CONTENTS

This bulletin is a companion to SARE's Cover Crop Topic Room, an online collection of select, mostly SARE-based resources on cover crops. Information is available at www.SARE.org/Cover-Crops on the following topics:

- Selection and Management
- Economics
- Ecosystem Services
- Establishment
- No-Till
- Soil and Fertility Management
- Water Management
- Pest Management
- Crop Rotations
- Cover Crop Surveys

SARE's Topic Rooms contain dozens of publications, videos and other educational materials on a wide range of topics, including local food systems, high tunnels, small ruminants and more. Visit www.SARE.org/Topic-Rooms.

Written by Andy Clark, SARE

Sustainable Agriculture Research & Education

Cover Crops for Sustainable Crop Rotations

Photos (clockwise) **Guihua Chen and Univ. of MD researchers demonstrated that brassica cover crops help reduce soil compaction.** *– Ray Weil* **Forage radish.** *– Edwin Remsberg* **Sunn hemp on Cedar Meadow Farm in Pennsylvania.** *– Abby Massey*

COVER CROPS ARE AN INDISPENSABLE TOOL. They are planted to slow erosion, improve soil health, enhance water availability, smother weeds, help control pests and diseases, increase biodiversity, and bring a host of other benefits to your farm.

Cover crops have also been shown to increase crop yields, break through a plow pan, add organic matter to the soil, prevent leaching of nutrients and attract pollinators. There is a growing body of evidence that shows cover crops improve resilience in the face of erratic and increasingly intensive rainfall, as well as under drought conditions. Cover crops help when it doesn't rain, they help when it rains, and they help when it pours!

Cover Crops Increase Yield

SARE.org/Cover-Crops/Survey

MANY RESEARCH STUDIES AROUND THE world demonstrate that cover crops can increase yield. The yield benefit is often apparent after just one year of using cover crops, and farmers will start to see other benefits, such as improved soil health, after several years of using them in crop rotation. According to an analysis of yield data collected in a national cover crop survey, farmers can expect a 3% increase in their corn yield and a 4.9% increase in soybeans after five consecutive years of cover crop use. In the drought year of 2012, farmers reported even greater yield increases when they used cover crops: 9.6% in corn and 11.6% in soybeans. Learn more at www.sare.org/cover-crop-economics.

Whether you are just starting with cover crops, or have some experience growing them, the SARE Cover Crop Topic Room has a wealth of information you can use. Here we summarize some of it and provide an introduction to many of the benefits of growing cover crops. For in-depth resources, visit the website listed in each section.

A Profitable Long-Term Investment

SARE.org/Cover-Crops/Economics

DETERMINING WHEN COVER CROPS PAY for themselves is not as simple as comparing the added first-year costs with the return on the following crop. Cover crops should be viewed as a long-term investment that gradually improve farm management in multiple areas. Over time,

COVER CROPS AND NO-TILL INCREASE DAIRY PROFITS AND SOIL HEALTH

New England dairy farmers have a short window of time for planting and harvesting high-quality forage, which leaves little room to plant cover crops to replenish the soil. But a University of Maine Cooperative Extension research team, led by Extension Educator Rick Kersbergen, found that shorter-season silage corn and no-till planting gives farmers time to use cover crops and improves forage quality, resulting in increased milk production and farm profitability.

The research team found that no-till reduced farmers' fuel use by 5.7 gallons per acre and labor by 2.75 hours per acre, saving on average $50 per acre. Cover crops provided nitrogen, lowering the amount of fertilizer they needed. "Winter cover crops were not something we used on every field before no-till, but now they are essential," say farmers Jeffrey and Penny Stevens, who participated in the project.

For more information, go to www.SARE.org/Project-Reports and search for LNE09-287.

A cover crop grows in no-till corn residue on a Maine farm. - *Photo by Rick Kersbergen*

Cover Crop Adoption by the Numbers[1]

- *Cover crops were planted on 15.4 million acres in 2017, a 50% increase over five years.*
- *Eight states more than doubled their cover crop acreage from 2012 to 2017.*
- *The number of farms planting cover crops increased 15.2% from 2012 to 2017.*

[1] *From the Census of Agriculture*

this investment leads to lower costs and, sometimes, increased revenue. An analysis in the SARE bulletin *Cover Crop Economics* reveals that in some situations cover crops can pay off in year one, such as when they are used for grazing or to manage herbicide-resistant weeds. In other situations, such as when using them to alleviate compaction or to improve nutrient management, a payoff is more likely in the second or third year.

Selection and Management

SARE.org/Cover-Crops/Selection

TO SELECT COVER CROPS FOR YOUR operation, first identify your primary objectives for adding them to your system. Do you want to add nitrogen (N) to your soil, increase soil organic matter, reduce erosion, provide weed control, manage nutrients or conserve soil moisture? While all cover crops provide many benefits, some species or "cocktails" (cover crop mixes) are better than others, depending on your specific objectives.

Next, identify the best time and place to fit cover crops into your rotation (see **Crop Rotations**). Are you looking for winter cover crops to scavenge N, summer cover crops to break soil compaction, a window in a small-grain rotation to supply much-needed nutrients, or even a full-year cycle to improve soil or suppress weeds? Consider creating a new rotation or modifying an existing one to accommodate your long-term objectives for planting cover crops. Also remember that there is likely no single cover crop that is right for your farm (see **Mixtures or Cocktails**).

Finally, think through exactly how and when you will seed, terminate and plant into your cover crop. Do you know a reliable source for cover crop seeds, what will the weather be like, can you get into the field, do you want it to winterkill, and what labor and equipment will you need? Find information to help you answer these questions in the Cover Crop Topic Room or *Managing Cover Crops Profitably* (see page 4 sidebar), but above all, consult local expertise, including other farmers.

Legumes

Legume cover crops (clovers, vetch, peas, beans) can fix a lot of N for subsequent crops, generally ranging from 50-150 pounds per acre, depending on growing conditions. You can usually reduce your N fertilizer inputs following a legume, but they are not very good at scavenging N left over after cash crops.

Legumes also help prevent erosion, support beneficial insects and pollinators, and can increase the amount of organic matter in soil, although not as much as grasses. Legumes differ in their productivity and adaptability to soil and climatic conditions.

Non-Legumes

Non-legume cover crops include the cereals (rye, wheat, barley, oats, triticale), forage grasses (annual ryegrass) and broadleaf species (buckwheat, sunflower, mustards and brassicas). While the species vary considerably, non-legumes are most useful for scavenging nutrients, providing erosion control, suppressing weeds and producing large amounts of residue that add organic matter to the soil.

Plant a non-legume whenever a field has excess nutrients, particularly N. When planted as a fall cover crop, non-legumes consistently take up 30-50 pounds of N per acre. If large amounts of N are left in the soil from the summer crop or due to a history of manure applications, non-legumes can scavenge upwards of 150 pounds per acre. Depending on your conditions—including soil residual N status—you may not be able to reduce your N fertilizer inputs for the subsequent crop, particularly in the first few years of cover cropping.

Mixtures or Cocktails

Although seeding and managing cover crop mixes or "cocktails" can be more complicated, they allow you to attain multiple objectives at once. Cover crop mixtures offer the best of both worlds by combining the benefits of grasses and legumes, or using the different growth characteristics of several species to fit your needs. Compared to pure stands of legumes or non-legumes, a mixture of two or more species—a cocktail—usually produces more overall biomass and N, tolerates adverse conditions, increases winter survival, provides ground cover, improves weed control, attracts a wider range of beneficial insects and pollinators, and provides more options for use as forage. However, cocktails often cost more, can create too much residue, may be difficult to seed and generally require more complex management.

Crop Rotations

SARE.org/Cover-Crops/Rotation

ONE OF THE BIGGEST CHALLENGES OF COVER cropping is to fit them into your current rotations, or to develop new rotations that take full advantage of their benefits. There may be a role for cover crops in almost all rotations, but the diversity of cropping systems precludes addressing them here. Learn more by reading *Crop Rotation on Organic Farms*, visiting the Cover Crop Topic Room, reviewing SARE grant results and consulting local expertise.

Whether you add cover crops to your existing rotations or totally revamp your farming system, you should devote as much planning and attention to your cover crops as you do to your cash crops. Failure to do so can lead to failure of the cover crop and cause problems in other parts of your system.

Cover Crops for No-Till Farming

SARE.org/Cover-Crops/No-Till

NO-TILL FARMING OR OTHER CONSERVATION tillage systems are good opportunities to plant cover crops. A cover crop mulch can increase water infiltration and also improve moisture availability by preventing evaporation. Cover crop residue helps control weeds, which is especially important in organic no-till agriculture.

Cover Crops for Organic Farms

PLANT COVER CROPS ON ORGANIC FARMS TO provide N, manage weeds and improve soil health. In organic no-till farming, use a roller-crimper to kill the cover crop and leave the mulch on the soil surface to conserve water. Or, incorporate the cover crop into the soil (sometimes called a green manure) before planting your main crop.

Soil and Fertility Management

SARE.org/Cover-Crops/Soil

COVER CROPS MAINTAIN AND IMPROVE SOIL fertility in a number of ways. Protection against soil loss from wind and water erosion is perhaps the most obvious soil benefit, but providing organic matter is a more long-term and equally important goal. Cover crops contribute indirectly to overall soil fertility and health by catching nutrients before they can leach out of the soil profile or, in the case of legumes, by adding N to the soil. Their roots can

Learn from the Experts

In 2014 and again in 2017, leading soil health experts and farmers convened for the National Conference on Cover Crops and Soil Health. Watch presentations on a variety of topics at ***www.SARE.org/CoverCropConference****.*

DRYLAND FARMERS FIND COVER CROPS CONSERVE MOISTURE

When it comes to incorporating cover crops into a dryland rotation, many farmers hesitate, wondering: "How much moisture is the cover crop going to demand, and will I pay for it later in lost cash-crop yields?"

This is the "first question and major concern any dryland farmer has about cover crops," says Bladen, Neb., farmer Keith Berns, who conducted research with his brother on their 2,000-acre farm—about two-thirds of it dryland. Keith and Brian Berns found that, in fact, cover crops can significantly boost corn yields in a non-irrigated setting.

In one trial, they planted corn after a cover crop mix of grasses, legumes and brassicas, and saw a corn yield that was about 10% better than planting straight into wheat stubble.

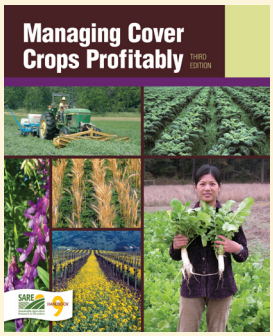
In their trials, the Bernses tested both cover crop monocultures and mixes—including sunflowers, soybeans and oilseed radish—but found that mixes were the best performers, in part because they were more frugal with water. They found that the cover crop mixes used far less water than the cover crop monocultures, and were on par with water use in wheat stubble alone.

Through their SARE-funded research, the Berns brothers developed the Cover Crop SmartMix Calculator, an online spreadsheet that calculates seed quantities and cost, carbon-to-nitrogen ratio (C:N), nitrogen-fixation potential and other factors for mixes of nearly 40 cover crop species.

Visit www.SARE.org/Keith-Berns to hear Keith Berns talk about his experience with SARE.

Brian and Keith Berns (left to right) at a cover crop field day in Pennsylvania. *- Photo by Mandy Rodrigues*

SARE Publications on Cover Crops and Soil Health



Managing Cover Crops Profitably
www.SARE.org/MCCP

Cover Crop Economics
www.SARE.org/cover-crop-economics

Cultivating Climate Resilience on Farms and Ranches
www.SARE.org/climate-resilience

Photos (left to right): **Dave Brandt.** *- Photo by Dena Leibman* **John Burk driving a tractor on his Michigan farm.**

even help unlock some nutrients in the soil, converting them to more available forms. The amount and availability of nutrients from cover crops will vary widely depending on such factors as species, planting date, plant biomass and maturity at termination date, residual soil fertility, and temperature and rainfall conditions. See *Building Soils for Better Crops* for more information on building soil health by using cover crops and other practices.

Climate Resilience and Water

SARE.org/Cover-Crops/Water

EVIDENCE IS MOUNTING THAT COVER CROPS help stabilize yields and improve moisture availability in the face of increasingly erratic weather. Is it too wet in spring? Cover crops take up water (via evapotranspiration) and usually allow you onto the field earlier than if you did not have a cover crop growing. Alternatively, if facing drought or practicing dryland farming, cover crops still help boost yields while being very efficient with water use. If you use no-till, the cover crop mulch increases water infiltration and conserves moisture into the summer. Added carbon and root channels, in addition to increased soil pore space, help improve soil water-holding capacity—in any tillage system.

Pest Management

SARE.org/Cover-Crops/Pests

COVER CROPS CAN CREATE HABITAT FOR pests, such as seed corn maggots that are attracted to decaying residues, or tarnished plant bugs that feed on the flowers. They also reduce infestations by insects, diseases, nematodes and weeds. Cover crops that attract and retain beneficial insects—when allowed to flower—include buckwheat, clovers and brassicas. Cover crop mulches suppress weeds and reduce splashing of soilborne pathogens onto leaves, while some, such as sudangrass, brassicas and mustards, reduce populations of verticillium wilt and other soil pathogens. In Michigan, for example, some potato growers report that two years of radish improves potato production and lowers pest control costs. Pest-fighting cover crop systems help minimize pesticide use, and as a result cut costs and reduce your chemical exposure.

Ecosystem Services

SARE.org/Cover-Crops/Ecosystem-Services

COVER CROPS ENHANCE BIODIVERSITY ON the farm and contribute to a healthier ecosystem in many ways. Flowering cover crops can provide food and habitat for important pollinators and beneficial insects. They can also support birds and other wildlife. Cover crops protect water quality by curbing soil erosion and reducing nitrogen losses by an average of 48%. By stimulating biological activity in the soil, cover crops planted on a large scale can sequester huge amounts of atmospheric carbon.

Conclusion

REGARDLESS OF YOUR OBJECTIVES FOR growing cover crops, there are many viable and tested options available for you to try. Consult the many resources available, talk to other farmers and start with small plots as you fine-tune your system. Be sure to read the book *Managing Cover Crops Profitably*, browse around the SARE Cover Crop Topic Room, review SARE grant results and consult local expertise for more information on cover crops.

WHY COVER CROPS? SEE AND HEAR FROM FARMERS, IN THEIR OWN WORDS.

"We lose less than 100 pounds of soil per year [to erosion] because of cover crops."
- Dave Brandt, Carroll, Ohio

"The biggest benefit we are seeing from cover crops is the regeneration of our soil. ... Because we have gone to this type of production model, we are able to produce our cash commodities at a fraction of the cost."
- Gabe Brown, Bismarck, N.D.

"Every species [of cover crop] is giving a different benefit to the soil, it just depends on what prescription you want for that particular field."
- John Burk, Bay City, Mich.

Watch cover crop innovators speak about their experiences with cover crops at www.SARE.org/Cover-Crop-Innovators.