

Cover Crop Decision Guide for Annual 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 over the winter. Cover crops replace a fallow period in annual systems, which allows for cover crops to 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 for your operation 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 annual production systems

When thinking about planting winter cover crops in annual cropping systems, a number of factors should be considered. These include the cover crop growth window, local conditions such as soil type and weather, availability of irrigation to help germinate the cover crop, the type of ground management in the system (tillage vs. no-till), and how the cover crop will fit into the crop rotation.

Examples

🌿 If planting a cover crop after tomatoes and before corn, you may want to prioritize planting a cover crop that will **provide nitrogen** for the corn crop.



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

🌿 If your soil has high organic matter but drains poorly, you might want to plant a cover crop that will **increase water infiltration** such as a stand of grasses and brassicas.

It should also be noted that in annual systems, certain groups of cover crops species are less common to plant, such as clover/medic mixes, which are more commonly seen in a no-till vineyard or orchard. For a more thorough guide to growing cover crops in annual production systems, see UCANR's *Cover Cropping for Vegetable Production*.

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, as well as encourage a healthier population of beneficial insects. Choosing a mix of multiple cover crop species rather than just one helps to take 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. A mix of species that are higher in carbon, such as grasses and brassicas, can be combined with nitrogen-fixing legume species in order to optimize decomposition of the cover crop and ensure nutrients are available for the cash crop. In addition, considering different growth patterns of cover crop species, such as vining species like peas and upright grasses like oats, can lend to a mix that complements rather than competes.

I want my cover crop to... solve problems

Goals	Plant Characteristics	Possible Species*	Considerations
Improve infiltration	Plants with deep roots and fibrous root systems (grasses, brassicas, some legumes)	Triticale, common vetch, mustards	Any cover crop will improve infiltration to some degree by protecting the soil, reducing surface crusting and improving soil structure. Cover crops are especially effective when planted densely and managed with mowing, leaving mulch on the surface.
Reduce compaction	Plants with large taproots and fibrous root systems (brassicas, grasses)	Canola, radishes (Daikon, tillage radish), grasses (rye, barley, wheat)	Canola (and mustards) need to be managed carefully in annual systems to ensure they don't become a weed (by going to seed) or become too fibrous before cover crop is terminated. Radishes are very effective, particularly when left to decompose in place (no-till). Grasses such as rye, barley and wheat can also reduce compaction.
Control erosion	Plants with fibrous roots	Barley, rye, annual ryegrass, balansa clover, canola	To maximize erosion control, reduce or eliminate tillage and manage cover crop with mowing. It should be noted these recommendations are focused on erosion on flat versus hilly land.
Suppress weeds	Plants with vigorous seedlings (brassicas or mix of legumes and grasses)	Annual ryegrass, oats, radish, balansa clover, rye, lana woollypod vetch, hairy vetch, field peas	Rapidly growing grasses can out-compete resident weeds. Radishes and some mustards can develop a canopy that discourages weed establishment. Increase seeding rate to effectively suppress weeds using a mix with a high proportion of grasses and brassicas.
Control soil-borne pests and diseases	Plants that produce toxic compounds (brassicas, some grasses, legumes)	"Nemfix" mustard, canola, rye, barley, radish	A diverse cover crop mix will encourage a diversity of soil microorganisms that may help suppress soil diseases. Mustards and some brassicas may suppress pathogenic nematodes and soil-borne diseases, and should be terminated before full flowering. Check that your cover crop is not a major host of a pest or disease that may affect your following crop.
Control arthropod pests	Plants that encourage beneficial insect populations	Common vetch, rye, barley, sweet alyssum, phacelia, buckwheat, bell beans	Aboveground pests can be managed by increasing beneficial insects (see below). Certain cover crops can host arthropod pests (e.g. bell beans and certain aphid species).

table continued on next page

I want my cover crop to... provide benefits

Goals	Plant Characteristics	Possible Species*	Considerations
Provide nitrogen	Legumes	Lana woolypod vetch, purple vetch, common vetch, winter peas, fava/bell beans	Incorporated legume stands release N quickly; 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 begins to decline rapidly. To ensure high N fixation, inoculate seed prior to planting. Decomposition of grasses can cause a temporary N deficiency for 2-4 weeks after termination; consider adding an N source during this period.
Build organic matter	A mix of plants that produce high amounts of biomass (grasses, mustards, some legumes)	Oats, barley, rye, triticale, bell/faba beans, peas, purple vetch, common vetch, lana woolypod vetch, common mustard, radish	Plants with high carbon-to-nitrogen ratios (grasses) decompose more slowly 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.
Attract pollinators	Flowering plants that provide pollen and nectar (brassicas, legumes, phacelia, other flowering broadleaves)	Phacelia, birdsfoot trefoil, buckwheat, sanfoin, hairy vetch, field peas, canola, radish	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. In situations where there isn't sufficient time to let plants flower, consider planting a pollinator mix on a field border. A diversity of plant structures is helpful in creating habitat. To maximize the effect of this mix for the following cash crop, look into which insects are predators to the pest you're trying to control.
Provide habitat for beneficials	A mix of plants that provide food resources and habitat for laying eggs and/or overwintering (grasses, brassicas, legumes)	Common vetch, rye, barley, sweet alyssum, phacelia, bell beans	
Scavenge nutrient	Plants with fibrous roots (grasses) and deep taproots (mustards)	Cereal rye, radish, annual ryegrass, barley, oats, canola, phacelia	In certain cases, you may want a cover crop that can take up residual nutrients such as nitrogen and make these available for the next crop. Most grasses will scavenge N as well as radish and rapeseed.
Supply (spring) forage	A mix of plants that provide a diversity of nutrition to the animal	Forage radish, barley, oats, triticale, sanfoin, clover, some legumes	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.

*In annual cropping systems, cover crops are typically planted as winter annual green manure mixes which are planted in the fall and mowed and/or incorporated in the spring. The possible species listed for this table would be included in green manure mixes.

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
Residue management	Consider the amount of residue you're comfortable managing when deciding on your mix: legumes break down faster than annual grasses and brassicas.	In annual systems, the cover crop should have ample amount time to decompose before planting the following cash crop (typically two to three weeks after incorporation).
	Terminate cover crops earlier in the spring to allow for earlier decomposition.	
	To speed up decomposition, chop residue into finer pieces prior to incorporation (e.g. flail mow). In dryer conditions, overhead irrigation will also speed up decomposition.	
Getting into the field	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 field will have less standing water than a fallow field after a heavy rain event. Late spring rains can delay cover crop termination due to field conditions, thereby delaying the planting of the next cash crop. Note that grass crowns can be difficult to incorporate in spring — you may consider an implement like a v-blade plow to undercut over-grown crowns.
	In annual systems, if a green manure cover crop stand is holding a lot of moisture in the biomass, disking may be more effective than mowing.	
Cover crops becoming weeds	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.	In some annual production systems, mustards are avoided altogether so there is no risk of them becoming weedy. Wollypod vetch may also be avoided as it produces hard seed which will persist in a field a long time if allowed to go to seed.
	In low-lying wet/poorly drained fields, avoid planting mustards and wollypod vetch.	
Cover crops hosting pests	Brassicas can host certain pests and diseases of cruciferous crops (e.g. flea beetle, bacterial leafspot) and should be carefully managed in rotations with other crops in the brassica family.	Like any crop, cover crops can be host to particular arthropod or soil borne pests, but in many cases, these pests will not become a pest in the cash crop. As a rule of thumb, avoid planting cover crops that are in the same family as your cash crop.
	If you are 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.	
	Avoid cover crop species that host arthropod pests that are also pests to your cash crop. (e.g. bell beans hosting bean aphid).	
Additional management or labor	When possible, line up cover crop management operations (ground prep, irrigation, mowing, etc.) with regular field operations.	Growing cover crops in annual systems will require additional management and labor and should be factored into a grower's management schedule for the year. For growers interested in no-till systems, cover crops can be managed successfully using roller crimpers and no-till planters.
	Expect a learning curve: it typically takes more than one season to optimize the efficiency of your cover crop management.	
Water usage	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 particularly arid growing regions such as the southern Central Valley, cover crops are generally not recommended.
	Consider planting cover crop species that require less water.	

Tips for getting your cover crop in the ground

- 🌿 **Seed:** Buy the appropriate mix and quantity for the selected planting area. This will be influenced by your planting method, i.e. drill or broadcast. 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):** The correct Rhizobium inoculant is necessary for N fixation to occur. Purchase the appropriate inoculant for the legumes you'll be planting and store it properly to maintain viability before use. Some small seeded legumes like clovers can be purchased with a pre-coated inoculant.
- 🌿 **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. Allow at least two to three weeks for incorporated residue to decompose before planting the following cash crop.
- 🌿 **Irrigation:** To ensure the cover crop germinates well and creates a good stand, a light irrigation (8 -12 acre-inches for earlier planting in annual system) 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.





Diverse Mix

Choosing to plant a diverse mix of cover crops helps ensure that you will get a reasonable stand of cover crop, despite seasonal fluxes in weather, differences in soil type, drainage throughout the field, etc.



Transitioning from one seasonal crop to another

Cover cropping in annual systems provides benefits as farmers transition from one seasonal crop to another. At The Collins Farm, a diverse mix of different species is planted in order to help increase nitrogen and carbon content in the soil.

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 for successfully implementing 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 that have 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
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 Innovation 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