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ORGANIC GRAIN
CROPPING SYSTEM AND MARKETING
Inservice Education for the Northeast US

THE RODALE INSTITUTE

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Author: Patricia S. Michalak
Editorial team: Jeff Moyer, Carlos Murillo and William Liebhardt
Designer: Tokiko Jinta
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FOREWORD

"Why should I grow my grain organically?" I am sure this is a question many farmers have asked themselves. And hopefully this book will help answer that question. It offers straight-forward information on growing and marketing organic grain, if you decide that these crops suit your operation and goals. In this book you will find production, storage, and marketing information with a level of detail that is very pertinent and helpful.

Of course, there are advantages and disadvantages to any method of grain production. To consider the current, predominantly conventional grain production systems that farmers employ, let's start by assessing where the grain business stands in the US and in industrial agriculture around the world. What are the facts?

Most grains are commodities that move in national and international trade. For most of the last 40 years, there has been a grain surplus in both the national and international markets. At the same time, prices for these commodities have been so low that many grain farmers have been forced out of the business.

For most of the last 40 years, input costs and marketing efforts have taken more and more of the farmer's dollar. At the same time, farms have gotten larger and farmers have been told to get bigger and more efficient in order to stay competitive. Even while yields per acre continue to climb, costs for the farmer also continue to increase, forcing their net return to hold even at best.

Over those same 40 years, government programs have encouraged the increasing number of large-scale grain farmers to overproduce, keeping grain prices low. In fact, growing government support programs for many of the grain crops now provide about half the net income for many grain farmers. Of course, tax payers do not like their money going to large farmers who continue to get bigger. Public opinion is beginning to crown the farmer out on a tractor as the new "welfare queen." At the same time, many farming inputs, such as fertilizers and chemical pesticides, have trickled away from farmlands to degrade the environmental quality of surrounding watersheds, further angering the public.

This is the kind of treadmill farmers have walked on for years and years, and there appears to be no end in site. Given this scenario, the obvious question arises: Why continue to grow grain products that have so little potential to provide an adequate financial return and a decent lifestyle?

Fortunately, there are harbingers of hope in the world of agricultural grain production. To begin, grain operations (and agriculture of all types) can provide and maintain open space that can be enjoyed by the public and wildlife alike. Also, when managed correctly, grain production can enhance the natural resource base of the community as a whole—many grain farmers are very good stewards of the land. And while the future of the conventional grain market appears rather bleak, the developing organic grain markets provide a structure of inputs, markets, and prices that can make grain production profitable again.

So if you are ready and willing to make a change, take a chance, travel down a new stretch of road. I recommend organic grain production as an excellent opportunity to improve your income, your farm environment, and your health. The transition to organic grain production may require a change in your mindset and in some of your management practices, but the potential benefits are enormous.

If you do decide to grow organic grains, what can you expect? If you already grow grain, then you have substantial knowledge and experience that can be put to good use. Many farmers who have made this change say that they really enjoy the challenge of making the transition, and have discovered a renewed interest and energy in farming. In fact, they've found that it is fun to manage a more biologically-based farming system. One farmer told me that, in the process of transitioning a portion of his operation from conventional to organic grain production, he became a much better manager of his conventional crops. He found that he went out into the field more often and observed what was happening on the ground. Consequently, the decisions he made were based on better knowledge than in the past and produced better results. He said it was really stimulating to follow the development of his fields. For example, he began to see worms in fields where previously he hadn't seen any at all, and he noticed that water stopped pooling in his fields after heavy rains. Both occurrences are indications of improving soil quality.

Of course, once you decide to make the transition to organic grain production, you will have a whole new crop of questions. Most farmers first ask about input substitutions to manage fertility and weeds. These are the questions that this book is written to address. You'll find that, as you move through the three-year transition from conventional to organic management, you will have plenty of opportunity to learn and understand the management techniques you'll need to farm organically and successfully. This book will give you the information you need to select crops that will help you move into the organic cycle, establish a good crop rotation, and manage it for the nitrogen requirements of heavy feeding crops such as corn.

This book also addresses questions about the very important issue of marketing. In conventional grain production, marketing is usually comprised of harvesting your grain and selling it, or harvesting, storing and selling it during the season. Conventional markets are well established and so are their prices. In contrast, organic grain marketing may take more work at the outset. You may need to store your grain, and investigate the outlets in your area. But once found, the potential for financial return in organic grain marketing is substantially higher. Of course, it is important to find out what you can market before you plant, in order to reduce your risk later on. This book provides the information you need to find and develop those organic markets that are best suited to your operation.

Finally, the most vital component of your transition plan is *you*. When you decide to make the change to organic production, a positive, "can do" attitude can set you well on the road to success. Be patient with yourself because, as with every new endeavor, there is a learning curve. Talk to other farmers and resource organizations about the organic grain production and marketing process. Remember that every year is a new year, with new opportunities for learning, growth, and success. And, most importantly, enjoy the journey – as master of your operation, only you can decide what systems work best for you and your farm and deliver the kind of livelihood you want.

Bill Liebhardt
Research Manager, The Rodale Institute

CHAPTER 1 INTRODUCTION

The final rule of the Organic Foods Production Act of 1990 was published by the USDA in December 2000, and by late 2002, most organic growers must be certified by a State or private agency accredited under these national standards. At the same time, a growing demand for organic livestock feed and human foods has created new marketing opportunities for grain producers in the northeast US.

In 1997 (the last year for which statistics are available), 0.1 percent of US corn and soybeans were grown under certified organic farming systems, along with over 1 percent of oats, and nearly one-third of the US buckwheat crop. A good market exists for producers to supply organic livestock feed requirements. In Pennsylvania, organic livestock producers have asked organic certified growers for corn, barley, oats, wheat and spelt.

Opportunities are increasing for organic grain producers to market human food grade grains to food processors. In the retail organic food market, large mainstream food marketers (such as Kellogg Company and General Mills) have entered the organic market, and natural food supermarket chains have prospered. According to Packaged Facts, a market research firm, the 2000 total organic foods market reached $7.8 billion, a 20-percent increase over 1999 sales of $6.5 billion. Organic grain producers in the northeast US will find markets with manufacturers of snack foods, tofu and baking products, and others.

To help farmers take advantage of the organic grain market, farmers Cooperative Extension personnel and other agricultural educators all need to quickly familiarize themselves with National Organic Program (NOP) regulations and the basics of organic production. In response, this handbook provides an introduction to organic grain production and marketing, with references to National Organic Program rules and regulations. Please remember that every effort was made to be as accurate as possible when citing NOP rules and regulations. In the case of a discrepancy, your questions on meeting certification requirements should be directed to your certification agency.

While this handbook was written for agricultural educators, its voice is directed at organic producers (i.e., "you must follow NOP guidelines" is directed at the grower) in the northeast and mid-Atlantic US. Sources of information include Extension publications from the northeast, mid-Atlantic, and mid-West US as well as interviews with organic growers, organic grain buyers, and many other others.

CHAPTER 2 ORGANIC SYSTEM

Organic Agriculture

Organic agriculture is an ecological production management system that promotes and enhances biological diversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain, and enhance ecological harmony. Characteristics of organic agriculture are reduced soil erosion, lower fossil fuel consumption, and elimination of pesticides by natural management of insects, diseases and weeds. The USDA National Organic Program(NOP) final rule established national standards for the production and handling of organically produced products, including a National List of substances approved for and prohibited from use in organic production and handling.

Making the Transition

Converting to organic production requires a period of transition for both the farm and the farmer. If you are a conventional grain farmer interested in making the transition to organic production, you can use your skills and knowledge developed through years of experience growing grains. You need to build on that base by learning how to structure rotations and crops to take full advantage of the biological processes, manage and incorporate cover crops into the rotation, develop the skill of mechanical weed control, and fulfill recordkeeping requirements for certification. You will also need to increase their involvement in the marketing process.

Many farms in the northeast US already have a diverse crop rotation that includes soybeans, corn and wheat. If this describes your farm, little capital investment will be required for you to make the transition to organic grain production, since you already own or have access to the equipment needed. The additional equipment that is required consists of weed management equipment such as a rotary hoe and cultivator. If you do not have grain storage facilities, you may need to add storage space.

Once you have decided to make the switch to farming organically, start with only a small fraction of your total acreage. This book can be used to design a crop rotation for the trial fields, use a crop rotation that may be duplicated on a larger scale later. Learn from their mistakes and fine-tune your organic system plan before applying the plan to larger portions of the farm. Start by applying for certification of the organic portion of your acreage, then certify more acreage each year. Some growers begin by certifying acreage that has been out of production, or in a federal or state set-aside program for several years. NOP final rules state that any field or farm parcel used to produce an organic crop must have had no prohibited substances applied to it for at least three years prior to harvest of the crop. Find out more about certification and prohibited substances in "Chapter 6: Organic Certification."

Learn more about converting from conventional to organic production from The Rodale Institute's Farming Systems Trial™(FST). The FST was established in 1982 to compare and study side-by-side conventional and organic systems.

Three distinct methods of crop production were compared in the FST:

- Conventional, with typical inputs of standard agricultural fertilizers and pest-control chemicals.
- Organic, using animal manures as a primary nitrogen source for heavy-feeding crops such as corn.
- Organic, using legume green manure crops as the primary nitrogen source.

The FST provided the opportunity to study the period of transition that conventional farms go through when switching to organic methods. Primary conclusions reached after the first 15 years of the study include:

- After a transition period of about four years, crops grown under organic systems yield as well as or better than crops grown under the conventional system. Moreover, organic systems can out-produce the conventional system in years of less-than-optimal growing conditions such as drought.
- Organic systems that use only legume cover crops as a nitrogen source, as well as those that use animal manures, are capable of supplying enough nitrogen to produce crop yields equivalent to those grown with mineral fertilizers—even for heavy nitrogen users such as corn. Overall, available nitrogen levels are increasing in the organic systems while nitrogen levels are decreasing in the conventional system.
- After a transition period characterized by reduced yields, the organic systems were competitive financially with the conventional system. Projected profits ranged from slightly below to substantially above those in the conventional system, even though economic analysis did not assume any price premium for organically grown crops.

Because of its diversity of marketable crops, an organically managed farm may suffer fewer income fluctuations than a conventionally managed one. Tending to this diversity, however, requires significant labor and management skill. Starting small is one way that conventional growers may switch to organic agriculture, while gaining the necessary management skill to farm organically on a larger scale.

CHAPTER 3 SOIL HEALTH

Cover Crops

Just as soil remains covered with plants or litter year-round in natural ecosystems, organic producers use cover crops to prevent erosion on both hilly and flat land. Cover crops may also double as green manures if they are plowed or turned into the soil. Cover crops provide multiple benefits in organic system plans: They smother weeds, enhance nutrient and moisture availability, prevent nutrient leaching and runoff, help control pests, and provide habitat for beneficial insects, while reducing costs and increasing profits. Some cover crops are also known as forage crops or cash crops or grain crops—buckwheat and rye are good examples. Many organic growers rely on the nitrogen-fixing capacity of legume cover crops. Use this section with "Crop Rotation", page 11, to add cover crops to your organic system plan.

Nonlegume cover crops

Nonlegume cover crops include the annual cereals (rye, wheat, barley, oats), annual or perennial forage grasses (ryegrass) and warm-season grasses such as sorghum-sudangrass. Grass cover crops (GCC) are higher in carbon than legume cover crops, so they tend to break down more slowly than legumes, resulting in longer-lasting residue and increased soil organic matter over time. Grass cover crops add little nitrogen to the soil, but will help to keep excess nitrogen from leaching. GCC such as rye and sorghum-sudangrass may provide so much organic matter that they are difficult to incorporate. A mixture of grass and legume cover crops may be the solution to nitrogen tie-up in crop rotations with nitrogen demanding grain crops.

Buckwheat is a short-season summer cover crop that is quick to establish. Its residue breaks down quickly, releasing nutrients to the next crop. Buckwheat is used most commonly as a mid-summer cover crop for weed suppression and to protect bare soil. In the Northeast, a winter grain or cool-season cover crop often follows it.

Legume cover crops

In the Northeast, legume cover crops include the winter or summer annuals such as crimson clover and hairy vetch; perennials such as alfalfa, red clover and white clover; and the biennials such as sweetclover. Legume cover crops (LCC) are lower in carbon and higher in nitrogen than grasses, resulting in faster breakdown of legume residues. LCCs provide nutrients more quickly than grasses, but do not increase soil organic matter as much. Some organic producers use a LCC as their primary source of nitrogen. If so, take care to establish the cover crop using the same care as required for a cash crop, to insure a successful stand.

How to use cover crops

Select cover crops based on the requirements and characteristics of your farm system. Use **Table 1–Cover Crops** when selecting cover crops that do well in the Northeast States.

What do I want to accomplish? You might need a winter annual cover crop that adds nitrogen and reduces soil erosion. Or, a cover crop that will help to control quackgrass while providing forage.

Define planting and harvest dates. Working with your crop rotation plan, look for open blocks of time in each field. Several common options for Northeast grain farmers: Take advantage of the fall season to sow a winter cover of rye; or, sow a cover like hairy vetch or red clover into corn before grain harvest; or, plant buckwheat following harvest of winter wheat in summer.

Table 1–Cover Crops

Select cover crops based on the job you would like them to perform. The following cover crops do especially well in the Northeast States. Seeding times and rates are for New York.

COVER CROP	Nitrogen source	Soil building	Erosion fighting	Subsoil loosening	Weed fighting	Pest fighting
annual ryegrass		X	X			
berseem clover	X					
buckwheat					X	
hairy vetch	X					
oats			X			
red clover	X					
rye		X	X		X	X
sorghum-sudan grass hybrid		X		X	X	X
sweetclover	X	X		X		
white clover			X			

Cover crop	Type	Seeding rate	Time of planting
annual ryegrass	annual grass	18-20 lb/acre	August through September
sorghum-sudangrass hybrid	warm-season annual grass	50 lb/acre	Late Spring through summer
buckwheat	warm-season annual broadleaf	60 lb/acre	Late Spring through summer
hairy vetch	annual winter hardy legume	35-40 lb/acre	Late August through early September
red clover	Perennial legume	10-15 lb/acre	Early spring or late summer
berseem clover	Winter annual	8-12 lb/acre	Late August through early September
annual sweetclover (Hubam)	Annual legume	25 lb/acre	Early spring
sweetclover (yellow blossom and white)	Biennial, winter-hardy legume	15 lb/acre	Early spring to midsummer
rye	Winter-hardy small grain	80-110 lb/acre	Late August through mid-October
oats	Nonwinter-hardy small grain	60-100 lb/acre	August through early September
wheat	Winter-hardy small grain	80-110 lb/acre	Mid-September through early October

Describe the niche. What are the weather, soil temperature and moisture likely to be then? Will I have time to make this work? Do I have the needed equipment and labor? How do I kill it and plant into it?

Learn more about many more cover crops and how to use them in the SARE Handbook 3, "Managing Cover Crops Profitably".

Crop Rotation

Crop rotation is an important tool that organic producers use to manage crop nutrients and avoid pest problems. The National Organic Program Final Rule (NOPFR) defines crop rotation as "the practice of alternating the annual crops grown on a specific field in a planned pattern or sequence in successive crop years so that crops of the same species or family are not grown repeatedly without interruption on the same field." When planned properly, rotation of grain and other crops can help to maintain or increase soil fertility, reduce the need for nutrient additions, add organic matter to soil, increase water infiltration, distribute the load of fieldwork throughout the year, control pests and reduce soil erosion.

As an organic grower, you may not plant the same crop two years in a row in the same field without interruption—such as planting a cover crop in between. Continuous cropping is poor soil management and if you practice it, your certification agency may require annual tests to show the soil is not being depleted. Perennial crops such as pasture and hay do not have to be rotated, according to the NOPFR.

A rotation of three to five years—or longer, if practical—helps manage weeds and other pests while maintaining soil fertility. Ideally, different types of crops such as warm-season (corn or soybeans) and cool-season (small grains or canola) crops should be mixed. By including in your rotation perennial crops such as a two to four year hay that is cut and harvested several times each year, perennial weeds will be weakened due to periodic removal of top growth. In addition to the main crops, cover crops should be added to capture nutrients, protect soil from erosion and, in the case of legumes, add nitrogen to the soil.

By increasing crop diversity in your rotation, you will be able to vary the timing of primary tillage, which disrupts weed establishment and weed seed production.

Sample crop rotations for the northeast US

Here are two useful crop rotations for producers of organic cash grain crops.

1. Corn→Rye cover crop→Soybean→Rye cover→Oats→Wheat→Hairy vetch cover or Hay
2. Corn→Rye grain→Wheat with relay-cropped soybeans→Oats→Barley→ Vetch cover crop

Plant diversity groups

Use the following plant diversity groups to help plan organic crop rotations.

Perennial legumes: alfalfa, red clover and white clover

Summer annual legumes: annual sweetclover (Hubam)

Winter annual/biennial legumes: hairy vetch, berseem clover, sweetclovey (yellow blossom and white)

Winter cereals: wheat, barley, rye

Spring cereals: oats, spring barley
Summer annuals: buckwheat, sunflowers, annual ryegrass, soybeans, sorghum sudan-grass
Row crops: corn, soybeans
Heavy feeders: corn, winter wheat
Medium feeders: winter wheat, oats, winter rye, winter barley
Light feeders: buckwheat, soybeans

Crop rotation tips Edited from Canadian Organic Growers, "Organic Field Crop Handbook", 2nd edition

1. Select your cash crops—the crops for which you have a good market. Use your marketing skills to determine which crops are currently selling. Pick crops that do well on your farm.
2. Build the soil. Within your rotation, alternate:
   - Nitrogen fixers with nitrogen consumers (soybeans with corn)
   - Cash crops with cover crops (corn with hairy vetch)
   - Deep-rooted crops with shallow-rooted crops (alfalfa with corn)
   - High-root biomass with low-root biomass (rye with oats)
   - More moisture needed with less moisture needed (corn with barley)
   - Allelopathic crops (rye and sunflowers) to prevent buildup of toxins.
3. Conserve nutrients. Look for empty spots in your rotation, and fill them with cover crops. Avoid leaving fields empty after crop harvest. Alternate heavy feeders with light feeders. Incorporate residues—avoid selling straw.
4. Control weeds and other pests. Within your rotation, alternate:
   - Slow-growing crops with weed-smothering crops (forage legumes)
   - Seeding and tillage dates (i.e., alternate between warm-season and cool-season crops)
   - Include rye and sunflowers
   - Drilled crops with row crops
   - Avoid continuous perennial forage
   - Grow mixed hay stands, rye or buckwheat to choke out persistent annual weeds
   - Separate small grain crops by a legume or broadleaf crop
5. Demands on labor, equipment and knowledge.
   - Diversify crops & farm activities to distribute work throughout cropping season
   - Consider sharing equipment ownership

Crop rotation worksheets Edited from Canadian Organic Growers, "Organic Field Crop Handbook", 2nd edition

Follow these steps and use the corresponding worksheets when planning your crop rotation. You can find more worksheets and extra details in *Organic Field Crop Production.*

Step 1. Take a farm inventory

This is a good place to begin when preparing your organic system plan, too. Assess your farm's strengths, weaknesses and obstacles (such as perennial weeds or recent pesticide applications), plus the factors you can not change—such as climate or distance to markets.

The following is a list of some of the key features of a farm inventory which will assist you in establishing your priorities. It is worthwhile to go through the list and make a inventory of your own farm. Writing down the features of your farm will aid you in understanding the strengths and weaknesses of your farm, and provide an important base from which to make well-informed decision.

KEY FEATURES OF A FARM INVENTORY

Soil resources
- Soil types
- Major soil problems
- Organic matter
- Fertility (nutrient availability)
- Water availability
- Soil tilth and structure
- Soil life
- Background of pesticide use
- History of fertilizer use
- Residues of pesticides and fertilizers in the soil

Biological factors
- Weed populations (and history of weed problems)
- Populations of pests and beneficial organisms
- Crop disease problems (and the history of problems)
- Past crop rotation
- History of livestock on the farm
- Patterns of livestock disease
- Forests, bush and shelterbelts
- Wildlife

Climatic factors
- Corn Heat Units or Growing Degree Days
- Temperature
- Solar radiation
- Precipitation
- Evaporation
- Microclimatic features

Physical resources
- Equipment
- Available capital (loans/ savings)
- Land (rented/owned)
- Housing
- Potential for on-farm processing

Human resources
- Farmer & family
- Advisors
- Suppliers
- Community services & support

Markets
- Opportunities in regular & specialty markets
- Distance to markets
- Available transportation to markets
- Potential for cooperative marketing
- Value-added market opportunities in your region

Step 2. Draw a farm map

If possible, break fields into equal-sized parcels. Take soil samples from each field. A farm map is essential for your own organization and is invaluable when you are requesting organic certification.

Use the following guidelines for making the map:

- Assign numbers to each of your fields. This is required for organic certification.

- Number the fields in multiples of 10 or 100 so that if a field is divided in the future, you will still have a logical numbering system (i.e., field 100 can be divided into fields 101, 102, etc,).

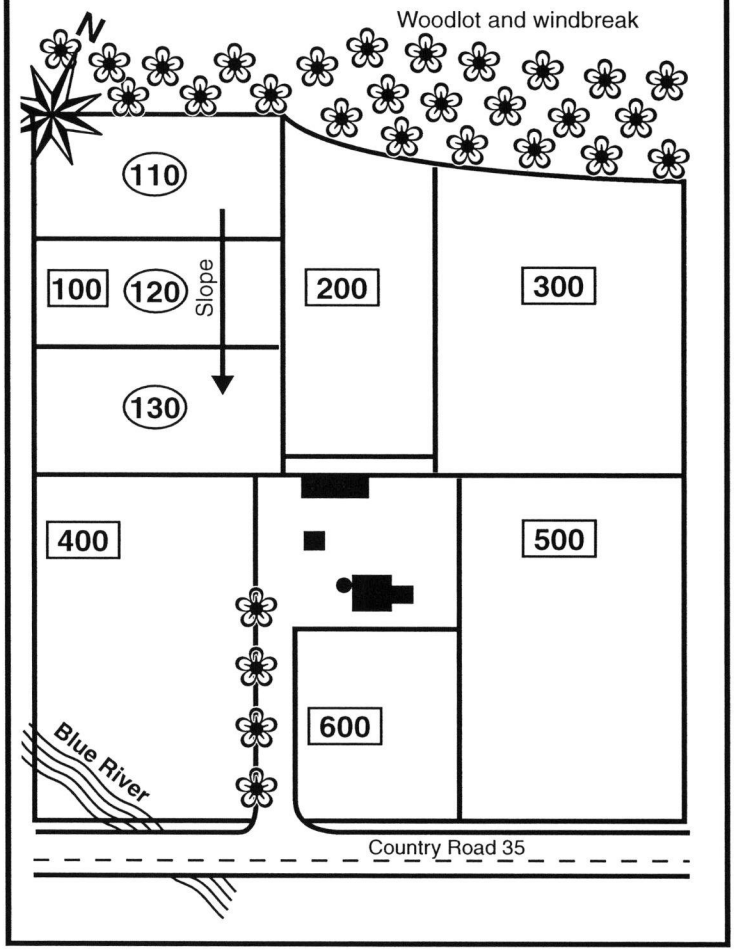
- If possible, break field into equal-sized parcels. This helps when growing a number of different fields, as the total crop yield will not vary widely from year to year.

- Divide fields according to their proposed use. For example, cleared land which may be unsuitable for cultivation (used for permanent pasture, permanent hay fields, or trees).

- Productive land with some drainage limitations or other problems, and productive land with few limitations.

- You may want to sort crops into groups with similar limitations. For example, assign wet fields to crops such as corn, oats and red clover. Well-drained fields can grow corn, barley, oats, alfalfa and winter cereals.

Example of a farm map showing field number system



- Ideally, soil samples should be taken from each field.

- Having a few copies of the map means that you can also use it to draw an annually updated weed map. This is a way of tracking nutrient imbalances and planning crops that are needed for weed management.

Step 3. Crops grown to meet farm needs

List your crops and acreages. Start with the crops required for feed, pasture, hay and cash. Next, consider alternative crops that might be new. Finally, make a list of the cover crops that might fit your system.

To begin the process of rotation design, first determine the characteristics and needs of your farm.

Number and type of livestock to feed:

_____

_____

Farm size: _____

Number of fields:

Field number:	Size:

Crops required for feed, pasture and hay:

Crop:	Tonnage:	Acreage:

Other crops:

Crop:	Tonnage:	Acreage:

Are there any alternative crops that could be substituted for the sake of crop rotation design? This might involve the changing of livestock rotation to allow more flexibility in rotation design. Some organic daily farmers have substituted corn silage with better-quality hay and intensive pasture management. Some hog producers have replaced corn with mixed grain for their sows. This use of alternative crops reduces the use of concentrates, moves away from row cropping (with its extra labor and tillage demands) and provides better ground cover, nutrient cycling and weed management.

Alternatives:	Acreage:

Acreage available for cash crops:

_____

_____

_____

To determine which crops will best fit into your rotation and are most suitable for your land, list possible:

- **green manure crops** that can increase soil fertility:

  _____

  _____

  _____

- **catch crops,** which are fast-growing crops that "catch" and hold available nutrients:

  _____

  _____

  _____

- **break crops,** which are planted between two crops sharing similar pests and disease problems (to break pest and disease cycles):

  _____

  _____

  _____

Step 4. Estimate quantities of manure, compost and soil amendments

Estimate manure, compost and other inputs. Livestock producers should calculate their annual manure and compost production. All growers—with or without livestock—should find cover crops or green manure crops that can help to make up for soil shortcomings.

For livestock producers
Composted manure plays a vital role during the early years of an organic farm. The following formulas help you to determine the quantity of manure/compost produced by your herd. The calculations give you an estimate of how much compost is available to be used on your land.

To calculate annual manure production:

Number of		Multiple by (in tons)	Tons produced
cows:	_____	**13.0**	_____
hogs:	_____	**1.8**	_____
sheep:	_____	**1.1**	_____
goats:	_____	**1.1**	_____
horses:	_____	**10.0**	_____
layer-hens:	_____	**0.05**	_____

Total:
tons of manure/year.

Note:
This figure is for annual manure production and much of it will have fallen in the pasture. To estimate the quantity of manure that falls in the barn or yard, divide total manure production by 365 (which gives an average daily production), then multiply by the number of days the livestock are in confinement. If the livestock are confined for part of the day (e.g. dairy cows that are inside for 12 hours a day), adjust the formula accordingly.

Conversion factors

To convert from	To:	Multiple by:
pounds	kilograms	0.454
tons	kilograms	1016
pounds/acre	kilograms	1.1
acres	hectares	0.405

To calculate the quantity of compost that your operation produces:

Annual manure production .....(a)
(in confinement):

Annual straw use
(__number of bales X .....bale weight):.....(b)

Total weight (line a + line b).....(c)

Multiply total (c) by 0.7 = ...tons compost/year (assuming a 30% reduction in bulk).

Calculate soil amendments

A grower who does not have livestock knows that green manures are very necessary to the health and fertility of the soil. Regular soil tests are important to determine if there are any major deficiencies which may make it necessary to purchase soil amendments.

Did your soil test indicate any particular deficiency that must be addressed?

Field 1:
Nutrients lacking:.....
Sources: green manure crop.....
Soil amendments (e.g. rock phosphate).....

Field 2:
Nutrients lacking: .....
Sources: green manure crop.....
Soil amendments (e.g. rock phosphate): .....

Step 5. Maximize soil coverage

Maximize soil coverage. Use this worksheet to map your crop rotation, ensuring that your soil is covered as much as possible.

An important goal of organic farming is to keep the ground covered as much as possible. Use this example as a model to map your crop rotation to ensure that your soil is covered as much as possible.

YEAR	SEASON	FIELD ONE		FIELD TWO	
		Cash crop	Green manure/ forage	Cash crop	Green manure/ forage
1	Spring	Wheat			Alfalfa
	Summer	Wheat			Alfalfa
	Fall		Hairy vetch		Alfalfa
	Winter		Hairy vetch		Alfalfa
2	Spring	Oats			Alfalfa
	Summer	Oats	Clover		Alfalfa
	Fall		Clover		Alfalfa
	Winter		Clover		Alfalfa
3	Spring	Corn			Alfalfa
	Summer	Corn			Alfalfa
	Fall	Rye		Wheat	
	Winter	Rye		Wheat	
4	Spring	Rye		Wheat	
	Summer	Rye		Wheat	
	Fall		Hairy vetch		Hairy vetch
	Winter		Hairy vetch		Hairy vetch
5	Spring	Barley		Oats	
	Summer	Barley	Alfalfa	Oats	Clover
	Fall		Alfalfa		Clover
	Winter		Alfalfa		Clover
6	Spring		Alfalfa	Barley	
	Summer		Alfalfa	Barley	
	Fall		Alfalfa	Rye	
	Winter		Alfalfa	Rye	

Step 6. Balance machine and labor usage

Design your final crop rotation. Put together everything—main crops, cover crops, compost applications, and off-farm inputs.

Chart labor demands through the growing season. Charts help you to see the potential strengths and weaknesses of a crop rotation. Fill in the required compost applications, seeding, tillage, cultivation and harvesting operations for each individual crop. Simply looking at the table allows you to recognize potential conflicts in machinery and labor demand. This cannot take into account any weather considerations and will therefore be of only limited use. In addition, allow for time to watch each crop closely to monitor potential problems and crop needs as the season progresses.

	FIELD 1 Winter wheat/ hairy vetch	FIELD 2 Alfalfa forage	FIELD 3 Barley/fall rye	FIELD 4 Oats/red clover
April			Prepare seedbed Seed barley	Prepare seedbed Seed oats and clover
May			Harrow for weed control	
June		1" cut hay		
July	Harvest wheat Spread manure	2" cut hay		Harvest oats
August	Plant Hairy vetch	3" cut hay	Harvest barley Apply compost	
September			Prepare seedbed Plant fall rye	
October				Chisel plow clover

Step 7. Design crop rotation

Balance machine and labor usage. Review your crop rotation with machinery and labor in mind.

This is the point to prepare a crop rotation for each field on your farm. In completing this section, double-check *step 4. Maximize soil coverage* and *step 5. Balance machine and labor usage* along with *step 1. The farm map.*

		FIELD 1	FIELD 2	FIELD 3
Year 1	Main crop			
	Green manure break/cover crops			
	Compost application			
	Off-farm inputs			
Year 2	Main crop			
	Green manure break/cover crops			
	Compost application			
	Off-farm inputs			
Year 3	Main crop			
	Green manure break/cover crops			
	Compost application			
	Off-farm inputs			
Year 4	Main crop			
	Green manure break/cover crops			
	Compost application			
	Off-farm inputs			
Year 5	Main crop			
	Green manure break/cover crops			
	Compost application			
	Off-farm inputs			

Compost

Organic growers use compost because it improves and restores soil health. Compost acts as both an amendment and a fertilizer. As an amendment, compost influences plant growth indirectly via improvements to soil tilth and water infiltration, and may help to control some plant diseases. As a fertilizer, compost affects plant growth directly by adding to the supply of available macronutrients and micronutrients in soil.

By definition, compost is any mixture of decomposed organic matter made by a biological process involving a mixture of microorganisms. The raw materials of compost are variable, but most farm composts are made from animal manure (high in nitrogen) mixed with plant wastes such as straw or spoiled hay (high in carbon). Adequate moisture, aeration and microorganisms are necessary. According to NOPFR regulations, composted plant and animal materials may only be used if they are produced through a process that (1) establishes an initial C:N ratio of between 25:1 and 40:1—*that includes most manure/bedding mixes*—and (2) maintains a temperature of between 131°F and 170°F for three days using an in-vessel or static aerated pile system, or (3) maintains a temperature of between 131°F and 170°F for 15 days using a windrow composting system, during which period the materials must be turned a minimum of five times.

Compost quality

Whether you make your own compost or purchase it, learn how to evaluate compost in order to use it most efficiently. Compost quality varies greatly and depends on the method of composting, the raw materials used, and the age of the compost. Compost processes are either aerobic or anaerobic. Aerobic decomposition, the preferred process, occurs when oxygen is available. Aerobic composting is commonly done in a windrow—a long, narrow flat row that is turned periodically. Anaerobic decomposition occurs in the absence of oxygen—picture a lagoon filled with liquid manure—and is actually a fermentation process. Fermentation produces compounds that may be toxic to plants or inhibit plant growth.

Compost maturity also influences quality. Generally, mature compost has a lower C:N ratio, a higher humus content, and less volume. If compost is immature, it may release toxins that can harm plants, particularly small plant seedlings.

When using compost for corn, soybeans, buckwheat and small grains, look for the following characteristics:

- dark brown to black in color
- no objectionable odor
- particle size less than 1/2"
- neutral pH
- soluble salt concentration less than 20 mhos per cm
- less than 5% foreign materials by dry weight
- temperature close to the ambient temperature
- does not reheat after being turned.

Applying compost

"Not all composts are created equal. You can apply too much compost. . . "—Carolyn Reider, Researcher at The Rodale Institute.

If you want to make your own compost, several good guides are listed in "Resources." If you make your own compost, have it analyzed for plant nutrients by a reputable laboratory that has experience testing compost. If you purchase compost, ask for a copy of the test results or arrange for testing yourself. Application rates should be based on soil test results, crop needs, and the compost analysis. Rates will vary depending on the quality of the compost, as well as on the crop, soil type, and other factors.

When trying to meet the nitrogen demands of a crop, avoid overloading soil with phosphorus and potassium. Researchers at The Rodale Institute found that phosphorus and potassium overload commonly occurred when manure-based compost was applied solely to satisfy crop nitrogen needs, but not when plant-based compost was used. As a result, researchers have decreased the frequency of compost applications—only every 3 or 4 years—based on plant phosphorus requirements, and not on nitrogen needs. Try substituting another nitrogen source such as a legume, and reduce the application rate of compost. Nitrogen-demanding crops such as corn perform well with a combination of hairy vetch or other green manure plus compost. The combination may be particularly important during the transition period from conventional to organic methods. Use **Table 2–Compost** to compare mature compost with leguminous green manures.

Apply compost using a conventional manure spreader. Before planting, incorporate compost into the top 4 inches of soil. Mature compost may be safely applied to growing plants.

Nutrient Management

According to the NOPFR, organic producers "must manage soil fertility, including tillage and cultivation practices, in a manner that maintains or improves the physical, chemical and biological condition of the soil and minimizes soil erosion." Organic nutrient management is a combination of practices, including crop rotation and the use of cover crops, manure and compost. As an organic producer, you are required to have an organic system plan (OSP). It's a good idea to prepare a nutrient management plan, too. Contact the local USDA - Natural Resources Conservation Service office, the local Cooperative Extension office, the local Conservation District office, or a professional agricultural consultant for instructions. Have your soil tested each fall or spring by a professional laboratory. If you make your own compost, have it tested, too. Use the test results to help you meet the goals of your nutrient management plan.

By managing nutrients, you can achieve a balance of nutrients added to the system (such as compost, livestock manure or green manure crops) with nutrients taken from the system (as harvest). In doing so, you'll avoid contaminating ground water and other natural resources.

When applying compost or manure, follow these guidelines for efficient application:

- Compost and manure may not be applied in a way that contaminates water resources.
- Plow or incorporate compost immediately after spreading. Solid raw manure will lose about 21% of its nitrogen to the atmosphere if spread and left for four days.
- Before corn and other nitrogen-using grains, apply manure to the preceding cover crop in order to reduce nutrient loss.
- Use soil testing to monitor levels of phosphorus and potassium. At The Rodale Institute, researchers found a build up of soil P and K after repeated annual heavy applications of compost.

Table 2–Compost

Attribute/Effect	MATURE COMPOST	GREEN MANURE (Leguminous)
N content	Highly variable (1-4%)	Fairly consistent (~4%)
Other nutrients	Can contain significant amounts of P and K, Ca/Mg, micronutrients	May increase plant availability of P & some micronutrients but there is no net gain
Nutrient availability	Slow, prolonged release of nutrients	Fast release of nutrients, peaking after 2-4 weeks
Stimulation of soil microbes	Most decomposition occurred in the compost pile so modest increase in microbial activity	Rapid decomposition and corresponding increase in microbial activity
Humus content	Up to 60% humus	Plant residue contains the precursors to humus
Nitrate leaching potential	Periods with reduced plant uptake, esp. bare fallows	Early spring following incorporation
Nitrogen loss from soil	May reduce N loss because a greater proportion of applied N is in stable forms	May reduce N leaching by scavenging N that would be lost under a bare fallow
Soil tilth	Immediate benefits, depends on humus content	Improved soil tilth develops over time
Planting date	Can be planted immediately following incorporation	Shallow incorporation requires a delay of 1-2 weeks
Cost	Purchased composts can be expensive, composts can be made from materials available on farm, cost vary	Highly variable, depends largely on seed cost

CHAPTER 4 PEST MANAGEMENT

Organic producers rarely have significant insect and disease problems. Pest management options for producers of organic field crops focus on cultural techniques (including crop rotation and sanitation), mechanical techniques (including cultivation, mowing and plowing), and reliance on naturally occurring biological controls. According to NOP regulations, organic producers "must use preventive practices to manage crop pests, weeds and diseases." When preventive practices fail to provide control, an approved biological or botanical substance may be used. Be sure to check with your certification agent before applying pest control products. Some certifiers and inspectors will make application recommendations for you. However, production of organic grain crops is most economical when based on preventive practices. See the individual chapters on corn, soybeans, buckwheat and small grain production for crop-specific pest management.

This chapter briefly describes the insects and diseases likely to be found in field crops, and the management practices that influence them. In organic systems, a balance of beneficial insects and pests is likely to be present at all times. However, if pests cause concern, get help to assess the damage. Check with other organic producers, your certification agent or your Cooperative Extension office for help identifying problems you discover in your crops. Experience helps when trying to identify beneficial insects, crawling pests, diseases and weeds. Sometimes, a microscope or special training is necessary to properly identify insects, diseases and weeds. Cooperative Extension provides several inexpensive publications on pest control. Also, see "Resources," page 73.

Three biological controls naturally occurring in grains

Most field crop insects are not pests at all—they're beneficial. To encourage most beneficial insects, practice crop rotation, grow cover crops, and keep field size to a minimum.

Predatory ground beetles (Carabids) are important predators of many grain pests, including slugs, cutworms, maggots and other pests that spend part of their life in or near soil. They eat weed seeds, too. Adults are iridescent, blue-black or brown beetles, up to 1 inch long, with long legs.

Minute pirate bugs (Orius species) are common insect predators in grain crops and surrounding areas. Pirate bugs devour a variety of pests, including spider mites, potato leafhoppers, insect eggs, aphids, thrips, and small caterpillars, sucking juices from their prey through a sharp needle-like beak. Adults are very small (1/8 inch long), oval-shaped, and black with white wing patches.

Lady beetles—particularly the seven-spotted lady beetle, Coccinella septempunctata—have a big appetite for aphids and other soft-bodied pests in field crops and surrounding areas. Most are shiny, round, red-to-orange beetles with dark spots. Larvae are spindle-shaped, up to 3/8 inch long and dark colored with orange spots.

Insect Pests

Practices that contribute to management of insect and crawling pests include crop rotation, sanitation, using resistant varieties, weed management in and near the crop, and manipulating planting date. Also, see "Management practices and insect pests of corn, soybeans and wheat," page 26.

Corn. The best control for corn rootworm is crop rotation. European corn borer damages very little field corn in Pennsylvania. Watch for armyworm damage in cornfields that were in sod the previous year or in fields where rye or wheat was used as a mulch. Control action usually is not profitable unless 7% or more of plants are infested or showing damage symptoms. Cutworms are among the most difficult insect pests of corn to control. Control weeds, especially early weeds such as chickweed, in and near crops, and plant early to reduce cutworm problems. Watch for cutworm damage from mid-May to early June.

Soybeans. Soybeans growing in the northeast US are relatively free of insect pests.

Small grains. Few insects are of economic importance to small grains in New York and Pennsylvania. The most frequent insects are aphids, armyworms, cereal leaf beetles, and Hessian flies.

Plant Disease

To manage plant diseases in grain crops, organic producers rely on resistant varieties, sanitation and clean seed, crop rotation, tillage, weed management and providing the right soil pH and nutrient requirements. Also, see "Management practices and diseases of corn, soybeans and wheat", page 25.

Corn. Corn diseases are strongly influenced by weather conditions and are very difficult

to predict. In Pennsylvania, corn is occasionally bothered by Northern leaf blight, Bacterial leaf blight, Gray leaf spot and Stalk rot.

Soybean. By delaying planting until soil has warmed, organic producers avoid many early soybean diseases.

Small grains. The major foliar diseases in Pennsylvania are powdery mildew, septoria leaf spot, and leaf rust. In Pennsylvania, the economic damage caused by these diseases varies from year to year, depending on the weather, the host plant resistance, and the presence of a pathogen. Seed- and soil-borne diseases may reduce wheat, barley, oat, and other small grain yields. Principal diseases of seed include seed decays, seedling blights, and loose and covered smuts.

Managing Weeds

In row crops, organic growers rely on timely cultivation to control weeds before planting and early in the season, and by delaying planting until soil has warmed sufficiently for quick crop germination. Avoid planting row crops where perennial weeds are problem. Plant a sod crop with two or three cuttings per year instead. Good small-grain stands are highly competitive with weeds. In addition, organic producers practice crop rotation to prevent continuous management practices and aid in weed management. See the individual chapters on corn, soybeans, buckwheat and small grain production for crop-specific weed management.

Management practices and diseases of corn, soybeans and wheat

Key +2 = greatly reduces pest risk +1 = reduces pest risk 0 = no or little effect on pests -1 = small increase in pest risk -2 = strong increase in pest risk ? = unknown	Crop rotation			Tillage			Planting date		Plant population		Row width		Cultivation		Pesticides			
Diseases	Continuous	2 year	3+ year	No-till	Chisel	Moldboard	Early	Late	Low	High	Narrow	Conventional	Early	Late	Seed treatment	Foliar	Cover crops	Pest resistant varieties
CORN																		
Corn grey leaf spot	-2	+1	+2	-2	-2	+2	0	0	+1	-1	-1	0	0	0	+1	+1	?	+2
Stewart's leaf blight	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+1	+1	0	+1
Corn ear mold	-2	-1	+1	-2	-1	+1	0	0	0	-1	-1	0	0	0	0	0	?	+1
SOYBEAN																		
Soybean root and stem rot	-2	-1	0	0	0	0	-2	+1	0	-1	-1	0	0	0	+1	0	-1	+2
White mold	-2	-1	0	?	0	0	0	0	+1	-1	-2	+1	0	0	0	+1	?	+2
WHEAT																		
Barley yellow dwarf	-1	0	0	0	0	0	-2	0	0	0	NA	NA	0	0	0	NA	0	NA
Wheat yellow mosaic	-2	-1	0	0	0	0	-2	0	0	0	NA	NA	0	0	0	NA	?	+2
Powdery mildew	-2	-1	0	-2	-2	+1	-1	0	-1	+1	NA	NA	0	0	0	+2	?	+2
Wheat scab	-2	-1	0	-2	-1	+2	0	0	0	0	NA	NA	0	0	0	+1	?	+1
Wheat leaf rust	0	0	0	0	0	0	-1	0	0	0	NA	NA	0	0	0	+2	?	+2
Wheat loose smut	0	0	0	0	0	0	0	0	0	0	NA	NA	0	0	+2	0	?	NA

Source: Cavigelli, M.A., S.R. Deming, L. K. Probyn and D. R. Mutch, eds. 2000. Michigan Field Crop Pest Ecology and Management. Michigan State University Extension Bulletin E-2704, 108 pp.

Management practices and insect pests of corn, soybeans and wheat

Key
+2 = greatly reduces pest risk
+1 = reduces pest risk
0 = no or little effect on pests
-1 = small increase in pest risk
-2 = strong increase in pest risk

Insect pests	Soil type				Crop rotation			Tillage			Planting date		Plant population		Row width		Cultivation		Field size and borders		Pest resistant varieties
	Coarse	Fine	Soil quality	Cover crops	Continuous	2+ year	3+ year	No-till	Chisel	Moldboard	Early	Late	Low	High	Narrow	Conventional	Early	Late	Small w/borders	Large w/o borders	
CORN																					
European corn borer	0	0	+1	+1	-1	0	+1	-1	-1	+1	0	-1	0	0	0	0	0	0	+1	-1	+2
Corn rootworm, larvae	+1	-1	+1	+1	-2	+2	+2	0	0	+1	0	-1	-1	0	0	0	0	0	0	0	+2
White grubs	+1	-1	+1	-1	0	0	0	0	0	+1	-1	+1	-1	+1	0	0	0	0	0	0	0
Cutworms	+1	-1	+1	0	0	0	0	-2	-1	+1	-1	+1	-1	+1	0	0	0	0	0	0	0
Wireworms	+1	-1	+1	-1	0	0	0	0	0	+1	-1	+1	-1	+1	0	0	0	0	0	0	0
True armyworms	0	0	0	-2	0	0	0	+1	+1	0	-1	+1	-1	+1	0	0	0	0	+1	-1	0
SOYBEANS																					
Spider mites	-2	+1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	+1
Cutworms	0	0	0	+1	0	0	0	-2	+1-1	0	-1	+1	0	0	0	0	0	0	0	0	0
Seedcorn maggot	0	0	+1	-1	0	0	0	+1	0	-1	-1	+1	-1	+1	0	0	0	0	0	0	0
Potato leafhopper	0	0	0	0	0	0	0	0	0	0	0	-1	-1	0	+1	0	NA	0	0	0	+2
WHEAT																					
Cereal leaf beetle	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hessian fly	0	0	0	0	-1	0	0	0	0	0	-2	-1	-1	+1	0	0	0	0	0	0	+2

Source: Cavigelli, M.A., S.R. Deming, L. K. Probyn and D. R. Mutch, eds. 2000. Michigan Field Crop Pest Ecology and Management. Michigan State University Extension Bulletin E-2704, 108 pp.

CHAPTER 5 MARKETING

Food vs. Feed Markets

Most growers market organic grains as livestock feed or as human food grade. While organic crops are considered a specialty, you will earn a premium price—over conventional grain—either way. However, organic livestock feed is at the low end of the price spectrum, and human food grade is at the high end. When deciding where to start, consider the comparison of organic feed grade and organic human grade grains in **Table 3**, and their marketing in **Figure 1**. If you are new to organic farming, keep your risks low by growing for the livestock feed grade market, then add human food grade grains later. Whether you choose to produce livestock feed or human food grains, be prepared for fluctuations in the market.

There are additional markets that haven't been developed or are limited. For example, you could harvest rye and sell it as seed for cover crops. (You can't sell your own organic seed for grain unless you are a certified organic seed dealer. However, other organic growers may use it for cover crops.) With access to a greenhouse, you could produce sprouted wheat grass for the health food market. Or, market your grains for nonfood uses; however, this market has not been developed for organic grains. For example, conventional corn is used in the manufacture of a variety of products, including fireworks, cosmetics, and for leather tanning.

Tips for a Good Marketing Plan

The most successful farms today employ some form of strategic business and marketing plans. With planning, you will enjoy better control over price and your farm business. And if you are new to organic grain marketing, the risks are high—as with any new venture. You help minimize these risks through a well-researched marketing plan. Here are some quick tips to get you started on your Marketing Plan. See Resources on Agricultural Marketing (p. 75) for more information on Farm Marketing and Business Planning.

Quick tips to get started:

Marketing begins before the first seed is planted:
Marketing begins with research. Always remember this.

Research is asking lots of questions:
Ask your buyers, your suppliers, and the growers doing something similar. Anybody that has a stake in the kind of business you are trying to run. Back it up with research from the Internet. The Internet has the most up-to-date information. If you do not have access to the Internet, have someone assist you. This is a marketing tool like no other.

Know your customer:
Whether your customer is a broker, a processor, a retailer or the end-consumer himself, you need to know who this is and how they think. Identify your end-consumer. Are you marketing to humans or animals? And if you're marketing to animals, what is their end product (meat, dairy)?

Know your competitors:
Always get a feel for what others are doing, and how many are doing what you would like to do. Make yourself different, unique. Learn from the competition's successes and failures. Why reinvent them?

Know the 4 P's:
This is your Marketing Mix. The Marketing Mix is like 4 legs of a chair to your farm business. Inattention to any one leg can be disaster!

Product: what will I produce? What does the market (consumers) demand?

Price: what price will the market bear? How much control do I have over price? How far from is my product from the consumable stage at the point of sale?

Promotion: How will I communicate to the target consumers that I have something they want?

Place (Distribution): How will I get my product to the consumers? How many channels will it go through, and what are my options? Is direct marketing an option?

Keep good records:
Even a simple record keeping system can give you loads of information about your business. Looking at what is selling or not, or where all your money is going, gives you a financial snapshot of your business. You can then determine what is working, and what is not.

Evaluate Yourself:
Always rate yourself as things go on. Ask your buyers or consumers what they think, and how you can improve. Do an annual or biannual review. Survey your customers.

Table 3

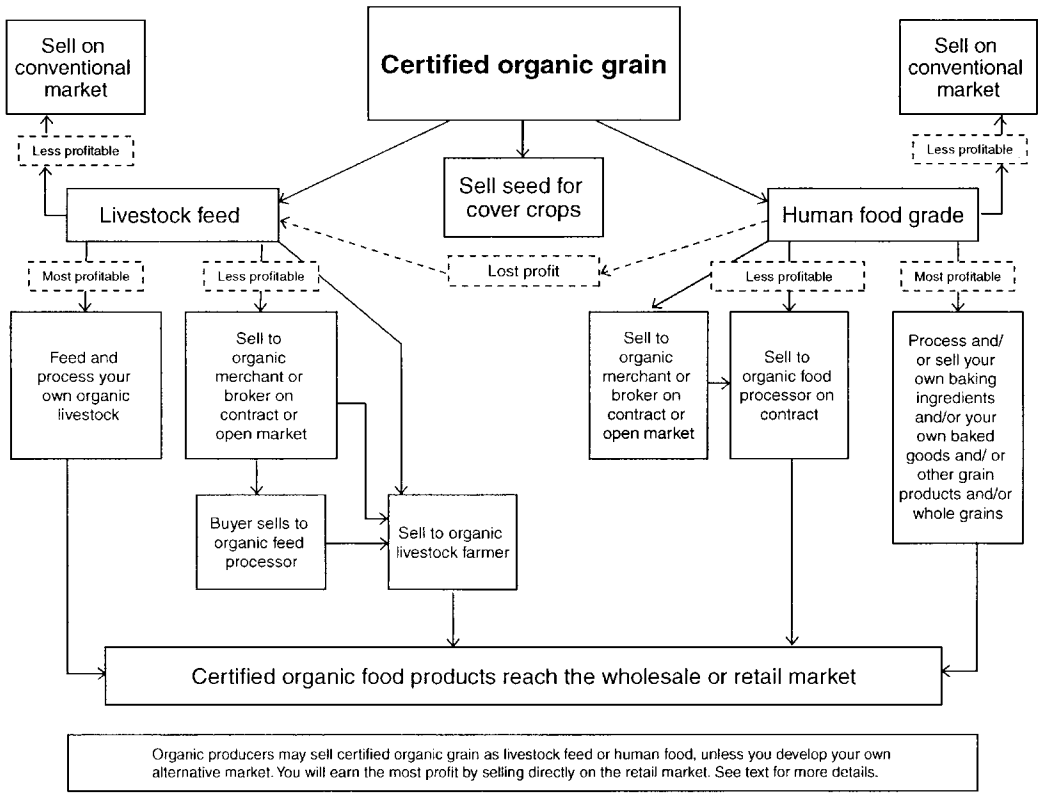
Organic feed grade grains:

- You can skip the rigid specifications associated with producing grains for human consumption. Stick to livestock feed if you dislike details.
- You can sell directly to local organic animal producers, and both of you get a better deal since the middleman is eliminated.
- To be successful and stay that way, you'll have to maintain a good relationship with your buyer(s).
- Grain appearance isn't as important, but you should avoid selling low quality or weed seed-contaminated feed grains to other farmers.
- Crop variety isn't as important—but yield is. Your seed must be untreated, non-GMO and preferably certified organic.
- A contract is optional. You can sell to many organic mills without a contract.
- You must maintain the identity of the organic grain.
- Works especially well if you're raising livestock.
- You will earn a lower price for feed grade grains.

Organic human grade grains:

- Growing organic human food grade grains requires more attention to detail. Your contract with a buyer may come with a long list of quality specifications. Ignore them, and your crop will end up in the livestock feed bin.
- Until you've established a long-term relationship with a reputable buyer, don't grow without a contract.
- To be successful and stay that way, you'll have to maintain a good relationship with your buyer(s).
- You can sell directly to an organic food processor or distributor, and both of you get a better deal since the middleman is eliminated.
- Growing the right crop variety may be more important than yield. You may have to purchase a specific variety of seed with limited availability. Your seed must be untreated, non-GMO and preferably certified organic.
- You must maintain the identity of the organic grain.
- You will earn a higher price for human food grade grains.

Figure 1



Storage

Storage is one of the most important factors of your organic marketing system. You may need to store a crop for several weeks or several months, since even the largest buyer may not have sufficient storage capacity for your entire crop at one time. Some buyers will specify multiple deliveries in the contract. Storage must keep out bugs, keep out rodents, and maintain the proper environmental conditions. Farm bins are the most efficient way to store an organic grain crop. You'll need more bins if your crop rotation is diverse. You'll need larger bins if your fields and harvests are large. If you have a split operation, extra storage space may be necessary to prevent commingling of organic and conventional products. Start with one or several bins, then add as necessary. Some organic producers lease their empty storage bins to other organic producers or organic millers. Bins should be identified with numbers, letters or names and a log maintained of their contents.

Quality

Grain quality is another important factor in your organic marketing system. The quality of your product determines its value. It might mean the difference between organic feed grade soybeans sold at $10/bushel vs. organic food grade soybeans sold at $18/bushel. To produce a crop with the highest value, you must be able to:

1. Grow a clean, weed-free crop in the field;
2. Harvest the crop at the proper maturity without damage;
3. Store the crop without contamination in the proper environment;
4. Deliver an acceptable identified organic crop to the buyer;
5. Collect payment for the crop.

Pay attention to crop quality from the day that seeds contact the soil, until the day you receive payment. That means you'll have to control weeds, pests and volunteer crops in the field. When combining beans, stop to clean out the combine after you've passed over a rise in the field. Don't use the barn floor as a temporary storage space—mice and barn cats are sure to contaminate the grain. Keep odors, stains, foreign material and broken seeds to a minimum. With or without a contract, before you plant a crop, be aware of the requirements of your buyers so you'll know how to produce the quality they want. Also, see "Chapter 7: Organic grain production techniques" for more specifics on grain quality.

Contracts

All grain buyers—millers, livestock producers, feed and food processors and distributors—must have access to a dependable supply of high-quality grains. To meet the demand, buyers will contract with producers to supply a grain crop within a specified time period, at a specified price. Contracts are legal agreements between the farmer and the buyer. Contracts are more common to large grain producers in the western states, than to the comparatively small grain producers of the northeast states. Location aside, many farmers are reluctant to contract for a crop they don't have. Some millers predict that the trend will change as more organic grain products, and new organic producers,

enter the market. Most sources agree that it is in the farmer's best interest to have a contract with a buyer when producing organic or other specialty crops. It only makes sense that as your risk increases with high value specialty crops, the need for a contract is greater.

What to look for in a contract

Of course, once you have a contract, things can go wrong. That's where good communication between the farmer and buyer comes in. Answer these questions before you sign a contract:

1. Do you understand what you are agreeing to? For example, are you selling a specific variety? A specific quality? You may have to clean and deliver the grain, or store the grain and make multiple deliveries. Some buyers will contract for all of your grain production, while others want only a fraction of it.
2. What price will you be paid?
3. When will you be paid? What can you do if you are not paid?
4. What will happen if you can not meet the terms of the contract? If your yield falls short? When a buyer contracts for 5,000 bushels of soft red winter wheat, the wheat is tagged for a specific customer. As one miller put it, "We bought the crop and we have sold the crop." That's why the farmer must supply any shortfall, whether that means finding another local source for the same organic crop or paying the difference.

A good buyer will be willing to work with the farmer, not against him. A contract should work well for both parties. When selling grains under contract, have your lawyer examine the contract before you sign. Once you and the buyer have worked together for several years, you may find that you know what to look for without legal assistance. Start small, with the minimum lot size for which a buyer will contract. Don't put all of your eggs in one basket, either. Sell and contract with several different buyers. We've covered only the basics here, for more information on contracts, see "Resources," page 73.

Making Sure You Get Paid

Once your crop has been harvested and delivered, how can you ensure payment? Start by checking out the buyer. Avoid large financial losses by starting small—that is, contract with a new buyer for the minimum quantity. You can ask other organic producers about their experiences with a particular buyer. Do farmers tend to stay with a buyer more than one year? If the buyer is certified, check with their certification agency. Or, check with your organic certifier. Have other organic growers had a problem with the buyer? You can ask a buyer for a bank letter of credit, or for names of other growers they do business with. Or, you can subscribe to the credit reference business company Dunn and Bradstreet (dunnandbradstreet.com) and get a credit report for a fee.

Finding a Buyer

Most producers agree that finding a buyer is the toughest part of farming. This is where networking helps. Here are just a few ideas for selling your crop:

- Join a grain cooperative—or start one.
- Find a buyer you can work with, then plan your crops based on his/her needs.
- Get on the Internet. If you can't find a local buyer, there might be a better market in another state.
- Create your own website.
- List your crops with your certification agency. Organic certification agencies are the first place buyers look for organic farmers.
- Advertise in local/regional weekly farm or other publications.
- Contact local grain millers, grain brokers, and food processors.

Backhauling

As concern over food safety increases, so will Federal and State regulations based on consumer protection. In Pennsylvania, a Department of Environmental Protection regulation states that it is a violation to "transport, or knowingly provide a vehicle for the transportation of, a food product or produce intended for human or livestock consumption, in a vehicle which has been used to transport municipal, residual or hazardous waste, or chemical or liquid, in bulk, which is not a food product or produce." For the organic producer in Pennsylvania, that means that you may not haul compost ingredients—yard waste such as leaves, or food waste such as cabbage leaves or apple pomace—in the same truck used to deliver grain to the miller. However, the restrictions do not apply to commercial-grade compost. Likewise, clean fill such as uncontaminated soil, bricks, rocks, tree stumps and used asphalt are not considered waste and may be transported in the same vehicle. Producers in other states should check for similar regulations that may apply to their operation.

CHAPTER 6 ORGANIC CERTIFICATION

In this chapter, you'll find highlights and excerpts of the standards that apply to the production of organic corn, soybeans, buckwheat and small grains. This chapter should not be used in place of the NOPFR. Consult your certifying agent for clarification of the requirements you must meet.

Federal Standards

Beginning on October 21, 2002, organic growers must be certified by a USDA-accredited certifying agent to sell, label, or represent their products as organic. The National Organic Program Final Rule (NOPFR) is the lengthy volume (over 500 pages) of the *Federal Register* in which the standards have been spelled out. The NOPFR addresses crop production and handling, certification and record- keeping requirements. You can view the entire NOPFR and related documents at the homepage www.ams.usda.gov/nop/. The most significant portion of your time will be spent preparing the organic system plan (OSP).

Organic System Plan [Section 205.201]

According to the NOPFR, the organic system plan contains six components, listed below with a brief explanation of each.

1. "The OSP must describe the practices and procedures used, including the frequency with which they will be used, in the certified operation." That means that you must write a report that lists and describes the methods you plan to use in order to produce an organic grain crop. This includes practices such as applying manure to supply nitrogen to corn, or planting a variety of corn with resistance to disease, or delaying the planting of a corn crop in order to control weeds. How many times do you plan to apply manure or till that field of corn? You must include frequency in the report, too.

2. "The OSP must list and characterize each substance used as a
production or handling input, including the documentation of commercial availability, as applicable." If you can't easily find

a source of the commercial organic seed you planned to plant, you'll need to describe your search for it. Keep a list of the seed suppliers you contact. Do the same for all production inputs you use—from purchased compost to biological controls. Another example—farmers who apply manure to their fields must document in their organic system plans how they will prevent that application from contributing to water contamination.

3. "The OSP must identify the monitoring techniques which will be used to verify that the organic plan is being implemented in a manner which complies with all applicable requirements." You are responsible for monitoring your own success. Thus, if your OSP calls for improvements in soil organic matter content in a particular field, the plan should explain how you will measure it.

4. "The OSP must explain the record keeping system used to preserve the identity of organic products from the point of certification through delivery to the customer who assumes legal title to the goods." Keep receipts, tags and empty bags. For each crop, the audit trail must trace the product from the field to the buyer (see "Record-keeping" on page 36).

5. "The OSP must describe the management practices and physical barriers established to prevent commingling of organic and nonorganic products on a split operation and to prevent contact of organic production and handling operations and products with prohibited substances." That means that if you produce both organic and nonorganic grains on the same farm, you must have a written plan to keep the organic and nonorganic grains separate. You'll have to store organic and nonorganic seed bags in separate locations. Drift from nonorganic farms has been a difficult issue for organic producers from the beginning. The organic system plan must outline steps that you will take to avoid drift.

6. "The OSP must contain the additional information deemed necessary by the certifying agent to evaluate site-specific conditions relevant to compliance with these or applicable state program regulations." Each farm is unique. Your certifying agent may require additional specific information in order to evaluate your application.

Organic crop production—regulation highlights

- Land will have no prohibited substances applied to it for at least 3 years before the harvest of an organic crop.
- The use of genetic engineering (included in excluded methods), ionizing radiation and sewage sludge is prohibited.
- Soil fertility and crop nutrients will be managed through tillage and cultivation practices, crop rotations, and cover crops, supplemented with animal and crop waste materials and allowed synthetic materials.
- Seed must be organic. If you can't find organic seed, you may use untreated nonorganic seed. Request a letter from the seed company stating that the seed is not genetically engineered. Non-GMO inoculants are allowed. There is no allowance for seed treated with prohibited materials such as Captan and similar fungicides.
- Crop pests weeds and diseases will be controlled primarily through management

practices including physical, mechanical and biological controls. When these practices are not sufficient, a biological, botanical or synthetic substance approved for use on the National List of Allowed and Prohibited Substances (see page 37) may be used.

- A producer of an organic crop must manage soil fertility, including tillage and cultivation practices, in a manner that maintains or improves the physical, chemical, and biological condition of the soil and minimizes soil erosion.
- The producer must manage crop nutrients and soil fertility through rotations, cover crops and the application of plant and animal materials.
- The producer must manage plant and animal materials to maintain or improve soil organic matter content in a manner that does not contribute to contamination of crops, soil or water by plant nutrients, pathogenic organisms, heavy metals or residues of prohibited substances.

Manure and Compost—Regulation Highlights

The regulations contain restrictions on composting and the application of raw manure on soil used for growing crops for human consumption. Raw animal manure must be composted unless it is:

1. Applied to land used for a crop not intended for human consumption;
2. Incorporated into the soil not less than 120 days prior to the harvest of a product whose edible portion has direct contact with the soil surface or soil particles;
3. Or, incorporated into the soil not less than 90 days prior to the harvest of a product whose edible portion does not have direct contact with the soil surface or soil particles.

Composted plant and animal materials may only be used if they are produced through a process that:

1. Established an initial C:N ratio of between 25:1 and 40:1—that includes most manure/bedding mixes;
2. And, maintained a temperature of between 131°F and 170°F for three days using an in-vessel or static aerated pile system;
3. Or, maintained a temperature of between 131°F and 170°F for 15 days using a windrow composting system, during which period the materials must be turned a minimum of five times.

Who Must Be Certified?

If you sell $5,000 or more in organic agricultural products, you must be certified. Operations that sell less than $5,000 a year in organic agricultural products are exempted from certification (although they may choose to be certified) and preparing an organic system plan, but they must operate in compliance with these regulations and may label products as organic.

Certification Process

1. Request materials. To start the process, contact any USDA-accredited certifying agent in your state. You can find a list of agents under "Resources," page 73. The NOP plans to

provide a list of accredited agents on or about April 21, 2002, which will be accessible on the NOP website at www.ams.usda.gov.nop. We'll use the procedure used by Pennsylvania Certified Organic (PCO), an accredited agency in Pennsylvania, as an example of the certification process. On request, PCO will send you a certification manual and forms you must complete and return, with a fee.

2. Return the application and fee. PCO screens your materials to determine your eligibility, and will send you an initial review report. If your application is not approved, you will be notified and given a period of time to make corrections. If you fail to make the required corrections, certification is denied. If your application is complete and approved, PCO assigns your file to an inspector.

3. On-site inspection and report. An independent field inspector will contact you to arrange an on-site inspection. The inspector will personally view all areas of your farm or production facility, including your records. The inspector will forward a detailed report to PCO.

4. Approval or denial. If your farm is approved for certification, you will sign a producer agree ment and receive your organic certificate. If you are denied certification, or there are conditions that must be met prior to certification, you will be notified.

5. Continuation of certification. Each year, submit your updated Organic System Plan and annual fees to PCO in order to continue your certification. Annual inspections will be performed. You must notify your agent immediately of any changes that could affect your operation's compliance with the regulations, such as application of a prohibited pesticide to a field. Certification will remain in effect until terminated, either voluntarily or through the enforcement process.

Certification Agencies

The first announcement of accredited certifying agents will not occur until on or about April 21, 2002. At that time, the NOP will provide a list of accredited certifying agents which will be accessible on the NOP website at www.ams.usda.gov.nop or by request through the NOP office at 1400 Independence Avenue, SW; Room 2510 South Building; Washington, DC, 20250.

Record-Keeping Requirements

Your certification agent can supply you with forms for record-keeping. Examples of records to keep include:

- application for certification
- organic system plan and supporting documents
- purchased inputs, including seeds, transplants and substances (fertilizers, pesticides)
- field operations records (planting, inputs, cultivation and harvest)
- storage records (bin registers)
- producer invoices and contracts
- receiving manifests (bills of lading) and receiving tickets
- signed receipt for cleaning grain trucks between handling of conventional and organic grains

- transaction, producer and handler certificates
- weigh tickets, receipts and tags
- cash purchase receipts.

National List of Allowed Synthetic and Prohibited Non-Synthetic Substances

The Organic Materials Review Institute (OMRI) is a nonprofit organization whose mission is to publish and disseminate lists of materials that are allowed or prohibited for use in the production, processing, and handling of organic food and fiber. OMRI has other roles, too. You should consult the OMRI Materials Lists to determine which products (fertilizers, pesticides, soil additives, etc.) you may use as a producer of organic grain. You can access the lists at the OMRI web site www.omri.org/, or purchase a copy of the lists by subscribing to OMRI. Also, see "Resources," page 73.

State Organic Programs

The Organic Foods Production Act of 1990 (OFPA) authorizes the Secretary of Agriculture to approve state organic programs that are consistent with the national organic standards and regulations established under the OFPA. Under USDA's National Organic Program (NOP), a state government may request the Secretary to approve its state organic program. Once a state's requested organic requirements are approved by the Secretary, those requirements become the NOP requirements for organic producers, handlers, and certifying agents operating in the state.

NOP and OMRI

Check with your certifier before applying any product or material. At the time of printing, the USDA National Organic Program (NOP) is working with the Organic Materials Review Institute (OMRI) to publish an up-to-date list of approved materials and processes. You can view recent changes to the list at www.OMRI.org.

CHAPTER 7 ORGANIC GRAIN PRODUCTION TECHNIQUES

Before fieldwork can begin, take time to prepare for the growing season. Use this chapter as a guide to growing organic corn, soybeans, buckwheat, wheat, rye, oats, barley and spelt. Start with the following basics:

1. Conduct research. Contact buyers to find out more about what's in demand. Read everything you can find concerning your crops. Start with this book, then search the Internet and your local library. Examine your own goals and abilities, too. Growing organic feed for livestock is easily doable; growing organic food-grade grains requires more time, labor and money. Also, see "Marketing," page 27 and "Resources," page 73.

2. Obtain a contract. Whenever possible, contract your acreage before planting the crop, particularly if you decide to grow human grade food grains. You may want to contract with several buyers. Also, see "Contracts," page 30.

3. Prepare to keep it clean. Premium prices are paid for cleaned and delivered grain. Processors require grain that is free of stones, debris, cobwebs, dust and rodents. Before harvesting, control weeds to prevent plant juices and seeds from contaminating your crop during harvest. While harvesting, keep the combine properly adjusted to avoid cracking the grain. Read the sections in this chapter on producing each crop.

4. Invest in storage. After harvest, store grains in clean, rodent-proof bins. Your contractor or certification agency may have additional standards concerning storage.

Corn Production

Maize *Zea mays* is a coarse annual grass. Corn supplies most of the feed grain and silage fed in the US. Corn is fed to livestock to produce meat, eggs and dairy products. Corn contributes to material needs—fuel, clothing, paint, tires, plastics and more. And, corn is consumed everyday as breakfast cereal, soda, snack chips and other processed food products. Organic corn may be difficult to produce during the organic transition period, unless producers can supply sufficient nitrogen and focus on an entire sequence of rotated crops. Organic corn yields may equal or excel conventional yields, depending on hybrids grown, soil fertility status, and weed and pest management.

Seed selection

Plant breeders have used genetics to alter the starch, protein and oil content of corn to meet the needs of livestock feed, human food and industry. Most of the corn produced in the eastern states is of the yellow dent type. Yellow dent has high feed value, and has the highest content of carotene (Vitamin A) of the cereal grains. However, yellow dent has limited levels of lysine and tryptophane—amino acids that are essential in the diet of nonruminant animals. Many hybrids are available. Yellow dent corn is also called field corn.

Few open pollinated (OP) or non-hybrid varieties of grain corns are available today. Some organic producers grow OP varieties for silage and saving their own seed. In general, OP varieties lack the uniform growth, plant size, maturity and resistance to insects and diseases of hybrid corn. Hybrids are the choice of all grain producers—conventional and organic—due to their availability and diversity. On average, hybrid corn varieties have a 60 per cent yield advantage over OP varieties. Some specialty corns, such as blue corn, are available only as OP.

When growing corn hybrids, certified organic producers must select organic untreated non-GMO (genetically modified organism) [1] types. If organic seed is unavailable, untreated non-GMO hybrids may be used but you must document your search for organic seed. Consult your organic certification agency and contract when making decisions regarding selection of seed variety and source, especially if your plans change. Also, see "Organic Certification," page 33.

[1] GMO corn is any corn hybrid that has been genetically modified through biotechnology procedures to add a specific trait, such as Bt corn, NaturGard®, Roundup Ready®, etc. You should check with your certifier for the latest updates on contamination of organic corn by GMO types.

In Pennsylvania and New York, you can find evaluations for late-season hybrids, late medium-season hybrids, early medium-season and short-season hybrids in Cooperative Extension (CES) publications. Consider market demands when selecting hybrids. Check for yield history, maturity, standability, disease resistance, drought tolerance and dry-down. Hybrid performance varies among locations and years. You should grow more than one hybrid each year, just to be safe in case one hybrid fails. Choose hybrids with a wide range of adaptability for the best results. You should consider your own experience,

as well as that of your neighbors, when choosing corn hybrids. Many organic producers feel that growing a good quality, untreated variety that grows well in their location is the most important factor—above and beyond whether the seed is organic.

Specialty corn

Specialty corns include white and yellow food corn, blue and red food corn, popcorn, high-lysine, high-oil, high amylose, waxy, flour, flint and ornamental corns. Production practices for specialty corns are similar to those for yellow dent corn. In general, grain yields and test weights of specialty corn hybrids are lower than those of yellow dent corn hybrids. Depending on the type of specialty corn, extra steps may be necessary in order to produce a successful, high-quality crop. Plan to conduct your own research, on the Internet or at the library, when growing specialty corns for the first time. In most cases, producers have a limited choice of varieties—whether open-pollinated or hybrid.

White and yellow food corn hybrids are dent corn with specific starch traits. New higher yielding hybrids of white corn produce similar yields to yellow corn. Older varieties of white corn may yield up to 13% less. Producers can expect premiums for both white dent and yellow dent food corn. The premium paid for yellow food grade often depends upon the hybrid grown. New, higher yielding yellow food hybrids with desirable processing traits yield essentially the same as other dent hybrids. White and yellow food corns are typically contracted and sold to dry-mill processors and used in alkaline cooking processes for making masa, tortilla chips, snack foods and grits. White corn is equal to yellow corn in carbohydrate content but contains less vitamin A.

Management

The principal guidelines for organic production are to use materials and practices that enhance the ecological balance of natural systems and that integrate the parts of the farming system into an ecological whole. Remember!—Management practices that preserve the certified organic identity of the grain must be followed and documented from planting through storage and delivery to buyer. Also, see "Organic Certification," page 33, for tips on maintaining organic grain identity.

Establishment and cultivation

Seed depth: 1.5 to 2.0 inches

Desired plant population for organic corn grain: 24,000 to 28,000 plants per acre or higher

Test weight: 56 lb/bu

After primary tillage, allow the soil to rest for 7 to 10 days, then use a harrow to prepare the seedbed. Weeds that germinate can be controlled with a second harrowing or cultipacking before planting.

Conventional corn can be planted safely 10 to 14 days before the average date of the last killing frost; this ranges from April 15 to May 15 in Pennsylvania and New York. However, organic producers often plant corn later than conventional producers in order to 1) manage annual weeds, and 2) rely on warmer soil temperatures that encourage quick germination of untreated corn seed. In Pennsylvania, that may mean planting in the

middle or end of May, instead of April. NC+ Organics, a seed supplier, recommends planting their untreated corn seed when early morning soil temperature is at or near 60°F. Since organic corn seed is untreated, and since plants may be thinned by cultivation, use a corn planter to plant seed at a rate slightly higher than conventional producers. Like conventional corn, most organic producers plant seed in 30" or 36" rows. Rows placed closer together may be difficult to cultivate, or cause nutrient stress, or may provide too much shade if you plan to overseed rye or another crop in the fall.

Since corn is a row crop, mechanical cultivation is necessary for weed management. Under high weed pressure, use a rotary hoe, chain link harrow or tine weeder within five days of planting. These implements will flick small weed seedlings out of the ground, leaving roots exposed to the drying effects of wind and sun.

Once corn germinates, wait several days before using the rotary hoe again. Continue to use the rotary hoe as long as weeds are germinating or until the crop is too big, then begin cultivating.

A cultivator with a guidance control system will save you time but is not necessary. Guidance control allows you to cultivate faster, closer to the row, and more efficiently since it steers itself through the rows while you drive the tractor. Continue to cultivate at 7 to 10-day intervals for weed management, until the corn is too tall. Organic corn usually requires 1 to 3 cultivations with a rotary hoe, and 1 to 3 cultivations with a cultivator, depending on the weather. All cultivations are most successful when performed in the heat of the day and in bright sunshine. Rain immediately following cultivation may replant the weeds. Also, see "Managing Weeds," page 25.

Soil fertility

Best soil pH: Above 6.0

A corn crop yielding 120 bushels per acre of grain corn removes the following nutrients from the soil: 90 lb N/bu of corn; 50 lb/a of phosphate; and 35 lb/a of potash.

Organic nutrient management is a combination of practices, including crop rotation and the use of cover crops, manure and compost. As an organic producer, you are required to have an organic system plan (OSP). It's a good idea to prepare a nutrient management plan, too. Contact the local USDA - Natural Resources Conservation Service office, the local Cooperative Extension office, the local Conservation District office or a professional agricultural consultant for instructions. Have your soil tested each fall or spring by a professional laboratory.

If you make your own compost, have it tested, too. Use the test results to help you meet the goals of your nutrient management plan.

Corn grows best on well-drained, fertile soil. Corn is a moderate to heavy nutrient consumer, and should be avoided during transitional years when converting to organic production. Nitrogen fertility is usually the most important limiting factor in organic corn production. Corn is most economical when based on biologically fixed nitrogen (gained from legumes in the rotation), recycled nutrients (from livestock manure) and a biologically active soil.

Applying manure and compost

Apply compost or aged manure, as determined in your nutrient management budget, immediately before plowing in spring. Many producers will apply 5 tons/acre or less of finished compost. At The Rodale Institute, compost applications are infrequent—only every 3 or 4 years—and are based on plant phosphorus requirements, and not on nitrogen needs. Research in California has shown that by applying compost to a preceding legume cover crop, before plow down, you're likely to achieve greater yields than when legume cover crops or compost are used alone. Or, apply compost in the fall to green manure crops such as rye before plowing and planting corn the following spring. Many commercial organic products are not economical for agronomic crops. Managing crop systems to naturally build soil nutrient levels is the preferred approach. Once they've gone through the transitional period, many organic producers find that nitrogen supplied by cover crops and legumes, along with infrequent applications of compost or manure, is sufficient for corn production.

When applying compost or manure, follow these guidelines for efficient application:

- Compost and manure may not be applied in a way that contaminates water resources.
- Plow or incorporate compost immediately after spreading. Solid raw manure will lose about 21% of its nitrogen to the atmosphere if spread and left for four days.
- Before corn, apply manure to the preceding cover crop in order to reduce loss.
- Use soil testing to monitor levels of phosphorus and potassium. At The Rodale Institute, researchers found a build up of soil P and K after repeated annual heavy applications of compost.

Corn rotation

Corn benefits from rotation. Avoid growing continuous corn. Rotation reduces the inoculum for corn diseases and insects. Corn yields often increase 5 to 7% following soybeans and up to 10 to 15% following hay. Input costs for corn in a rotation often are reduced substantially because of the need for less nitrogen and pest control costs. Corn following alfalfa, especially with a composted manure application, should have sufficient nitrogen to produce a yield similar to conventional yields. Also, see "Crop Rotation," page 11.

Cover crops

Legumes are the best choice before planting corn. Following corn, rye or brassicas are the best choices and may be sown into standing corn. Also, see "Cover Crops," page 9.

Harvest, cleaning and storage

Expected yield for organic corn: 85-170 bu/acre

Harvest organic corn using the same techniques as conventional corn. However, food grade corn should be handled more carefully than animal feed. Food grade corn, like certified organic corn, must be kept separate in order to maintain value and identity. To avoid excessive mechanical damage to kernels, make sure the combine is properly adjusted. Set the clearance and speed of the cylinder according to the operator's manual as a starting point and make slight adjustments in the field as needed. If conventional crops are also harvested, the machine must be thoroughly cleaned between crops. Combine

cleaning must be documented. If you hire a custom harvester, you are responsible for making certain they meet the standards.

Field drying is best and allows the kernel to reach full maturity. Corn may be machine dried using conventional methods. Grain kernel temperature should be kept below 140°F (90°F is better yet) during the entire drying process to minimize undesirable quality losses.

Storage bins should be swept, vacuumed or blown clean prior to placing grain in them to reduce insect and contamination problems. Remove all dust, moldy grain and debris. Keep weeds around the bins mowed. Use a gravity table or screen to clean the dry corn before placing it into a storage bin, to improve airflow and reduce the potential for spoilage problems. Some buyers will clean the grain for you. However, you may have to pay for this service. In the end, you may be paid for the amount of grain delivered minus the debris removed. You may have to store the grain until the buyer has adequate storage or a customer.

Once a month during the fall and winter, you should run a cooling cycle to lower the grain temperature by 10°F to 15°F. The remainder of the time, the fan should be covered to minimize moisture accumulation in the stored grain, especially during premature warming periods in the early spring.

Marketing

It's a good idea to read "Marketing," page 27 before reading this section. Marketing organic grains is very different from marketing conventional grain. As an organic grain producer, you have more marketing options, but you'll have to find them. You will get the best price in the organic market by selling livestock feed or human food grade corn. There is no established market for industrial uses of organic corn. The best plan may be to sell to several different markets, including direct marketing to local livestock farmers or food processors, or to grain merchants and brokers. Or, you can process and sell your own organic corn food products. To get started, use the following key to help you choose between livestock feed and human food grade markets.

Organic grain crop market key

1. First, determine the quality of the crop you think you can grow. Can you produce organic animal feed? *If "Yes," go to 2.* Or, can you produce organic human food grade grain? If *"Yes," go to 5.*

2. Can you sell and deliver directly to local organic animal producers? *If "Yes," go to 3.* Or, can you sell and deliver your crop to a merchant or broker of organic feed grains? *If "Yes," go to 4.*

3. With direct sales, both buyer and seller win. You may get a *higher* price, compared to a merchant or broker. The animal producer often pays a *lesser* price. Can you sell all of your crop to local organic animal produces? *If "Yes," you're done!* Or, do you have unsold livestock grade organic grain? *If "Yes," go to 4.*

4. If you have unsold livestock grade organic grain, and no direct buyers, arrange to sell your organic livestock grade crop to a merchant or broker. Next year, contact merchants

or brokers before you plant. Or, add livestock to your operation and sell certified organic animal products such as meat, eggs or cheese. You're done!

5. Do you have plenty of organic growing experience? *If "No," go back to 2.* Growing food for humans is more complicated. You'll have to comply with quality standards, develop your own market, and/or locate a buyer(s) for your product. Remember—practice makes perfect! Are you still interested in growing organic human grade grains? *If "Yes," go to 6.*

6. Obtain a contract to sell and deliver your crop to a buyer of organic food grade grains. Or, obtain a contract to sell and deliver your crop directly to a food processor. Or, sell directly to local, national or international customers. You can add value by turning your grains into milled flours, baking mixes, cereals or baked items such as breads, muffins, etc. Work with a Community Supported Agriculture (CSA) to sell whole or milled grains directly to local customers. Sell to health food stores or restaurants, or roadside stands or farmer markets. Sell via a Website or produce auction. Before you begin, talk with state department of agriculture officials to learn about regulations.

Soybean Production

The soybean *Glycine max* is a broad-leaved annual legume grown for its seed. Soybeans are the largest source of vegetable oil and high-protein animal feed in the world. The US is the world's leading producer of soybeans. In the US, nearly all soybeans are crushed to extract oil for food and industrial use, and the high-protein meal for animal feed. A comparatively small amount of whole soybeans are used for seed, dairy feed, and for food such as tofu, soymilk, miso; for soup, salad and snacking beans; and for roasting. Like corn, soybeans have many nonfood uses and may be found in soy-based scented candles, crayons, biodiesel fuel, ink, bodycare products, solvents and many other products. At the time of publication, there is a good market for organic human food grade and livestock feed grade soybeans.

Seed selection

Two types make up the majority of soybeans grown in the US: oil beans and food beans. Oil beans are the type commonly grown by farmers as livestock feed. They are of medium size, ranging from 3000 to 4000 seeds per pound, with a yellow or yellow-brown seed coat and a dark colored hilum. They have high oil content, medium to low protein content and high yield potential.

Oil soybean varieties fall into several maturity groups; most varieties are useful only in a limited area. You can find evaluations for local soybean hybrids in Cooperative Extension publications. Select a variety that matures before the first fall frost, and with disease resistance and lodging resistance. A tall-branching variety will fill in the rows and provide good shading. Soybean varieties are also available for use as a forage crop. Many organic producers feel that growing a good quality, untreated variety that grows well at their location is the most important factor—above and beyond whether the seed is organic.

Since soybean seed is sensitive to rough handling and storage conditions, bin run grain should not be used for seed.

In contrast, soybeans that are intended for human food possess a clear hilum. Many food grade varieties are available, differing in protein content, yield, seed size, and flavor. Variety is often specified in contracts for organic food grade soybeans. See "Human food grade soybeans" box, below.

Certified organic producers must select organic untreated non-GMO (genetically modified organism) seed. If organic seed is unavailable, untreated non-GMO hybrids may be used but you must document your search for organic seed. Consult your organic certification agency and contract when making decisions regarding selection of seed variety and source, especially if your plans change. Also, see "Organic certification," page 33.

Human food grade soybeans

Food beans have been selected and bred over the past several decades for various soyfoods for direct human consumption. They are called specialty or identity-preserved soybeans, and usually carry a premium price in the market for a trade-off in yield or other agronomic characteristics. Food beans are further classified into tofu beans, natto beans, sprout beans, and green vegetable soybeans. Most often, these beans are extra clean, with superior seed quality (U.S. Grade 1 or higher). Tofu beans are bred for soymilk and tofu production. In general, they are higher in protein content (40% or higher, dry matter basis) and lower in oil content. Most tofu beans have medium to large seed size (larger than 3600 seeds per pound). However, large seeded soybeans are preferred because they are visually appealing and have less hull in proportion to the whole soybean weight.

Because seed color affects visual appearance of soyfoods, most tofu beans have a clear hilum, light yellow to yellow seed coat, and light yellow cotyledons that result in a whiter soymilk or tofu product, which is visually more appealing to most consumers. In contrast, manufacturers of natto, an ethnic Japanese food of fermented whole soybeans, prefer small to extra small soybeans for better fermentation. These beans are called, appropriately, natto beans. For sprouts production, soybeans with medium seed size and high germination rate are preferred. For consumption as a green vegetable, immature soybeans with large seed size, clear hilum, thin seed coat, high contents of sugar and free amino acids (to impart sweet and delicious taste), and tender texture (to have a better mouthfeel) are preferred. They are known as edamame beans.

For mature soybeans consumed in the form of either cooked or roasted whole beans called soynuts, similar features would also be desirable, that is, large seed size, clear hilum, thin seed coat, and soft texture.

Management

Most organic producers manage soybeans much like corn. For the cleanest beans at harvest time, level the soil before planting to help keep the combine header clean.

Establishment

Seed depth: 1 to 1-1/2 inches

Planting rate: 200,000 to 250,000 seeds/a

Seed size: Human food grade: 2000 to 3600 seeds/lb; Livestock feed grade: 3000 to 4000 seeds/lb

After primary tillage, allow the soil to rest for 7 to 10 days, then use a harrow to prepare the seedbed. Weeds that germinate can be controlled with a second harrowing or culti packing before planting. Most organic producers plant soybeans later than conventional growers in order to manage annual weeds, and rely on warmer soil temperatures that encourage quick germination of untreated soybean seed. Soil temperature should be 60°F in the middle of the day. At The Rodale Institute in southeast Pennsylvania, organic soybeans are planted between May 20 and June 5. Inoculate soybean seeds with Rhizobia from a non-GMO source before planting. Since organic seed is untreated, and since plants may be thinned by cultivation, use a corn planter to plant soybean seed at a rate of 5 to 25% higher than conventional soybean producers. Most organic producers plant seed at a rate of 200,000 to 250,000 seeds per acre in 30" rows. Rows placed closer together may be difficult to cultivate. Since soybean is a row crop, mechanical cultivation is necessary for weed management. Weed management management operations can should begin as early as a few days after planting. To control kill weed seedlings that are in the white root stage, drag implements such as a rotary hoe, chain link harrow or tine weeder across the field before soybean seedlings have emerged. These implements will flick small weed seedlings out of the ground, leaving roots exposed to the drying effects of wind and sun.

Rotary hoeing can be done both before and after bean seedlings have emerged, typically about 5 and 12 days after planting. However, there is a critical stage of growth during which rotary hoeing should not be done in soybean. Do not rotary hoe when soybean seeds have germinated and the seedlings are in the "hook" stage, when the stems are curled and the cotyledons have not yet opened above ground. At this stage, the hoe will catch the "hooks" and flip the beans out of the ground along with the weeds.

After the hook stage, care should be taken to rotary hoe only when bean seedlings are limp and flexible so rotary hoe tines will not snap them off. Generally, rotary hoeing is best done in the afternoon when bean plants are flexible and not turgid.

Some organic farmers do as many as four rotary hoeings within the first two weeks of planting. Rotary hoeing is the best method of controlling weeds in the row. Typically, rotary hoeing is not done after the beans are about three inches tall, since the beans' foliage covers the row at this stage, and the rotary hoe is unable to efficiently attack weeds in the row.

Begin cultivations when the soybeans are four to five-inches tall. Timing of cultivation should be based on the presence and size of weeds. Typically beans are cultivated two or three times before the canopy closes. All cultivations are most successful when performed in the heat of the day and in bright sunshine. Rain immediately following cultivation may replant the weeds. While honing your cultivation skills, some weeds are bound escape. When that happens, devote some time to handpulling of weeds since, if allowed to set seed, they can affect the quality of your harvested beans as well as contribute to future weed problems. Also, see "Managing Weeds," page 25.

Pennsylvania State University: Fine-tuning your soybean planting rate

Increase the seeding rate per acre by:	Decrease the seeding rate per acre by:
5% for each planned rotary hoeing	10% if lodging has been a problem
10% for rough seedbeds	10% if planting a lodging-susceptible variety
10% for short-season varieties	
10% for cold soils	

Nutrient management

Soil pH: 6.0 to 6.5

A soybean crop yielding 40 bushels per acre removes the following nutrients from the soil: 150 lb/a; of nitrogen; 40 lb/a of phosphate; and 56 lb/a of potash.

Organic nutrient management is a combination of practices, including crop rotation and the use of cover crops, manure and compost. As an organic producer, you must have an organic system plan (OSP). It's a good idea to prepare a nutrient management plan, too. Contact the local USDA - Natural Resources Conservation Service office, the local Cooperative Extension office, the local Conservation District office, or a professional agricultural consultant for instructions. Have your soil tested each fall or spring by a professional laboratory. If you make your own compost, have it tested, too. Use the test results to help you meet the goals of your nutrient management plan.

Manure or compost applications are usually unnecessary, since soybean in rotation will make use of nutrients applied to the previous crop. If soil test results indicate a need for nutrient addition, apply compost or manure before establishing the crop. Soybeans that have been properly inoculated with nitrogen-fixing bacteria rarely respond to additional nitrogen.

If the previous year's crop was not soybeans, inoculate seed with fresh, viable, nitrogen-fixing bacteria immediately before planting.

Soybean rotation

Soybeans are often rotated with corn and other grains. A common rotation is corn→soy beans→small grain→legume. Most winter-hardy cover crops, including rye, winter wheat and spelts, may be sown into soybean stubble. Or, overseed soybeans at the yellow-leaf stage (when 50% of the leaves have turned yellow) with another legume or winter cereals. Soybeans may be substituted for oats, or used as a catch crop where spring-sown grasses or hay have failed. An organic producer in southeast Pennsylvania recommends plowing sod before soybeans, followed by corn. The rotation helps to manage weeds in soybeans, while providing nitrogen to corn. Also, see "Crop rotation," page 11.

Cover crops

On hilly land, erosion from soybeans in rows is equal to or greater than erosion from corn. Soybeans are not commonly sown as a cover crop; however, certain forage types are. Also, see "Cover crops," page 9.

Pest management

Severe insect and disease problems are rarely a problem in soybeans in Pennsylvania and New York. In dry years, spider mites may damage soybean leaves. Japanese beetles and other leaf-chewing pests cause minor damage in some years. If you notice sufficient damage that may impact yields, contact your organic certification inspector for management recommendations, new products are coming on-line constantly. Most problems will be managed through long-term planning and rotations.

Manage weeds in soybeans with mechanical methods. Compared to organic corn, weed management is more challenging in organic soybeans since their foliage does not provide significant shade between rows until later in the season. Remember!!—food grade soy beans must be kept free of seeds from weeds and volunteer crops such as corn.

Harvesting, cleaning and storage

Harvest organic soybeans using the same techniques as conventional soybeans. However, food grade soybeans should be handled more carefully than animal feed. Food grade soybeans, like certified organic soybeans, must be kept separate in order to maintain value and identity. There are two things to avoid during soybean harvest: split beans and dirty beans. To avoid excessive mechanical damage to beans, make sure the combine is properly adjusted. Set the clearance and speed of the cylinder according to the operator's manual as a starting point and make slight adjustments in the field as needed. If conventional crops are also harvested, the machine must be thoroughly cleaned between crops. Combine cleaning must be documented. If you hire a custom harvester, you are responsible for making certain they meet the standards.

Combine when moisture in beans is 14%. Harvest may begin at a higher moisture content, but some drying will be required for safe storage. Delaying harvest in order to lower the moisture content may increase shattering losses and decrease seed quality. Be very careful when harvesting—four beans per square foot left behind in the field equals 1-bushel per acre.

Storage bins should be swept, vacuumed or blown clean prior to placing beans in them to reduce insect and contamination problems. Remove all dust, moldy grain and debris. Keep weeds around the bins mowed. Use bean ladders in bins to reduce damage when loading food grade soybeans into storage bins. Use a gravity table or screen to clean the dry beans before placing it into a storage bin, to improve airflow and reduce the potential for spoilage problems. It is important to level off the beans in the bin to provide uniform grain temperature control. Start the fan when you begin to fill the bin and run it for six weeks from time of filling in the fall until grain mass is at 35°F-40°F. Cooling is critical to eliminate moisture migration, insect and mold growth. Aeration reduces moisture content and keeps soybeans in excellent condition. Monitor temperature through the winter and aerate in early spring to equalize storage temperatures. After each aeration cycle, seal fan inlets to prevent air leaks and to keep insects out. Make sure exhaust vents, hatches and leave openings are adequate to allow humid air to vent.

Some buyers will clean the grain for you. However, you may have to pay for this service. In the end, you may be paid for the amount of grain delivered minus the debris removed. You may have to store the grain until the buyer has adequate storage or a customer.

Processing and using soybeans

Soybean meal is the most valuable product obtained from soybean processing, ranging from 50 to 75% of total value. Soybean meal is the world's dominant high-protein feed, accounting for nearly 65% of world supplies. Livestock feed accounts for 98% of soybean meal consumption. The remainder is used in human foods. Soybean oil accounts for about two-thirds of the vegetable oils and animal fats consumed in the United States. It is used mainly in salad and cooking oil, bakery shortening, and margarine, as well as a number of industrial applications. Organic soybean oil is a light, bland, odorless vegetable oil and is high in polyunsaturates. The oil is expeller pressed from certified organic soybeans and then purified without the use of chemicals or other synthetic aids. Soymilk is a protein-rich, milk-like liquid typically obtained from the soaking and grinding of whole soybeans with water. Tofu is soybean curd, resulting from the coagulation of protein from soymilk by the use of calcium sulfate, magnesium chloride, calcium chloride or other suitable coagulating agent.

Marketing soybeans

It's a good idea to read "Marketing," page 27 before reading this section. Marketing organic beans and grains is very different from marketing conventional beans and grains. As an organic producer, you have *more* marketing options, but you'll have to find them. You will get the best price in the organic market, selling human food grade soybeans or livestock feed. The best plan may be to sell to several different markets, including direct marketing to local livestock farmers or food processors, or to grain merchants and brokers. Or, you can process and sell your own organic corn food products or develop a market for organic industrial soybean products. Soybeans have been used to make scented candles, crayons, biodiesel fuel, ink, body care products, solvents and many other products.

To get started, use the organic grain crop market key to help you choose between livestock feed and human food grade markets, page 29. At the time of publication, there is a good market for organic human food grade and livestock grade soybeans.

Buckweat Production

Common buckwheat (*Fagopyrum esculentum* Moench) is a broad-leaved annual grain plant in the botanical family Polygonaceae and is grown for human consumption and as animal feed. Buckwheat is one of the best sources of high quality, easily digestible protein in the plant kingdom. In North America, it is marketed primarily in pancake mixes or as flour. In India, buckwheat is raised as a leafy vegetable crop. The leafy tender shoots of the plants are harvested, and the remainder of the crop is harvested for grain and straw. Buckwheat can also be used as a green manure crop, as a smother crop to crowd out weeds, as a source of nectar for bees and as a source of pharmaceuticals. Buckwheat hulls are used in packaging or in buckwheat pillows.

Seed selection

Check with other organic growers, your Cooperative Extension office or local seed supplier for varieties that have been evaluated under your growing conditions. Grain varieties will vary in seed size, resistance to lodging, grain ripening, attractiveness to bees, and yield. Millers may request a specific variety when contracting for buckwheat. Variety is less important when growing buckwheat as a cover crop. Certified organic growers must select organic untreated seed. If organic seed is unavailable, untreated conventional varieties may be used but you must document your search for organic seed. Consult your organic certification agency and contract when making decisions regarding selection of seed variety and source, especially if your plans change. Also, see "Organic certification," page 33.

Some buckwheat varieties available in the northeast US include:

Common: Seed lots tested under this name range from small to medium in seed size and have medium-to high-test weight.

Mancan: A large seeded variety for milling and dehulling; resistant to lodging.

Manisoba: In New York tests it has surpassed Manor in yield by about 10 percent.

Manor: A high-yielding buckwheat variety. It is medium in height and maturity. Manor produces larger and heavier seeds than common buckwheat and is therefore preferred by millers. It also ripens evenly so less grain may be lost because of shattering.

Management

In general, buckwheat production practices are the same throughout North America.

Establishment

Seed depth: 1.5 to 2.0 inches

Seeding rate for grain production: 36 to 72 pounds per acre.

Common buckwheat weight: 15,000 seeds per pound

Soil preparation and seeding depth are about the same as for small grains. However, when sowing buckwheat as a spring grain crop, extra attention to weed management is necessary. As with corn, use shallow tillage such as a rotary hoe in early spring to stimulate weed germination. Follow up with a second rotary hoeing just before planting. Use a harrow to create a firm seedbed. Additional weed management is not necessary. If soil has been plowed for a previous crop that has failed, only disking or harrowing may be required. Rolling or cultipacking the seedbed just prior to seeding is sometimes helpful. Crusting on clay soils may result in poor seedling emergence.Sow buckwheat with a grain drill. Poor stands are likely when seeds are more than two inches deep. Thin stands of buckwheat will produce strong plants that branch and resist lodging on good and. Thick stands produce plants that are spindly and have short branches and poor seed set. Grain yields are highest if buckwheat is planted immediately after risk of frost. Calculate local seeding date by allowing a period of 12 weeks for growth before the average date of first fall frost. Buckwheat emerges in 4 to 5 days and has little tolerance to frost. Buckwheat is a short-duration crop (3-4 months) and requires a moist and cool temperate climate. While buckwheat plants flower profusely, only 10 per cent to 20 percent of the flowers set seed.

Soil fertility

Soil pH: Buckwheat grows well on acid soils. Buckwheat has about the same acid tolerance as oats and potatoes. A buckwheat grain crop yielding 30 bu/acre removes the following nutrients from soil: 42 lb/a of nitrogen, 20 lb/a of phosphate and 35 lb/a of potash. Organic nutrient management is a combination of practices, including crop rotation and the use of cover crops, manure and compost. As an organic producer, you are required to have an organic system plan (OSP). It's a good idea to prepare a nutrient management plan, too. Contact the local USDA - Natural Resources Conservation Service office, the local Cooperative Extension office, the local Conservation District office, or a professional agricultural consultant for instructions. Have your soil tested in the fall or spring by a professional laboratory. Use the test results to help you meet the goals of your nutrient management plan.

High levels of nitrogen result in excessive vegetative development, lodging and reduced seed set of buckwheat. Once lodged, a buckwheat plant does not return upright. Boost low-fertility sites with an application of compost prior to planting buckwheat grain, since it requires fairly high levels of phosphorous in order to set seed and mature. Buckwheat has moderate feeding needs compared to most other grains, and if compost or livestock manure is not applied, the removal of nutrients by a buckwheat grain crop may have a depressing effect on the yield of the following crop. Buckwheat does not grow well in heavy, wet soils or in soils that contain high levels of limestone. Adequate soil moisture is essential for good yields. When moisture is limited, buckwheat is very sensitive to high temperature and hot dry winds.This usually results in the loss of flowers, a condition called "blasting." Flowering at temperatures above 30°C results in a lowering of yield. Yield and seed size will increase with high soil moisture.

Buckwheat rotation

Rapidly growing, shallow-feeding buckwheat may remove excessive amounts of minerals. A winter cover crop should follow buckwheat grain, to increase organic matter and reduce erosion. Soft buckwheat stubble may be more subject to erosion than small-grain stubble. Volunteer plants (sunflower, rapeseed, mustard and corn) may be a problem in buckwheat planted early. Volunteer buckwheat can be a problem in crops following buckwheat. Because of buckwheat's early competitiveness, it is not useful as a companion crop for establishing legumes. Buckwheat works well as a second crop, especially if the first crop fails.

Pest management

Buckwheat suffers little damage from diseases or insects. The diseases most frequently reported are leaf spots and root rots, downy mildew and powdery mildew. Wireworms, cutworms, aphids, birds, deer and rodents attack buckwheat occasionally. Grasshoppers may defoliate field borders when their population is high and other food sources are scarce. Japanese beetles may damage buckwheat flowers, but are usually of minor importance. Storage beetles and grain moths may damage stored buckwheat.

When birds are numerous, they may do considerable damage to buckwheat grain before the crop is ready for harvest. Deer and other wildlife may also damage buckwheat if the

field is adjacent to a wooded area or other cover for wildlife. Rats and mice can be very destructive in buckwheat fields, especially when the plants have lodged.

Buckwheat as a smother crop or green manure crop

Seeding rate for green manure: 45 to 90 pounds per acre.

Buckwheat is a good competitor because it germinates rapidly, and the dense leaf canopy quickly shades the soil. With adequate soil moisture and buckwheat's rapid growth, most weeds will be smothered. However, if weeds are more advanced than the buckwheat plants, buckwheat is a poor competitor. Some growers in the northeast states use buckwheat to control quackgrass. Before planting, cultivate to break up the quackgrass sod, then use a rotary hoe several times before planting. Scientists have reported that buckwheat can be used to eradicate Canada thistle, sowthistle, creeping jenny, leafy spurge, Russian knap weed and perennial peppergrass.

Buckwheat is a useful green manure crop. It can produce significant amounts of dry matter—up to 3 tons per acre after 6 to 8 weeks of growth on relatively unproductive land in Pennsylvania. Where a second crop of green manure is desired, rye may be drilled into the buckwheat stubble and plowed under in the spring. You might be able to drill into the buck wheat stubble without previous disking or plowing. Buckwheat green manure may also fit into fairly tight rotations such as when a crop is harvested prior to mid-July and a succeeding crop is not scheduled until fall.

Harvesting and storage

Expected yield for buckwheat: 1,200 to 1,600 pounds/acre

One hundred pounds of clean buckwheat may yield 60 to 75 pounds of flour, 4 to 18 pounds of middlings and 18 to 26 pounds of hulls.

Buckwheat matures in about 12 weeks. If harvest is delayed, seeds shatter easily due to wind. Combine buckwheat when 75% of seeds are brown or black, when flowering has almost finished, and when the plants have lost most of their leaves. When immature plants are harvested, green seeds and moist fragments of the plants cause difficulties in storing the grain. However, considerable grain loss from shattering may occur if the crop is left standing, especially after a killing frost. Dry buckwheat to 16% or less moisture before storage. Artificial drying should not exceed 43°C. Store buckwheat with the hulls on, and remove the hulls just before using, to prevent rancidity.

Processing and using buckwheat

Buckwheat is a versatile grain crop. Common buckwheat may be milled for flour or groats (hulled grains). Buckwheat flour can be milled so fine that it is as white as wheat flour. The most important quality attributes of buckwheat groats are color and flavor. The color is light green in freshly harvested seed, but gradually changes to reddish brown during storage. Loss of desirable flavor, nutrients, and formation of brown pigments accompany the color change. Buckwheat middlings, composed mostly of the germ and the inner covering of the grain just beneath the hull, are used for feed. When used as livestock feed, buckwheat should be used at less than 25% of the grain ration, since it may cause light sensitivity. Cleaned buckwheat hulls are used as a filling for pillows recommended by chiropractors and physical therapists.

Other uses for buckwheat

Organic honey. When growing buckwheat for grain, consider working with a local beekeeper to produce organic honey, too. Buckwheat has a long blooming period, especially in September when other sources of nectar are limited. The honey is dark in color, and has a strong flavor. Buckwheat was once an important honey crop in the Northeast US. Due to the decline of buckwheat as a grain crop, buckwheat honey is so uncommon that it may command a price higher than other honeys. One acre of buckwheat may support a hive of bees and yield up to 150 pounds of honey in a season. A strong colony may glean 10 pounds of honey per day while foraging buckwheat.

Pharmaceuticals. Buckwheat's rich chemistry may be a source of pharmaceuticals. One of the numerous phenolics in buckwheat is rutin (quercetin-3-rutinoside). Natural rutin was used as a drug for the treatment of vascular disorders and as a protection against the after effects atomic radiation, until synthetic rutin replaced the rutin found in the leaves, stems, flowers and fruit of buckwheat. Current research is investigating the use of buckwheat as a treatment for diabetes and high cholesterol.

Marketing and economics

It's a good idea to read "Marketing," page 27 before reading this section. Marketing organic grains is very different from marketing conventional grains.

As an organic grain grower, you have more marketing options, but you'll have to find them. At the time of publication, there is a limited market for buckwheat in the northeast states unless you are able to market it outside of the region or add value by processing. Other than its use as a cover crop, buckwheat has not been grown extensively in recent years because other grain crops were more profitable. In New York, several buckwheat millers buy organic human grade buckwheat for grain and hulls with or without a contract. Check with the buyer before you plant, since some millers require a proprietary variety. The best plan may be to sell to several different markets, including direct marketing to local food processors, or to grain merchants and brokers. Or, you can process and sell your own organic baking products. To get started, use the organic grain crop market key, page 29, to help you choose between food grade and nonfood grade markets.

Wheat Production

Wheat *Triticum vulgare* is an annual or winter-annual grass. Soft red winter wheat is grown in the eastern US. Soft white winter wheat is grown in northern New York and Michigan. Most winter wheat is marketed as a cash crop for milling, and is processed into cake, biscuit, cracker, pretzel, pastry, and family flours. Soft white winter wheat is also used for pastry flour and shredded and puffed breakfast foods. For bread flour, soft winter wheats are sometimes blended with flour of the hard red wheats. Wheat is also used in livestock rations.

Seed selection

Disease resistance is the primary consideration for organic producers marketing their soft red winter wheat in the organic pretzel industry. Check with other organic producers, your Cooperative Extension office or local seed supplier for recommendations of varieties that have been evaluated under your growing conditions. Varieties will vary in winter hardiness, yield and bushel weight, straw length and resistance to leaf rust, Powdery mildew and Hessian fly. Select a bearded variety for fields heavily grazed by deer. Organic producers must select organic untreated seed. If organic seed is unavailable, untreated conventional varieties may be used but you must document your search for organic seed. Consult your organic certification agency and contract when making decisions regarding selection of seed variety and source, especially if your plans change. Also, see "Organic Certification," page 33.

Management

In the northeast US, winter wheat offers several advantages over spring wheat. Winter wheat out-yields spring wheat, while protecting the soil from erosion over winter. Winter wheat in a hardened condition has survived temperatures as low as –40°F when protected by snow. Winter wheat produces more straw than spring-sown varieties. In addition, winter wheat provides better weed competition.

Establishment

Seed depth: 3/4 to 1-1/2 inches
Planting rate: 2 to 3 bu/acre or 120-150 lb/acre
Test weight: 60 lbs/bushel
Incorporate legumes or other green manures in July or August, then disk several times at 2-week intervals for weed management and seedbed preparation. Both conventional and organic producers plant wheat one to two weeks after the Hessian fly free date, in order to control this pest. In Pennsylvania, the date usually falls between September 20 and October 15. In New York, planting normally occurs from mid-September until October 1. However, some organic producers claim they obtain the highest yields by planting wheat up to 6 weeks later. Organic producers sow wheat using a grain drill at a rate of 2 to 3 bushels per acre. Sow at the heavier rate under poor conditions or when planting late. Also, see "Pest management," page 23.

Soil fertility

Soil pH: Between 6.0 and 7.0

A wheat crop yielding 60 bushels of grain plus straw per acre removes the following nutrients from the soil: 90 lb/a of nitrogen; 60 lb/a of phosphate; and 110 lb/a potash per acre.

Organic nutrient management is a combination of practices, including crop rotation and the use of cover crops, manure and compost. As an organic producer, you must have an organic system plan (OSP). It's a good idea to prepare a nutrient management plan, too. Contact the local USDA - Natural Resources Conservation Service office, the local Cooperative Extension office, the local Conservation District office, or a professional agricultural consultant for instructions. Have your soil tested each fall or spring by a professional laboratory. If you make your own compost, have it tested, too. Use the test results to help you meet the goals of your nutrient management plan.

Winter wheat is a moderately heavy feeder, although not as demanding as corn. If soil test results indicate a need for nutrients, apply compost at a rate of 5 tons/a or less to the preceding hay crop before plowdown. Like corn, winter wheat is most economical when based on biologically fixed nitrogen (gained from legumes in the rotation), recycled nutrients (from livestock manure) and a biologically active soil. Also, see "Nutrient management," page 21.

Crop rotation

In the eastern states, rotate winter wheat with at least one legume and one or more cultivated crops. Some producers place winter wheat in the crop rotation after clover, hay or soybeans. Since it is a moderately heavy feeder, winter wheat should not follow any crop that also demands a highly fertile soil. Wheat should not follow corn in the rotation. Buckwheat is a good cover crop following winter wheat, as is hairy vetch or crimson clover. Apply manure or compost to wheat stubble after harvest, if the following crop requires a boost.

Cover crops

You can undersow (frost seed) fall planted winter wheat with red clover early in spring at a rate of 10–15 lbs/acre during heavy frost. Harvesting winter wheat in July and early August allows cover crops to be seeded in August or September. Also, see "Cover crops," page 9 and "Crop rotation," page 11.

Pest management

Once established, wheat competes well with most weeds. Annual weeds that germinate in the fall will be winter-killed. Crop rotation provides control against most winter wheat pests and diseases. In Pennsylvania, some organic producers successfully sow winter wheat up to six weeks later, to avoid pests that might take hold in warmer fall weather. Both conventional and organic producers plant wheat one to two weeks after the Hessian fly free date, in order to control this pest. Select a bearded variety of wheat for fields heavily grazed by deer. Also, see "Pest management," page 23.

Harvesting, cleaning and storage

Harvest organic winter wheat using the same techniques as conventional wheat. Winter wheat is usually harvested in July or August using a combine, when grain contains 14% or less moisture. Food grade wheat should be handled more carefully than animal feed. Keep organic food grade wheat separate from other grades in order to maintain value and identity. To avoid excessive mechanical damage to grain, make sure the combine is properly adjusted. A high combine cylinder speed cracks grain. Set the clearance and speed of the cylinder according to the operator's manual as a starting point and make slight adjustments in the field as needed. If conventional crops are also harvested, the machine must be thoroughly cleaned between crops. Keep records of combine cleaning. Some buyers require cleaning of combines between crops in order to avoid contamination. If you hire a custom harvester, you are responsible for making certain they meet the standards. Moisture content for storage should be 12% or less.

Storage bins should be swept, vacuumed or blown clean prior to placing grain in them to reduce insect and contamination problems. Remove all dust, moldy grain and debris. Keep weeds around the bins mowed. Some buyers will clean the grain for you. However, you may have to pay for this service. In the end, you may be paid for the amount of grain delivered minus the debris removed. You may have to store the grain until the buyer has adequate storage or a customer.

Processing and using wheat

100 lbs of wheat will produce 72 lbs of flour.

Remaining 28 lbs is classified as millfeed.

Wheat for animal feed is cracked or rolled, except for poultry. Turning wheat into human food requires more attention to cleaning and processing. During milling, the wheat is cleaned, cracked, rolled and/or sifted. By-products of wheat milling include bran, germ, shorts, and middlings. By-products have nutritional benefits and may be used as food for people or livestock. Graham or whole-wheat flour is the entire wheat grain ground into flour, and it includes all of the bran. Freshness is a primary concern. Once a grain is ground, it starts to oxidize. Whole-wheat flour tends to become rancid and infested with insects more quickly than does white flour. Rye *Secale cereale* is a cool season annual cereal grain.

Marketing

It's a good idea to read "Marketing," page 27, before reading this section. Marketing organic grains is very different from marketing conventional grains. As an organic grain producer, you have more marketing options, but you'll have to find them. You will get the best price in the organic market, selling either livestock feed or human food grade wheat. The best plan may be to sell to several different markets, including direct marketing to local livestock farmers or food processors, or to grain merchants and brokers. Or, you can process and sell your own organic baking products. To get started, use the organic grain crop market key, page 29, to help you choose between livestock feed and human food grade markets. Most winter wheat in the northeast US is marketed as a cash crop

for milling, and is processed into pretzel, cake, biscuit, cracker, pastry and family flours. At the time of publication, there is a very good market for organic winter wheat in the northeast US and elsewhere.

Limited local markets exist for spring wheat in the northeast US. Red spring wheats may have potential as an additional small grain crop for farmers interested in producing local bread flours.

Rye Production

Rye *Secale cereale* is a cool season annual cereal grain. Rye is grown in most of the US except the extreme southwestern States. Rye is also called winter rye, cereal rye, and rye grain. Today, 90% of all rye is produced in Europe. Russia is the major producer, followed by Poland, Germany and the Czech Republic. Less than 50% of the rye grown in the U.S. is harvested for grain, with the remainder used as pasture, hay, or as a cover crop. About half of the amount harvested for grain is used for livestock feed or exported, and the remainder is used for alcoholic beverages, food, and seed. Both organic and conventional farmers often plant rye as a cover crop or green manure crop.

Seed selection

Check with other organic producers, your Cooperative Extension office or local seed suppliers for varieties that have been evaluated under your growing conditions. "Aroostook" and "Balbo" are common winter rye varieties that do well in the northeast US. Characteristics of "Aroostook" are good winter hardiness, poor lodging resistance, and high yields of straw and grain. "Balbo" is less hardy than "Aroostook." All seed should be from disease-free fields. Seed should be free of weeds and ergot bodies, and have at least 85% germination. Stored rye seed quickly loses its ability to germinate—more than do other cereals. State certified seed is recommended for its proven adaptation to local conditions. Certified organic producers must select organic untreated seed. If organic seed is unavailable, untreated conventional varieties may be used but you must document your search for organic seed. Consult your organic certification agency and contract when making decisions regarding selection of seed variety and source, especially if your plans change. Also, see "Organic certification," page 33.

Management

Rye is the most hardy of all winter grains, and is managed much like winter wheat in the northeast US.

Establishment

Seed depth: 1 to 2 inches
Seeding rate: 90 to 120 lbs/acre
Test weight: 56 lbs/bushels
Incorporate preceding cover crops and green manures in late summer, then disk several

times at two-week intervals for weed management and seedbed preparation. On fall plowed ground, disk and harrow and then drill rye. If fall plowing is not possible, particularly after corn harvesting, disk and drill the rye into the soil. Rye is often drilled into small grain stubble without previous preparation. When grown for grain, rye should be seeded at about the same time as winter wheat. When grown as a cover crop or green manure, some producers plant rye 2 to 8 weeks earlier to insure a heavy blanket of growth for protection over winter. However, rye has also been successfully planted as late as November in Michigan, to provide winter cover after corn. Higher seeding rates might be needed when planting later than desired or when perennial weed management is important. Spring rye, like other spring small grains, should be sown as early as possible.

Nutrient management

Soil pH: 5.6 to 5.8 or higher

A rye crop which yields 45 bushels of grain plus 2 tons of straw per acre removes approximately 75 lbs of nitrogen, 25 lbs of phosphate and 45 lbs of potash per acre. Organic nutrient management is a combination of practices, including crop rotation and the use of cover crops, manure and compost. As an organic producer, you must have an organic system plan (OSP). It's a good idea to prepare a nutrient management plan, too. Contact your local USDA - Natural Resources Conservation Service office, your local Cooperative Extension office, your local Conservation District office, or a professional agricultural consultant for instructions. Have your soil tested each fall or spring by a professional laboratory. If you make your own compost, have it tested, too. Use the test results to help you meet the goals of your nutrient management plan.

Winter rye and winter wheat respond similarly to nutrient additions. Heavy nitrogen applications causes rye to lodge. If soil test results indicate a need for nutrients, apply compost at a rate of 5 tons/a or less to the preceding crop before plowdown. Like corn, winter rye is most economical when based on biologically fixed nitrogen (gained from legumes in the rotation), recycled nutrients (from livestock manure) and a biologically active soil. Also, see "Nutrient management," page 21.

Rye rotation

Alternate summer fallow with winter rye and repeated summer tillage after rye harvest to control annual and perennial weeds such as quackgrass, sowthistle and Canada thistle. In rotations that include a small grain, rye may replace wheat, spelt or barley. Follow rye grain with oats, barley, potatoes, soybeans or buckwheat. However, small grains that follow rye may suffer from volunteer rye. Otherwise, rye can be used at any stage in the rotation. Some organic growers rely on rye to suppress weeds before rotation to soybeans. Rye's early harvest leaves sufficient time to establish a quick cover crop such as buckwheat. To prepare for a cover crop, chop the rye straw before tillage. Rye is a moderate feeder and makes a good cover crop or grain crop following unrelated summer grains.

Rye as a cover crop and green manure

For green manure, sow anytime spring through mid-fall at 4-6 lbs. per 1000 sq. ft. (2 bushels per acre). Use rye as a cover crop after corn or before or after soybeans. As a cover crop, rye helps to prevent soil erosion, adds organic matter, competes well with annual weeds, and takes up excess nitrogen. Rye also has allelopathic, or seed germination suppressive, properties. Rye is a useful emergency cover crop to fill gaps between other crops, or if a crop is removed early because of failure, rye can be seeded to protect the soil until time to plant the next crop.

As a green manure crop, rye is particularly suitable because of its winter hardiness and its rapid growth early in the spring. Plow or disk a rye green manure when about 20 inches tall.

Pest management

Most organic producers following a diverse crop rotation and using disease-resistant varieties are not bothered by pests in rye. Hessian fly will sometimes lay eggs on rye leaves, but rarely causes damage. Rye will provide cover for some beneficial insects. When winter rye is sown early, grasshoppers may deposit eggs which may hatch and injure nearby crops. Weeds are rarely a problem; annual weeds that germinate in the fall will be winterkilled. Rye grows quickly in early spring, smothering spring weeds. Rye residues may suppress the germination of some small-seeded weeds in successive crops. Also, see "Pest and Disease Management," page 25-26. Ergot and stem or stalk smut are common diseases in rye in the northeast US.

Ergot. Rye is susceptible to ergot. When rye contains 0.5% or more of ergot, it is considered unfit for food or feed. Large spur-like purplish-black bodies (sclerotinia) in the rye kernel are characteristics. Ergot bodies over-winter in the field, or with the seed in storage, and germinate under favorable conditions in the spring. The disease can be partly controlled by sowing ergot-free seed or year old-seed on land where rye has not been grown for 1 or 2 years previously. The mowing of ergot infested grasses adjacent to rye fields is also helpful. Resistant varieties are not yet available.

Stem or stalk smut. This is a very common disease in rye. The symptoms appear first as lead gray, long narrow streaks on the stems, sheaths and blades; streaks later turn black. Infected plants are darker green than normal and somewhat dwarfed. The stems usually are twisted or distorted, and the heads fail to emerge from the sheath. Spores can be carried both on the seed and in the soil. Organic producers may rely on crop rotation for disease control where the spores are soil-borne. Resistant varieties are also available.

Harvesting and storage

Yield range: 125–150 bales of straw/acre; 30–50 bushels of grain/acre.

Harvest organic winter rye using the same techniques as conventional rye, when it is mature and has reached the hard kernel stage (i.e., a fingernail can make only a light indent in the kernel). As a grain crop, rye heads early and matures earlier than winter wheat in the northeast US. Rye can be harvested and threshed in one operation with a combine, or swathed and later threshed. Food grade rye should be handled more care-

fully than animal feed. Keep organic food grade rye separate from other grades in order to maintain value and identity. To avoid excessive mechanical damage to grain, make sure the combine is properly adjusted. A high combine cylinder speed cracks grain. Set the clearance and speed of the cylinder according to the operator's manual as a starting point and make slight adjustments in the field as needed. If conventional crops are also harvested, the machine must be thoroughly cleaned between crops. Keep records of combine cleaning. Some buyers require cleaning of combines between crops in order to avoid contamination. If you hire a custom harvester, you are responsible for making certain they meet the standards. To reduce shatter loss when direct combining, begin harvest at about 22% moisture and follow by drying. Moisture content needs to be below 15% to avoid discounts at elevators. Grain moisture should be 12% for long term storage. During storage, the grain needs to be aerated to control the temperature of the stored grain to avoid moisture buildup in bins during fluctuating outdoor temperatures. Storage bins should be swept, vacuumed or blown clean prior to placing grain in them to reduce insect and contamination problems. Remove all dust, moldy grain and debris. Keep weeds around the bins mowed. Some buyers will clean the grain for you. However, you may have to pay for this service. In the end, you may be paid for the amount of grain delivered minus the debris removed. You may have to store the grain until the buyer has adequate storage or a customer.

Rye food considerations

When mixed with 25% to 50% wheat flour, rye flour makes a nutritious bread. The more wheat, the softer, lighter and milder the bread. Rye flours are also used as fillers in sauces, soups and in processed meats such as sausages. Rye starch can be used in the manufacture of matches. In addition, rye starch and rye gums are used in glue, plastics and paper. When used as livestock feed, rye grain has a feeding value of about 85% to 90% that of corn, and contains more digestible protein and total digestible nutrients than oats or barley. Rye is best when mixed with other grains at a proportion less than a third, because it is not highly palatable and is sticky when chewed.

Marketing and economics

It's a good idea to read "Marketing", page 27, before reading this section. Marketing organic grains is very different from marketing conventional grains. As an organic grain producer, you have *more* marketing options, but you'll have to find them. You will get the best price in the organic market, selling livestock feed or human food grade wheat. The best plan may be to sell to several different markets, including direct marketing to local livestock farmers or food processors, or to grain merchants and brokers. Or, you can process and sell your own organic baking products. To get started, use the organic grain crop market key, page 29, to help you choose between livestock feed and human food grade markets. Production costs for rye should be similar to those for wheat and barley. Rye straw can often be sold at premium for bedding or to fruit and vegetable producers who prefer rye straw as mulch. At the time of publication, there is a limited market for rye grain in the northeast States unless you are able to market it outside of the region or add value by processing. Your best choice may be to use rye as a green manure, or produce seed for sale to other producers.

Oats Production

Oats *Avena sativa* are grown as a cool season annual cereal throughout the northeast US. Most oats are used as feed for cattle, horses, pigs and poultry. Some acreage is also used for pasture, hay and silage. Less than five percent of the total production in the US is used as food—mainly in breakfast foods and oat flour.

Seed selection

Check with other organic producers, your Cooperative Extension office or local seed suppliers for varieties that have been evaluated under your growing conditions. 'Ogle' is popular throughout the northeast US. In Pennsylvania, 'Blaze' is comparable to 'Ogle' in grain yield and more resistant to crown rust. 'Pennuda' hull-less oats have high available protein and are preferred for animal feed. Oats varieties for milling should have a plump kernel and high test weight of at least 38 lbs/bu and groats that resist turning dark. Organic producers must select organic untreated seed. If organic seed is unavailable, untreated conventional varieties may be used but you must document your search for organic seed. Consult your organic certification agency and contract when making decisions regarding selection of seed variety and source, especially if your plans change. Also, see "Organic Certification", Chapter 33.

Management

Oats do best when planted early on well-drained, fertile soil. Avoid planting in cold, wet soil heavy with residues.

Establishment

Seed depth: 1 to 1-1/2 inches
Seeding rate: 90 to 100 lbs/acre
Test weight: 34 lbs/bushels
After primary tillage, allow the soil to rest for several days, then use a harrow to prepare the seedbed. Use a grain drill to sow oats as early in the spring as possible. Oats are sown in Pennsylvania from March 15 to April 25; in New York, sow in April. If oats are used in a forage seeding, reduce the seeding rate by 50 percent. If used as a companion crop for legumes and grasses, reduce the seeding rate by 30 percent. Sow at the heavier rate if weeds have been a problem. Some organic growers use a harrow to control annual weeds before the oats have emerged. Avoid harrowing after emergence.

Nutrient management

Soil pH: 6.0 or above or between 6.5 and 7.0 when seeded with legumes
An oats crop which yields 80 bushels of grain plus straw per acre removes approximately 90 lbs nitrogen, 70 lbs phosphate and 120 lbs potash per acre.
Organic nutrient management is a combination of practices, including crop rotation and the use of cover crops, manure and compost. As an organic producer, you must have an organic system plan (OSP). It's a good idea to prepare a nutrient management plan, too.

Contact your local USDA - Natural Resources Conservation Service office, the local Cooperative Extension office, your local Conservation District office, or a professional agricultural consultant for instructions. Have your soil tested each fall or spring by a professional laboratory. If you make your own compost, have it tested, too. Use the test results to help you meet the goals of your nutrient management plan.

Oats is a moderate feeder that is prone to lodging, so avoid applications of compost or manure. If soil test results indicate a need for nutrients, apply compost at a rate of 5 tons/a or less to the preceding crop before plowdown. Like most grains, oats is most economical when based on biologically fixed nitrogen (gained from legumes in the rotation), recycled nutrients (from livestock manure) and a biologically active soil. Also, see "Nutrient management," page 21.

Oats crop rotation

Add oats to your crop rotation as a nurse crop when establishing a legume sod such as alfalfa or red clover.

Oats as a cover crop and green manure

As a cover crop or green manure, oats may be sown at anytime of year. Oats will help to suppress weeds, prevent erosion, scavenge excess nutrients and add biomass to soil. To use oats as a winter-killed cover, sow at the highest locally recommended rate at least 40 to 60 days before your area's first killing frost.

Pest management

Most organic producers following a diverse crop rotation and using disease-resistant varieties are not bothered by pests in oats. Cereal leaf beetle will damage oats rarely in Pennsylvania. Barley yellow dwarf virus is transmitted by aphids, and may cause oats leaves to turn reddish. Also, see "Pest and Disease Management," page 25-26.

Harvesting and storage

Harvest organic oats in August when grain contains 14% or less moisture. Use the same harvesting techniques as conventional oats. Food grade oats should be handled more carefully than animal feed. Keep organic food grade oats separate from other grades in order to maintain value and identity. To avoid excessive mechanical damage to grain, make sure the combine is properly adjusted. A high combine cylinder speed cracks grain. Set the clearance and speed of the cylinder according to the operator's manual as a starting point and make slight adjustments in the field as needed. If conventional crops are also harvested, the machine must be thoroughly cleaned between crops. Keep records of combine cleaning. Some buyers require cleaning of combines between crops in order to avoid contamination. If you hire a custom harvester, you are responsible for making certain they meet the standards. Moisture content for storage should be 12% or less.

Storage bins should be swept, vacuumed or blown clean prior to placing grain in them to reduce insect and contamination problems. Remove all dust, moldy grain and debris. Keep weeds around the bins mowed. Some buyers will clean the grain for you. However,

you may have to pay for this service. In the end, you may be paid for the amount of grain delivered minus the debris removed. You may have to store the grain until the buyer has adequate storage or a customer.

Processing and using oats

For human food use, the groat or inner kernel is rolled into flakes and used as oatmeal in breakfast foods and baking. Oat flour contains an antioxidant, which is used to preserve quality by delaying rancidity. Oat flour may also be mixed with wheat flour for multigrain baked products. Livestock producers should avoid feeding moldy oats, caused by improper curing or storing of oat hay. Ingestion may cause paralysis, convulsions or death if sufficient quantities are ingested.

Marketing

It's a good idea to read "Marketing," page 27, before reading this section. Marketing organic grains is very different from marketing conventional grains. As an organic grain producer, you have more marketing options, but you'll have to find them. You will get the best price in the organic market, selling livestock feed or human food grade wheat. The best plan may be to sell to several different markets, including direct marketing to local livestock farmers or food processors, or to grain merchants and brokers. Or, you can process and sell your own organic baking products. To get started, use the organic grain crop market key, page 29, to help you choose between livestock feed and human food grade markets. Production costs for oats should be similar to those for wheat and barley. Oat straw can often be sold for animal feed or bedding or to fruit and vegetable producers who prefer oat straw as mulch. At the time of publication, there is a limited market for oat grain in the northeast states unless you are able to market it outside of the region or add value by processing. Your best choice may be to use oats as a green manure or nurse crop.

Barley Production

Barley *Hordeum vulgare* is an annual or winter-annual grass. The Midwest leads the United States in barley production. However, winter barley produces a high-quality feed grain in Pennsylvania and New York. Barley is also used for human consumption in soups and cereals and for malting.

Seed selection

Select spring-sown barley grain in the cool climates of northern Pennsylvania and farther north. Grow winter-sown barley in southern Pennsylvania and where winters are mild. Malting varieties tend to lack winter hardiness. Check with other organic producers, your Cooperative Extension office or local seed supplier for recommendations of varieties that have been evaluated under your growing conditions, since barley varieties will vary in winter hardiness. Organic producers must select organic untreated seed. If organic seed is unavailable, untreated conventional varieties may be used but you must document your search for organic seed. Barley seed is easily produced. Consult your organic certification agency and contract when making decisions regarding selection of seed variety and source, especially if your plans change. Also, see "Organic certification," page 33.

Management

Manage barley as a winter or spring annual grain. In New York, spring barley acreage may be increasing since many farmers grow it as an alternative for oats or corn. However, barley is less productive than good corn. New varieties of barley have the potential for producing higher grain yields and feed energy per acre than oats.

Establishment

Seed depth: 1.5 to 2 inches
Seeding rates for winter or spring barley: 96 to 120 lbs/a or 2-1/2 bu/a
Test weight: 45 lb/bushel
Grow barley as a winter or spring cereal. Barley thrives in a cool climate; however, barley should be sown when the soil is warm and not too wet. Before sowing, prepare the soil as for winter wheat. Incorporate legumes or other green manures in July or August, then disk several times at 2-week intervals for weed management and seedbed preparation. Sow winter barley with a grain drill between September 10 and October 5 in Pennsylvania. Unlike wheat, barley planting should not be delayed. Barley is not susceptible to Hessian fly; however, since barley is very susceptible to barley yellow dwarf virus, do not plant earlier than September 10. Adjust the seeding rate to conditions, increasing the rate under poor conditions. Where barley is not winter hardy, obtain maximum yields from spring barley by planting as early in spring as possible. Use the same rate of planting as winter barley;
however, sow at a heavier rate where weed management is required.
Work in previous cover crops and harrow immediately before seeding if necessary to control annual weeds. Some farmers seed barley in two directions, applying half the seed in one direction, and the rest in the opposite direction for better coverage and weed management. Use a rotary hoe after planting to control germinating weeds. Another cultivation can be done with a weeder harrow when the barley is at the four- or five-leaf stage.

Nutrient management

Soil pH: 6.5 to 7.0
A crop yielding 75 bushels plus straw per acre removes 105 lbs of nitrogen, 45 lbs of phosphorus and 110 lbs of potassium per acre.
Organic nutrient management is a combination of practices, including crop rotation and the use of cover crops, manure and compost. As an organic producer, you must have an organic system plan (OSP). It's a good idea to prepare a nutrient management plan, too. Contact the local USDA - Natural Resources Conservation Service office, the local Cooperative Extension office, the local Conservation District office, or a professional agricultural consultant for instructions. Have your soil tested each fall or spring by a professional laboratory. If you make your own compost, have it tested, too. Use the test results to help you meet the goals of your nutrient management plan.
Barley has a shallow root system and is a light feeder. Heavy applications of nitrogen induce lodging and encourage weed development. If soil test results indicate a need for nutrients, apply compost at a rate of 5 tons/a or less to the preceding hay crop before

plowdown. Like corn, winter barley is most economical when based on biologically fixed nitrogen (gained from legumes in the rotation), recycled nutrients (from livestock manure) and a biologically active soil. Winterkill may increase if soil pH is below 6.5 and/or phosphate availability is low. Also, see "Nutrient management," page 21.

Barley rotation

Like oats, spring barley is managed as a light feeder and is usually placed at the end of a grain rotation. In the eastern US, many producers use the following rotation: corn→barley→leguminous hay or pasture crop with barley as a companion crop. Barley also makes a good companion crop when establishing stands of pure alfalfa.

Barley as cover crop or green manure

Plant barley to control erosion and to scavenge excess nutrients. Barley produces plenty of biomass in a shorter time than other cereal crops. As a spring annual cover crop, drill at 50 to 100 lb/a (1 to 2 bu) from 3/4 to 2 inches deep into a prepared seedbed. Use a lower rate if overseeding as a companion crop or a higher rate for very weedy fields. As a winter annual cover crop, plant barley in late summer or early fall. Barley works well in mixtures with other grasses or legumes. As a cover crop, the cost to drill barley is $9.38/acre at $0.05 to 0.20 per pound.

Pest management

Cutworms and Hessian fly occasionally bother barley. More important, barley supports populations of beneficial insects. Research literature suggests that barley helps to reduce soil populations of root-knot nematode (Meloidogyne hapla), and may inhibit germination and growth of some weeds. Plant-produced chemicals protect barley from fungi, armyworm larvae, bacteria and aphids. To avoid leaf diseases, plant resistant varieties and do not follow wheat in the rotation. Barley yellow dwarf virus is transmitted to barley by aphids, and may cause barley plants to turn yellowish and grow stunted. Compared to winter grains, barley has an open canopy, and is less competitive with weeds. Also, see "Pest management," page 23.

Harvest, processing and storage

Harvest organic winter barley using the same techniques as conventional barley. Winter barley is harvested when the tops turn down towards the ground, in New York in mid-July before wheat is ready. Cut when the heads have turned a golden yellow, and while the straw is slightly green, to reduce shattering loss. Food grade barley should be handled more carefully than animal feed. Keep organic food grade barley separate from other grades in order to maintain value and identity. To avoid excessive mechanical damage to grain, make sure the combine is properly adjusted. A high combine cylinder speed cracks grain. Set the clearance and speed of the cylinder according to the operator's manual as a starting point and make slight adjustments in the field as needed. If conventional crops are also harvested, the machine must be thoroughly cleaned between crops. Keep records of combine cleaning. Some buyers require cleaning of

combines between crops in order to avoid contamination. If you hire a custom harvester, you are responsible for making certain they meet the standards. Moisture content for storage should be 12% or less.

Storage bins should be swept, vacuumed or blown clean prior to placing grain in them to reduce insect and contamination problems. Remove all dust, moldy grain and debris. Keep weeds around the bins mowed. Some buyers will clean the grain for you. However, you may have to pay for this service. In the end, you may be paid for the amount of grain delivered minus the debris removed. You may have to store the grain until the buyer has adequate storage or a customer.

Processing and using barley

Most organic barley is used for animal feed. Barley flour is produced by milling the grains, or as a by-product in pearl barley manufacturing. Barley flour is unsuitable for use alone in bread making, and is often mixed with 10–25% wheat flour for baking purposes. Barley may also be processed in soups or cereals.

Marketing barley

It's a good idea to read "Marketing," page 27, before reading this section. Marketing organic grains is very different from marketing conventional grains . As an organic grain producer, you have *more* marketing options, but you will have to find them. You will get the best price in the organic market, selling either livestock feed or human food grade wheat. The best plan may be to sell to several different markets, including direct marketing to local livestock farmers or food processors, or to grain merchants and brokers. Or, you can process and sell your own organic baking products. To get started, use the organic grain crop market key, page 29, to help you choose between livestock feed and human food grade markets. Most barley in the northeast US is marketed as a cash crop for livestock feed. At the time of publication, there is a limited market for organic barley, unless you are able to market it outside of the region or add value by processing.

Spelt Production

Spelt *Triticum spelta* is a close relative of common wheat. Spelt was grown on a limited basis throughout most grain-growing regions of the US in the early 1900s. Limited availability of cultivars, low test weight and the need to dehull the grain are factors that contributed to declining spelt production. Currently, spelt is produced in Pennsylvania, Ohio and the midwest. The feed value of spelt is similar to oats.

Management

In the northeast US, grow spelt much like winter wheat. When grown as a spring grain crop, spelt should have an advantage over spring oats during cold, dry springs. Spelt tolerates poorly drained and low-fertility soils better than other small grains.Yields and agronomic traits vary significantly. Proprietary cultivars of spelt for human food are presently grown in US.

Use a grain drill to sow spelt at a rate of 90 to 112 kg/ha. Spelt is susceptible to lodging so avoid applications of manure and compost with high nitrogen content. In Ohio, spelt yielded 85 percent of soft red wheat, but 20 to 30 per percent of the weight was chaff. Unlike wheat, spelt does not release the chaff during threshing, resulting in a lower bushel weight; hulls must be removed in a specialized dehuller.

Spelt should be swathed when the stem has not completely turned color. Delayed harvest can result in significant head shatter at maturity. Store spelt grain at 13 percent moisture or less.

Marketing

Spelt yields are below those of wheat; however, premium prices may be offered for spelt in specialty markets. Some organic millers offer contracts for spelt grain. Some organic dairy farmers in Pennsylvania have requested spelt from grain producers, for use as a livestock feed. Spelt may be exported to Germany where the price is reportedly higher than common wheat. Spelt products are available through organic health food outlets as grain, whole grain and white flours, and processed products including pasta, cereals, and packaged mixes for bread, muffins and pancakes. The suggested attributes of spelt relative to wheat are ease of digestion, taste, and that individuals with certain allergies to common bread wheats can consume spelt.

CHAPTER 8 ECONOMICS

Economic Comparison of Organic and Conventional Soybeans

The charts below compare the costs of inputs and field operations for organic and conventional soybeans, as well as estimated gross income for those crops. (We did not compare organic human consumable soybeans with conventional human consumable soybeans, due to a lack of market.)

The estimated gross income from organic food grade soybeans in 2001 was $675.00 per acre, with an estimated cost of $147.38 per acre for production. In the same year, the estimated gross income from the conventional livestock soybeans was $180.00, with a production cost of $138.68 per acre. It is important to note that, in producing organic human consumable soybeans, the highest returns go to producers who deliver clean beans with minimal cracked or broken seed coats. (Cracked, broken, or dirty beans, or those contaminated with weed seeds, may be charged a "cleanout" price of $7-9 by the dealer.)

The information in these budgets is based on commonly used farm management practices. While the results are believed to be accurate and reliable, they are not guaranteed. Actions taken as a result of this information are solely the responsibility of the user.

	Organic Human Consumable Soybeans		Cost/Acre	Conventional Livestock Soybeans		Cost/Acre
INPUTS						
Seed (lb/acre)		97	$44.62		75	$25.88
Pesticides:			(Spring 2002 price)			(Spring 2002 price)
dual (pt./acre)		0	$0.00		1.5	$19.94
canopy (oz/acres)		0	$0.00		5	$12.66
Operations:	trips across field/year			trips across field/year		
Moldboard Plow		1	$12.40		0	$0.00
Chisel Plow		0	$0.00		1	$12.30
Disk		1	$11.30		1	$11.30
Cultipack		1	$10.50		1	$10.50
Plant (corn planter)		1	$13.60		0	$0.00
Plant (grain drill)		0	$0.00		1	$13.30
Rotary Hoe		1	$2.56		0	
Spray		0	$0.00		1	$7.70
Cultivate		3	$27.30		0	$0.00
Harvest		1	$25.10		1	$25.10
			(operation costs based on PA Dept. of Ag. Custom Machinery Rates)			
TOTAL COST/ACRE:			**$147.38**			**$138.68**

Estimated Gross Income

	Yield (Bu/Acre)	Price/Bu	Income/Acre	ReturnOver Cost
Organic Human Consumable Soybeans	45	$15.00	$675.00	$528.00
Conventional Livestock Soybeans	45	$4.00	$180.00	$38.00
		Difference	$495.00	$490.00

CHAPTER 9 BEYOND ORGANIC: REGENERATIVE FARMING

The Concept of Regenerative Agriculture

In the late 1970s, Robert Rodale—a creative thinker, The Rodale Institute founder and owner of the publishing company Rodale Press, centered on holistic health and organic gardening—began to apply his problem-solving skills to the world's shortage of food. By that time, world agriculture had passed through the Green Revolution. Subsequent agricultural technologies were based on petro-chemicals, biology, ecology, or soil organic matter, and became the focus of agricultural research. Rodale, however, recognized in all of agriculture the lack of a human dimension and a spiritual relationship with soil. He began to visualize a new kind of agriculture, centered on people and their ability to rebuild and renew from the soil upwards. Rodale called this "regenerative agriculture." Rodale preferred the term "regenerative" because it encompassed not only farming methods but also the ultimate goal of farming: the production and consumption of wholesome, nutritious food while restoring the resource base. The regenerative process is a continuous circle of renewing local resources combined with responsible human action.

The Practice and Advantages of Regenerative Agriculture

Rodale died in 1990, but the development and promotion of regenerative agriculture continues. At The Rodale Institute in Kutztown, Pennsylvania, the goals of regenerative agriculture are to:

- Build and maintain healthy soil;
- Sustain food production for the well-being of people;
- Generate farm income;
- Protect the environment.

Rotating crops, growing cover crops, composting to recycle wastes, controlling erosion, agroforestry and intercropping are among the practices common to both organic farming and regenerative farming. Regeneration takes place as raw land is improved into rich soil. The continual cycling of

water, nitrogen and minerals through plants, soil and the atmosphere is a clear demonstration of regeneration. The best way to appreciate and understand nature's mastery of regeneration is to witness the ebb and flow of life around us.

New Roles for Farmers

The regenerative approach invites us to share ideas and work with friends, neighbors and our community. Our common goal is to grow healthy food on healthy soil for healthy people.

RESOURCES

Best Resources on Organic Grain Production

Appropriate Technology Transfer for Rural Areas (ATTRA)
P.O. Box 3657
Fayetteville, AR 72702
Telephone: (800)346-9140
Website: www.attra.org/

Wallace, J., ed. 2001. *Organic field crop handbook.* 292 pages.
Canadian Organic Growers, Inc.
P. O. Box 6408, Station J,
Ottawa, Ontario, K2A 3Y6 Canada.
Telephone: (613)231-9047
E-mail: info@cog.ca

Cooperative Extension

Find local CES resources at:
The Cooperative State Research,
Education and Extension Service
United States Department of Agriculture
Cooperative State Research, Education, and Extension Service
1400 Independence Avenue S.W., Stop 2201
Washington, DC 20250-2201
Telephone: (202)720-7441
Website: www.reeusda.gov/

Cooperative Extension Publications on Line

Cornell University.
2001 Cornell Guide for Integrated Field Crop Management.
Website: www.css.cornell.edu/extension/CornellGuide.html

Cornell University
Organic Grain: Another Way" Video Series is funded by Northeast SARE
Cornell University Resource Center
Telephone: (607)255-2080
E-mail: resctr@cornell.edu.

Jokela, B., F. Magdoff, R. Bartlett, S. Bosworth, and D. Ross. 2001. *Typical crop nutrient removal.*
University of Vermont Extension. BR 1390. Website: ctr.uvm.edu/pubs/nutrientrec/table19.htm

Serotkin, N. and S. Tibbetts, eds. 1999.
The Penn State Agronomy Guide 1999-2000.
The Pennsylvania State University
University Park, PA 16802
Website: agguide.agronomy.psu.edu/default.html

The Pennsylvania State University
PSU Farm Management: Enterprise Budgets.
Website: agguide.agronomy.psu.edu/PDF/1-11.pdf

Nutrient Management

Find local NRCS resources at:
Natural Resources Conservation Service
Attn: Conservation Communications Staff
P.O. Box 2890
Washington, DC 20013
Website: www.ny.nrcs.usda.gov/agwaste/nut_bugt.htm

Find local NACD resources at:
National Association of Conservation Districts
Website: www.nacdnet.org/

Compost

Compost Analysis

Agri Analysis, Inc.
280 Newport Road
PO Box 483
Leola, PA 17540
Telephone: (717)656-9326

A & L Labs Eastern Labs
7621 White Pine Rd.
Richmond, VA 23237-2296
Telephone: (804)743-9401

University of Maryland
Soil Testing Laboratory
The University of Maryland
College Park, MD 20742

Woods End Research Laboratory, Inc.,
P.O. Box 297
Mt. Vernon, Maine 04352
Telephone: (207)293-2457
Email: info@woodsend.org

Compost Publications

Dougherty, Mark. 1999.
The Field Guide to On-Farm Composting.
NRAES 114. Natural Resource, Agriculture and Engineering Service
Website: www.nraes.org/publications/

Rynk, Robert, ed. *On-Farm Composting Handbook.*
NRAES-54. Natural Resource, Agriculture and Engineering Service
Website: www.nraes.org/publications/

Crop Rotation

Wallace, J., ed. 2001. *Organic field crop handbook.* 292 pages.
Canadian Organic Growers, Inc.
P.O. Box 6408, Station J,
Ottawa, Ontario, K2A 3Y6 Canada.
Telephone: (613)231-9047
E-mail: info@cog.ca

Cover Crops

Bowman, Greg, C. Shirley and C. Cramer. 1998. *Managing cover crops profitably.* The Sustainable Agriculture Network Handbook Series Book 3.
Available from: Sustainable Agriculture Publications
Hills Building, Room 10
University of Vermont
Burlington, VT 05405-0082

Organic Certification

National Organic Program
National Organic Program. USDA Agricultural Marketing Service.
Website: www.ams.usda.gov/nop/

Organic Materials Review Institute (OMRI) has compiled a listing of companies that do testing for the presence of genetically modified organisms (GMOs) or that sell a test that you administer yourself.
Website: www.omri.org/

Sources of Information
Future Harvest—Chesapeake Alliance for Sustainable Agriculture
106 Market Court
Stevensville, MD 21666
Telephone: (410)604-2681
Website: futureharvestcasa.org/
Network of farmers, professionals, landowners in Chesapeake region; promotes sustainable agriculture.

National Organic Directory
Community Alliance with Family Farmers
P.O. Box 363
Davis, CA 95617
Telephone: (800)852-3832
Fax: (916)756-7857
E-mail: nod@caff.org
Website: www.caff.org

Organic Pages
Organic Trade Association
P.O. Box 547
Greenfield, MA 01302
Telephone: (413)774-7511
Fax: (413)774-6432
E-mail: info@ota.com
Website: www.ota.com/

Pennsylvania Association for Sustainable Agriculture
114 West Main Street
Millheim, PA 16854
Telephone: (814)349-9856
Website: pasafarming.org/

Pennsylvania Organic Directory
Available Through PCO
PO Box 452
Centre Hall, PA 16828
Telephone: (814)364-2330
E-mail: PaOrganic@aol.com
Website: hometown.aol.com/paorganic

The Rodale Institute
611 Siegfriedale Road
Kutztown, PA 19530
Telephone: (610)683-1400
Website: rodaleinstitute.org

Organic Certification Programs
Connecticut NOFA Office
PO Box 386
Northford, CT 06472
Telephone: (203)484-2445
Fax: (203)484-7621
E-mail: nofact@connix.com
Website: ct.nofa.org

Delaware Department of Agriculture
2320 S. Dupont Hwy
Dover, DE 19901
Telephone: (302)739-4811
Website: state.de.us/deptagri/

Farm Verified Organic, Inc.
International Certification Services, Inc.
5449 45th St. SE
Medina, ND 58467 USA
Telephone: (701)486-3578
E-mail: farmvo@daktel.com
Website: ics-intl.com

Maine Organic Farmers and Gardeners Association (MOFGA)
Eric Siderman
P.O. Box 170
Unity, ME 04988
Telephone: (207)568-4142
Website: mofga.org

Maryland Department of Agriculture
Organic Certification Program
50 Harry S. Truman Parkway
Annapolis, MD 21401
Telephone: (410)841-5770

New Hampshire Department of Agriculture
Bureau of Markets
Organic Certification Program
Box 2042
Concord, NH 03302-2042
Telephone: (603)271-3685
E-mail: vsmith@agr.state.nh.us

NOFA Massachusetts Office
411 Sheldon Road
Barre, MA 01005
Telephone: (978)355-2853
Fax: (978)355-4046
E-mail: jackkitt@aol.com
Website: www.massorganic.org

NOFA New Hampshire Office
4 Park Street, Suite 208
Concord, NH 03253
Telephone: (603) 224-5022
E-mail: nofanh@innevi.com

NOFA New Jersey Office
60 S. Main Street
P.O. Box 886
Pennington, NJ 08534
Telephone: (609)737-6848
E-mai: nofanj@aol.com

NOFA New York Office
P.O. Box 880
Cobleskill, NY 12043
Telephone: (518)734-5495
Fax: (518)734-4641
E-mail: office@nofany.org
Website: www.nofany.org

NOFA Vermont Office
P.O. Box 697, Bridge St.
Richmond, VT 05477
Telephone: (802)434-4122
Fax: (802)434-4154
E-mail: nofavt@together.net
Website: www.nofavt.org

Organic Crop Improvement Association International
1001 Y Street, Suite B
Lincoln, NE 68508-1172
Telephone: (402)477-2323
Website: ocia.org/

Pennsylvania Certified Organic
P.O. Box 452
Centre Hall, PA 16828
Telephone: (814)364-1344
Website: hometown.aol.com/paorganic
Non-profit certification agency.

Quality Assurance International
12526 High Bluff Drive, Suite 300
San Diego, CA 92130
Telephone: (619)792-3531
Website: rockymountainmilling.com/qai.htm

Rhode Island Organic Certification Committee
Department of Environmental Management
Division of Agriculture
Dennis Martin
235 Promenade Street
Providence, RI 02908
Telephone: (401)222-2781
Website: state.ri.us/dem

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The Pennsylvania State University.
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Website: www.cas.psu.edu/docs/CASDEPT/IPM/FldCrop/default.html?search=author

Marketing

American Agricultural Law Association (AALA)
University of Arkansas
College of Law
Fayetteville, Arkansas 72701
Telephone: (501)575-7389
Website: www.aglaw-assn.org

Indiana Soybean Board
5757 W 74 St.
Indianapolis, IN 46278
Telephone: (317)347-3620
E-mail: info@indianasoybeanboard.com

Illinois Specialty Farm Products
College of Agricultural, Consumer, and Environmental Sciences
University of Illinois at Urbana-Champaign
Funded by the Illinois Council on Food and Agricultural Research
Website: web.aces.uiuc.edu/value/contracts/default.htm

National Corn Growers Association
Attn: Communications Department
1000 Executive Parkway, Suite 105
St. Louis, MO 63141
Website: www.ncga.com/03world/main/primary.html

NCGA National Corn Growers Association
1000 Executive Parkway, Suite 105
St. Louis, MO 63141-6397
Telephone: (314)275-9915
E-mail: corninfo@ncga.com
Website: www.ncga.com

Organic Food Business News
Hotline Printing and Publishing
P.O. Box 161132
Altamonte Springs, FL 32716
Telephone: (407)628-1377
Unlike conventional grain, USDA does not systematically report organic prices. OFBN, a private firm based in Florida, publishes a weekly organic price report containing farmgate (the price the farmer gets) prices for grains and produce.

Organic & Natural News
P.O. Box 40079
Phoenix, AZ 85067-0079
Telephone: (480)990-1101
E-mail: onn@vpico.com
Website: www.organicandnaturalnews.com/

Organic Trade Association
74 Fairview Street
P.O. Box 547
Greenfield, MA 01302
Telephone: (413)774 7511
E-mail: info@ota.com
Website: www.ota.com

Organic Growers and Buyers Association (OGBA)
8525 Edinbrook Crossing - Suite 3
Brooklyn Park, MN 55443-1966
Telephone: (800)677-6422 or (612)424-2450
E-mail: ogba@mwt.net
Website: www.ogba.org/

Organic Trade Association
74 Fairview Street
P.O. Box 547
Greenfield, MA 01302
Telephone: 413-774 7511
E-mail: info@ota.com
Website: www.ota.com

Popcorn Institute
401 N. Michigan Ave.
Chicago, IL 60611-4267
Telephone: (312)644-6610
E-mail: lori_warner@sba.com
Contact: Lori Warner, Marketing Manager

Snack Food Associations
1711 King Street, Suite One
Alexandria, VA 22314
Telephone: (703)836-4500
E-mail: awilkes@sfa.org
Website: www.sfa.org
Contact: Ann Wilkes,
Vice President, Communications

Consumer Research Related to Consumer Health and Nutrition Behavior
The Hartman Group
1621 114th Ave SE#105
Bellevue, WA 98004
Telephone: (425)452-0818
Fax: (425)452-9092
Website: www.hartman-group.com/

Labeling
The Consumer Union Guide to Environmental Labels
Website: www.ecolabels.org/home.cfm

Sources of Organic Seed

NC+ Organics
3820 No. 56th St.
P.O. Box 4739
Lincoln, NE
Telephone: (800)279-7999
E-mail: organics@nc-plus.com
Website: www.ncorganics.com

Organic Grains Production

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Organic Grain Buyers, Pennsylvania

American Health and Nutrition
Telephone: (734)677-5570
Website: www.organictrading.com/
Buyer of organic grains.

Benzel's Bakery, Inc.
5200 Sixth Ave.
Altoona, PA 16602
Telephone: (800)344-4438
E-mail: pretzels@benzels.com
Buyer of organic flour.

Buckeye Pretzel Company, Inc.
P.O. Box 113, Route 405
Montgomery, PA 17752
Telephone: (800)257-6295
Website: buckeyepretzel.com
Buyer of organic flour.

Clarkson Grain
320 East South Street
P.O. Box 80
Cerro Gordo, IL 61818
Telephone: 217/763-2861 or 800/252-1638
E-mail: cgci@one-eleven.net
Website: www.clarksongrain.com/
Buys organic grain.

Earth's Best/H. J. Heinz
P.O. Box 57
Pittsburgh, PA 15230
Telephone: (802)388-6601
Website: earthsbest.com/main.html
Buyer of organic grain.

Fresh Tofu, Inc.
1101 Harrison Street
Allentown, PA 18103
Telephone: (610)433-4711
Email: tofu@fast.net
Buyer of food-grade soybeans.

McGeary Grains, Inc.
P.O. Box 299
Lancaster, PA 17608
Telephone: (800)624-3279
Email: sales@mcgearygrain.com
Buyer of organic grain.

Strictly Organic
34 Evergreen Rd
Lebanon, PA 17042
Telephone: 717-273-1555

Organic Grain Buyers, Maryland

Cohen Marketing Services
2501 Boston Street, Suite 303
Baltimore, MD 21224
Telephone: (410)563-8855
E-mail: dcohen@bcpl.net
Buyer of organic grain.

Organic Grain Buyers, New York

Agriculver, Inc.
3900 McIntyre Road
Trumansburge, NY 14886
Telephone: (617)387-5788
Certified grain cleaner.

Agway, Inc.
3717 Yagel Road
Geneva, NY 14456
Buys, cleans, stores, markets organic grains.

Birkett Mills
163 Main Street
Penn Yan, NY 14527
Telephone: (315)536-3311
Website: www.thebirkettmills.com/
Buyer of buckwheat.

Community Mill and Bean, Inc.
267 Route 89 South
Savannah, NY 13146
Telephone: 315/365-2664
Buys organic grains.

New Hope Mills
RD 2 Box 269 A
Moravia, NY 13118,
Telephone: (315)497-0783
Buyer of buckwheat.

Organic Grain Buyers, Other States

Clarkson Grain
320 East South Street
P.O. Box 80
Cerro Gordo, IL 61818
Telephone: (217)763-2861 or (800)252-1638
Email: cgci@one-eleven.net
Website: www.clarksongrain.com/
Buyer of organic grain.

Eden Foods, Inc.
701 Tecumseh Road
Clinton, MI 49236
Telephone: (517)456-7424
Buyer of organic grain.

Golden Organics
607 10th Street, Suite 205
Golden, CO 80401
Telephone: (303)273-5942
Email: organic@aol.com
Buyer of specialty grain.

Pacific Soybean and Grain, Inc.
P.O. Box 123
Tiffen, IA 52340
Telephone: (319)545-5167
Buyer of food-grade soybeans.

Purity Foods, Inc.
2871 W. Jolly Road
Okemos, MI 48864
Telephone: (517)351-9231
Website: purityfoods.com
Buyer of organic grain.

SK Food International
P.O. Box 1236
Wahpeton, ND 58075
Telephone: (701)642-3929
Website: skfood.com/
Buyer of specialty grain.

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The Rodale Institute
Kutztown, PA 19529
Telephone: (610)683-1400
FAX: (610)683-8548
Website: www.rodaleinstitute.org

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Chapter 6

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Organic Materials Review Institute (OMRI) Website: www.omri.org/

Pennsylvania Certified Organic, 1919 General Potter Hwy., Suite 1, Centre Hall, PA 16828;
Telephone: (814)364-1344
FAX: (814)364-4431
Website: paorganic@aol.com

Chapter 7

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Website: www.indianasoybeanboard.com/
Indiana Soybean Board
5757 W 74 St.
Indianapolis, IN 46278-1755
Telephone: (317)347-3620
Fax: (317)347-3626
E-mail: info@indianasoybeanboard.com
Website: www.indianasoybeanboard.com/

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Website: www.css.cornell.edu/extension/CornellGuide.html

National Organic Program/USDA
Website: www.ams.usda.gov/nop/

Ohio Seed Improvement Association
6150 Avery Road
Box 477
Dublin, Ohio 43017
Telephone: (614)889-1136
Website: www.ohseed.org/

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Website: agguide.agronomy.psu.edu/

Sustainable Agriculture Network, University of Vermont
Burlington, VT 05405-0082.

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Weights, measures and abbreviations

1 dry bushel (bu) = 32 quarts or 1.244 cubic feet

1 acre (a) = 43,560 square feet or 2.471 hectares

1 pound (lb) = 16 ounces or 453.59 grams

1 short ton = 2000 pounds

The RODALE INSTITUTE

Healthy Soil, Healthy Food, Healthy People®

611 Siegfriedale Road, Kutztown, PA 19530-9320
Tel 610-683-1400 Fax 610-683-8548
info@rodaleinst.org www.rodaleinstitute.org

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