Farmers Guide & Resource To Quality Small Grains Production

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This booklet has been published as the collaborative effort of Michael Fields Agricultural Institute in East Troy, WI; the University of Wisconsin-Center for Integrated Agriculture Systems and UW Agronomy Department at Madison, WI; and Oatlink of Poplar Grove, IL. It expands, updates and revises material developed in "A Farmers Guide to Quality Oat Production." The guide was the work of a pilot small grains project conducted in Boone County, IL, through a Boone County Soil and Water Conservation District and Illinois Department of Agriculture Sustainable Agriculture project. This publication marks expansion of that pilot project into a 3-year initiative supported by the USDA North Central Sustainable Agriculture Research and Education and Fund for Rural America programs. This initiative is working with farmers in portions of Iowa, Illinois, Minnesota and Wisconsin toward "Diversifying Corn and Soybean Rotations for Profit and the Environment in the Upper Midwest." Funding for this publication was provided by USDA- NCSARE.

Contents

Facing intense challenges in agriculture, farmers must try alternatives, chart new course

American farmers face one of the most economically competitive and risky environments they have ever encountered.

Softening export markets from economic turmoil abroad. Rising competition from expanding global production. Declining commodity payments as the result of landmark national agricultural reforms. Volatile domestic demand from cyclical cuts in livestock production and concentration.

Anyone of these factors should signal caution to a cash grain producer. Together, they cry out for farmers to reexamine their market strategy and risk, to firmly resolve to try alternatives, to adapt and change their production practices.

Is it wise to meet this economic situation with yet more record harvests of corn and soybeans? Will this mean yet more stagnant prices, lingering or expanding carryovers, a glut in production, prolonged interest payments on storage costs?

With tens of millions of acres planted in just two crops across a vast expanse of the Upper Midwest, fanners face even greater challenges on the ground. Vast expanses of these twin monocultures have invited a widening array of insects, diseases and weeds, which predictably have built -- and will continue to build -- resistance to chemical control over time.

Such antagonists to crop production are posing new threats to farmers. They come at a time when regulation under The Food Quality Production Act may remove many common, widely-used pesticides from corn and soybean production.

Western and northern corn root worm, soybean cyst nematode, white mold, brown stem rot and persistent weeds are all showing increasing resistance to commonly used pesticides and crop rotation as a control mechanism. At the same time, public concern over ground and surface water pollution from leaching and runoff of chemical inputs is rising toward new regulation.

Breaking these disease and pest cycles with expanded rotations, can also cut reliance on chemical input costs and overall expenses. But can new cash grains make sufficient contributions --in the health and yield of corn and soybean production, in overall soil fertility and retention, in improved nutrient management, in the spreading of labor costs and time --to maintain or improve the profitability of conventional production?

Answers to this very important question can only come from farmers themselves. Unless farmers are willing to:

- Try expanded rotations in fields they farm.
- Experiment with cover crops for nitrogen credits.
- Learn to market alternative grains and meet market expectations for quality.
- Study for themselves the impact diversification has on their soil; their corn and soybean production; their ability to break disease, weed and pest cycles; the spreading of their labor costs and time.

The question will go unanswered, misperceptions will prevail and the mentality toward small grains will remain 100 years old.

This USDA Fund for Rural America project seeks to assist those fanners who want to arrive at their own answers to these intense challenges. It aims to help them face the serious economic and agronomic pressures that are increasingly linked to limited rotations.

The production strategy this project has proposed confronts these challenges head-on. It takes advantage of new cropping system flexibility to adopt more diversified, value-added, integrated production systems.

Diversification can reduce agronomic risk and income fluctuation. Value-added commodities can increase farm income. On-farm enterprise integration can reduce production costs and environmental impacts. And new or better-integrated markets for quality grains can increase farm incomes.

This project will focus on cash grain production of high-grade oats, barley and winter wheat -- grown with cover crops and used to expand the conventional com-soybean rotation.

Oat fields once spread across millions of acres in the Upper Midwest. Most nutritious of the cereal grains, oats served many purposes beyond the breakfast table. From their yellow flower clusters at harvest time came high quality feed for livestock and high energy grain for horses. And their stalks yielded bedding straw for farm animals.

In 1965, Wisconsin farmers were planting more than 2 million acres in oats, nearly one million acres under their record harvest of 1945. Iowa had just under 3 million acres planted in oats in 1965 (down from a peak of more than 6.5 million acres in 1950). Illinois had more than 1.2 million acres planted in oats in 1965 (40 years after its record harvest of 4.855 million acres in 1925). And Minnesota had more than 3.2 million acres planted in oats in 1965.

Today, while demand for small grain commodities remains stable[1], production in the United States has fallen drastically.
Federal farm policies, trends in agribusiness, radical shifts in livestock production and agricultural research dollars in the past 30 years have all turned cash grain production toward corn and soybeans -- and away from small grains. Food processors and malt houses, while still concentrated in the Upper Midwest, now go to foreign markets for more than 50 percent of their small grains needs.

In 1996, oat plantings fell to 430,000 acres in Wisconsin, to 320,000 acres in Minnesota, to 285,000 acres in Iowa, and to 90,000 acres in Illinois.

Similar stories can be told for barley production in the Upper Midwest, with acreage falling so low in Illinois and Iowa that state agricultural statistics services stopped keeping track of plantings (in 1981 and 1973 respectively). Record wheat harvests in Illinois and Iowa date to the turn of the century and the late 1800s.

This project seeks to diversify Upper-Midwestern cropping systems by re-introducing production of small grains -- with cover crops -- into the now conventional corn-soybean rotation.

To help fanners deal with the challenges they are facing both in the field and the economy, new long-term cash grain strategies are needed. To remain competitive internationally, to restore their role environmentally as good stewards of soil and water resources, to enhance the economic life of rural communities -- farmers, grain handlers and food processors must work together, find and try new alternatives.

Adopting a cash grain focus

What is most important in growing a small grain crop? Many successful oat producers identify the importance of variety selection. Others insist that timing, planting oats early, for instance, is the key.

A farmer who decides to plant oats, barley or winter wheat must take this production as seriously as corn or soybean production. Successful growers of small grains have the same focus and dedication for these crops as conventional farmers --for whom tremendous technical and agronomic assistance from the

[1] Of the 130 million bushels of barley malted each year in the United States, more than half is malted in the Upper Midwest. Breweries located here in large part because, historically, barley was grown in this region. The same holds true for oats, for which domestic production has been upwards of 100 million bushels. The largest mills (Quaker, General Mills and Kellogg) are all located in the Upper Midwest, though like the malting houses, they now obtain most of their raw materials from outside the region. Domestic demand for high quality horse feed in an expanding recreational market also remains strong in the eastern portion of the United States.

agribusiness community is readily available--invest in production of corn and soybeans.

A farmer must commit to growing an oat, or barley, or winter wheat crop that is as much a winner as a prize field of corn or soybeans. Most successful corn growers, for example, would not select a corn hybrid without considering the field history, soil type, fertility program, drainage and future goals.

All successful ***plantings*** begin with successful ***planning.*** Following are a few considerations and suggestions to help the farmer who wants to develop a successful plan in the planting of small grains.

- Check labeling for all chemicals used in current production for restrictions related to wider rotations.
- Review and understand your soil test results.
- Ask yourself what problems may be associated with the fields where you are considering planting your small grain.
- Consider how much nitrogen credit you can add to your production by making use of a small grain and/or a cover crop in rotation with corn and soybeans.
- Consider how much herbicide you will need after shifting weed pressures and populations.
- Ask yourself what can be accomplished in the small grain portion of your rotation to achieve organic amendments.
- Weigh the costs and benefits of harvesting straw from your small grain field or leaving it behind for subsequent crops.
- Reflect on which varieties will best fit your program.

Proper attention given to planning will address most, if not all of these important considerations.

Select best variety for your crop

First and foremost, consult your state Crop Improvement Association Guide. The "randomized and replicated" field trials in all the published results show not only yields, but lodging scores, disease resistance, grain quality, and many other attributes of the varieties available.

Carefully consider the purpose -- dairy feed, milling grade, horse oats, cash crop vs. nurse crop -- of the small grain before selecting the variety you want to plant.

Iowa
Iowa crop Improvement Association
112 Agronomy Building
Iowa State University
Ames, Iowa 50011

Wisconsin
Wisconsin Crop Improvement
554 Moore Hall
University of Wisconsin
Madison, WI 53706

Minnesota
Minnesota Crop Improvement Association
1900 Hendon Avenue
University of Minnesota
St. Paul, MN 55108

Illinois
Illinois Crop Improvement Association 3105
Research Road P.O. Box 9013
Champaign, IL 61826

Consult variety recommendations in the detailed "Devising a Strategy" section for each small grain in this guidebook (p.14).

Ensuring seed quality can pay

Planting high quality seed is essential for producing high yielding small grains. Only seed that is weed-free, germination-tested, and pure should be planted. The cost of quality seed is not a negative factor in "profit per acre." Various seed treatments are available, but as of this date, we have no cost/benefit guidelines for incurring the additional expense.

Study field history, lay of field

Previous field history is as important to small grains planting as it is to corn and soybean production.

First, check chemical labels for herbicides that have been applied to the field being planted to small grains. Triazine carry-over is ***not*** the problem it was 15 years ago. However, check the label on currently used chemicals. For example, Pursuit is labeled for use 18 months before oats. Harness is 2 years. See UWEX publication A3646, Field Crops Pest Management in Wisconsin, for a complete list of herbicide rotation restrictions.

Compaction is one of the more common factors affecting oat yields. Oats grow better on well-drained soils. Conventional wisdom has long held that, "oats like their feet dry, while corn likes to keep its feet in water."

Corn and soybean diseases seldom affect oats. Scientific research associated with this project is being conducted to demonstrate the extent to which small grains in rotation will at least ***"cut"*** many soybean diseases and ***"change"*** weed pressures in corn, while ***"allowing"*** nitrogen to be more available to subsequent rotations.

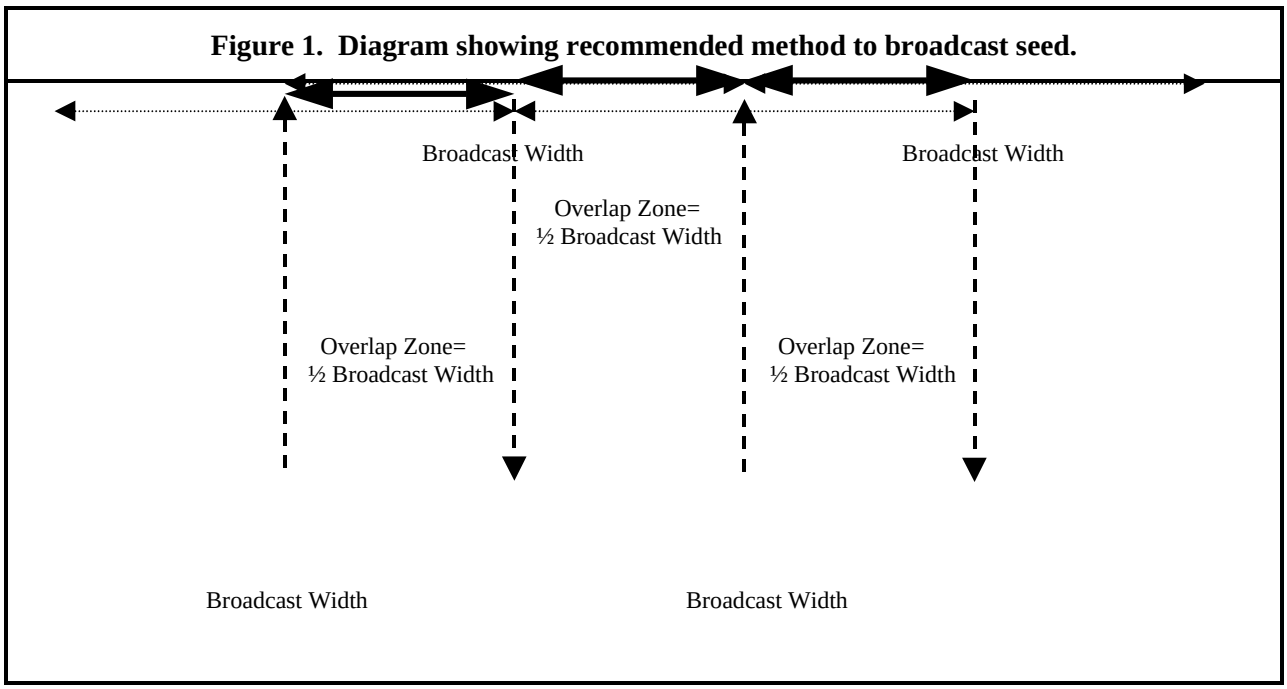
Preparing seedbed and frost seeding

Oats and other small grains can be planted successfully under a variety of soil conditions. Selection of a seedbed preparation technique should be done with a goal of planting as early as possible.

Again, conventional wisdom has dictated that all frost must be out of the soil before oats can be seeded without causing compaction. Frost-free ground, however, needs many days of drying before it can support the weight of modern machinery .Our limited research suggests that the benefit of earlier planting is not compromised by doing light tillage or a seeding operation ***while frost*** is still supporting the machinery .The '1rick" of frost seeding is working with "freeze-dried" surface conditions with no snow cover, a condition that creates a suitable base for the planting equipment. All spring-planted small grains do better when planted shallow. A one-inch depth usually works well.

Fields that have been tilled in the fall have the potential to be very mellow. These fields may need to be firmed up to achieve the one-inch planting depth. Frost seeding is a compromise and should be approached cautiously. When you are frost seeding, increase the seeding rate by one-half to 1 bushel per acre to help ensure a good stand.

Figure 1. Diagram showing recommended method to broadcast seed.



Plowing levels ground, but often comes too late in the spring to achieve the benefits of an early spring planting of oats or other small grain crops. However, if manure has been surface applied, plowing will minimize the effects of the high nitrogen content commonly found in the manure. ***It is generally best to find an alternate field rather than chance lodging caused by nitrogen in the manure.*** Spring plowing can provide an excellent seedbed, but the likely delay in planting may lead to an unacceptable compromise in yield potential.

Light tillage aerates the soil and redistributes residue, both of which help to ensure a reliable oat crop. Broadcast seeding of oats can be done before light tillage if the field is smooth and level. Be sure to keep the tillage operation very shallow. Many growers mix 18-46-0 or similar dry fertilizer with the seed oats and *double spread* with a spinner fertilizer box or use the "air-flow" system. Rollers, spike harrows and cultipackers can be used to provide seedbed firming.

Double spreading is a technique used to ensure even application of seed and fertilizer. If, for example, the broadcast spreader covers a 90-foot width, the operator will travel one direction across the field, but makes the next pass at a distance equal to one-half the broadcast width (see Figure 1). In this example the next pass would be made at a distance of 45 feet from the last pass. The broadcast spreader is set to spread at one-half the desired spreading rate because the ground is covered twice.

Whatever tillage is employed, good seed to soil contact is essential, and seed depth should be no greater than one inch. Soil should never be worked when excessive moisture is present, be it seeding, tilling or harrowing. Use proven techniques for your soil type and conditions and experiment with techniques that are working elsewhere and that may give you a production edge.

Planting dates, rates, technique

Yield potential for small grains declines as planting dates are delayed. Studies at Iowa State University have shown a loss of 1.3 bushels yield/acre/day if oats are planted after April 16. For northern Illinois, the yield loss seems to begin after a planting date of April 1.

This is particularly true if the objective is to produce high yielding, high test weight, milling quality oats.

For this reason, practices such as no-till drilling, frost seeding, and other techniques, which allow seeds to be placed "as correctly" as possible when the soil temperature reaches 34 degrees should be used.

It appears that physiological maturity is greatly influenced by that "trigger date." This creates the best potential for the oat crop to fruit in the cooler temperatures of June, and it offers the advantage of fewer midsummer thunderstorms that could damage the crop before harvest.

Beyond April 15, high yield potential has been lost, mostly because of lower test weight. After Apri115, the economics may be in favor of a different crop. In any "system approach" to profitable crop production, ***flexibility*** is an essential part of a sound production plan.

Planting rates depend on variety, seeding method, and production goals. Seeding rates range from 2 ½ bushels to 4 bushels per acre. The lowest rate would be with alfalfa under seeded. The highest would be broadcast seeding of short straw varieties. Check the rated lodging score against the seeding rate. Oats with low lodging scores can often be pushed in population.

Fertilize for soil test, yield goals

In our "corn belt" area, soil tests often reveal very high fertility levels. This makes adding fertilizer a little tricky, as too much will cause excessive growth, lodging, and yield reduction.

In the last two years of the Illinois pilot project, 41 site years of data was generated from growers. Soil tests were collected on every field. Generally, if soil tests indicated that the phosphorous levels were at ***50 pounds per acre or greater***, not much response from the addition of starter fertilizer was apparent. Fields below ***50 pounds per acre*** showed a significant yield increase, even with low amounts of starter. ***(150 lbs 18-46-0)***

Additional nitrogen, regardless of form, caused a yield reduction from lodging when ***50 pounds per acre*** was exceeded.

It appears that small grain growers are more consistent and more profitable by going easy on the fertilizer. Grain quality also dropped when fertilizer rates exceeded 50 pounds per acre. Fields exhibiting a high fertility produced excellent yield and high quality oats where no additional starter fertilizer was applied. Research associated with this Fund for Rural America project is being conducted to address this issue.

Controlling for weeds

Tillage for seedbed preparation helps control broadleaf weeds, but does little for grasses. Early planting gets the oats ahead of the grasses, which are not much of a problem. Lambsquarter and Giant Ragweed will grow rapidly after the soil temperatures get in the mid 50s.

If these types of weeds get a good start, spraying with MCPA Amine or the other recommended chemicals is about the only alternative to a mower.

Good control is often obtained with reduced rates. All herbicides must be sprayed before the boot stage, usually around June 1 in the Upper Midwestern region.

Check with your local Cooperative Extension Office, and/or consult the "Field Crops Pest Management in Wisconsin -1999" available from Cooperative Extension Publication, Room 245, 30 N. Murray St., Madison, WI 53715. Phone: (608) 262-3346.

Scouting for pests and diseases

Scouting should include checking each stand (initially) and monitoring development of weed, insect and disease pressure. Commonly, growers get concerned about 30 days after planting that their crop is not thick, tall, or green enough.

This is common with early planted oats but the oats are continuing to mature physiologically. By May 1, you will probably still see the ground in the field, but by May 20 the plants should be closed in, shading weeds and the soil. Scouting weekly will keep you informed of the crop condition; it provides timely information about management options that can keep your cropping system profitable.

Harvesting for best results

Swathing and direct-cut combining each have advantages and disadvantages. Either can be very successful in zones where 30 or more inches of rainfall is not uncommon.

Threshing the "good" oats from the heads and getting a "clean" sample is a problem for most growers in our project. Oats need to be threshed with a very tight concave setting and high cylinder speed in a conventional machine. Cylinder speeds of 1200 RPM put a strain on drive belts that have only been used for speeds of 600 RPM. Also, the engine works much harder.

Even when the oat crop's moisture level is down to 13 percent, the grain at the base of the oat pinnacle (oat head) is difficult for the combine to thresh.

These are often very high test weight oats. Proper combine settings will allow the maximum test weight of your crop while lowering field losses. Some field loss is necessary when the combine cleaning fan is running at the necessary speed to properly separate the grain.

However, the oats blown over the chaffers are generally "light oats" that cause very little yield reduction. Check your operator manual for settings recommended for your machine.

Handling and storage

Oats to be stored on the farm should be harvested at or near 13% moisture. Up to 15% is safe if they are put in a clean bin with aeration. Oats left overnight in the combine, truck or wagon will test several points wetter the following day, resulting in dockage. Deliver oats immediately or store with air for at least 3 days.

If you handle oats through an auger after they sit or cure for 3 days, they will pick up a few pounds of test weight when graded. This is an acceptable practice. In Europe, growers may not only store the oats for a time, but also clean them several times.

Check the label of any and all fumigants that you plan to use for insect control. Make sure the chemical is safe for use in oats.

Marketing: Profits don't just happen; strategy yields return

Oats are in great demand by milling houses and processors. However, they must be quality oats. This means 36 lbs+ test weight at 13% moisture and **not** mixed with barley or wheat. These quality standards (Table 1) can be met with the newer varieties and good management practices.

A potential alternative for the marketing of oats is the horse market. There are a record number of horses in the United States today, and the owners of these horses generally prefer high quality oat feed. Determining how to tap into this potential market in your locality may offer a significant boost to your marketing options.

Test Weight in Pounds per Bushel	Percent Moisture	Percent Foreign Matter (FM)	Grade of Oats
38 lbs or more	13% or less	1% or less	Milling Oats (#2 heavy white oats)
Other Specifications:	⇨ 10% small oats (5/64" by ¾" slots) allowed ⇨ 96% SCO Minimum ⇨ 0.2% Maximum heat damage allowed ⇨ 11.25% Minimum Groat Protein ⇨ No Live Infestation ⇨ All grain **must** be free of fumigant or pesticide residue		

Table 1. General Milling Oat Specifications

The key to higher financial returns from small grains remains in management practices that lead to a high quality end product. **Quality oats** will command higher prices and quality oats **can** be produced on your farm.

A key purpose for re-introducing oats into your cropping rotation is to lower your financial risk. Increasing diversity in your cropping rotation is a potential hedge against any number of surprises that can occur between planting season and the time you sell your crop.

Diversity is only one component of this hedge. **Flexibility** is another important element. Markets, weather, soil, weed pressure, or other conditions may create a need to alter your planting strategy.

With this last thought in mind, explore other small grain options, such as hard red winter wheat. Diversity in small grains may be as important as diversifying corn and soybean rotations.

Devising post-harvest program

Part of the strategy of including a small grain/cover crop in your rotation is that the crop is off the field in late July or early August. This is a great opportunity to plow down a green manure, work on problem areas of the field, be it weed patches or tile problems. There has been very good research done in many of these areas.

Another popular option is to use tillage or chemicals after the harvest to create a "green free" period. By eliminating all vegetative growth, air and sunlight combine to interrupt the life cycles of molds, funguses and some plant diseases. Improved crop health the following year has been widely reported, but documentation of this phenomenon is scarce.

References

Illinois Agronomy Handbook 1995-1996, University of Illinois at Urbana-Champaign, College of Agriculture, Cooperative Extension Service, Circular 1333.

A Guide to Quality Oat Production, Agriculture Extension Service, University of Minnesota, AG-BU-2019- December 1983.

Field Crops Pest Management in Wisconsin, C.M. Boerboom, J.D. Doll, R.A. Flashinski, C.R. Grau, J.L. Wedberg, Cooperative Extension Publications, University of Wisconsin-Extension A3646 1996.

Legume Cover Crops in Wisconsin, A Guide for Farmers, Jim Stute, Wisconsin Department of Agriculture, ARMPUB 55 8/96.

*Sample Production Log**

Name: _____ Address: _____

Phone: (_____)_____ E-Mail: _____

Field Location:

County: _____ Township: _____ Section: _____ Range: _____

Number of Acres: _____ Variety of Oats: _____ Planting Rate: _____ bushels/acre

Planting Date: _____ Longitude: _____ Latitude: _____

Field History:

1997 Crop: _____ 1996 Crop: _____

Chemicals: _____ _____

Rate: _____ _____

Weeds: _____ _____

Other: _____ _____

Soil Test Values:

P_1: _____ K: _____ Ca: _____ Mg: _____

Water Ph: _____ Cat Exc: _____ Organic Matter: _____

Soil Type: _____ Slope: _____

Expenses-Inputs:

Seed: $_____ Fertilizer: $_____ Insurance: $_____ Tillage: $_____

Planting: $_____ Spraying: $_____ Swathing: $_____ Combine: $_____

Hauling: $_____ Storage: $_____ Other: $_____

Total Expenses: $_____

Income:

Total Bushels: _____ Moisture: _____ Test Weight: _____

Price/Bu: $_____ Income from Oats: $_____ Income from straw: $_____

Total Income After Expenses: $_____

*** A separate seed-book size data input log has been developed for this project.**

Field Map and Scouting Notes:

Devising a strategy for your small grain in rotation with corn and soybeans

Read through the following procedures and considerations and carefully devise a strategy for including a small grain in your rotation.

ADDING OATS

Field selection:
Oats prefer well-drained soils, so selecting a field that dries out relatively early in the spring is important. Taking account of a field's prior weed control practices is also important. A number of corn and soybean herbicides have restrictions when used in rotation with oats, and many corn herbicides have 2-year restrictions for small grains. Consult the product's label for this information. For a comparison of restrictions, see the 1999 Pest Management in Wisconsin Field Crops cooperative extension publication A3646.

Tillage/Planting:
The key to high yields and heavy test weight oats is early planting. Optimally, oats should be planted by April 10. Conventional land preparation and drilling gives the best stands. However, it is often difficult to complete this type of land preparation by early April. Growers have two alternatives for getting around this problem:

- **No-till drilling into "freeze dried" soil (late March)**. There is usually a period in March when the soil surface thaws enough to permit no-till drilling (l-inch depth), yet soil strength is adequate to hold heavy no-till equipment. Seed planted this way is ready to germinate once temperatures reach 34 degrees. The conventional seeding rate of 3 to 3.5 bushels/acre should be increased to 3.5 to 4.5 bushels/acre.

- **Broadcast seeding (early April).** On fields that have been tilled in the fall, light tillage and broadcast seeding followed by a roller spike harrow or cultipacker can be done once some of the frost has left the soil. We do not recommend no-till broadcasting of oats.

Selecting a variety:
There are many very good oat varieties available that may fit your production goals. We offer information on three varieties for you to consider:

- ***Dane:*** For first-year growers of high-quality oats, we recommend Dane. This is an early-maturing, high-yielding oat developed at the University of Wisconsin and released in 1991. When planted early, it flowers before the hotter weather in late June. It has disease resistance, and the stiff straw and short height reduce lodging. In a conventional tillage system, it must be planted at 3 to 3.5 bushels/acre for maximum yields -- even when there is an underseeding of alfalfa or clover[2]. This oat is not a smother crop, so be sure to plant it thick at this rate. If you are cropping alfalfa or red clover for nitrogen credits, you can plant this oat at full rate and not worry about shading the under -seeding. The crop will reach maturity ahead of all other oats and will usually be out of the field in late July (providing there is an absence of prolonged rains) in the Upper Midwest region. This oat gives consistent, reliable yields in most weather conditions. First- time oat growers, or "let's be sure to make a profit" oat growers do well with this variety.

- ***Blaze:*** This is a relatively new variety from the University of Illinois. It is tan-seeded with excellent yield potential and high test weight. Blaze is tolerant to

[2] More details on recommended small grain varieties can be found in Extension Publication A3397 (Small grain Varieties for Grain and Forage in Wisconsin, 1999).

Barley Yellow Dwarf Virus and has moderate resistance to Crown Rust.

- ***Jerry:*** High test weight, high yield, strong disease resistance package, and in the mid- season maturity group. This is a white oat with a high test weight that can go direct to the "Equine market." North Dakota State release with good straw yield and strength.

Companion-seeding a **cover crop:**
With oats, it is possible at planting time to companion seed a legume cover crop. The Small Grains Initiative recommends medium (not mammoth) red clover seeded at 10 to 12 lbs./acre for most producers. We recommend Arlington Medium red and Common Medium Red from a good seed source. (Not using certified seed can give highly variable performance.)

Experience has shown that this system will result in good cover crop production in most years, without adversely affecting oat yield. Straw yield may be somewhat lower since the cutter bar must be set higher to avoid contaminating the straw with red clover at harvest time. Total nitrogen in the legume biomass generally exceeds 120 pounds per acre by fall.

Refer to technical information on red clover in this guidebook for additional details on cost, management and performance.

Sequential-seeding a cover crop:
For producers who prefer to plant a cover crop after the small grain harvest, we recommend hairy vetch. Management information on vetch is also provided in this guidebook.

Dealing with weed pressure:
Weed control is important for obtaining optimum yields. High planting densities and early planting reduce the chances that growers will need to use herbicide. When herbicides are necessary, and clover is companion seeded with the oats, MCPA amine may be applied at 12 ounces per acre around June 1 (before the boot stage). Other herbicides will adversely affect the red clover[3]. For sole seeded oats, Banvel, Buctril, Harmony Extra, Stinger and 2,4-D are all appropriate herbicides.

Fertilizing your crop:
Oat fertilization at optimum soil test levels we recommend NPK rates of 40-40-120. If oats are undersown with a leguminous cover crop, nitrogen applications can be halved. Oats following soybeans do not need any nitrogen. Oats should not be planted on fields that have recently been manured.

Pest control:
The incidence of most oat diseases and insects, including Barley yellow dwarf and stem rust, are reduced if the oats are planted early or if a tolerant variety is used. If needed, appropriate fungicides include Dithane m-45, Manzate 200, and Pennocozeb. Aphid control in oats can be accomplished with Cygon 400, malathion, Penncap and Warrior[4].

ADDING BARLEY

Field selection:
Barley grows best in well- drained soils that are neither very high in organic matter nor recently manured. Barley is easier to add to cropping systems than oats because it has few rotational constraints due to herbicides. It should not be planted, however, the year following soybeans that have received applications of herbicides that have a 12-month or greater restriction (see product label). If the barley is for malting, it is not advisable to plant it following corn due to the increased risk of scab. Many corn herbicides also have 2-year restrictions for small grains. Always read pesticide labels carefully for restrictions. For a comparison of restrictions see UWEX. Publication A3646.

[3] If alfalfa is companion seeded instead of red clover, either MCPA or Buctril can be used if needed.

[4] More details on pest management in small grains can be found in Extension Publication A3646 (1997 Field Crops pest Management in Wisconsin).

Tillage/Planting:
The key to high yields of barley is planting by April 1 so that flowering takes place during rnid - to late - May. As maximum day temperatures climb above 63 degrees F, the number of spikelets per head decreases. Conventional land preparation and drilling give the best stands. However, it is often difficult to complete this type of land preparation by late March. Growers have two alternatives for getting around this problem:

- **No-till drilling into "freeze dried" soil (late March).** There is usually a period in March when the surface thaws enough to permit no-till drilling (l-inch depth) yet soil strength is adequate to hold heavy no-till equipment. In this way the seed is ready to germinate once temperatures reach 34 degrees F. Seeding rates should be 2 to 2.5 bushels/acre.

- **Broadcast seeding (early April).** On fields that have been tilled in the fall, light tillage and broadcast seeding followed by a roller or cultipacker can be done once some of the frost has left the soil. Seeding rates should be 1.5 to 2 bushels/acre.

Varieties[5]:
Two types of barley are grown in Wisconsin: feed barley and malting barley. Hazen and Kewanee are the leading varieties of feed barley. They are both six-row, smooth-awned varieties, taking about 50 days to head and 110 days to mature. Yields above 75 bushels/acre are common. Excel, Robust and Stander are varieties approved for malting. They are similar to the feed types except that they offer somewhat less resistance to leaf rust and powdery mildew.

Companion-seeding a legume cover crop:
With barley, it is possible at planting time to companion seed a legume cover crop. The Small Grains Initiative recommends planting medium red clover seeded at 10 to 12 lbs./acre. This system usually provides good cover crop production, without adversely affecting barley yield. Straw yield may be somewhat lower since the cutter bar must be set higher to avoid contaminating the straw with red clover at harvest. Total nitrogen in the legume biomass averages 120 lbs./acre by fall.

Weed control:
Barley planted early at high seeding rates is very competitive with weeds. However, if broadleaf weeds are a problem, Banvel, Buctril, Harmony Extra, Stinger or 2,4-D are all appropriate herbicides. When barley is companion seeded with clover, MCPA amine can be applied around May 1 (before the boot state)[6]. Follow label guidelines carefully to avoid injury to the legume seeding.

Fertilizing your crop:
Recommended NPK fertilization for malting barley at optimum soil test levels is 50-40-80 lbs./acre. However, barley following a good crop of soybeans or undersown with a legume usually does not need any additional nitrogen. Protein levels in malting barley above the accepted 13.5 percent result when more nitrogen is available than is needed to produce the obtained yield. This most frequently happens either when:

- The field has too much available nitrogen; OR
- When heavy crop vegetative development is followed by adverse conditions after heading, thus reducing potential grain yield.

Pest control:
The incidence of most barley diseases and insects, including barley yellow dwarf and stem rust, are reduced if the barley is planted early and if tolerant varieties are used. If needed, appropriate fungicides include Dithane M-45, Manzate 200, and Penncozeb. Aphid control in barley can be accomplished with malathion and Penncap-M.

[5] More details on recommended small grain varieties and pest management can be found in Extension Publication A3646 (1998 Pest Management in Wisconsin Field Crops) and A3397 (Small Grain Varieties for Grain and Forage in Wisconsin -1998).

[6] If alfalfa is companion seeded, either MCP A or Buctril can be used.

ADDING WHEAT

Field selection:
Wheat should follow early maturing soybeans for optimal yield because low residue levels and good soil conditions will promote rapid germination and seeding establishment. Weed control in the soybean field is important: winter wheat should not be planted on fields that have been treated with Command, Sonolan, or Treflan. It is also inadvisable to plant wheat within 4 months of applying post emergence Pursuit on soybeans. Other post-emergence herbicides that require a 4-month wait before planting wheat include Reflex and Reliance. Many soybean herbicides limit or prevent the planting of wheat. Many corn herbicides also have 2-year restrictions for small grains. Always read pesticide labels carefully for restrictions. For a comparison of restrictions see UWEX publication A3646

Tillage:
Both conventional and no-till options work. While the best stands usually result from conventional tillage, if the fall is dry, deep, no-till planting into moist subsurface soil works well. When the planting date is delayed or when temperatures are below normal, conventional tillage is preferable.

Planting:
Ideally, winter wheat should be planted at a rate of3 bushels/acre by Sept. 20. This is usually possible only if the wheat follows a short-cycle soybean (<1.9 maturity rating). Aerial seeding just prior to soybean leaf drop is an option. It permits earlier planting dates. Aerial seeding should be done at 15 percent higher planting rate (3.5 bushels/acre) than when seed is drilled.

Wheat planted following full-season soybean varieties will often be delayed until Oct. 10 to 20. Planting rates should be increased to 3.5 bushels/acre if this method must be used.

Varieties:
Under most conditions, cultivars with high yield potential and moderate winter hardiness outperform cultivars with lower yield potential and greater winter survival. However, if wheat planting is delayed past Oct. 15, winter hardiness is of greater importance in southern Wisconsin. Public varieties of winter wheat recommend by the Small Grains Initiative include[7]:

- **Cardinal:** beardless, soft red winter wheat developed at Ohio State University. It has a medium maturity rating, excellent straw strength, high yield potential (70 bushels/ acre), and moderate winter hardiness.

- **Dynasty:** bearded, soft red winter wheat also developed at Ohio State University. It has a medium maturity rating, excellent straw strength, good yield potential (65 bushels/acre) and moderate winter hardiness. Seed for this variety is relatively scarce.

- **Glacier:** bearded, soft red winter wheat developed at the University of Wisconsin. It has a medium maturity rating, excellent straw strength, good yield potential (66 bushels/acre) and a high level of winter hardiness.

Frost-seeding a cover crop:
In late February or early March, a legume cover crop should be frost seeded over the wheat. The Small Grains Initiative recommends medium (not mammoth) red clover seeded at 15 to 18lbs./acre for most producers. We recommend Arlington Medium Red and Common Medium red from a good seed source. (Not using certified seed can give highly variable performance). Experience has shown that this system will result in a good cover crop stand most years, without adversely affecting wheat yield or reducing straw quality.

Straw yield may be somewhat lower since the cutter bar must be set higher to avoid contaminating the straw with red clover at harvest time. (Refer to technical information on red clover in this guidebook for additional details.

[7] Recommendations based on Agronomy Advice publication, "1997 Winter Wheat Variety Results and Recommendations" and the 1997 Extension publication A3397, "Small Grain Varieties for Grain and Forage in Wisconsin."

Sequentially seeding a cover crop:
For those producers who prefer to grow the cover crop after the wheat is harvested, we recommend hairy vetch. Refer to the enclosed technical sheet on vetch for additional information.

Weed control:
Conventionally tilled winter wheat seldom requires chemical weed control. With no-till systems, control of broadleaf weeds (for example, shepherd's purse and pennycress) may be important. MCPA Buctril, Banvil and Harmony Extra are all options. If the wheat includes a companion seeded leguminous cover crop, the only option is MCPA amine (8 to 12 oz./acre) applied in mid- to late May.

Fertilizing your crop:
At optimum soil test levels, we recommend NPK rates of 60-60-100. For wheat following soybeans, no more than 40 to 50 lbs/acre of nitrogen should be applied. On high test soils (P>30 ppm, K>170 ppm) no additional fertilizer should be applied.

Pest control:
The incidence of most diseases and insects in wheat can be reduced by non- chemical management practices. Crop rotation with corn and soybeans reduces take-all and septoria leaf blotch. Delayed planting controls most barley yellow dwarf. Alternative host control limits leaf rust and take-all. Varietal selection is also key to controlling many diseases and pests. For producers who nevertheless have difficulty with pests and disease, recommended fungicides include Bayleton, Dithane M-45, Manzate 200, Penncozeb, and Tilt. Insecticides for aphid control include Cygon 400, Malathion, Penncap-M and Warrior[8].

[8] More details on recommended small grain varieties and pest management can be found in Extension publications A3646 (1997 Field Crops Pest Management in Wisconsin) and A3397 (Small Grain Varieties for Grain and Forage in Wisconsin --1997).

Cutting chemical inputs, halting erosion, and getting nitrogen from cover crops

A benefit of including small grains in the corn-soybean rotation is the opportunity to grow a legume cover crop. Traditionally, cover crops are thought of as green manures, used to supply nitrogen to the following corn crop, reducing or eliminating the need for fertilizer N. They offer several other benefits as well. These include: reducing soil erosion and often helping growers meet conservation compliance, adding organic matter to the soil, as well as possibly interfering with the lifecycles of several corn and soybean pests. The following discussion of cover crops is specific to establishing cover crops with small grains. For more in-depth information refer to the following publication: *Cover Crops in Wisconsin: A Guide for Farmers* (bulletin ARMPUB55), available from the Michael Fields Agricultural Institute or the Wisconsin Department of Agriculture, Trade and Consumer Protection.

LEGUME ESTABLISHMENT OPTIONS

Several legume establishment methods and timing are possible with small grains in the Upper Midwest. Substantial legume yields are possible if the right legume is matched to the right establishment option.

INTERSEEDING IN WINTER WHEAT

Frost Seeding Legume seed is broadcast onto frozen soil, typically in mid-March when snow cover is gone and the soil freezes at night and thaws during the day. This freeze-thaw cycle causes the soil to form cracks into which broadcast seed falls. This is done with a broadcast seeder mounted on a small tractor or ATV. A fertilizer dealer may be able to apply clover seed with fertilizer if the dealer has "air-flow" equipment.

Advantages	Disadvantages
Frost Seeding • Fast • Inexpensive *Drilling* • Uniform stands are usually achieved.	*Frost Seeding* • Timing is difficult. Freeze/thaw cracking phenomenon often occurs only a few days each year. • Stands are often variable. • Thin layer of frozen soil often cannot support weight of equipment. • Cold temperatures may kill freshly germinated seedlings. *Drilling* • Slower than frost seedling. • Soil may not dry sufficiently to permit drilling before wheat tillers. Legumes seeded after wheat tillers often die due to competition.

INTERSEEDING IN WHEAT - GENERAL

Advantages	Disadvantages	Legume Choices
• High legume yields are possible because of a relatively long growing season. Much of it without competition from wheat.	• Underseeding eliminates possibility of herbicide use to control broadleaf weeds. Tall growing legumes can interfere with grain harvest and will "contaminate" straw.	• Red clover is the best option for interseeding because of its tolerance to low light intensities and semi-prostrate growth habit. It will spread out while shaded by wheat, allowing it to suppress weeds. Other clovers may be acceptable but will probably not be as productive. Do not use hairy vetch because its climbing growth habit can cause severe lodging.

Drilling: Legume seed is drilled into wheat after the soil has thawed but before wheat begins to tiller. Drill should be set just deep enough to assure good soil-to-seed contact.

COMPANION SEEDING WITH SMALL GRAINS

Legumes can be consistently and reliably established by companion seeding with small grains. This establishment method is the cheapest because the legume and primary crop are planted in one pass. Most Midwestern research shows that underseeded legumes do not reduce small grain yields and that legumes yield similarly whether seeded with oat, barley, or spring wheat. Successful establishment of companion seeded legumes depends on early planting and good soil/seed contact, just as with alfalfa establishment.

Advantages	Disadvantages	Legume Choices
• High legume yields are possible because of a relatively long growing season. Much of it without competition from the small grain.	• Underseeding eliminates possibility of herbicide use to control broadleaf weeds. • Tall growing legumes can interfere with grain harvest and will "contaminate" straw.	• True clovers such as red and, to a lesser extent, ladino are best suited to companion seeding. Clovers are tolerant of the low light intensities found under the small grain canopy and tend to spread out to capture light rather than grow upright, shading out weeds in the process. Berseem clover and annual medic have potential for companion seeding.

SEEDING AFTER SMALL GRAIN HARVEST

Legumes can be successfully established after harvest of small grains. Substantial legume yields are often achieved because of the length of the growing season available for growth. Dry soil conditions are often encountered in mid- to late July, which may delay germination. Drilling seed or performing light tillage after broadcasting seed is preferred over leaving seed on the soil surface. Germinated seed on the soil surface may dry out and die. Existing weeds must be controlled.

Advantages	Disadvantages	Legume Choices
• Legumes do not interfere with growth or harvest of the primary crop. • No-till establishment is possible.	• Establishment requires additional field operations. • Weed competition can be severe especially when seeded in July. Weed pressure becomes less severe as planting dates become progressively later.	• Large-seeded legumes are the best choice for " sequential" seeding if maximum legume yield in the seeding year is desired because they have an early competitive advantage over small -seeded legumes and many weed species. Hairy vetch has proven to be productive when seeded after small grains. Annual medic and berseem clover look promising but have not been thoroughly tested at this point. • If legumes are going to be allowed to overwinter and produce growth the following spring, other legumes such as alfalfa (use cheap seed), red clover, and sweetclover all can b e used. However, establishment without herbicide is risky, and spring growth will add little biologically fixed nitrogen to the soil (see Management section).

SUCCESS WITH LEGUMES

Chances for success with legumes will be greatly enhanced if the following general rules are followed:

1. **Inoculate legume seed** with the proper strain of *Rhizobium* bacteria. Different legumes require different strains, and many commercial products contain strains for several species. Inoculation is an inexpensive way to insure adequate nitrogen fixation will occur.

2. **Use seed with a high total germination.** A high percentage of hard seed is acceptable when establishing perennial forages but not for green manuring. In addition to reducing legume yield (or increasing seeding cost to get the desired stand), hard seed may result in a weed problem the following year under certain circumstances.

3. **Provide good soil/seed contact.** Legume seed needs good soil/seed contact to germinate rapidly. Cover seed when possible. This is especially true for large-seeded species such as hairy vetch.

4. **Minimize competition from weeds.** Small-seeded legumes germinate and grow very slowly initially, making them poor competitors with weeds. Anything which can be done to reduce or suppress weed competition will improve the chances for legume success.

SEEDING YEAR MANAGEMENT

The goal of seeding year management is to maximize legume yield and minimize weed pressure.

Weed Control

Weed management is critical for success with cover crops. Weeds are the major management problem when legumes are seeded in spring. Weeds are often a problem when legumes are seeded following harvest of another crop. Also the type of weed present depends on when the legume is seeded. Broadleaves such as pigweed, lambsquarters, velvetleaf, and smart weed as well as foxtail tend to be a problem when legumes are seeded after pea, snap bean, or early sweet corn harvest. Volunteer grains and foxtail are the predominant weeds when legumes are seeded after small grains. Weeds can also be a problem in companion seeding situations, especially when the small grain stand is thin. The following options can be used to help control weeds and reduce weed pressure.

Seed Legume with a Small Grain

Small grain species such as oat and rye germinate and grow rapidly and can provide some weed suppression until the legumes become well established. Using small grains also provides early ground cover to protect the soil. Establishing legumes with a small grain works best for spring and early summer seeding. Small grains should be planted "out of season" (i.e., use winter rye in spring and oats for summer or fall seedings) to minimize competition and volunteer seed production. Use a medium seeding rate to prevent excessive competition. Small grains can also be killed chemically for about $10/acre.

Tillage

Two successive light tillage operations can reduce weed pressure by encouraging weeds to germinate with the first pass and killing them with a second pass 10 to 14 days later. This method will control the first flush of weeds but will leave the soil bare longer and will delay legume seeding.

Clipping

Clipping can be very effective in reducing weed pressure. Clipping works best with legumes seeded in spring (either alone or with a small grain), and when weed pressure is light to moderate or is coming from a late flush of weeds. Clipping is ineffective when weed pressure is heavy and legumes are not well established. Also, only certain legumes will tolerate clipping. Species which use

root reserves for regrowth tolerate clipping well and will grow rapidly following clipping. Red clover tolerates clipping well. Species which rely on photosynthate for regrowth (i.e., remaining leaves capturing solar energy which is used for new plant tissue) respond poorly to clipping because of slow growth after being cut. Sweetclover is a legume which responds poorly to clipping, while hairy vetch is set back. Setting the cutter bar as high as possible will reduce the setback caused by clipping.

Herbicides can be used to control heavy infestations of grass weeds, especially volunteer small grains, but can add substantially to total costs for using legumes. Excessive growth by grass species may indicate that soil nitrogen is readily available, a situation where grass species are preferred because of their ability to grow rapidly and capture available soil N.

Applying Nitrogen To Small Grains

Does applying nitrogen to the small grain affect seeding year dry matter yields or nitrogen accumulation when legumes are interseeded? Work in Wisconsin suggests that adding nitrogen does not reduce either dry matter yield or nitrogen accumulation whether red clover was frost seeded into winter wheat or companion seeded with oat, spring wheat, or barley. Excess N, beyond what the small grain can use, may promote weed growth after harvest. Excess N can also reduce the amount of biologically fixed nitrogen added to the system because all legumes will preferentially use available soil nitrogen instead of fixing their own. Excessive lodging or foxtail pressure late in the growing season may indicate over application of fertilizer nitrogen to the small grain.

LEGUME CHARACTERISTICS

RED CLOVER *(Trifolium pratense* L.)

Red clover is a moderate to high producer of dry matter and nitrogen in the seeding year. It is well adapted to many soil types, tolerates clipping well, and stands up to traffic. Red clover can be either biennial or a short-lived perennial. Mammoth or "single cut" is a true biennial while medium or "two cut" is a perennial. Individual plants have an upright growth habit with multiple major stems and a large branching taproot with many secondary roots. Herbage nitrogen content ranges from 2.0 to 3.0% on a dry-weight basis.

GROWTH CHARACTERISTICS AND REQUIREMENT	Cold tolerance:	Medium
	Drought tolerance:	Low
	Winterhardiness:	Medium
	Soil type:	Medium to heavy. More tolerant of wet, acidic soils than other legumes.
	Soil pH:	6.2 to 7.0. Will tolerate pH as low as 5.2.
	Soil fertility:	P and K in medium to high range.
CULTURAL INFORMATION	Seeding rate alone:	10-12 lb/acre companion seeded. 15-18 frost seeded.
	Seeding rate with others:	10-12 lb/acre.
	Seeding date range:	March to August. Later seeding reduces winter survival.
	Planting depth:	Less that ½"
	Seedbed preparation:	Firm seedbed required. Adapted to frost seeding.
SEED	Cost:	$0.80-2.50/lb depending on variety and type. Use common seed or unimproved varieties for green manuring as persistence is not necessary.
	Availability:	Widely available.
PEST PROBLEMS	Susceptible to leaf diseases such as anthracnose, leafspot, and powdery mildew. Insects feed on clover but seldom cause economic injury in the seeding year.	
USES	Best when companion seeded with small grains or frost seeded. May perform satisfactorily when seeded after harvest of short season crops but will not produce significant growth until the spring of the second year. Interseeding into corn or soybean is risky.	
SPECIAL CONSIDERATIONS	Red clover is often difficult to kill with tillage.	

HAIRY VETCH *(Vicia villosa* Roth)

Hairy vetch is a moderate to high producer of dry matter and nitrogen in the seeding year .It is well adapted to many soil types and is very competitive with weeds once established. Hairy vetch is an annual but can function as a winter annual in Wisconsin if well established. It will winterkill if it blooms before a killing frost. Hairy vetch is easily and effectively killed with tillage or mowing (after blossom); although rank growth is often a problem. Individual plants are vine-like with a climbing growth habit. The root system is fibrous. Herbage nitrogen content ranges from 3.2 to 4.2% on a dry-weight basis.

GROWTH CHARACTERISTICS AND REQUIREMENT	Cold tolerance: Drought tolerance: Winterhardiness: Soil type: Soil pH: Soil fertility:	High Medium High Sandy to heavy. Not adapted to poorly drained soils. 6.0 to 7.0 is optimum. Will tolerate 5-8. P and K in medium to high range.
CULTURAL INFORMATION	Seeding rate alone: Seeding rate with others: Seeding date range: Planting depth: Seedbed preparation:	25-30 lb/acre drilled or 30-40 lb/acre broadcast. Reduce seeding rate ~ 25%. April to September 15. Seeding year growth limited when seeded after mid-August. ½-1". Best if drilled. Does not require the fine, firm seedbed that small-seeded legumes require. Suitable to no-till.
SEED	Cost: Availability:	$0.70-1.00/lb. Widely available but often requires a special order.
PEST PROBLEMS	Susceptible to common leaf diseases such as leafspot and anthracnose. Believed to ~ a possible alternate host of the soybean cyst and root-knot nematode.	
USES	Best when seeded in spring on fallow ground, on "set-aside" acres, or after harvest of short-season crops. When seeding in spring, consider planting with winter rye to provide weed suppression and early ground cover. When seeding in late summer, consider including oats for die same reasons. Interseeding into corn or soybeans is risky.	
SPECIAL CONSIDERATIONS	Do not companion seed with small grains or grow in rotation before winter wheat. Hairy vetch will climb up small grain and cause lodging, making harvest difficult. It also has hard seed and may become a problem weed in small grains. Hairy vetch does not tolerate wheel traffic.	