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Growing Cover Crops in Alaska

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What is a cover crop?

A cover crop is a crop that is planted to occupy soil that would otherwise be fallow (bare), but is not intended to provide a harvested crop product. Cover crops feed the soil and protect the ground surface in between cash crop production seasons, or in bare spaces (such as between garden beds or on field edges).

Cover crops can be planted in small areas or across large acreages, and can consist of a single species or a mix of many species. Planting a cover crop is a good way to conserve and build soil health and enhance the agricultural ecosystem. The practice offers benefits and risks.

Alternative and related terms for cover crop

Ley crop & catch crop: Synonymous with cover crop

Companion crop & intercrop: Cover crops that are planted within or between the cash crop rows and are allowed to grow alongside the cash crop

Green manure: Cover crop that is tilled into the ground after a period of growth

Fodder & forage crop: Cover crop that is grazed by livestock or harvested for livestock feed

Benefits of cover cropping

Many benefits of a cover crop relate to enhancing and protecting the soil, which in turn improves the land's ability to support healthy crop production for many years. Specific soil-related benefits include:

- **Erosion prevention**: Soil is a limited resource, and is subject to loss and degradation at faster rates than it can be regenerated. Wind and water are primary agents for moving soil. Cover crop roots, leaves and stems reduce the ability for soil particles to become suspended in wind and water, and moved off site. They also protect the soil surface from the impact of heavy raindrops and overhead irrigation, which can dislodge soil particles and make them susceptible to traveling. Dead cover crop residue that is left behind after a season will continue to provide these benefits until the soil is cultivated and seeded.
- **Compaction relief and water storage:** Plant roots are helpful in breaking up compacted soil and creating pockets and channels in the soil, which are critical for storing water and allowing air and water to pass through the soil. The soil structure created by plant roots is more effective at enhancing soil water storage than tillage and fallow (Basche & DeLonge, 2017), and a loose, crumbly soil is also ideal for supporting plant growth and habitat for other soil critters.
- **Nutrient retention:** If plant nutrients are free in the soil, they face the risk of being lost, through leaching (downward movement with water) or volatilization (escape to the atmosphere in gas form). If nutrients are stored inside plant and microbial tissues, they are retained in the shallow soil and root zone where they can cycle through the plant-soil system. Cover crops help to capture free nutrients in the soil

and secure them; the nutrients are then released as the cover crops decompose, similar to slow-release fertilizers. In addition to scavenging nutrients, some cover crops have associations with beneficial bacteria (e.g. rhizobia), which capture nitrogen from the atmosphere and convert it to plant-available form. Likewise, most plants associate with beneficial fungi (e.g. mycorrhizal fungi), which are skilled at accessing and sharing forms of phosphorus that are not available to plants on their own. Once these nutrients are secured by the microbes and cover crops, they can cycle through the soil-plant system to feed subsequent crops.

- **Carbon storage:** All plants convert carbon dioxide in the atmosphere into the building blocks of their bodies, through the process of photosynthesis. Some of that carbon is sent belowground into roots and out into the soil in molecular form. When plant tissues die, the carbon in those tissues provides food and energy for soil organisms (like microbes and worms). Plants are like a conduit for channeling carbon from the atmosphere into the soil. Once in the soil, carbon participates in many aspects of soil health.

- **Biodiversity preservation:** Agricultural systems tend to support lower biodiversity than natural areas, and we know that ecosystems benefit from higher biodiversity, so it is in our best interest to create opportunities for diversification in agricultural lands. While cash crops tend to be planted in monocultures, we can use cover crops to increase biodiversity, either alongside monocrops, or in adjacent seasons. In addition to increasing the number of plant species, cover crops provide food and habitat for pollinators, surface-dwelling critters, and belowground organisms.

- **Disease suppression:** Plant pathogens (diseases) can accumulate in the soil if they have a host plant present year after year. The concept of crop rotation aims to disrupt disease life cycles by creating a break in host availability. Cover crops can also accomplish this if they are not a host for a disease. Some brassica species (such as canola) are also known to produce volatile antimicrobial compounds, which can have a sterilizing effect on the soil (Hansen et al., 2019).

In addition to the soil benefits, cover crops offer additional services:

- **Weed suppression:** Weedy plant species take advantage of bare ground, and once established, they can be persistent competitors with cash crops. Weed management should aim to reduce weed growth and seed production in soils intended for crop production. Cover crops can be effective at reducing weed pressure in two ways: (1) by occupying space that would otherwise be occupied by a weed, and (2) by producing chemicals (called allelochemicals) that inhibit neighboring plant growth. The ability for cover crops to battle weeds in these ways depends on the species and how well they establish and grow.

- **Pollinator resources:** Flowering cover crops provide pollen and nectar to bees, butterflies, flies, birds, and other pollinators, which supports their populations. Cover crops can also attract pollinators to farms and gardens where they can also pollinate nearby cash crops.

- **Potential economic gain:** While there are costs associated with growing a cover crop, the benefits listed above may lead to economic gains (Snapp et al., 2005). It is difficult to assign a dollar value to many of the benefits listed above; however, the benefits may ultimately lead to reliable, low input, environmentally-friendly production of healthy cash crops (Schipanski et al., 2014). Cover crops may provide value in alternative forms, such as in animal gains (when the cover crop is used as a forage) or in honey production. Certainly, the economic value of growing a cover crop depends on its unique situation.

Many of these benefits fall into the category of being "ecosystem services," which are critical jobs that nature does for us. Studies have demonstrated that as plant biomass increases, the plant's contribu-

tion to ecosystem services also increases (Finney et al., 2016). Of course, the extent that a cover crop provides an ecosystem service depends on many factors. There is a lot to learn about how biomass correlates with the ecosystem services listed above in Alaska environments, but it is an important concept to keep in mind.

Risks of cover cropping

As with any management practice, cover cropping offers risks in addition to the benefits. Before attempting to grow a cover crop, it is important to recognize the risks and decide if the expected benefits outweigh the potential risks.

- **Nutrient tie up:** One benefit of cover crops is that they scavenge and capture nutrients from the environment and incorporate them into their biomass, which prevents loss. Once in plant tissues, nutrients will not be available to cycle through the soil-plant system until they are released through the process of decomposition. Some studies have shown that nitrogen secured in cover crop biomass may not be immediately available for cash crop uptake (Kuo and Sainju, 1998; Starovoytov et al., 2010). The rate of nutrient release from cover crop biomass depends on the plant species, with green leafy cover crops decomposing faster than mature grass cover crops.

- **Excess water use:** Plant species differ in their demand for water. Especially for cover crops that are grown for the full season, or during dry periods of the year, they may deplete water stored in the soil profile. Removing excess water from the profile may be a goal of cover cropping (such as in swampy areas), but if not, it is important to monitor soil moisture levels to avoid robbing a future crop of stored water. Of course, this risk is lower in areas with adequate precipitation and irrigation.

- **Weed management interference:** A cover crop should never compromise a weed management program, but rather complement it. Anticipating that weeds will likely emerge from within a cover crop stand, it is worth the time to develop a plan for managing weeds within a living stand and after the cover crop phase has ended. In addition, cover crop species should be selected with the intention that they will not persist as weeds in subsequent crops. For example, it is risky to allow a grass cover crop to set and shatter seed prior to a small grain cash crop phase, as volunteer cover crop seeds can contaminate the small grain harvest.

- **Pest and disease attraction:** Just as cover crops can attract beneficial insects and provide food and habitat for small critters, they can also beckon some problematic and nuisance species. This is a trade-off of increasing biodiversity in the agriculture system. Cover crops may host diseases and root maggots, and they provide adequate food and shelter for slugs. If any of these species are persistent threats in your operation, it is worth designing some strategies to minimize these risks as you develop a cover crop plan.

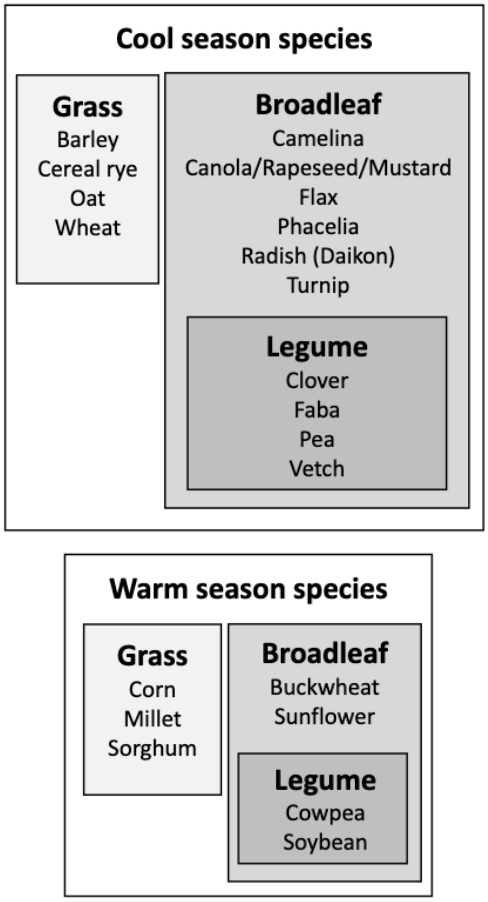
- **Potential economic loss:** Just as there is a chance to improve the farm enterprise budget with cover cropping, there is a chance to experience loss (Snapp et al., 2005). Seed and input costs of cover cropping are rarely immediately recovered through soil benefits. Furthermore, a cover crop stand may die prematurely due to a number of factors (poor germination, unfavorable weather patterns, or pest pressures). Cover cropping requires an investment mentality, where benefits will be realized over time.

Selecting a cover crop

Many plant species can be used as cover crops, and deciding which species to include can be overwhelming. Each plant species fills a unique set of roles in the environment, so a solid approach to cover crop selection is to first identify what goal you want to achieve with the cover crop.

Annuals, biennials, and perennials can all serve as cover crops, but this publication only focuses on annual species. The chart below can help you decide on some species that fill specific roles.

A few additional considerations that go into selecting species and designing a mix:



If your goal is to ...	Then try ...
Break up compaction	Rapeseed, radish, turnip, sunflower
Fix nitrogen	Legumes
Prevent erosion	Grasses, pea, radish, buckwheat, flax
Support pollinators	Mustard, phacelia, radish, buckwheat
Support beneficial soil fungi	Flax, grasses
Control weeds	Cereal rye, camelina
Produce a green manure	Pea, buckwheat, radish, clover
Grazing	Pea, grasses, turnip, radish clover
Harvest for hay, haylage or silage	Grasses
Scavenge nutrients	Cereal rye, oat, radish, flax, buckwheat
Use excess water	Cool season grasses
Grow biomass quickly	Pea, radish, buckwheat, oat
Support for driving and walking surfaces	Cereal rye, clover

Figure 1: *Roles of different cover crop species. Some potential cover crop species are listed and grouped according to their seasonality and growth type. Use the table to identify species that meet specific cover cropping goals.*

- **Keep the species list simple:** In many cases one to three species will be sufficient for providing a nice set of benefits, while also being affordable and practical. If too many species with overlapping roles are grown together, they may compete with one another.
- **Think about plant architecture:** Do you want a plant that grows tall and upright, or something that spreads outward and stays low to the ground? Select species that are compatible with one another, with the space they'll be occupying, and with neighboring land use.
- **Start small:** If you have not grown some of your selected species before, and you aren't sure how they will behave on your land and in your climate, keep the initial effort small. As you become more familiar and comfortable with growing cover crops, you can increase the acreage and mix complexity.

Caring for a cover crop

Soil preparation and seeding

Seeding a cover crop follows the same principles as direct seeding other crops. The seed needs favorable temperatures and soil moisture to germinate and it needs to be in direct contact with the soil. In beds and fields that have been tilled, the seed can be broadcast and raked for incorporation, or it can be placed with seeding equipment.

In areas that have not been tilled, no-till seeding implements should be used.

In most cases, we want to keep cover crop input costs and labor to a minimum, but we also want to provide favorable conditions so that the cover crop grows and does its job. Many common cover crop species are selected because they are hearty and don't need a lot of care or special growing conditions.

We want to encourage the cover crop to scavenge and capture soil nutrients, so we don't recommend adding fertilizer unless it is absolutely necessary, such as in a severely depleted soil. Likewise, if the soil pH is excessively low (less than 5.5) or high (greater than 8), you may consider amendments that correct the pH. A soil test prior to seeding can help guide the need for soil amendments that will benefit the cover crop and subsequent cash crops.

If your cover crop mix includes legumes (peas or clovers), you may consider adding a rhizobia inoculant, which will help the plant form a beneficial relationship with soil bacteria and capture nitrogen. Inoculants can be purchased from farm and garden supply retailers and seed companies.

Ensure that you order an inoculant that is compatible with the species of legume that you will be seeding. Some legume seeds are sold and packaged with the inoculant already applied to the seed.

Many garden seed retailers offer cover crop seeds and mixes. Some larger seed companies specialize in cover crop seed, and they offer a variety of pre-made mixes as well as custom mixes. Their websites are excellent sources for learning more about specific roles of different cover crop species, as well as estimating seeding rates, planting depths, germination temperatures, and other agronomic details.

Alternatively, leftover farm, garden, or flower seeds may also provide a sufficient cover crop mix. If you happen to have older seeds and the species meet your cover cropping goals, put them to use!

Seeding rates and optimum seeding temperatures should be provided on the seed packet or by the supplier. See the table of seeding rates that have been successful for some cover crop species grown in Southcentral and Interior Alaska. The timing of seeding depends on your goals and your cash crop schedule (see Figure 2), but generally, the best time to plant a cover crop is whenever you can.

Species common name	Seeding rate (lbs/ac)	Seeding rate (oz/sq-ft)
Clovers	15	0.006
Pea	100	0.037
Buckwheat	50	0.018
Flax	40	0.015
Phacelia	5	0.002
Canola, camelina, mustard, rapseed	5	0.002
Radish	8	0.003
Barley, cereal rye, oat, wheat	80	0.029
Sorghum	10	0.004

Table 1: *Cover crop seeding rates. Recommended seeding rates for individual cover crop species grown in Alaska. Seeding rates should be adjusted if the species are included in a mix. The total rate for a mix can range from 15 lb/ac to over 30 lb/ac, depending on the seed identities and sizes.*

In-season management

As with soil preparation, in-season management for cover crops should be low maintenance. In very dry seasons, supplemental irrigation may be necessary to keep the cover crop alive. Despite our efforts to encourage the cover crops to outcompete weeds, they may still emerge within a cover crop stand.

Managing weeds in a cover crop is especially challenging because methods that terminate weeds are also likely to terminate the cover crop. For small acreages, hand-pulling weeds or removing their flowers and seed heads may be the best option. For larger acreage, cultural and chemical weed management strategies may be necessary. Maintaining

Cover crop opportunity		May	June	July	Aug	Sept
Full season		X	X	X	X	X
Early season		X	X	X		
Late season				X	X	X
Shoulder seasons	Year 1				X	X
	Year 2	X				

Figure 2: *Cover crop opportunity based on season.*

Full season: *Plant a cover crop in the spring to occupy fallow land through the season. This duration will produce the most biomass, and some species may produce seed. Unless terminated early, the cover crop will winterkill.*

Early season: *Precede a late-season cash crop succession with a fast-growing cool season cover crop. This will need to be planted as early as possible and terminated by tillage, spraying, roller-crimping, tarping, mowing or grazing.*

Late season: *Follow an early harvest with a fast-growing cover crop. Unless terminated early, the cover crop will winterkill. Aim to seed the cover crop in mid- to late-July.*

Shoulder seasons: *Plant winter annual cover crops in the fall to establish protective cover. Winter annuals will re-emerge early in the spring to provide cover prior to planting a crop. The cover crop will need to be terminated with tillage, grazing, spraying, roller-crimping, mowing or tarping.*

a weed-free seedbed is important in all cultivated lands, and should be a top consideration when designing a cover crop plan.

Cover crops as feed and forage

Animal feed and forage production may be a primary goal of cover cropping, or it may be an added benefit, to be used as needed. The integration of animals into a cover cropped system has been known to enhance soil benefits and economic gain (Kelly et al., 2021).

This section focuses on a few considerations for grazing and harvesting cover crops, but please recognize that the topic deserves more detailed study of animal nutrition and feed quality.

In general, the best cover crop varieties for feed and forage allocate more biomass to leaf growth, rather than growth of roots, stems, tendrils, or seeds. If the cover crop will be grazed, select fast-growing, cool-season species such as forage peas, forage turnips, radish, clovers, and spring cereal grains (oats, barley, wheat, or triticale).

Cover crop suppliers offer grazing mixes and wildlife food plot mixes that include these types of species. If the cover crop will be harvested for hay or haylage, the mix should include fewer leafy green species and more grasses, as big green leaves contribute too much moisture to the hay mix. Interior Alaska's summer heat can support vegetative growth of warm season grasses, such as sorghum and millet. Creative mixes that include both cool and warm season species may offer both a hay crop and a post-haying grazing opportunity.

Grazing and haying are both methods of terminating a cover crop. Any growth that occurs after these operations will likely be subject to winterkill. Stubble, plant residues, and animal wastes left behind will also provide protective soil cover through the winter and windy shoulder seasons.

Cover crop termination

In Alaska, it is likely that most annual cover crops will die during winter, but there are other options for killing a cover crop if it needs to be terminated during another time of year. Annual cover crops can be mowed or hayed, tilled into the soil, roller crimped with specialized equipment, tarped, grazed, sprayed with an herbicide, or any combination of these methods. Depending on your goals, you may need to monitor cover crop growth and terminate it before it becomes a problem. For example, if you plant a cover crop in a garden bed in June with the goal to condition the soil for vegetables the following year, you want to ensure that the cover crop produces enough biomass to cover and protect the soil, but does not excessively dry out the soil or create too much residue to slow spring warm-up and interfere with vegetable planting. If a satisfactory amount of biomass is achieved, you may consider terminating the cover crop in August, well before a hard frost. Similarly, if a cover crop produces seed, you should expect to see that species emerge in the future. To prevent self-seeding, terminate the cover crop before it produces mature seed.

Final thoughts

Using a cover crop to enhance your agricultural ecosystem requires thought, planning, and a willingness to experiment. There is not a prescription or single approach to growing a successful cover crop. Furthermore, soil management is a long-term goal, requiring the perspective that each year is a learning experience and a step toward long-term sustainability. Each year is also an opportunity to try something new and adjust approaches that you've tried in the past.

Researchers at the University of Alaska Fairbanks Agricultural and Forestry Experiment Station and Cooperative Extension Service have active and ongoing projects evaluating the benefits, risks, and agronomics of cover crops for Alaska farms and gardens.

Connect with us through your local Extension office or online to learn about the latest cover crop recommendations and to share your adventures in cover cropping.

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