

Cover Crop Handbook:
A Guide to Using Buckwheat, Sunn Hemp, and Oats
as Cover Crops in Hawai'i

O'ahu Resource Conservation & Development Council
And
Crop Care Hawai'i, LLC

In cooperation with
University of Hawai'i College of Tropical Agriculture and Human Resources,
UH Department of Plant and Environmental Protection Sciences
USDA Natural Resources Conservation Service
Hawai'i Agriculture Research Center

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Sunn hemp cover crop demonstration site, central O'ahu

Introduction

Much of the information in this handbook comes from a study done by the O'ahu Resource Conservation and Development Counsel (RC&D) and Crop Care Hawai'i, LLC, with help from the University of Hawai'i College of Tropical Agriculture and Human Resources (CTAHR) and Department of Plant and Environmental Protection Sciences, the USDA Natural Resources Conservation Service (NRCS), the Hawai'i Agriculture Research Center (HARC), and the many farmers who participated in the study.

The study, *Advancing the Adoption of the Cover Crop Technology using Sunn hemp, Oats, and Buckwheat in Commercial Rotational Crops in Hawai'i*, involved 14 large scale (6 acre) demonstration plantings of the cover crops buckwheat, sunn hemp, and oats, alone and in combination, with a bare ground fallow field as a control. Demonstration plots were planted on the islands of O'ahu, Kaua'i, Maui, Moloka'i, and Hawai'i on farms growing such diverse crops as papaya, pineapple, sweet potato, organic vegetables, short term row crops, coffee, seed corn, and tomatoes. Soil and tissue samples were taken before planting and after establishment and measured for nutrients. Weed growth, erosion, and nematode counts were also observed, along with signs of beneficial insect attraction and pest resistance. Yield of subsequent cash crop plantings was also measured for some sites.

Because demonstrations included only one cover crop planting, much of the data, though showing general trends, was inconclusive. In order to provide more complete information, this handbook also includes information and results from other studies done by CTAHR and NRCS and compiled on CTAHR's website (<http://www.ctahr.hawaii.edu/sustainag/cc-gm/index.html>).

What are Cover Crops?

- Non-cash crops
- Limited maintenance
- Mostly legumes, grasses and grains
- Excellent weed control
- Good erosion control
- “Green manure”
- Attract beneficial insects

Cover crops are non-cash crop plants that farmers grow in order to cover and improve the soil, suppress weeds, and attract beneficial insects.

Cover crops are non-cash crop plants that are planted by farmers to cover and improve the soil, suppress weeds, and attract beneficial insects. Certain cover crops, especially those in the legume family, are high in nitrogen and provide extra nitrogen to the soil that can be taken up by the succeeding crop, in some cases replacing synthetic fertilizers as a nitrogen source. Other cover crops take up and recycle excess nitrogen that the cash crop cannot or does not use, thereby preventing excess nitrogen from leaching into soil and surrounding waterways. Cover crops can also be tilled into the soil and thereby provide additional biomass, or “green manure”, which



Sunn hemp being used for weed suppression in a pineapple field, Maui

Increases the level of organic matter in soil. Increasing organic matter may increase microbial matter which then helps to make nitrogen more available to cash crops and may also utilize additional carbon. Cover crops with deep roots improve soil structure by allowing for greater percolation and soil tilth.

Cover crops grow quickly and generally do not need much, if any, irrigation. They out-compete weeds and reduce the need for herbicides. Cover crops can also attract beneficial insects such as predatory wasps, tachinid flies, and reduce pests such as nematodes. Attracting beneficial insects and reducing pests can limit the need for pesticides and is especially useful for organic farming.

Cover crops are an excellent erosion control tool. Erosion begins when rain or wind detaches soil particles and the particles are then transported from their original location. Cover crops protect against erosion by covering the soil and dispersing the rain or preventing wind from reaching the soil. At the same time cover crops can increase the soil’s capacity for infiltration so more water can be absorbed in the field rather than running off.

What kinds of cover crops are used in Hawai'i?

Buckwheat (*Fagopyrum esculentum*)

- Annual grain
- Broadleaf
- White flowers
- Shallow fibrous roots surrounding longer taproot
- Grows between 2 and 5 feet high
- Fast-growing (establishes in 7 to 10 days)
- Grows year-round in Hawai'i
- Tolerates low fertility and acidic soils (pH 4-6)
- Will wilt temporarily during the heat of the day, but does not tolerate shade
- Increases phosphorous availability in soil



Buckwheat is a fast growing grain that suppresses weeds and attracts beneficial insects.



Sunn hemp is a tall legume that adds nitrogen to the soil.

Sunn Hemp (*Crotolaria juncea*)

- Annual legume
- Simple elliptical leaves 2.5 to 5 inches long
- Bright yellow flowers
- Thick fibrous stem
- Long taproot with fibrous lateral roots
- Grows 4 to 6 feet high with branches at 2 feet
- Fast-growing (establishes in 7 to 10 days)
- Grows year-round in Hawai'i
- Grows well by itself and in combination
- Increases nitrogen availability in soil
- Drought resistant

Oats (*Avena sativa*)

- Annual grass
- Long thin leaves
- Shallow fibrous roots
- Grows 2 to 5 feet in height
- Fast-growing (establishes in 7 to 10 days)
- Grows year-round in Hawai'i
- Grows well by itself and in combination, especially with legumes
- Tolerates low fertility soils
- Takes up and stores excess nitrogen
- Produces allelopathic compounds that suppress weeds



Oats establish quickly, provide weed suppression, and add organic matter to the soil.

Other potential cover crops that have been used in Hawai'i

Other cover crops commonly used in Hawai'i include perennial peanut, rye, mung bean, cowpea, and many others. Information on them can be found on University of Hawai'i's CTAHR website (www.ctahr.hawaii.edu).

What are some of the benefits and drawbacks of specific cover crops?

Buckwheat

Advantages

No to low maintenance. Only maintenance is plowing under or seed harvesting and possibly irrigation. If planted before the rainy season, no irrigation required.

Weed suppression. Growing buckwheat greatly reduces weed growth on fields.

Quick establishment. Time to establishment is approximately 7 to 10 days.

Attracts beneficial insects. Buckwheat flowers produce nectar, which attracts pollinators and other beneficial insects.

Reduces soil erosion. Soil is held in place by fibrous roots, keeping rain from eroding away valuable topsoil.

Good topsoil conditioner. Roots keep soil from compacting as it does when left bare.



Buckwheat flowers provide habitat for pollinators and other beneficial insects.

Disadvantages

Nematodes. Some varieties of buckwheat may attract root-knot nematodes so it is advised to not use buckwheat as a cover crop in areas where there is a known nematode problem.

Sunn hemp

Advantages

No to low maintenance. Only maintenance is plowing under or seed harvesting and possibly irrigation. If planted before the rainy season, no irrigation required.

Quick establishment. Time to establishment is approximately 7 to 10 days.



Nodules on sunn hemp roots store nitrogen.

Weed suppression. Growing sunn hemp greatly reduces weed growth on fields.

Reduces soil erosion. Fibrous roots are good at keeping valuable topsoil in place during rain events.

Adds nitrogen to soil. Sunn hemp fixes nitrogen, enriching the soil when it is incorporated.

Good windbreak. Due to its height, Sunn hemp can serve as a windbreak, allowing better erosion control from wind and rain.

Increase in tomato crop yield. Sunn hemp significantly increased tomato yield in the demonstration planting. This may be due to nitrogen addition from the sunn hemp.

Reduces pests. Can potentially be used as a trap crop in reducing thrip densities in cash crops. Tall growing sunn hemp may act as a physical barrier which could impede movement of insect-pests. Also, a reservoir of Lepidoptera egg parasitoids can be created by growing sunn hemp, reducing problems from corn earworm and other pests.

Trichogramma wasps are parasitoids of corn earworm and other pests and are attracted by Lepidoptera eggs laid on sunn hemp flowers. (Photo courtesy of Mark Wright & Roshan Manandhar, UH Dept. of Plant and Environmental Protection Sciences)



Disadvantages

Fibrous. Sunn hemp gets fibrous as it matures and can be more difficult to incorporate as green manure if left too long. For easiest incorporation, roll and crimp or plow under as soon as the plants start to flower (around 60 days from planting).

Reduction in tuber crop yield. Use of sunn hemp in rotation with tuber crops can cause a reduction in cash crop yield. This may be due to an increase in soil nitrogen in the sunn hemp plots which could cause an increase in foliar growth and subsequently a reduction in tuber production.

Some varieties toxic. Some varieties of sunn hemp are toxic to livestock. However, “Tropic Sun,” the variety commonly used in Hawai’i, is not toxic and will not harm livestock.

Oats

Advantages

No to low maintenance. Only maintenance is plowing under and possibly irrigation. If planted before the rainy season, no irrigation required.

Quick establishment. Time to establishment is approximately 7 to 10 days. Good for short growing windows.



Oats produce allelopathic compounds that suppress weed growth, as on this coffee farm on Kauai.

Weed suppression. Oats greatly reduce weed growth on fields by establishing quickly and smothering competing weeds.

Allelopathic. Oats also suppress weeds by producing compounds that inhibit growth of nearby plants.

Organic matter. Oats add large amounts of biomass when grown, then incorporated in a field.

Reduces soil erosion. Roots keep soil in place, keeping rain from washing away valuable topsoil.

Inexpensive. Seed to plant oats is less expensive than many other cover crops.

Adapted to many different soil types. Oats can grow in a wide range of pH's and nutrient densities.

Disadvantages

Must wait to plant cash crops. Allelopathic abilities require farmers to wait 2 to 3 weeks to plant susceptible cash crops (lettuce, wheat, cress, rice, or peas) after incorporating oats. Cash crops planted immediately after incorporation may be subject to stunted growth. Allelopathic effects diminish and disappear completely by 3 weeks.

What are the economics of using cover crops?

Associated Costs

Direct: *Impact can be assessed in dollar amounts.*

- Cover crop seed cost
- Cover crop seed shipping cost
- Cover crop planting costs
- Cover crop seed harvesting costs
- Possible cash crop yield decrease

Indirect: *Factors that could have an impact on overall production and sustainability, but cannot be measured in dollar amounts.*

- Cover crop competition if grown with cash crop

Basic costs associated with planting cover crops vary from farm to farm because of different labor and equipment costs, but include the initial cost of the seed, field preparation and planting, minimal maintenance (either harvesting or plowing down), and possibly irrigation (depending on what time of year the cover crop is planted). Harvesting seed from your first planting will eliminate for future plantings the highest cost, which is the initial cost of the seed.



Sunn hemp seeds can be harvested for future planting.

Cover crop seed cost (not including shipping)

	Buckwheat	Sunn Hemp	Oats
Average Seed Cost	\$2/lb	\$3/lb	\$1.50/lb
Seeding Rate	60 lb/acre	40 lb/acre	70 lb/acre
Total Est. Cost/Acre	\$120	\$120	\$105

Farmers need to keep in mind the needs of their cash crops when planting cover crops. Yield response to the cover crops will differ depending on the nutrient requirement of the cash crop. Nitrogen additions to the soil from sunn hemp could cause a decrease in yield of some crops, such as tubers, while increasing yield in others. Also, if cover crops are planted alongside certain cash crops, they could potentially block needed sunlight or compete for nutrients.

Expected Savings

Direct

- Reduced weed control costs
- Reduced fertilization costs
- Reduced pest control costs
- Potential cash crop yield increase

Indirect

- Reduced soil erosion
- Weed suppression
- Soil microorganism increase
- Soil carbon increase
- Numbers of natural enemies
- Nematode reduction



Heavy erosion can result from leaving land bare during a heavy storm, which is what happened to this farm on O’ahu.

Buckwheat, Sunn hemp, and Oats, alone and in combination, help to decrease soil erosion on farms. Their roots trap and keep soil in place during rain events and even flooding, keeping the nutrient-rich topsoil from being washed away.

Farmers using cover crops report savings in weed control due to high weed suppression. Some farmers also report savings due to a decreased need for pesticide application. Research done on cover crops grown on corn fields showed an increase in a beneficial wasp that is parasitic to lepidoptera and corn earworm, resulting in reduced pest control cost. Cover crops also have the

potential to increase yield of cash crops. Tomatoes especially have been shown to increase crop yield when planted in rotation with Sunn hemp. Though not shown conclusively in this study, most likely because it studied only one planting, other studies on cover crops have shown a reduction in need for fertilizers over time because of nutrient additions by cover crops.

What are the planning guidelines for planting cover crops?

Site Preparation: Prepare the field by clearing the area to be planted to the selected cover crop(s) either by removing any weeds and disking, or by some other means.

Herbicides, such as glyphosate products, can be used to clean field of weeds prior to planting the cover crops. Cover crops should not be planted within 7 days after application of some herbicides. Otherwise, damage or death of the emerging seedlings may occur.

Planting Seeds: For small fields or if intercropping, seed can be broadcast either by hand or manual broadcast fertilizer/seed spreaders. For larger fields, mechanical seed spreading (with tractor mounted fertilizer/seed spreaders) and/or seed drilling may be more economical.



In small fields, seeds can be incorporated by dragging a piece of chain link fence behind a four wheeler.

Incorporation: It is essential that there is adequate soil-to-seed contact so it is best to incorporate seeds very soon after spreading. In small fields or rows, this can be accomplished using a piece of chain link fence dragged behind a four wheeler (All-terrain Vehicle—ATV) or by raking soil over the seeds. In larger fields a light harrow to no more than 1 inch deep is recommended.

Timing & Irrigation requirements: If seeds are planted just before the rainy season (mid-October through mid-April), no irrigation is necessary for any of the above cover crops. In the dry summer months irrigation is needed. Note: when sunn hemp is planted between the months of September and December it will flower quickly (generally within 6 weeks of planting). For seed production this is desirable. Additionally, sunn hemp plants will be shorter during the Sep-Dec time frame because of the flowering response. Sunn hemp planted between January and August will become tall (5 feet +) which increases its utility as a windbreak. Buckwheat and oats are not, generally, impacted by time of year plantings.

Germination & Establishment: Time to establishment is approximately 7-10 days for all 3 types of cover crop after the first rain of more than 0.5 inches occurs. Sunn hemp will sprout within 24 hours. Buckwheat and oats will sprout within 72 hours of receiving moisture.

Management: Generally not much is required with respect to management. Once the crop is planted and moisture is received the best approach is to leave the cover crops alone. No fertilizer, no irrigation, and no pest control efforts are made. Minimizing the cover crop management minimizes cost associated with the practice thus making it more economical and useful.

Where do I get seed?

Seed sources in Hawai'i

Koolau Seed & Supply, Inc. (808-239-1280). (sunn hemp and other cover crop suppliers)

Crotolaria Seed Specialists, LLC (808-341-0230). (sunn hemp growers and suppliers)

Fukuda Seed Store, Inc. (808-841-6719). (sunn hemp and other cover crop suppliers)

Seed sources on the U.S. mainland

Peaceful Valley Farm and Garden Supply (888-784-1722). (buckwheat, sunn hemp, and other cover crop suppliers)

Douglass King Company (210-661-4191). (oat and other cover crop suppliers)

What should I do when I'm ready to put in my cash crop?

Prior to planting commercial crops, cover crops need to be killed, then incorporated into the soil. Cover crops left to seed can turn into weeds during the cash crop planting, so killing is best accomplished at late bud or early bloom stage, before any of the seeds have developed and while stalks are still fairly tender.

Methods for killing cover crops

- Spray with herbicide
- Mow
- Roller-crimp
- Combination of methods

Methods for incorporating cover crops

- Disking
- Roto-tilling
- Plowing
- Combination of methods



Sunn hemp can be roll-crimped and planted through the mulch, which keeps the soil covered and reduces erosion. (Photo courtesy Robert Joy, Honolulu NRCS)

How and when to kill and incorporate will vary for each farm and each cover crop, depending on equipment available, what will be planted in the next rotation, and the cover crop itself.

Buckwheat and other short, non-woody crops don't need to be mowed and can be incorporated while standing. For grasses and small grains such as oats, kill and incorporate at boot stage, when the head is just emerging from the stem. A good method for taller crops such as sunn hemp is to spray and/or roll the crop, then plant through the mulch. This leaves the soil covered and reduces potential erosion.

The commercial crop can usually be planted within two weeks of incorporation. However, if using oats as cover crop, wait 2-3 weeks after incorporation before planting your cash crop. This will give the allelopathic compounds produced by the oats time to lose their effect.

What are some other resources I can use to learn about cover crops?

- University of Hawai'i's College of Tropical Agriculture and Human Resources (CTAHR) Cover Crop and Green Manures Resource Page: <http://www.ctahr.hawaii.edu/sustainag/cc-gm/index.html>
- University of California-Davis Sustainable Agriculture Research and Education Program (SAREP) Cover Crop Resource Page: <http://www.sarep.ucdavis.edu/ccrop/>
- Sunn hemp for Soil Health and Nematode Management Youtube video: http://www.youtube.com/watch?v=AG_CYsVmQn4
- Sustainable Agriculture Research and Education (SARE): <http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version>
- Oahu RC&D video Cover Crops: Adopting Cover Crop Technology in Hawai'i: Available on DVD from Oahu RC&D

Additional information for this guide was taken from

CTAHR's Buckwheat information page: <http://www.ctahr.hawaii.edu/sustainag/cc-gm/buckwheat.html>

CTAHR's "Tropic Sun" sunn hemp information page: <http://www.ctahr.hawaii.edu/sustainag/cc-gm/sunn-hemp.html>

CTAHR's Oat information page: <http://www.ctahr.hawaii.edu/sustainag/cc-gm/oat.html>

Accelerating the Adoption and Implementation of Proven Cover Crop Technologies in Hawaii by Dr. John McHugh, Crop Care Hawaii:
http://www.ctahr.hawaii.edu/sustainag/NewFarmer/downloads/Accelerating_Adoption_of_Cover_Crops.pdf

Advice on obtaining seeds of green manure and cover crops in Hawaii (Joy and Evans):
<http://www.ctahr.hawaii.edu/oc/freepubs/pdf/SCM-13.pdf>

Pest Management Findings using Cover Crops (Roshan Manandhar and Dr. Mark Wright. Unpublished).

Accelerating the Adoption of Cover Crop Technology in Hawai'i: Economic Analysis (Crop Care Hawai'i, LLC. Unpublished).

Managing Cover Crops Profitably, 3rd Edition. (Sustainable Agriculture Research and Education (SARE) Publications): <http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version>