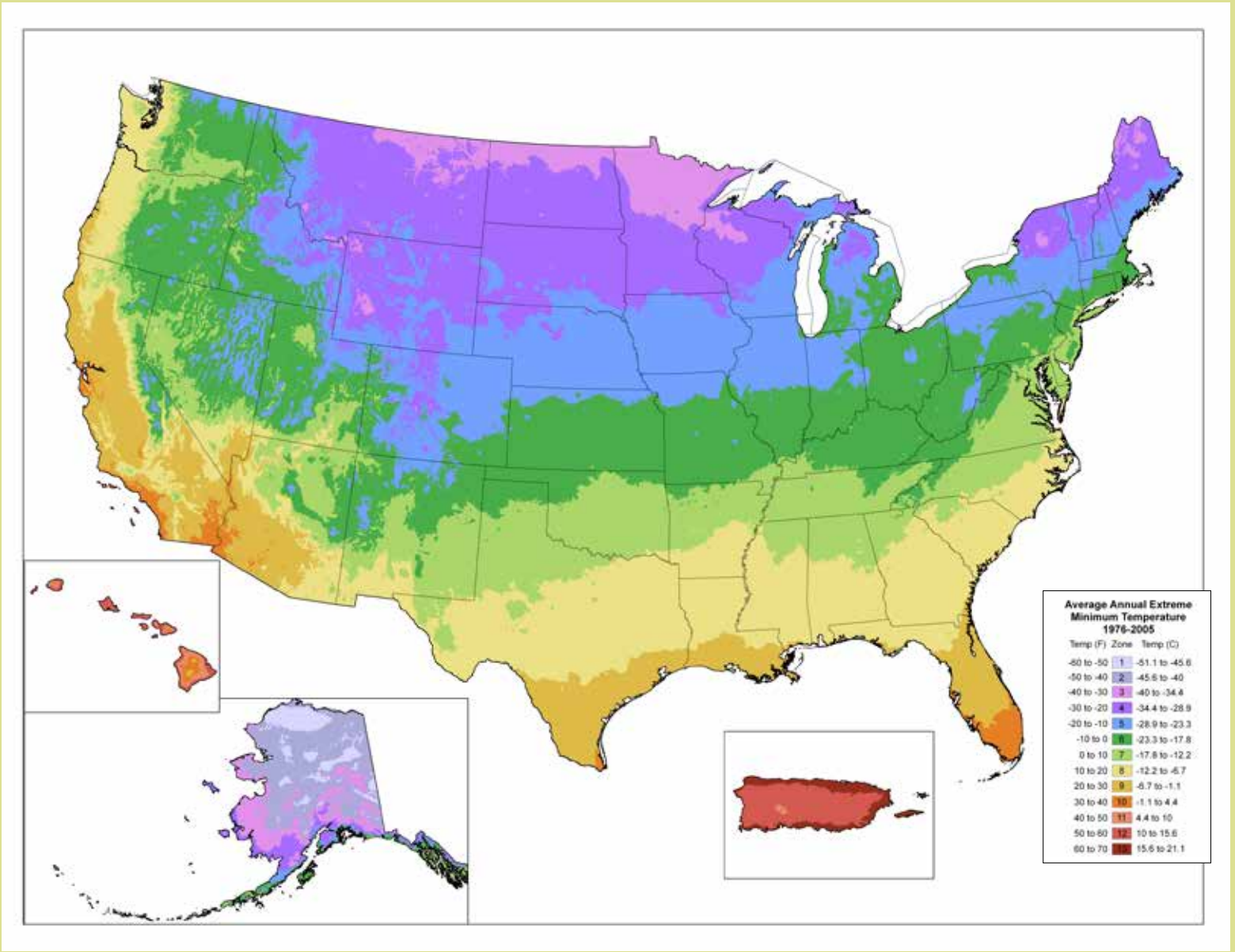
Managing Cover Crops Profitably

THIRD EDITION

SARE Sustainable Agriculture Research & Education

HANDBOOK 9

USDA Plant Hardiness Zone Map



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Managing Cover Crops Profitably

THIRD EDITION

Handbook Series Book 9

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Cover photos (clockwise from top left):

Jeff Moyer, farm manager for The Rodale Institute, kills a hairy vetch cover crop with a newly designed, front-mounted roller while a no-till planter drops seed corn behind the tractor. Photo by Matthew Ryan for the Rodale Institute.

Annual ryegrass overseeded into kale is already providing cover crop benefits before cash crop harvest. Photo by Vern Grubinger, Univ. of VT.

Guihua Chen, a Univ. of MD graduate student, studies the ability of forage radish to alleviate soil compaction. Photo by Ray Weil, Univ. of MD.

A winter smother crop of yellow mustard minimizes weed growth in a vineyard. Photo by Jack Kelly Clark, Univ. of CA.

"Purple Bounty" hairy vetch, an early-maturing, winter hardy variety for the Northeast, was developed by Dr. Tom Devine, USDA-ARS in collaboration with The Rodale Institute, Pennsylvania State University and Cornell University Agricultural Experiment Stations. Photo by Greg Bowman, NewFarm.org.

Red clover, frostseeded into winter wheat, is well established just prior to wheat harvest. Photo by Steve Deming, MSU Kellogg Biological Station.

Back cover photo: Sorghum-sudangrass increased irrigated potato yield and tuber quality in Colorado, whether it was harvested for hay or incorporated prior to potato planting. Photo by Jorge A. Delgado, USDA-ARS.

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FOREWORD

Cover crops slow erosion, improve soil, smother weeds, enhance nutrient and moisture availability, help control many pests and bring a host of other benefits to your farm. At the same time, they can reduce costs, increase profits and even create new sources of income. You'll reap dividends on your cover crop investments for years, because their benefits accumulate over the long term.

Increasing energy costs will have a profound effect on farm economics in coming years. As we go to press, it is impossible to predict how fast energy costs will increase, but since cover crop economics are rooted in nitrogen dynamics (how much N you save or produce with cover crops), fuel costs (the cost of N and trips across the field) and commodity prices, energy prices will certainly impact the economics of cover crop use.

Economic comparisons in the 2nd edition were based on the old economy of two-dollar corn, twenty-cent nitrogen and cheap gas. Some studies showed that cover crops become more profitable as the price of nitrogen increases. We retained some of these excellent studies because data from new studies is not yet available. What we do know is that cover crops can help you to increase yields, save on nitrogen costs, reduce trips across the field and also reap many additional agronomic benefits.

There is a cover crop to fit just about every farming situation. The purpose of this book is to help you find which ones are right for you.

Farmers around the country are increasingly looking at the long-term contributions of cover crops to their whole farm system. Some of the most successful are those who have seen the benefits and are committed to making cover crops work for them. They are re-tooling their cropping systems to better fit cover crop growth patterns, rather than squeezing cover crops into their existing system, time permitting.

This 3rd edition of *Managing Cover Crops Profitably* aims to capture farmer and other research results from the past ten years. We verified the information from the 2nd edition, added new results and updated farmer profiles and research data throughout. We also added two new chapters.

Brassicas and Mustards (p. 81) lays out the current theory and management of cover crops in the BRASSICACEAE family. Brassica cover crops are thought to play a role in management of nematodes, weeds and disease by releasing chemical compounds from decomposing residue. Results are promising but inconsistent. Try brassicas on small plots and consult local expertise for additional information.

Managing Cover Crops in Conservation Tillage Systems (p. 44) addresses the management complexities of reduced tillage systems. If you are already using cover crops, the chapter will help you reduce tillage. If you are already using conservation tillage, it shows you how to add or better manage cover crops. Cover crops and conservation tillage team up to reduce energy use on your farm and that means more profits.

We have tried to include enough information for you to select and use cover crops appropriate to your operation. We recommend that you define your reasons for growing a cover crop—the section, *Selecting the Best Cover Crops for Your Farm* (p. 12) can help with this—and take as much care in selecting and managing cover crops as you would a cash crop.

Regional and site-specific factors can complicate cover crop management. No book can adequately address all the variables that make up a crop production system. Before planting a cover crop, learn as much as you can from this book and talk to others who are experienced with that cover crop.

We hope that this updated and expanded edition of *Managing Cover Crops Profitably* will lead to the successful use of cover crops on a wider scale as we continue to increase the sustainability of our farming systems.

Andy Clark, Communications Director
Sustainable Agriculture Research and Education (SARE)
June, 2007

MANAGING COVER CROPS PROFITABLY

THIRD EDITION

ACKNOWLEDGMENTS

This 3rd edition could not have been written without the help of many cover crop experts. It is based in large part on the content of the 2nd edition, researched and written by Greg Bowman, Craig Cramer and Christopher Shirley. The following people reviewed the 2nd edition, suggested revisions and updates and contributed new content.

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HOW TO USE THIS BOOK

Think of this book as a tool chest, not a cookbook. You won't find the one simple recipe to meet your farming goals. You will find the tools to select and manage the best cover crops for the unique needs of your farm.

In this tool chest you will find helpful maps and charts, detailed narratives about individual cover crop species, chapters about specific aspects of cover cropping and extensive appendices that will lead you to even more information.

1. Start with *Top Regional Cover Crop Species* (p. 66). This chart will help you narrow your search by listing the benefits you can expect from the top cover crops adapted to your region. You'll discover which are the best nitrogen (N) sources, soil builders, erosion fighters, subsoil looseners, weed fighters and pest fighters.

2. Next, find out more about the performance and management of the cover crops that look like good candidates for your farm. You'll find two streams of information:

• **Charts** quickly provide you with details to help you compare cover crops. Performance and Roles (p. 67) lists ranges for N and dry matter production and ranks each cover crop's potential for providing 11 benefits. *Cultural Traits* (p. 69) and *Planting* (p. 70) explains the growth, environmental tolerances, seeding preferences and establishment costs for each crop.

• **Narratives.** The *Table of Contents* (p. 4) and the page numbers accompanying each species in Charts 2, 3 and 4 direct you to the heart of the book, the chapters on each cover crop. The chapters offer even more practical descriptions of how to plant, manage, kill and make the best use of each species. Don't overlook *Up-and-Coming Cover Crops* (p. 191) that briefly describes promising but lesser known cover crops. One of them may be right for your farm.

3. With some particular cover crops in mind, step back and look at the big picture of how you can fit cover crops into your farming operations. Sit down with a highlighter and explore these chapters:

• *Benefits of Cover Crops* (p. 9) explains important cover crop roles such as reducing costs, improving soil and managing pests.

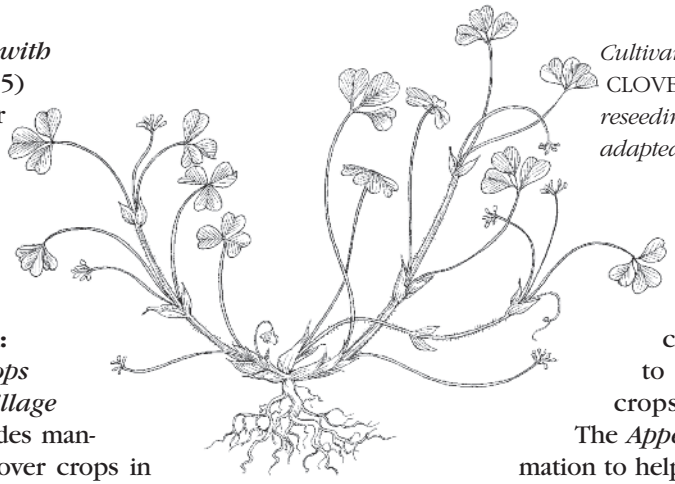
• *Selecting the Best Cover Crops* (p. 12) helps you evaluate your operation's needs and niches (seasonal, cash-crop related, and profit potential). Several examples show how to fit crops to detailed situations.

• *Building Soil Fertility and Tilth* (p. 16) shows how cover crops add organic matter and greater productivity to the biological, chemical and physical components of soil.

SORGHUM-SUDANGRASS *is a tall, warm-season grass that stifles weeds and decomposes to build soil organic matter.*

• *Managing Pests with Cover Crops* (p. 25) explores how cover crops change field environments to protect cash crops from insects, disease, weeds and nematodes.

• **New this edition:** *Managing Cover Crops in Conservation Tillage Systems* (p. 44) provides management details for cover crops in reduced tillage systems.



Cultivars of SUBTERRANEAN CLOVER, *a low-growing, reseeding annual legume, are adapted to many climates.*

• *Crop Rotations* (p. 34) explains how to integrate cover crops and cash crops in sequence from year to year for optimum productivity from on-farm resources.

• *Citations Bibliography* (p. 208) lists many of the publications and specialists cited in the book. Citations within the book are numbered in parentheses. Refer to the numbered citation in the bibliography if you want to dig deeper into a topic.

• *Climatic Zone Maps* inside the front and back covers help you understand differences in cover crop performance from location to location. You may find that some cover crops have performed well in tests far from where you farm, but under comparable climatic conditions.

The USDA **Plant Hardiness Zone Map** (inside front cover) shows whether a crop will survive the average winter in your area. We refer to the USDA hardiness zones throughout the book. **Readers' note:** A new version of the map is included in this reprint of the book (2012).

The U.S. Forest Service map, **Ecoregions of the United States** (inside back cover), served in part as the basis for the adaptation maps included at the beginning of each cover crop chapter. This ecosystem map, while designed to classify forest growth, shows localized climate differences, such as rainfall and elevation, within a region. See Bailey (citation #17 in Appendix F, p. 209) for more information about ecoregions.

4. Now that you've tried out most of the tools, revisit the charts and narratives to zero in on the cover crops you want to try. The *Appendices* include information to help you run reliable on-farm cover crop comparison trials. You'll also find contact information for cover crop experts in your region, seed and inoculant suppliers, references to books and academic papers cited in this book and websites with more cover crop information.

5. Finally, share your cover crop plans with farmers in your area who have experience with cover crops. Your local Extension staff, regional IPM specialist or a sustainable farming group in your area may be able to provide contacts. Be sure to tap local wisdom. You can find out the cover crop practices that have worked traditionally, and the new wrinkles or crops that innovative practitioners have discovered.

Abbreviations used in this book

A = acre or acres
bu. = bushel or bushels
DM = dry matter, or dry weight of plant material
F = (degrees) Fahrenheit in. = inch or inches
K = potassium lb. = pound or pounds
N = nitrogen
OM = organic matter
P = phosphorus
p. = page
pp. = pages
T = ton or tons
> = progression to another crop
/ = a mixture of crops growing together

BENEFITS OF COVER CROPS

RED CLOVER *is an annual or multi-year legume that improves topsoil. It is easily overseeded into standing crops or frostseeded into grains in early spring.*

Cover crops can boost your profits the first year you plant them. They can improve your bottom line even more over the years as their soil-improving effects accumulate. Other benefits—reducing pollution, erosion and weed and insect pressure—may be difficult to quantify or may not appear in your financial statements. Identifying these benefits, however, can help you make sound, long-term decisions for your whole farm.

What follows are some important ways to evaluate the economic and ecological aspects of cover crops. These significant benefits (detailed below) vary by location and season, but at least two or three usually occur with any cover crop. Consult local farming groups and agencies with cover crop experience to figure more precise crop budgets.

- Cut fertilizer costs
- Reduce the need for herbicides and other pesticides
- Improve yields by enhancing soil health
- Prevent soil erosion
- Conserve soil moisture
- Protect water quality
- Help safeguard personal health

Evaluate a cover crop's impact as you would any other crop, balancing costs against returns in all forms. Don't limit your calculations, however, to the target cover crop benefit. A cover often has several benefits. Many cover crops offer harvest possibilities as forage, grazing or seed that work well in systems with multiple crop enterprises and livestock.

SPELLING IT OUT

Here's a quick overview of benefits you can grow on your farm. Cover crops can:

Cut fertilizer costs by contributing N to cash crops and by scavenging and mining soil nutrients.

Legume cover crops convert nitrogen gas in the atmosphere into soil nitrogen that plants can use. See *Nodulation: Match Inoculant to Maximize N* (p. 122). Crops grown in fields after legumes can take up at least 30 to 60 percent of the N that the legume produced. You can reduce N fertilizer applications accordingly. For more information on nitrogen dynamics and how to calculate fertilizer reductions, see *Building Soil Fertility and Tilth with Cover Crops* (p. 16). The N value of legumes is the easiest cover crop benefit to evaluate, both agronomically and economically. This natural fertility input alone can justify cover crop use.

• **Hairy vetch** boosted yield for no-till corn more than enough to cover its establishment costs, a three-year study in Maryland showed. Further, the vetch can reduce economic risk and usually will be more profitable than no-till corn after a winter wheat cover crop (1993 data). The result held true even if corn were priced as low as $1.80 per bushel, or N fertilizer ($0.30/lb.) was applied at the rate of 180 lb. N/A (173).

• **Medium red clover** companion seeded with oats and hairy vetch had estimated fertilizer replacement value of 65 to 103 lb. N/A in a four-year study in Wisconsin, based on a two year rotation of oats/legume > corn. Mean corn grain yield following these legumes was 163 bu./A for red

clover and 167 bu./A for hairy vetch, compared with a no legume/no N fertilizer yield of 134 bu./A (400).

• **Austrian winter peas, hairy vetch** and NITRO alfalfa can provide 80 to 100 percent of a subsequent potato crop's nitrogen requirement, a study in the Pacific Northwest showed (394).

• **Fibrous-rooted cereal grains** or grasses are particularly good at scavenging excess nutrients—especially N—left in the soil after cash crop harvest. Much of the N is held within the plants until they decompose. Fall-seeded grains or grasses can absorb up to 71 lb. N/A within three months of planting, a Maryland study showed (46). Addition of cover crops to corn>soybean and corn>peanut>cotton rotations and appropriate timing of fertilizer application usually reduce total N losses, without causing yield losses in subsequent crops, a USDA-ARS computer modeling study confirms (354).

Reduce the Need for Herbicides

Cover crops suppress weeds and reduce damage by diseases, insects and nematodes. Many cover crops effectively suppress weeds as:

- A smother crop that outcompetes weeds for water and nutrients
- Residue or growing leaf canopy that blocks light, alters the frequency of light waves and changes soil surface temperature
- A source of root exudates or compounds that provide natural herbicidal effects

Managing Pests with Cover Crops (p. 25) describes how cover crops can:

- Host beneficial microbial life that discourages disease
- Create an inhospitable soil environment for many soilborne diseases
- Encourage beneficial insect predators and parasitoids that can reduce insect damage below economic thresholds
- Produce compounds that reduce nematode pest populations
- Encourage beneficial nematode species

Using a rotation of malting barley>cover crop radish>sugar beets has successfully reduced sugar beet cyst nematodes to increase yield of sugar beets in a Wyoming test. Using this brassica cover crop after malting barley or silage corn substituted profitably for chemical nematicides when nematode levels were moderate (231). A corn>rye>soybeans>wheat>hairy vetch rotation that has reduced pesticide costs is at least as profitable as conventional grain rotations without cover crops, a study in southeastern Pennsylvania shows (174). Fall-planted brassica cover crops coupled with mechanical cultivation help potato growers with a long growing season maintain marketable yield and reduce herbicide applications by 25 percent or more, a study in the inland Pacific Northwest showed (394).

To estimate your potential N fertilizer savings from a cover crop, see the sidebar, *How Much N?* (p. 22).

Improve Yields by Enhancing Soil Health

Cover crops improve soil by:

- Speeding infiltration of excess surface water
- Relieving compaction and improving structure of overtilled soil
- Adding organic matter that encourages beneficial soil microbial life
- Enhancing nutrient cycling

Building Soil Fertility and Tilth with Cover Crops (p. 16) details the biological and chemical processes of how cover crops improve soil health and nutrient cycling. Leading soil-building crops include rye (residue adds organic matter and conserves moisture); sorghum-sudangrass (deep penetrating roots can break compaction); and ryegrass (stabilizes field roads, inter-row areas and borders when soil is wet).

Prevent Soil Erosion

Quick-growing cover crops hold soil in place, reduce crusting and protect against erosion due to wind and rain.The aboveground portion of covers also helps protect soil from the impact of raindrops. Long-term use of cover crops increases water infiltration and reduces runoff that can carry away soil. The key is to have enough stalk and leaf growth to guard against soil loss. Succulent legumes decompose quickly, especially in warm weather. Winter cereals and many brassicas have a better chance of overwintering in colder climates. These late-summer or fall-planted crops often put on significant growth even when temperatures drop into the 50s, and often are more winter-hardy than legumes (361). In a no-till cotton system, use of cover crops such as winter wheat, crimson clover and hairy vetch can reduce soil erosion while maintaining high cotton yields, a Mississippi study shows (35).

Conserve Soil Moisture

Residue from killed cover crops increases water infiltration and reduces evaporation, resulting in less moisture stress during drought. Lightly incorporated cover crops serve dual roles. They trap surface water and add organic matter to increase infiltration to the root zone. Especially effective at covering the soil surface are grass-type cover crops such as rye, wheat, and sorghum-sudangrass hybrid. Some water-efficient legumes such as medic and INDIANHEAD lentils provide cover crop benefits in dryland areas while conserving more moisture than conventional bare fallow (383). Timely spring termination of a cover crop avoids the negative impact of opposite water conditions: excess residue holding in too much moisture for planting in wet years, or living plants drawing too much moisture from the soil in dry years.

Protect Water Quality

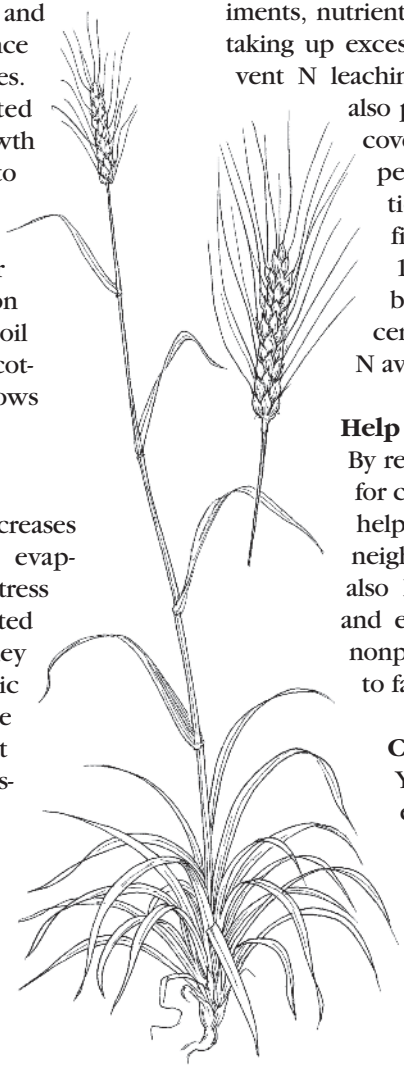
By slowing erosion and runoff, cover crops reduce nonpoint source pollution caused by sediments, nutrients and agricultural chemicals. By taking up excess soil nitrogen, cover crops prevent N leaching to groundwater. Cover crops also provide habitat for wildlife. A rye cover crop scavenged from 25 to 100 percent of residual N from conventional and no-till Georgia corn fields, one study showed. Up to 180 lb. N/A had been applied. A barley cover crop removed 64 percent of soil nitrogen when applied N averaged 107 lb./A (220).

Help Safeguard Personal Health

By reducing reliance on agrichemicals for cash crop production, cover crops help protect the health of your family, neighbors and farm workers. They also help address community health and ecological concerns arising from nonpoint source pollution attributed to farming activities.

Cumulative Benefits

You can increase the range of benefits by increasing the diversity of cover crops grown, the frequency of use between cash crops and the length of time that cover crops are growing in the field.



WINTER WHEAT *grows well in fall, then provides forage and protects soil over winter.*

SELECTING THE BEST COVER CROPS FOR YOUR FARM

by Marianne Sarrantonio

Cover crops provide many benefits, but they're not do-it-all "wonder crops." To find a suitable cover crop or mix of covers:

- **Clarify** your primary **needs**
- **Identify** the best **time** and **place** for a cover crop in your system
- **Test** a few options

This book makes selection of cover crops a little easier by focusing on some proven ones. Thousands of species and varieties exist, however. The steps that follow can help you find crops that will work best with a minimum of risk and expense.

1. Identify Your Problem or Use

Review *Benefits of Cover Crops* (p. 9) to decide what you want most from a cover crop. Narrowing your goals to one or two primary and perhaps a few secondary goals will greatly simplify your search for the best cover species. Some common goals for cover crops are to:

- Provide nitrogen
- Add organic matter
- Improve soil structure
- Reduce soil erosion
- Provide weed control
- Manage nutrients
- Furnish moisture-conserving mulch

You might also want the cover crops to provide habitat for beneficial organisms, better traction during harvest, faster drainage or another benefit.

2. Identify the Best Place and Time

Sometimes it's obvious where and when to use a cover crop. You might want some nitrogen before a corn crop, or a perennial ground cover in a vineyard or orchard to reduce erosion or improve weed control. For some goals, such as building soil, it may be hard to decide where and when to schedule cover crops.

To plan how and where to use cover crops, try the following exercise:

Look at your rotation. Make a timeline of 18 to 36 monthly increments across a piece of paper. For each field, pencil in current or probable rotations, showing when you typically seed crops and when you harvest them.

If possible, add other key information, such as rainfall, frost-free periods and times of heavy labor or equipment demand.

Look for open periods in each field that correspond to good conditions for cover crop establishment, underutilized spaces on your farm, as well as opportunities in your seasonal work schedule. Also consider ways to extend or overlap cropping windows.

Here are examples of common niches in some systems, and some tips:

Winter fallow niche. In many regions, seed winter covers at least six weeks before a hard frost. Winter cereals, especially rye, are an exception and can be planted a little later. If ground cover and N recycling needs are minimal, rye can be planted as late as the frost period for successful overwintering.

You might seed a cover right after harvesting a summer crop, when the weather is still mild. In cooler climates, consider extending the window by **overseeding** (some call this **undersowing**) a shade-tolerant cover before cash crop harvest. White clover, annual ryegrass, rye, hairy vetch, crimson clover, red clover and sweetclover tolerate some shading.

If overseeding, irrigate afterwards if possible, or seed just before a soaking rain is forecast. Species with small seeds, such as clovers, don't need a lot of moisture to germinate and can work their way through tiny gaps in residue, but larger-seeded species need several days of moist conditions to germinate.

When overseeding into cash crops early in the season, vigorous growth of the cover crop may cause water stress, increase disease risks due to lower air circulation or create new insect pest risks. Changing cover crop seeding rate, seeding time, or the rotation sequence may lessen this risk. To ensure adequate sunlight for the cover crop, overseed before full canopy closure of the primary crop (at last cultivation of field corn, for example) or just before the canopy starts to open again as the cash crop starts to die (as soybean leaves turn yellow, for example).

Expect excessive field traffic around harvest time? Choose tough, low-growing covers such as grasses or clovers. Limit foot traffic to alternate rows, or delay a field operation to allow for cover crop establishment.

Another option could be to use a reseeding winter annual that dies back and drops seed each summer but reestablishes in fall. Subclovers reseed well in regions south of Hardiness Zone 6. Shorter-season crimson clovers—especially varieties with a high hard-seed percentage that germinate over an extended period—work well in the Southeast where moisture is sufficient. Even rye and vetch can reseed if managed properly.

Summer fallow niche. Many vegetable rotations present cover crop opportunities—and challenges. When double cropping, you might have fields with a three- to eight-week summer fallow period between early planted and late planted crops. Quick-growing summer annuals provide erosion control, weed management, organic matter and perhaps some N.

Consider overseeding a spring crop with a quick-growing summer grain such as buckwheat, millet or sorghum-sudangrass, or a warm-season legume such as cowpeas. Or, you might till out strips in the cover crop for planting a fall vegetable crop and control the remaining cover between the crop rows with mowing or light cultivation.

Small grain rotation niche. Companion seed a winter annual cover crop with a spring grain, or frost seed (broadcasting seed onto frozen ground) a cover into winter grains. Soil freezing and thawing pulls seed into the soil and helps germination. Another option if soil moisture isn't a limiting factor in your region: broadcast a cover before the grain enters boot stage (when seedheads start elongating) later in spring or plant after harvest.

Look for open periods in each field or open spaces on your farm.

Full-year improved fallow niche. To rebuild fertility or organic matter over a longer period, perennials or biennials—or mixtures—require the least amount of maintenance. Spring-seeded yellow blossom sweetclover flowers the following summer, has a deep taproot and gives plenty of aboveground biomass. Also consider perennial forages recommended for your area. The belowground benefit of a tap rooted perennial can have tremendous soil improving benefits when allowed to grow for several years.

Another option is sequential cover cropping. Plant hairy vetch or a grass-legume mixture in fall, terminate it the following spring at flowering, and plant sorghum-sudangrass. The winter cover crop provides weed suppression and ground cover, but also nitrogen for the high-N sorghum-sudangrass, which can produce tons of biomass to build soil organic matter.

Properly managed, **living mulches** give many growers year-round erosion protection, weed control, nutrient cycling and even some nitrogen if they include a legume. Some tillage, mowing or herbicides can help manage the mulch (to keep it from using too much soil moisture, for example) before crops are strip-tilled into the cover or residue. White clover could be a good choice for sweet corn and tomatoes. Perennial ryegrass or some less aggressive turfgrasses such as sheep fescue may work for beans, tomatoes and other vegetables.

Create new opportunities. Have you honed a rotation that seems to have few open time slots? Plant a cover in strips the width of a bed or wider, alternating with your annual vegetable, herb or field crop. Switch the strips the next year. Mow the strips periodically and blow the topgrowth onto adjoining cash crops as mulch. In a bed system, rotate out every third or fourth bed for a soil-building cover crop.

Another option: Band a cover or some insect-attracting shrubs around fields or along hedgerows to suppress weeds or provide beneficial habitat where you can't grow cash crops. These hedgerows could also be used to produce marketable products such as nuts, berries or even craft materials.

3. Describe the Niche

Refer to your timeline chart and ask questions such as:

- How will I seed the cover?
- What's the weather likely to be then?
- What will soil temperature and moisture conditions be like?
- How vigorous will other crops (or pests) be?
- Should the cover be low-growing and spreading, or tall and vigorous?
- What weather extremes and field traffic must it tolerate?
- Will it winterkill in my area?
- Should it winterkill, to meet my goals?
- What kind of regrowth can I expect?
- How do I kill it and plant into it?
- Will I have the time to make this work?
- What's my contingency plan—and risks—if the crop doesn't establish or doesn't die on schedule?
- Do I have the needed equipment and labor?

4. Select the Best Cover Crop

You have identified a goal, a time and a place, now specify the traits a cover crop would need to work well.

Example 1. A sloping **orchard** needs a ground cover to **reduce erosion**. You'd like it to **contribute N** and **organic matter** and **attract beneficial organisms** but not rodents, nematodes or other pests. The cover **can't use too much water** or **tie up nutrients** at key periods. Too much N might stimulate excessive tree leaf growth or prevent hardening off before winter. Finally you want a cover crop that is easy to maintain. It should:

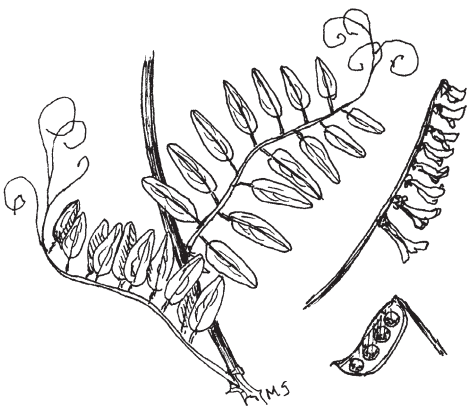
- be a perennial or reseeding annual
- be low-growing, needing minimal management
- use water efficiently
- have a soil-improving root system
- release some nutrients during the year, but not too much N
- not harbor or attract pests

For this orchard scenario, white clover is probably the best option north of Zone 8. A mixture of low-growing legumes or a legume and grass mix could also work. In warm regions, low-growing clovers such as strawberry clover and white clover work well together, although these species may attract pocket gophers. BLANDO brome and annual ryegrass are two quick-growing, reseeding grasses often suitable for orchard floors, but they will probably need some control with mowing. Or, try a reseeding winter annual legume such as crimson clover, rose clover, subclover, an annual vetch or an annual medic, depending on your climate.

Example 2. A **dairy** lacks adequate storage in fall and winter for the **manure** it generates, which **exceeds the nutrient needs** for its silage corn and grass/legume hay rotation. The cover crop needs to:

- establish effectively after (or tolerate) silage corn harvest
- take up a lot of N and P from fall-applied manure and hold it until spring

For this dairy scenario, rye is usually the best choice. Other cereal grains or brassicas could work if planted early enough.



HAIRY VETCH *is an winter annual legume that grows slowly in fall, then fixes a lot of N in spring.*

Example 3. In a moderate rainfall region **after small grain harvest** in late summer, you want **a soil-protecting winter cover** that can **supply N** for no-till **corn** next spring. You want to kill the cover without herbicides. You need a legume that:

- can be drilled in late summer and put on a lot of fall growth
- will overwinter
- will fix a lot of N
- can be mow-killed shortly before (or after) corn planting
- could provide some weed-controlling, moisture-conserving residue

Hairy vetch works well in the Northeast, Midwest and parts of the mid-South. Mixing it with rye or another cereal improves its weed-management and moisture-conservation potential. Crimson clover may be an appropriate choice for the southeastern Piedmont. Austrian winter pea could be considered, alone or in a mix, in coastal plain environments, but will winterkill in Zone 7 and below. Where grain harvest occurs in late spring or early summer, LANA woollypod vetch might be a better choice.

Example 4. After a **spring broccoli** crop, you need a **weed-suppressing cover that adds N** and **organic matter**, and perhaps **mulch**, into which you will **no-till** seed fall lettuce or spinach. You want a cover that:

- is very versatile
- grows fast in hot weather
- can be overseeded into broccoli
- germinates on the soil surface under dry conditions
- fixes N
- persists until you're ready to kill it

Here, a quick-growing, warm-season legume such as cowpeas may work, especially if you can irrigate to hasten establishment during dry conditions.

5. Settle for the Best Available Cover. It's likely the "wonder crop" you want doesn't exist. One or more species could come close, as the above examples indicate. *Top Regional Cover Crop Species* (p. 66) can provide a starting point. Check with regional experts. Keep in mind that you can mix two or more species, or try several options in small areas.

WINTER (cereal) RYE *is an annual grain that prevents soil and wind erosion. Its killed vegetation suppresses weeds for no-till planting.*

6. Or Build a Rotation Around Cover Crops. It's hard to decide in advance every field's crops, planting dates, fieldwork or management specifics. One alternative is to find out which cover crops provide the best results on your farm, then build a rotation around those covers, especially when trying to tackle some tough soil improvement or weed control issues. See *Full-Year Covers Tackle Tough Weeds* (p. 38).

With this "reverse" strategy, you plan covers according to their optimum field timing, and then determine the best windows for cash crops. A cover crop's strengths help you decide which cash crops would benefit the most.

For now, however, you probably want to fit one or more cover crops into your existing rotations. The charts and narratives in this book can help you select some of the most suitable species for your farming system and objectives. See *Crop Rotations with Cover Crops* (p. 34) to get you thinking more. When you've narrowed your choices, refer to Appendix A, *Testing Cover Crops on Your Farm* (p. 189) for some straightforward tips on what to do next.

Adapted from Northeast Cover Crop Handbook *by Marianne Sarrantonio, Rodale Institute, 1994.*