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Organic Small Grain Production Overview

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This publication gives a general overview of organic small grain production. It includes basic production principles, tips on transitioning to organic, ideas for rotation design, and examples of rotations from various parts of the United States.

A field of organic winter wheat at the Quinn Farm, Big Sandy, Montana. Photo: Susan Tallman, NCAT

Contents

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Introduction

Cereal grains serve as the primary source of carbohydrates for the human diet. Corn, rice and wheat together accounted for 87% of all grain production (UNFAO, 2008) and 43% of all consumed food calories worldwide in 2007 (UNFAO, 2007). Of these three crops, wheat ranks third in world grain production, with corn first and rice second.

Table 1. World Corn, Wheat and Rice Production

Crop	World Production (MMT)	U.S. Production (MMT)
Corn	826	307
Rice	685	9
Wheat	683	68
(UNFAO, 2008)		

Wheat and rice belong to a category known as small grains, which also includes barley, oats, rye, and triticale. This paper will give an overview of the organic production of these small grains, as well as buckwheat. (Rice is addressed in a separate ATTRA publication, *Organic Rice Production*.)

While all of the small grains are important and have a place in a crop rotation and in the human diet, wheat is the most significant in terms of amount produced and economic returns. Table 2 illustrates comparable small grain production in the United States and the world for the 2008/2009 crop year.

Table 2. Global Small Grain Production

Crop	World Production (MMT)	U.S. Production (MMT)
Wheat	683	68
Barley	154	5.2
Oats	26.4	1.2
Rye	17.3	.203
(UNFAO, 2008)		

Within the United States, the Great Plains states lead all others in small grain production. Kansas, North Dakota, Oklahoma, and Montana rank as the top wheat-producing states, respectively. In 2008, these four states combined produced 986,500,000 bushels (26.8 MMT) of wheat (USDA NASS 2008).

While wheat plays a significant role in the agricultural production of the United States, the USDA estimates that only 1% of all cropland in the country is certified organic (USDA ERS, 2008). Of 66 million acres in small grains production, only 492,355 are certified organic. As of 2008, Colorado ranked as the state with the most organic grain acreage, with 60,339 certified organic acres (USDA ERS, 2008).

Table 3: Top 10 States for Organic Small Grain Acreage, 2008

State	Total Organic Small Grain* Acreage
Colorado	60, 339
North Dakota	54, 685
Utah	54, 213
California	46, 223
Montana	44, 579
Texas	34, 176
Minnesota	28, 861
Nebraska	26, 217
South Dakota	23, 087
Wyoming	21, 079
U.S. Total	492, 355
Includes wheat, oats, barley, spelt, buckwheat, & rye. (USDA ERS, 2008).	

Demand for organic grains fluctuates according to buyers' needs. In general, however, the demand for organic foods continues to increase in the United States. According to the Organic Trade Association, demand for organic products has increased by about 20% every year since 1997 and, at $24.8 billion, accounts for 4% of total food sales in the United States (Organic Trade Association, 2010). The rate of growth slowed in 2009, with retail sales of organic food increasing by 5.1% from 2008 to 2009. But by contrast, total U.S. food sales increased by just 1.6% during that same time period (Organic Trade Association, 2010).

While the opportunity for producing organic grains is significant, organic production is not without its challenges. Weed management, soil fertility, soil moisture, tillage, rotation design, and marketing present a unique set of obstacles for organic grain farmers. (For more in-depth information on these topics, consult the other publications in the ATTRA Organic Small Grain Production series.)

There are several reasons to consider producing organic small grains.

Reasons to Consider Organic Grain Production

1. A farmer must innovate and experiment on his own farm. This can be a rewarding challenge.
2. Organic production means less pesticide exposure for the farmer and his family.
3. Organic production requires increased crop diversity, which spreads out the income source and helps break pest cycles.
4. With careful management, organic production can improve the health of the soil. With increased organic matter, there is increased nutrient availability, less soil crusting, and better water infiltration.
5. Not purchasing synthetic fertilizer and herbicide means less expense per acre and less potential need for an annual operating loan. Per-acre returns can be the same or better than conventional farming.
6. Cash crop yields can compare to 90 to 100% of conventional tillage system yields once the rotation is established.
7. Demand for organic grains is strong. Prices paid to organic producers are historically greater than those paid to conventional producers.
8. NRCS-EQIP funds may be available to help offset costs of conversion, such as seed costs for cover crops.
9. Programs may be available through state departments of agriculture to offset the costs of organic certification.
10. There is a strong support network in the organic community, offering advice, training, and resource materials. Linking with other farmers in the region is critical for success.

Reasons to Think Twice About Organic Grain Production

1. A farmer must innovate and experiment on his own farm. This can be a significant source of frustration.
2. Nutrient management is not as prescriptive as in conventional grain production. While nitrogen can be gained through green manure legumes, the nitrogen produced from these crops varies widely with the weather and precipitation.
3. Most large grain farms do not have easy access to large amounts of animal manure, which can be a key component to building soil fertility.
4. The first three to five years of organic production are the most difficult, as the system adjusts to new management. In addition, no organic price premiums are available during the three-year transition phase.
5. Without other organic farmers to talk to, it can be difficult to know what steps to take. Having other organic farmers in the area increases the chances of success.
6. Tillage is generally the most significant method of weed control in an organic system. But tillage can defeat the purpose of building soil organic matter and can increase soil erosion.
7. Currently, a system of continuous, no-till organic production has not been perfected for grains. A diverse no-till system can improve soil structure, increase organic matter, and decrease soil erosion better than the current tillage-dependent system of organic production.
8. Organic record keeping adds to the paperwork required to run the farm business.
9. A cash grain crop cannot be produced on each field every year.
10. Finding a buyer may be difficult for farmers who live in areas where grain has not traditionally been produced.

A Brief Definition of "Organic"

Organic farming is the act of producing food without the use of synthetic fertilizers or pesticides and without the use of genetically modified seeds or products. In order to sell crops as certified organic, a farmer must verify that he has followed these practices for at least 36 months prior to his first organic harvest. To become certified organic, a farmer must file an organic system plan (OSP) with a certifying agency and have an annual on-farm inspection. All certifying agencies in the United States use the same organic production standards, as set forth by the USDA in the National Organic Program, or NOP, to verify the process by which organic crops are produced.

The specific language of the National Organic Program can be accessed at the Federal Code of Regulations, Title 7 Part 205, National Organic Program. These regulations can also be read in the Organic Materials Review Institute (OMRI) Standards Manual 2009.

For more information on how to complete an Organic System Plan (OSP), refer to the *Organic Crops Workbook* by ATTRA. This workbook explains each step of filling out an OSP. The New Farm website from the Rodale Institute also offers step-by-step guidance on creating an OSP and provides several sample OSPs for reference: www.tritrainingcenter.org/code/osp_index.php.

To locate a certifier, access the list of accredited USDA organic certifiers at www.ams.usda.gov.

Certifiers charge a fee to apply for organic certification and a fee for the annual inspection. In addition, there is a fee based on total gross sales, which is often about 1%. The average organic grain farmer in Montana pays close to $1000 in total fees per year (Montana Organic Association, 2008). Talk with your certifier about potential cost-share programs for certification. In the past, the USDA has offered a cost-share program through state departments of agriculture. Check to see if this cost-share is still in place.

Production Principles

The key agronomic factors in growing organic small grains include building soil health, managing nutrients and water use, managing pests, and designing a rotation.

Top 10 Agronomic Principles for Growing Organic Small Grains

1. Maintain a healthy level of soil organic matter. Reduce tillage as much as possible to prevent organic matter depletion.
2. Test soils for nutrient availability on a regular basis. Harvesting grain removes nutrients from the system. These nutrients must eventually be replaced.
3. Provide nitrogen by growing green manure legume crops. Provide all other essential nutrients from organic fertilizer sources.
4. Provide as many nutrients as possible from biological sources, such as animal manure, green manure legumes, compost, and cover crops. Mined organic fertilizer sources such as rock phosphate are often expensive and have low nutrient availability.
5. Consider integrating livestock into the crop system. Manure is an excellent source of phosphorus and organic matter.
6. Reduce soil water loss in arid regions by terminating green manures before they use too much soil moisture. Maximize catchment of snow in the winter by cutting stubble higher at harvest.
7. Minimize fallow periods to provide ground cover, minimize erosion, and add biomass to the system.
8. Use multiple techniques for weed suppression, including tillage, variety selection, increased plant spacing and density, and crop rotation. Farmers with serious perennial weed problems, such as Canada thistle or field bindweed, should seek to control these weeds first, prior to producing organic grain. Alternate strategies such as pasture or hay production might be preferable until these weeds are under control.
9. Be aware that as humidity and temperature increase, so does pest pressure. Organic farmers will have more difficulty with disease and insect control in warm, humid regions.
10. Diversify the crop rotation as much as possible. A diverse rotation is essential to breaking pest cycles and spreading out financial risk.

Soil Health

A fallow field at Boehm's organic grain farm, Richardton, North Dakota. Photo: Susan Tallman, NCAT

The foundation of any good organic system is healthy soil. Soil organic matter is one of the most important measures of soil health, since so many soil properties are affected by it. According to the National Organic Program regulations, organic certification requires establishing a crop rotation that "maintains or improves soil organic matter content" (NOP, 2011). In most agricultural soils, organic matter accounts for only 1 to 6% of the soil mass. Even though it's a small fraction of the soil, organic matter contributes large benefits to the biological, physical, and chemical aspects of the soil.

From a *biology* standpoint, as organic matter increases, the population and activity of soil organisms also increase. These organisms break down the active organic matter and make the nutrients available to future crops through mineralization. When soil organisms aren't active, "more fertilizers will be needed to supply plant nutrients" (Magdoff and VanEs, 2000).

From a *physical* standpoint, as organic matter increases, the tilth of the soil improves. As organic matter breaks down, it leaves behind sticky substances known as glomalin that bind particles together and create aggregates. These aggregates improve soil structure and porosity, which in turn improve water infiltration and decrease soil erosion. The improved structure also allows for improved root growth. In addition, organic matter acts as a sponge to hold water, which helps to provide for crop growth even in a drought year.

From a *chemical* standpoint, as organic matter increases, the fertility of the soil increases. Because of its small particle size, humus acts similar to the clay fraction of soil and stores cations (positively charged nutrients such as Ca+2 and K+) on its exchange sites. Humus then serves as a bank of slow-release fertilizer throughout the growing season. This characteristic of organic matter becomes even more important in coarse soils with little clay. In these soils, organic matter can become the main source of natural fertility (Magdoff and VanEs, 2000).

Good management practices are necessary to maximize organic matter additions and decrease organic matter depletion. These practices are summarized in Table 4.

Table 4: Effects of Different Management Practices on Organic Matter

Management Practice	Gains Increase	Losses Decrease
Add materials from outside the field (manures, composts, etc.)	Yes	No
Better utilize crop residue	Yes	No
Include high-residue-producing crops in rotation	Yes	No
Include sod crops in rotation (grass/legume forages)	Yes	Yes
Grow cover crops	Yes	Yes
Reduce tillage intensity	Yes/No	Yes
Use conservation practices to reduce erosion	Yes/No	Yes

(Gilmour, 2009)

Further Resources

Building Soils for Better Crops by Magdoff and VanEs, an excellent resource for an in-depth discussion of organic matter and soil health.

Managing Cover Crops Profitably is a great resource for anyone looking for more information on cover crops. You can purchase the book or download a PDF copy at http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition. For further reading on soil biology, refer to the following NRCS brochure: "Soil Biology and Land Management," January 2004. http://soils.usda.gov/sqi/publications/files/soilbiolandmgt.pdf

Interpreting the Soil Conditioning Index: A Tool for Measuring Soil Organic Matter Trends, NRCS, Technical Note No. 16, April 2003.

Addition of Organic Matter

Active organic matter can be added to a small grain system in several ways: crop residues, cover crops, animal manures, and composts. In large systems, crop residues and cover crops will be the most common sources. In systems with livestock, such as a dairy operation, manure and compost may be more accessible.

How much is enough?

There is no ideal target level for organic matter, as the soil's capacity to hold it varies depending on soil texture and climate. Sandy soils may be able to hold up to 2% OM, while clay soils can hold as much as 6% OM (Magdoff and VanEs, 2000). Ideally, management should result in organic matter increasing over time, and then stabilizing.

Soil testing should be conducted every few years to monitor soil organic matter levels. Keep these tests on file, as organic matter levels can take a decade to show significant change. A lab test showing increased organic matter should verify results noticed from field experience, such as reduced crusting after a heavy rain, darker soil color, and improved yields under drought stress.

Crop Residue

Organic wheat stubble at the Quinn farm, Big Sandy, Montana. Photo: Susan Tallman, NCAT

Crop residues are a main source of organic matter in a small grain system. Because the residues of wheat, oats, and rye have a C:N ratio of about 80:1, they break down rather slowly compared to more succulent broadleaves (Magdoff and VanEs, 2000).

When managing crop residues in an organic system, a few principles should be noted:

- Leave as much crop residue in the field as possible. Removing residues will promote erosion, and removes valuable organic matter.
- Good residue management begins at harvest. Straw should be spread uniformly during harvest using the chaff spreaders, and not left in a windrow. This allows for an even rate of surface coverage and microbial activity.
- In low rainfall areas, where managing soil moisture reserves is essential, consider operating your combine header as high as possible to leave as much of the straw anchored to the soil as you can. One no-till study from Canada recommends leaving stubble over 12 inches (30 cm) in length when possible. More standing stubble in the field catches more snow for soil moisture reserves (Zentner et al., 2004).

Cover Crops

A spring pea cover crop at the Hinebauch Farm, Chinook, Montana. Photo: Susan Tallman, NCAT

The most common cover crops used in an organic small grain system are legumes such as peas, which also add nitrogen to the soil. For an in-depth discussion, see the ATTRA publication *Nutrient Management in Organic Small Grains.*

Further Resources

For an overview of using cover crop cocktails and their effect on soil organic matter, view the ATTRA webinar "Innovative No-Till: Using Cover Crop Cocktails to Improve Soil Health." www.attra.ncat.org/video/index.php

Animal Manure

The organic matter benefit from manure will depend on the type of manure used and the analysis of the specific manure. All manures are not created equal and many factors influence manure composition, such as the feed ration and the presence of bedding. Estimate the organic matter contribution of manure by multiplying the amount of dry matter by 25%, since 75% of the manure will decompose within a year (Magdoff and VanEs, 2000).

Compost

The amount of organic matter in compost can vary widely, from 30% to 70%, depending on the materials used (Bass, 2010). A lab analysis of the compost can help to determine the exact level.

Because of its relatively high organic matter levels, compost can add about the same amount of organic matter to the soil as a high-carbon cover crop. The challenge for many organic grain farmers, however, is to find a large enough source of compost for their large acreages.

Rate of Organic Matter Decomposition

The rate of organic matter decomposition is important. If the decomposition is too fast, nutrient release will be in a rapid burst and little organic matter will be left in the soil over the long term. If the decomposition is too slow, too much residue will tie up nutrients by immobilization, and not enough organic matter will be produced (Magdoff and VanEs, 2000). The ideal is to achieve a uniform, steady rate of decomposition.

Several factors will influence the rate of active organic matter decomposition, including climate and tillage.

Location

In general, as annual rainfall increases, soil organic matter increases, due to the increased plant biomass and residues. Conversely, as average temperatures increase, the amount of soil organic matter decreases. "In general, the decomposition of organic matter is accelerated in warm climates; a lower rate of decay is the rule in cool regions" (Brady 1990).

While a farmer cannot change his or her location, it is important to be aware of the difference it makes. Farmers in regions with higher rates of decomposition may need to consider more frequent additions of organic matter than those in regions with lower rates of decomposition.

Tillage

Tillage is another important factor in organic matter decomposition. Tillage stirs the soil, incorporates oxygen, and burns up organic matter. Note: "The most effective way to reduce (organic matter) decomposition is to reduce or eliminate tillage" (Gilmour, 2009).

Tillage equipment at the Quinn Farm, Big Sandy, Montana. Photo: Susan Tallman, NCAT

This point alone may be the key challenge of organic grain production: because organic systems rely heavily on tillage for weed control, there is a continual loss of organic matter from the system and an increased risk of soil erosion.

No-Till Organic

Because too much tillage can be detrimental, work is being done by the Rodale Institute and others to develop a no-till organic system. Early work with a roller crimper and no-till drill to seed soybeans into a rye cover crop in Pennsylvania has proved promising. However, there is much work to be done before this system is truly continuous no-till and adapted for various regions of the country.

Further Resources

For more information on Rodale's work to date, visit their website at www.rodaleinstitute.org/no-till_revolution.

The Roller-Crimper

The roller-crimper is an implement designed to terminate cover crops without tillage and is a key component of a no-till organic system. The drums of the implement are designed to be filled with water for added weight. The amount of water added varies depending on the size of the roller, as well as the field conditions where it will be used. In other words, different field conditions will require different amounts of added weight.

A roller-crimper implement in a cover crop of cereal rye, NDSU experiment station, Dickinson, North Dakota. Photo: Susan Tallman, NCAT

When using the roller-crimper, timing is essential to successful termination. If soil moisture is not a concern, grasses should be terminated during pollen shed and broadleaves during flowering. The ideal scenario is to terminate the cover crop at the peak of its biomass production. If soil moisture is a concern, however, termination may need to be earlier.

Jeff Moyer, farm manager at Rodale Institute in Pennsylvania, estimates that a rye cover crop should be terminated when it reaches a minimum biomass of 5000 lbs/acre.

Several farmers and researchers have been experimenting with the roller-crimper with mixed results. Dr. Perry Miller at Montana State University has done some work in Bozeman, Montana, research plots. He finds that if rolled too lightly, the cover crop won't terminate at all. But if rolled too heavily, the cover crop stems get cut and the crop will re-grow as a result. The ideal scenario is to provide enough pressure to crush the cover crop without cutting the stems. This can be a difficult sweet spot to find (Miller, 2009).

Members of the Burleigh County Soil Conservation District in Bismarck, North Dakota, have also been experimenting with the roller-crimper. In 2008, they rolled a cover crop mixture of peas and oats. The peas terminated beautifully, but the oats bounced back after a few days. In 2009, they terminated only a pea crop at the pod stage with great results. Dr. Pat Carr at the NDSU research station in Dickinson, North Dakota, has also done some preliminary work on rolling a cover crop of rye with good termination.

Where the implement is attached is also an important factor for successful termination. Rodale recommends mounting the roller on the front of the tractor so that it encounters the cover crop before the tractor tires do. The tires may not completely crush the crop and may allow for the cover crop to bounce back in the tracks a few days later. The success of this suggestion may depend upon the type of cover crop, however. A back-mounted roller-crimper terminated peas very successfully in Bismarck, North Dakota.

Organic farmers interested in using a roller-crimper should contact the Rodale Institute, as they have formed a testing group to share ideas and information. There is much that needs to be discovered and improved with this implement, and more on-farm trials are needed in various regions before the technique of using it is perfected.

Further Resources

Two equipment manufacturers in the United States supply roller-crimpers: I & J Mfg. in Pennsylvania, and Bigham Brothers Mfg. Co. in Texas. These roller-crimpers can be custom-made according to any width a farmer might need, based on tractor, 4-wheeler, or draft animal team size, and field layout. According to I & J Mfg., their 10.5-foot roller for a tractor mount weighs 1,600 pounds. empty and 2,400 pounds filled with water.

In addition, farmers are using various brands of stalk choppers, roller harrows, cultipackers, bed rollers, and land rollers, either factory-made or custom modified, to accomplish the same function of rolling down cover crops for no-till production.

Buckeye Tractor Company manufactured the 3-point hitch for front-mounting the roller-crimper for the Rodale Institute.

Buckeye Tractor Co.
P.O. Box 97, 11313 Slabtown Road
Columbus Grove, OH 45830
419-659-2162
800-526-6791 Toll-Free
419-659-2082 Fax
buctraco@bright.net
www.buctraco.com

I & J Manufacturing
5302 Amish Road
Gap, PA 17527
717-442-9451
717-442-8305 Fax
www.croproller.com

Bigham Brothers, Inc.
P.O. Box 3338
Lubbock, TX 79452
806-745-0384
800-692-4449 Toll-Free
806-745-1082 Fax
www.bighambrothers.com

Crop Production Definitions

Conventional: Growing crops with the use of tillage, such as chisel plow, disc, and harrows. Uses synthetic fertilizer and pesticides.

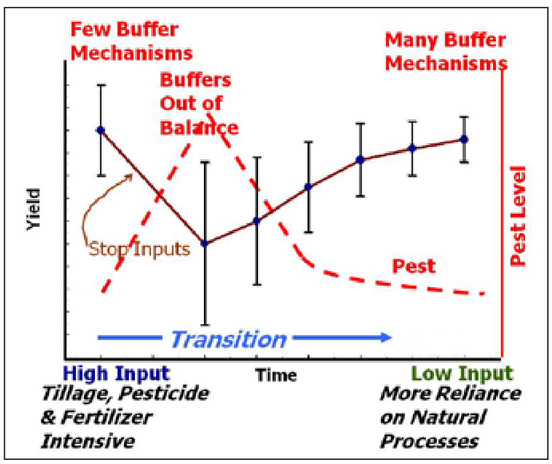
No-till: No tillage of the soil. Herbicide is widely used for weed control in place of mechanical tillage. Beneficial for decreasing soil erosion and building soil structure.

Organic: Growing crops without synthetic fertilizer and pesticides. Because broad-spectrum herbicides are not used, some mechanical tillage must be used to control weeds.

Transition to Organic

One of the main concerns producers express when contemplating a switch from conventional to organic grain production is the yield comparison between the two production methods. For most producers the first three years are the most difficult, as the system adjusts to new techniques.

Figure 1. The Transition Adjustment



Graph: Dr. Bruce Maxwell, Montana State University.

Figure 1 illustrates the potential drop in yield during the transition period. Notice, however, that over time organic yields do return to near-conventional levels, with less variability than before.

It takes time for the ecosystem to adjust to different farming techniques. In a conventional system, there are few buffers and many inputs. (A buffer would be any biological factor that minimizes adverse conditions, such as beneficial insects, microbial activity, etc.) During the transition period, the off-farm inputs (pesticides and fertilizers) are reduced, and the buffers are not quite developed yet. The system is unbalanced. As the rotation is established and the natural buffers increase, the system levels out and yields return to levels similar to before the conversion.

There have been several regional studies on yield differences between conventional-tillage and organic systems. Two of these studies were done in corn and soybean production systems. Cornell University in Ithaca, New York, did a 22-year study on yield differences in organic corn and soybeans and found that yields dropped by a third during the transition years, but then recovered to conventional levels after the transition (Lang, 2005).

"First and foremost, we found that corn and soybean yields were the same across the systems," said entomologist Dr. David Pimentel (Lang, 2005), who noted that although organic corn yields were about one-third lower during the first four years of the study, over time the organic systems produced higher yields, especially under drought conditions. The reason was that wind and water erosion degraded the soil on the conventional farm while the soil on the organic farms steadily improved in organic matter, moisture, microbial activity and other soil-quality indicators.

Another study, from Iowa, showed that organic corn yielded 98% and soybean yielded 91% compared with conventional-tillage systems. These high organic yields occurred in the first year of the transition (Delate et al., 1999).

Researchers at Montana State University conducted a four-year comparative study in Bozeman, Montana (Miller et al., 2008). They compared one organic system with three diversified no-till systems for yield and economic return. They found "the mean shoot biomass and grain yield for winter wheat in the organic system equaled or exceeded that in the three diversified no-till system phases." In addition, the grain from the organic system had better test weight, indicating improved water efficiency in the organic system. This may be due to a decreased nitrogen level in the organic system in the spring. Although this particular study showed similar yields in test plots, Dr. Miller estimates that in an actual farm setting, organic wheat generally yields less than that of continuous no-till wheat due to soil fertility issues (2009). These plot-scale studies were conducted on research land that had more-than-adequate levels of nutrients from fertilizer applications in prior experiments.

The economic returns from this study were also of interest. The organic system produced lower annual returns in the first three years of the study, when the transitional crops did not yet qualify for sale at an organic premium. When organic premiums were factored in during the last year of the study, the organic system produced much greater economic returns than the no-till systems. (This study assumed a 75% premium for spring wheat over the conventional market, 25% for barley, and 100% for lentils.)

Caution should be taken before extrapolating these results on a larger scale. This particular study was only four years in length, with no nutrients added to the organic plots. Over a longer period of time, those plots would need some source of fertility, such as manure or rock phosphate. The cost of this addition would decrease the net return of the organic system.

The best way to determine potential yield of organic crops is to ask other farmers in the area. Remember that annual yield is different than average yield, which looks at all years in a particular rotation. In any organic system, a cash crop cannot be grown every year due to the need for soil-building crops such as green manure in the rotation.

Ask other organic growers in your region for specific yield information.

Transition Out of CRP

CRP land has been enrolled in the Conservation Reserve Program of the NRCS. This land has been idle for at least 10 years and is often seeded into a mixture of native range species. While converting CRP land to organic is relatively simple from the certification perspective, it will be a challenge from the production perspective. Given time and good management, however, it is possible.

This land can be certified organic right away, as long as the farmer can verify that no synthetic fertilizers, pesticides, or GMOs have been used on the land in the past 36 months. This verification is done in the application paperwork of the certification process, and through the annual organic inspection of the farm. Contact a certifying agency directly to ask about their specific verification process.

Passing the certification requirements will be the easy part. The hard part will be bringing that land into successful production. Joe Carelton, NRCS Area Agronomist in Great Falls, Montana, offers some helpful insights on this topic. In his experience, bringing land out of CRP has been very difficult for both organic and conventional farmers in his area. The two main reasons for this are the low available nutrients and the large weed seed bank.

It is important to understand the quality of the soil prior to bringing land out of CRP. Typically, CRP land is marginal cropland. Ideally, a farmer would want to start an organic system on the best possible land to maximize productivity and decrease potential soil erosion.

CRP and Soil Fertility

Most CRP land has a lot of dead plant material that is very high in carbon. There will also be considerable coarse root material, which adds to the carbon load. This makes for a very high carbon to nitrogen ratio (C: N). When this material is plowed under, the soil microbes are overloaded and cannot break it down fast enough. These microbes will immobilize available soil nutrients to break down the plowed material.

CRP land with high carbon residue. Photo: Joe Carleton, NRCS

Most organic producers bringing out CRP land find they need to work it mechanically for a year to help break down the plant residue. Even then, the amount of soil nitrogen is very low. So the following year it is best to plant some type of green manure and till it under at mid-bloom stage. At this rate, it takes at least a year and a half to prepare for the first winter-seeded cash crop. During this time, it is critical to conduct soil tests to monitor fertility levels, as you will need to make crop decisions based on the nutrient levels in your soil. A light feeder such as barley may be a better choice for a first crop than wheat, because of lower soil fertility requirements.

> Organic producers have met with both failure and success with production on former CRP land. In 2007, I met an organic farmer who took land out of CRP in the spring and planted spring wheat that same year. His yield was only 5 bushels per acre! This story serves as a good caution to make sure you know your soil fertility levels and take time to build up your soil before expecting an economic return.
>
> In contrast, Randy Hinebauch of Chinook, Montana, has been successfully transitioning CRP into organic production for several years. However, he makes sure old residues are broken down before planting a cash crop. (See the ATTRA publication *Farmer Profiles: Two Organic Grain Farm Case Studies,* at https://attra.ncat.org/attra-pub/summaries/summary.php?pub=355, for more information.)

CRP and Weeds

The other major consideration in bringing land out of CRP will be the latent weed seed bank. There are weed seeds that have been waiting for years in this soil for the opportunity to germinate and grow. Consequently, there may be a high need for mechanical cultivation the first year or two, before planting a cash crop. Timing will be especially important in terminating a green manure crop. Make sure to plow it under before the weeds go to seed. Ideally, this will be at the mid-bloom stage of the legume, but it may need to be earlier for weed control. Follow with shallow tillage at each weed seedling flush. Consider starting your crop rotation with a forage crop such as an oat/pea mixture that can be hayed off in the spring to help with weed control.

Transition in Stages

Because the transition time can be a challenge, successful organic farmers often recommend transitioning in stages. Rather than converting the entire farm at once, divide it into sections and convert one portion at a time over the course of three to five years.

Producing both conventional and organic on the same farm is known as "parallel production," and presents its own challenges. The main challenge is to keep accurate records to prove that the conventional production practices have not carried over to the organic land. For example, implements need to be cleaned when moving from one type of field to the next and adequate buffer space must be maintained between fields. In addition, storage facilities must be thoroughly cleaned with organically approved methods, and bins must be clearly labeled to avoid any confusion.

> **Further Resources**
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> Canadian Organic Growers has an excellent book titled *Gaining Ground*, which profiles 80 Canadian farmers and their transition experiences.
>
> In addition, COG also publishes the *Organic Field Crop Handbook*, an excellent resource for organic grain farmers.
>
> Contact COG at www.cog.ca, or call 1-888-375-7383.
>
> The NRCS may provide some cost-share for transitioning to organic through the EQIP program. Check with your state NRCS office for more information on this program.
>
> Montana State University Extension has published a guide titled "From Conventional to Organic Cropping: What to Expect During the Transition Years" http://msuextension.org/publications/AgandNaturalResources/MT200901AG.pdf

Rotation Design

Farmers transitioning to organic often ask advice on the ideal rotation for their operations. One challenge of organic farming is that there is no single ideal rotation. The best rotation will be different for each farm, and should allow for some flexibility from year to year depending on weather conditions.

The National Organic Program standards require crop rotation for organic certification. The specific rule states:

> *The producer must implement a crop rotation including but not limited to sod, cover crops, green manure crops, and catch crops that provide the following functions that are applicable to the operation:*
>
> *a) Maintain or improve soil organic matter content;*
>
> *b) Provide for pest management in annual and perennial crops;*

c) *Manage deficient or excess plant nutrients; and*

d) *Provide erosion control*
(NOP, 2011).

There are a few principles for designing a good rotation. Several important points to consider include water use, soil fertility, diversity, and livestock integration.

Water Use

In areas with adequate rainfall, water use is not an issue. But in the arid West, water trumps all other factors in crop production. In any dry-region crop system, farmers must be very careful not to copy farming methods that work in humid areas. In 1959, two researchers from Montana made the astute observation that the early farmers and researchers of the Great Plains "tried to impose a humid-area system of agriculture in the area…" often with disastrous results (Army and Hide, 1959). Especially when using green manures and cover crops, great care must be taken to not deplete the soil moisture resources by letting the crop grow for an entire season.

Randy Hinebauch, an organic farmer in Chinook, Montana, says that every year that he harvests his peas in July or August for seed instead of terminating them for a green manure in June, he pays for it with lost wheat yield the next year. Meanwhile, Bob Quinn, an organic farmer in Big Sandy, Montana, uses less alfalfa in his rotation during dry weather patterns because it dries out the soil more than other green manure species, such as pea.

Water use in crop production is often referred to as crop intensity, and "means growing a combination of crops that will match soil water storage with crop water use under your local climatic conditions" (Montana NRCS, 2001).

Dr. Dwayne Beck of the Dakota Lakes Research Farm in Pierre, South Dakota, has developed a useful crop intensity calculator to help with soil moisture budgets (Dakota Lakes Research Farm, No date). Each crop is ranked for its relative water usage, then all crops are averaged over the length of the rotation for the intensity rating. Notice that these estimates were developed in long-term continuous no-till systems. **As a general rule, grain production systems with tillage, such as organic, will lose more water than continuous no-till systems.**

Close-up view of a Brown soil moisture probe, Hinebauch farm, Chinook, Montana. Photo: Susan Tallman, NCAT

While these guidelines are helpful, nothing beats getting out there yourself and monitoring your own fields. Monitor soils with a shovel or a Brown probe to make sure fields have adequate soil moisture. Take particular notice of how tillage affects stored soil moisture. Also, be aware of the water use of any soil-building cover crop. Fine tune the termination date of cover crops for your specific location.

Note: Local and state NRCS offices should be able to help with crop intensity calculations for dry regions.

Using a Brown soil moisture probe, Hinebauch farm, Chinook, Montana. Photo: Susan Tallman, NCAT

Fertility

Fertility also plays a part in rotation design. In general, nitrogen will be the determining fertility factor that influences an organic rotation. A good rule of thumb is to place your heaviest-nitrogen-using crop directly after a soil-building crop or manure application. For instance, if you are growing spring wheat for premium protein, you should place it in the rotation slot with the most nitrogen availability, such as after alfalfa.

Further Resources

The ATTRA publication *Nutrient Management for Organic Small Grains* gives in-depth information on soil fertility.

"Soil Nutrient Management on Organic Grain Farms in Montana" Montana State University Extension Bulletin EB0200, October 2010. Kathrin Olson-Rutz, Clain Jones, and Perry Miller. http://landresources.montana.edu/soilfertility/publications.html or call 406-994-3273 to order.

Diversity

"Diversity is another rotation design principle. The reasons for increasing crop rotational diversity include: to spread weather and price risks, to manage weed populations, reduce plant diseases, manage workloads, create the proper environment for subsequent crops, reduce fixed costs per unit of production, access alternative markets, etc." (Dakota Lakes Research Farm, No date).

Diversity plays a key role in the health of the soil microbiology. It is important that organic matter additions and crop residues come from various sources in order to stimulate a diverse soil microbial population. A long-term study conducted in Oregon showed the benefits of a diverse rotation to microbial populations. See Figure 2.

Notice that after 43 years, there was no measurable microbial population in the continuous wheat system. However, the diversified grass pasture and wheat-pea rotations had considerable microbial populations. What made the difference? The answer is diversity. With a diverse food source, various microbes can survive in the soil. These microbes are the key to a healthy soil, as they break down active organic matter into humus and release essential nutrients in the process. According to the NRCS Soil Biology Primer, "Compared to a field with a 2-year crop rotation, a field with 4 crops grown in rotation may have a greater variety of food sources (i.e., roots and surface residue) and, therefore, is likely to have more types of bacteria, fungi, and other organisms" (Tugel et al., 2000).

The small-grain crops are essentially cool-season grasses. If you live in a Northern Plains region where cool grasses predominate the natural ecosystem, the challenge will be to integrate more warm-season and broadleaf crops into the small grains system.

Further Resources

Dr. Martin Entz at the University of Manitoba has a great website on various crop rotations in no-till and organic systems at http://umanitoba.ca/outreach/naturalagriculture/

"Diversity Index for Crop Rotations" by Dr. Dwayne Beck at the Dakota Lakes Research Station. (www.dakotalakes.com/Publications/Div_Int_FS_pg7.pdf) In this tool, crops are broken into several basic categories: warm-season crops, cool-season crops, grasses, and broadleaves. The diversity score increases as crops from each of these categories are grown in rotation.

"Crop Rotations for Increased Productivity" North Dakota State University, EB-48, January 1988, www.ag.ndsu.edu/pubs/plantsci/crops/eb48-3.htm

The USDA-ARS in Mandan, North Dakota, has developed a Crop Sequence Calculator for the Northern Great Plains. You can order this free CD at www.ars.usda.gov/Services/docs.htm?docid=10791. While not developed specifically for organic systems, it does have some helpful information on developing a rotation with fertility and pest management in mind.

Figure 2. Effect of Diversity on Soil Microbes

Soil Microbes after 43 years in different cropping systems in Pendleton, Oregon

Cropping System	Microbial C	Microbial N	Microbial as % Soil C	Populations Bact.	Pseudo	Funji	Actin
	(kg/ha)			(million/gram soil)			
Grass pasture	1066	115	4.2	71	50	8	2
Wheat-pea	740	59	4.2	83	4	22	2
Wheat-wheat	504	45	2.9	-	-	-	-
Wheat-fallow	280	33	2.2	54	4	10	1

Collins et al., 1992

Livestock Integration

Photo: Gary Kramer, USDA NRCS

Long-term sustainability of organic small grain production may depend on integrating a livestock component for fertility. While this topic is beyond the scope of this paper, it should be a consideration in planning a farm system.

Livestock can add to the overall health of the farm by providing fertilizer in manure form. Grazing can help minimize pest and weed pressures, such as wheat stem sawfly and field bindweed. Cover crops can serve a dual purpose by also acting as forage crops for livestock. Furthermore, soil quality can be improved by adding perennial forages and pastures to the crop rotation.

See the ATTRA publication *Nutrient Management for Organic Small Grains* for more information on using manure for grain crop fertility.

Sample Rotations

Bob Quinn – Big Sandy, Montana

A variety of crops grow at the Quinn farm. Foreground: Strips of organic sunflower and lentils. Background: Organic wheat. Photo: Susan Tallman, NCAT

Bob Quinn farms 4,000 acres of organic grains near Big Sandy, Montana. Annual precipitation at Big Sandy is 13.8 inches. Bob outlines his rotation in both Simple and Complex terms.

Table 5: Quinn Simple Rotation

Year 1	**Cash crop** Alternate fall seeded, spring seeded, broadleaf, narrow leaf, early seeded, and late seeded.
Year 2	**Green manure** Alternate early seeded, late seeded, and deep rooted and shallow rooted.

Table 6: Quinn Complex Rotation

Year 1	**Winter wheat** Use mixture of varieties to maximize diversity.
Year 2	**Green manure** - peas (fall seeded) Will skip this green manure if soil test shows enough N.
Year 3	**Spring wheat** (use mixtures of varieties)
Year 4	**Green manure** – peas (spring seeded) (use mixture of varieties)
Year 5	**Cash crop** High oleic sunflower or safflower or pea seed or lentils.
Year 6	**Barley** underseeded with yellow blossom sweet clover and grass, or irrigated alfalfa and grass (for problem weed control).
Year 7	YBSC green manure or alfalfa hay
Year 8	Go back to the top or alfalfa green manure
Year 9	Year 2 or go back to the top

(North Dakota Organic Field Days, 2009)

Further Resources

For a more detailed description of the Quinn Farm, see the following article:

www.rodaleinstitute.org/2004630/quinn

NDSU Experiment Station – Carrington, North Dakota

A field of organic emmer at the NDSU - Carrington experiment station. Photo: Steve Zwinger

North Dakota State University conducts organic variety trials at their Carrington research station. Annual precipitation at this location is 17 to 19 inches.

Agronomist Steve Zwinger oversees this work and describes their organic rotation as:

Cover crop – spring wheat – peas (harvested for grain).

Steve finds that using a diverse, multi-species cover crop helps with weed control. He discs this in the fall and then does a light tillage pass in the spring before planting spring wheat.

Further Resources

You can access the variety trials at the Carrington agronomy website at www.ag.ndsu.edu/CarringtonREC/agronomy-1. Note that organic and conventional trials are combined in one annual report.

Carmen Fernholz – Madison, Minnesota

Carmen Fernholz has farmed 450 certified organic acres in Madison, Minnesota, since 1975. His location receives about 18 to 24 inches of annual precipitation.

His basic rotation is: corn – soybeans – wheat – alfalfa – alfalfa.

His small grains are always underseeded with a legume, and he can get two tillage passes in before seeding. He has 9” sweeps on 6” spacing on his chisel plow. He finds that alfalfa is the best way to manage Canada thistle. He used to have a thistle infestation of about 6% of his land area. By using alfalfa and haying, the infestation has decreased to about 1% (North Dakota Organic Field Days, 2009).

Further Resources

For a more detailed profile of Carmen Fernholz’s farm, you can access the following article: www.csrees.usda.gov/nea/ag_systems/in_focus/sustain_ag_if_profiles_fernholz.html

The University of Minnesota recently published the *Organic Risk Management* handbook, which includes in-depth information on growing organic crops in the Upper Midwest. An entire chapter is dedicated to organic small grain production. Access the online version at: www.organicriskmanagement.umn.edu/default.htm.

The University of Minnesota Southwest Research and Outreach Center in Lamberton, MN conducts research on organic crop production and hosts a website at http://swroc.cfans.umn.edu/ResearchandOutreach/OrganicEcology/index.htm.

Iowa State University – Ames, Iowa

Dr. Kathleen Delate of Iowa State University has overseen the Long Term Agroecology Research Site at Ames, Iowa, since 1998. This site receives about 34 inches of annual precipitation.

In this study, she is doing long-term comparisons of three rotations:

- conventional corn – soybean
- organic corn – soybean – oat/alfalfa – alfalfa, and
- organic soybean – wheat.

Dr. Delate has found the secret of high corn and soybean yields to be the addition of a small grain and legume mixture in the rotation, such as the oat/alfalfa mixture.

In this research, additional fertility comes from composted swine manure from a hoop house on the farm. This compost is only applied in the corn or oat phases of the rotation, at 4 T/acre. After 11 years, no detrimental buildup of phosphorus has been noted in the soil.

Further Resources

For a complete description of these field trials, visit: http://extension.agron.iastate.edu/organicag/rr.html

University of Nebraska – various locations

The University of Nebraska has an Organic Working Group and conducts organic grain variety trials at locations across the state (University of Nebraska, No date). Liz Sarno, Extension educator and organic project coordinator, oversees the work at four different sites, in Concord, Mead, Clay Center, and Sidney. Each of these stations has certified organic land for variety trials and crop systems research.

The Nebraska climate varies quite a bit from east to west, with the eastern three stations of Concord, Mead, and Clay Center receiving about 24 inches of annual precipitation. These three stations follow a typical corn belt organic rotation of:

corn – soybeans – winter wheat,

with cover crops added in between as needed. They are also experimenting with some alfalfa at these stations.

The Sidney station is in the western part of Nebraska and receives about 16 inches of annual precipitation, but in some years has been as low as 9 inches. Sidney practices a diverse dryland rotation of summer fallow – winter wheat – sunflowers – field peas – proso millet, with soil-building green manure crops spread in between.

Further Resources

Link to the University of Nebraska Organic Program at http://organic.unl.edu/

Of particular interest is their Healthy Farm Index: http://hfi.unl.edu/hfi.shtml. This project has collected data from 27 organic farms for three years, on birds, vegetation, and insects.

Kansas Organic Producers

Ed Reznicek – Goff, Kansas

Ed Reznicek is the head of the Kansas Organic Producers, a marketing cooperative of about 60 organic farmers. For more information on the Kansas Organic Producers, visit their website at www.kansasruralcenter.org/kop.htm

Ed suggests that the first place to start to design a rotation for a Kansas farm is the Kansas Rural Center. The KRC has developed a series of publications on topics such as crop rotation and various green manures suited for the area (www.kansasruralcenter.org/publications.html). Like Nebraska, Kansas exhibits climate changes as you move from east to west. Farms in eastern Kansas may get 35 inches of precipitation each year. By contrast, farms in the west may get only 14 inches of annual precipitation. Eastern Kansas organic farms employ a typical Corn Belt rotation of:

small grain underseeded with red clover – red clover green manure – corn – soybeans.

Farms with livestock will also incorporate a forage crop. Their rotations may be seven years in length. For example:

small grain underseeded with alfalfa – alfalfa – alfalfa – corn – soybean – corn – soybean.

Ed says that the market for organic wheat is not as strong as for organic corn and soybeans. If farmers have the chance, they will plant corn or soybeans.

For nitrogen fertility, producers use green manures. In western Kansas, green manures are often Austrian winter peas or cowpeas. Growers there have had problems with hairy vetch. It's a good winter annual, but it produces lots of small, hard black seeds. If these seeds are in the wheat crop when they take the grain to market, the buyer will dock the price. For phosphorus fertility, they use manure, rock phosphate, or a fish emulsion.

Bryce Stephens – Jennings, Kansas

Bryce Stephens is an organic farmer in Jennings, Kansas. Jennings is in the northwest corner of the state. This location gets about 18 inches of precipitation in a normal year, but as little as 10 inches in a drought year. Bryce has 880 certified organic acres, with half in crop land and half in pasture for his organic bison and cattle.

He says his rotation is complicated, but would describe it as:

Winter wheat – fallow – milo – yellow blossom sweet clover – alfalfa – forage crop.

He is the organizer of his local Organic Crop Improvement Association (OCIA) chapter. His chapter keeps a rotation guideline sheet with the following suggestions for rotations in this area:

a. Wheat, corn, milo, summer fallow, with green manure as needed

b. Wheat, milo, summer fallow, with green manure as needed
c. Wheat, milo, soybeans, summer-fallow, with green manure as needed
d. Soybeans, corn, sunflowers, with green manure as needed
e. Alfalfa, alfalfa, alfalfa, alfalfa, wheat, corn

For the complete rotation guidelines, contact the Kansas OCIA Chapter #3. The following website lists the contact information of all US chapters: www.ocia.org/ContactUs/USA.aspx.

For fertility Bryce uses manure from his livestock that has aged for three years. He finds the organic regulations for manure composting to be too complex, so he simply lets his manure age. Even so, his manure is still classified as "raw manure" under organic standards and must be applied no later than 90 days prior to harvest. He does say that he doesn't have enough manure to adequately fertilize his entire farm, but he uses what he has. He also uses green manure and purchases fish emulsion for soil fertility. He uses yellow blossom sweet clover and alfalfa for nitrogen, but no red clover. Red clover does not grow well in his region.

He plants his alfalfa with German millet as a nurse crop and lets the alfalfa stay in sod for about 5 years. He normally gets 3 cuttings of alfalfa, but can get as many as 5 or as few as 2. After the last cutting, he turns his livestock into the fields to graze them and clean up the weeds.

He has been experimenting with some no-till planting and plants his winter wheat directly into the alfalfa field without working in the alfalfa residue. He says he wouldn't recommend this to someone as a fail-proof method, but he has been playing with it and so far it has worked.

He uses intensive, rotational grazing for weed control and says he doesn't really have a weed problem. He keeps a herd of about 30 organic buffalo and 40 organic beef cows. His cows and buffalo really eat the weeds for him. He has a stocking rate of 10 acres per cow and would like to do more intensive grazing, but needs to build the fences first. He uses an heirloom variety of wheat that is tall and out-competes the weeds.

His biggest pest problems are Hessian fly and rust disease. While he sees both of these pests around, they have never been at damaging levels.

To this date, he has had no insect problems in his alfalfa. He notices that his non-organic neighbors have to spray once or twice a year for alfalfa weevils. He says he sees a lot of beneficial insects on his farm, and he thinks this is what is keeping the weevil pressure down. With everyone else spraying, the beneficial bugs are more likely to come to his farm to live.

He puts out "bug houses" around his farm to provide habitat for the beneficial insects. These are simple piles of brush or rocks that he places in his buffer strips. Every time he cleans up his shelter belt, he'll take the brush and build a pile somewhere near his field border. These piles provide a habitat for beneficial insects.

He says he's always trying something new. He put in 10 acres of milo, 10 acres of cane, and 4 acres of corn this year. He can get two crops per year in his region. Winter grains are harvested at the end of June. This allows a window of time from July to October for another crop. They are unable to grow spring wheat or durum in their region, and buyers reject wheat with protein less than 13%.

Bryce mentioned that the market for organic winter wheat at this time (Fall 2009) was terrible. The previous year, prices had been so high that buyers were still sitting on wheat they bought for $20/bushel. With current prices from $5.30 to $6.70, no one seemed to be buying. Some growers sold their organic wheat on the conventional market for cash flow purposes. Others chose to sit on their grain until the market improved.

Organic Food & Farming Education & Research Program – Wooster, Ohio

Dr. Deb Stinner is the main organic grains researcher for the Organic Food & Farming Education & Research program at Ohio State University in Wooster, Ohio (www.oardc.ohio-state.edu/offer/). Average precipitation for this location is 38 inches.

The common organic rotation in the area is:

corn – soybeans – soft winter wheat – red clover.

Also, a four-year rotation of corn-soybeans-soft winter wheat or spelt-red clover is a classic organic rotation in Ohio. In Dr. Stinner's organic research she favors a five-year rotation of corn-soybeans-oats-hard winter wheat or spelt-red clover.

They have been growing hard winter red wheat (Karl var.) since 1999 and are doing two organic variety trials in two different parts of the state this year.

Mary-Howell and Klaas Martens – Penn Yan, New York

Mary-Howell and Klaas Martens farm 1300 organic acres in Penn Yan, New York. Part of their rotation includes organic small grains. They also own and operate Lakeview Organic Grains, which sells organic livestock feed and organic seed to local farmers.

The Martens have been interviewed numerous times for various publications. Read more about them online.

Further Resources

For more information on the Martens' farming system, visit the following articles:

http://newfarm.rodaleinstitute.org/features/0802/mary_klaas/mary_klaas.shtml

www.neon.cornell.edu/focalfarms/photogal/martsfarm.html

https://attra.ncat.org/interviews/martens.html

Northern Grain Growers Association – Vermont

The Northern Grain Growers Association is an organization of organic and conventional grain growers who meet on a regular basis to exchange ideas and support grain-growing in the northeastern United States. They offer information on different types of northern grains, including everything from variety trials to baking quality. They work with University of Vermont Extension and can be contacted at their website, http://northerngraingrowers.org/.

Further Resources

Listen to some organic farmers describe their rotations at Organic Voices. Audio CDs or mp3s can be purchased at www.organicvoices.com.

Conclusion

There are many compelling reasons to grow organic small grains, such as decreased pesticide use, market prices above conventional grains, and more. However, care must be taken to follow good agronomic practices in order to maintain good soil health and adequate organic matter levels. Give attention to soil nutrient levels and rotation design. Minimize tillage and consider integrating livestock when possible.

Transitioning to organic production can be a challenge. The learning curve can be steep the first few years, and price premiums are not available until certification is achieved, usually in the third year of organic production. Plan cash flow accordingly, and transition in phases to allow for this adjustment time before yields and markets are established.

Become involved with local organic organizations. Link with other farmers and listen to their stories of success and failure. Nothing can substitute for the voice of experience in helping to raise organic small grains successfully.

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