, grasses)	<b>Green Manure:</b> canola, mustards, radishes, woollypod vetch. <b>Annual Re-seeding:</b> sweet clovers, red clover.	If desirable, growers may let mustards and radishes go to seed in orchards and they will likely come back on their own every winter. Daikon and tillage radish are excellent to combat compaction. Grasses can also be effective, especially to reduce compaction from winter traffic. In cases of soil cracking, triticale has been shown to repair cracking in heavy clay soils.
<b>Control erosion</b>	Plants with fibrous roots (grasses)	<b>Green Manure:</b> barley, rye, annual ryegrass, canola. <b>Annual Re-seeding:</b> balansa clover, crimson clover, sub clover, 'Blando' brome, 'Zorro' fescue.	The dense stem growth pattern of sub clover can help slow erosion. Re-seeding annual grasses are frequently planted on hillsides where erosion risk is high. In green manure cover crops, the root systems of grasses, particularly rapidly germinating species like barley, help prevent erosion. To maximize erosion control, reduce or eliminate tillage and manage cover crop with mowing.
<b>Suppress weeds</b>	Plants with vigorous seedlings (grasses, brassicas, perhaps with a legume added)	<b>Green Manure:</b> annual ryegrass, oats, radish, rye, lana woollypod vetch, hairy vetch, field peas, triticale, barley. <b>Annual Re-seeding:</b> white clover.	Rapidly growing grasses can outcompete resident weeds. Radishes and some mustards can develop a canopy that discourages weed establishment; rye, barley and oats also have allelopathic properties. Densely planted cover crops with higher seeding rates are most effective in suppressing weeds. Seed cover crops as soon as possible after ground prep to get a head start on the weeds. Annual re-seeding cover crops can be "high mowed" during dry weather in Jan-Feb (before flowering) to jump-start the cover crop and knock back weeds.
<b>Control soil-borne pests and diseases</b>	Plants that produce toxic compounds (brassicas, some grasses, legumes)	<b>Green Manure:</b> "Nemfix" mustard, canola, rye, barley, oats, radish. <b>Annual Re-seeding:</b> sub clovers, crimson clover.	Brassicas can be used for biofumigation to suppress soil borne pests like nematodes and common root rot. In cases where pathogenic nematodes and microbes are already a problem, find out what type of nematodes are present and be sure that none of the cover crop species you plant are hosts. In any case, cover crop species should be rotated. It's recommended that for nematode suppression cover crop residue is incorporated into the soil immediately after termination.
<b>Control arthropod pests</b>	Plants that encourage beneficial insect populations	<b>Green Manure:</b> phacelia, birdsfoot trefoil, sanfoin, hairy vetch, field peas, canola, radish. <b>Annual Re-seeding:</b> crimson clover, white clover, rose clover, persian clover.	Above ground pests can be managed by increasing beneficial insects (see "provide habitat for beneficials" below). Also consider host-pest relationships specific to each cover crop you plant (e.g., vetches and two-spotted spider mites).

table continued on next page

## I want my cover crop to... provide benefits

Goals	Plant Characteristics	Possible Species*	Considerations
<b>Provide nitrogen</b>	Legumes that form associations with Rhizobia bacteria	<b>Green Manure:</b> vetches, winter peas, fava/bell beans. <b>Annual Re-seeding:</b> sub clovers, red clover, sweetclovers, white clover, crimson clover, berseem clover.	Legumes release N more quickly, while grasses break down and release N slowly. A grass-legume mix has an intermediate rate of N release. Legumes grown for N should be terminated around the onset of flowering, when N fixation peaks. Incorporating cover crops at this time is recommended to maximize availability of cover crop N to the cash crop. In no-till systems where cover crops are mowed and left on the surface, the majority of N will still be available to the cash crop, however a small amount may be lost to volatilization during decomposition. To ensure legumes are fixing N, inoculate the seed before planting.
<b>Build organic matter</b>	A mix of plants that produce high amounts of biomass (grasses, mustards, some legumes)	<b>Green Manure:</b> bell/faba beans, peas, vetches, oats, barley, rye, triticale, common mustard, radish. <b>Annual Re-seeding:</b> sub clovers, red clover, Berseem clover, sweetclovers, crimson clover, zorro fescue, blando brome.	Plants with high carbon-to-nitrogen ratios (grasses) decompose slower than those with low ratios (legumes), so a mix of legumes and grasses is recommended. Organic matter increases from planting cover crops, particularly when combined with no-till and/or compost applications. High seeding rates will yield a dense cover crop stand which may require additional passes to terminate.
<b>Attract pollinators</b>	Flowering plants that provide pollen and nectar (brassicas, legumes, phacelia, other flowering broadleaves)	<b>Green Manure:</b> phacelia, birdsfoot trefoil, sanfoin, hairy vetch, field peas, canola, radish. <b>Annual Re-seeding:</b> crimson clover, white clover, rose clover, persian clover.	Pollinator mixes are most effective when flowering occurs successively throughout the cover crop growing season. You may need to balance the timing of your cover crop termination with the flowering of the plants to get the most out of your mix. A diversity of plant heights and growth patterns is helpful in creating habitat. To maximize the effect of this mix for your perennial system, look into which insects are natural enemies of the pest you're trying to control.
<b>Provide habitat for beneficials</b>	A mix of plants that provide food resources and habitat for laying eggs and/or overwintering (grasses, brassicas, legumes)	<b>Green Manure:</b> common vetch, rye, barley, sweet alyssum, phacelia. <b>Annual Re-seeding:</b> red clover, sweet clovers, sub clovers, crimson clovers.	
<b>Scavenge nutrient</b>	Plants with fibrous roots (grasses) and deep taproots (mustards)	<b>Green Manure:</b> rye, radish, annual ryegrass, barley, oats, canola, annual buckwheat. <b>Annual Re-seeding:</b> Berseem clover.	Most grasses will scavenge N, as will radish and rapeseed.
<b>Supply (spring) forage</b>	A mix of plants that provide a diversity of nutrition to the animal	<b>Green Manure:</b> forage radishes, barley, clover, peas.	Care should be taken in appropriate stocking densities and grazing periods of livestock to avoid compaction. Be sure to check that your mix doesn't include plants that are toxic to the type of livestock you're grazing. High proportions of some legumes may cause digestive problems for livestock.

\*In perennial cropping systems, growers have the option of planting a winter annual green manure cover crop which is usually planted every fall and mowed and/or incorporated in the spring, or planting an annual re-seeding mix, which is planted in the fall and managed in the spring/summer with mowing. These mixes are well-suited for no-till systems and once established additional seed only needs to be planted every 3 to 5 years (this can vary quite a bit). An additional option is to plant green manure and annual re-seeding mixes in alternating rows to rotate cover crops

## Common risks and concerns for winter cover crops

Like all agricultural management practices, the various risks and concerns must be considered when deciding whether or not to grow a cover crop and, if planted, how it ought to be managed. Here, we have outlined some of the key risks and concerns voiced by growers in Northern California, and corresponding strategies that have been used to address these risks.

Concerns	Strategies	Considerations
<b>Residue management</b>	Consider the amount of residue you're comfortable managing: legumes break down faster than annual grasses and brassicas.	In perennial systems, too much residue at harvest is a concern primarily for almonds. Terminating the cover crop in early spring will reduce the amount of residue. For walnuts, harvesting in the fall allows for cover crop decomposition throughout the summer. If grass crowns become fully mature, they can make floor management more difficult.
	Terminate cover crops earlier in spring to allow for earlier decomposition.	
	To speed up decomposition, chop residue into finer pieces prior to incorporation (e.g. flail mow). In drier conditions, overhead irrigation will also speed up decomposition.	
	If mulch is desired, use a sickle bar mower to leave larger plant pieces which will decompose slowly while protecting the soil.	
<b>Getting into the field</b>	If getting into the field in late winter or early spring is important, increasing the proportion of grasses in your green manure mix can help the soil dry out faster.	Generally speaking a cover cropped orchard/vineyard will have less standing water than bare ground floor after a heavy rain event. In years where there are late spring rains, cover crop termination will be delayed by orchard/ vineyard conditions.
	For green manure mixes, increasing the proportion of grasses can help the soil dry out faster.	
<b>Cover crops becoming weeds</b>	Terminate cover crops at the flowering stage to ensure that they do not go to seed if flowering is not desired for pollination or beneficial insect habitat.	Mustard will become a persistent weed in orchards if allowed to go to seed. If this is a concern, terminate at flowering.
	In low-lying wet/ poorly drained fields, avoid planting mustards and wollypod vetch.	
<b>Cover crops hosting pests</b>	If concerned about pathogenic nematodes, make sure the cover crop species you're planting are not hosts to the nematodes that are a problem for your crop.	Like any crop, cover crops can be host to particular arthropod or soil borne pests. For example, mustard can host Lygus. In many cases, however, these pests will not become a pest in the cash crop. Cover crops in no-till trees and vines may provide additional cover and/or forage for gophers.
	Avoid cover crop species that host arthropod pests that are also pests to your cash crop. (e.g. bell beans hosting bean aphid).	
	If increased gopher pressure is a concern, owl boxes around orchards and vineyards can be an effective strategy.	
<b>Additional management or labor</b>	When possible, line up cover crop management operations (ground prep, irrigation, mowing, etc.) with regular field operations.	Growing cover crops in perennial systems will require additional management and labor and should be factored into a grower's management schedule for the year. For growers interested in reducing disking operations, cover crops can be managed successfully with minimum till or no-till by mowing and/or grazing.
	Expect a learning curve: it typically takes more than one season to optimize the efficiency of your cover crop management.	
<b>Water usage</b>	If competition with cash crop is a concern, terminate cover crop early in the spring as soon as field conditions allow.	Cover crops may have both advantages and disadvantages to water use. They do require water to grow, but will also improve water infiltration, which may offset their water use. In arid regions such as the southern Central Valley, cover crops should be carefully selected for dry conditions, terminated early and may require supplemental water.
	Consider planting cover crop species that require less water.	



A young pistachio orchard with cover crop in between the rows.



Paicines Ranch grows cover crops in their vineyards, not only to build soil carbon and feed soil biology, but also to provide forage for sheep which are brought in to graze the cover crop.



Sierra Orchards brings in sheep every year to graze in their organic walnut orchards in order to help manage their cover crop while simultaneously enhancing benefits to the soil.



A field of mustard grows tall in between the walnut trees at Double A Farms. Here the mustard is used to help suppress plant-parasitic nematodes.



Cover crops are typically planted either with a seed drill or by broadcasting the seed. At River Garden Farms, they plant with a Great Plains no-till seed drill which allows them to plant cover crop seed with little to no soil preparation or disturbance.

# Resources for cover cropping in Sacramento Valley and Delta regions of California

While planting cover crops in your management system comes with a host of benefits, there can be a learning curve when first getting started. We recommend reaching out to your local technical assistance providers to work with you on the different steps to successfully implement cover crops into your management systems (seed selection, planting, termination, etc.) and to inform you of available cost share opportunities such as EQIP and CDFA's Healthy Soils program. The Natural Resources Conservation Service (NRCS) works with growers to implement cover crops and a number of other conservation practices through their cost share programs. Local Resource Conservation Districts (RCDs) can also be a great source of information on getting started with cover crops, particularly if you want to learn about programs offered by NRCS. Your local UC Cooperative Extension Advisor may be able to help with integrating cover crops into your specific cropping system. There are a number of seed companies with expertise in cover crop selection and may even have planting equipment you can rent or borrow if you purchase seed from them.

## NRCS Offices:

Colusa: (530) 458-2931  
Woodland: (530) 662-2037  
Vacaville: (707) 448-0106  
Stockton: (209) 337-2124  
Modesto: (209) 491-9320

## Resource Conservation Districts:

Alameda County: (925) 371-0154  
Contra Costa: (925) 269-9190  
Dixon: (916) 425-5669  
Solano: (530) 902-3414  
Suisun: (707) 794-1242  
San Joaquin: (209) 712-1693

## UC Cooperative Extension:

Contra Costa: (925) 608-6670  
San Joaquin: (209) 953-6100  
Capitol Corridor: (530) 666-8143  
Colusa: (530) 458-0570

## Seed Companies:

Kamprath Seed (wholesale): 800-466-9959  
Ag Seeds (retail): (530) 666-3361  
TS&L (retail): (530) 666-1239

## Non-profit Organizations:

Community Alliance with Family Farmers: (530) 756-8518  
National Center for Appropriate Technology:  
(530) 792-7338  
Seeds for Bees / Project *Apis m.* (916) 287-3035

## Written and Online Resources:

[Cover Cropping for Vegetable Production](#) by UC Agriculture and Natural Resources

[Managing Cover Crops Profitably, 3rd Edition](#) by Sustainable Agriculture Research and Education

[Cover Crop \(340\) in Organic Systems](#) by National Center for Appropriate Technology

[Cover Crops Database](#) by UC Sustainable Agriculture Research and Education Program

[Cover Cropping for Pollinators and Beneficial Insects](#) by Sustainable Agriculture Research and Education

[Cover Crop Economics report](#) by Sustainable Agriculture Research and Education

---

## ACKNOWLEDGEMENTS

This guide was created by the Community Alliance with Family Farmers (CAFF) in partnership with The Freshwater Trust  
[www.caff.org](http://www.caff.org)  
[www.thefreshwatertrust.org](http://www.thefreshwatertrust.org)

### Reviewers:

Mark Van Horn, Former Director of UC Davis Student Farm  
Rex Dufour, National Center for Appropriate Technology  
Tom Johnson, Kamprath Seeds, Inc.  
Billy Synk, Project *Apis m.*

This guide was made possible with funding from a Conservation Grant awarded to The Freshwater Trust. *This material is based upon work supported by the Natural Resources Conservation Service, U.S. Department of Agriculture, under number 69-3A75-17-287. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the U.S. Department of Agriculture. USDA is an equal opportunity provider and employer.*

This guide was also supported by the California Climate Investments program





# NOTES