Potatoes: Organic Production and Marketing

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This publication outlines approaches to organic and sustainable potato production. Practices include fertility and nutrient management; organic and biorational pest management for insects, diseases and weeds; and storage and marketing.

Introduction

This publication outlines many of the practices used in organic and sustainable potato production. While organic potato production can yield a premium price for your product, the production considerations are significant. This publication discusses organic soil and pest management strategies that help ensure growth of healthy and vigorous plants. Strategies include choosing potato varieties suitable for the area and intended use; using disease-free seed potato sources; appropriate soil fertility and management; weed, disease and insect control; harvesting methods and crop storage.

Economic and market evaluation are equally important topics in organic potato production. While direct-marketed organic potato sales appear to be strong, it can be difficult to enter wholesale markets due to storage complications and market control. These factors are discussed in greater detail as well.

Because each farm is a unique combination of soil, climate, environment, management and marketing techniques, it is important to plan and assess which practices described here are appropriate for a particular farm. There are numerous potato production manuals that are specific to regions within the United States. For further information on region-specific and potato production in general, within your region, consult your local Cooperative Extension Service or call the ATTRA information line at 1-800-346-9140 for county extension office contacts.

Section I

Organic production overview

Organic farmers adhere to certification guidelines that exclude the use of synthetic fertilizers and pesticides. Producers using these techniques are able to market their products as organic if they have gone through a certification process. If you are interested in becoming certified organic, ATTRA has many publications that can help you through the transition process. The ATTRA publication *Guide to ATTRA's Organic Publications* will help you get off to the right start.

Organic production practices maximize the use and recycling of on-farm nutrient sources, including animal and green manures. Techniques such as accurate soil analyses and nutrient crediting help producers avoid excess fertilizer applications. Sustainable farming methods also include

Potato plant. Photo by Dianne Earl. Courtesy of the National Education Network.

soil-building and -conserving practices such as adding organic matter and minimum-tillage approaches. Biointensive integrated pest management is also a sustainable farming method.

The primary goal of biointensive IPM is to provide guidelines and options for the effective management of pests and beneficial organisms in an ecological context. The flexibility and environmental compatibility of a biointensive IPM strategy makes it Zuseful in all types of cropping systems. See the ATTRA publication *Biointensive Integrated Pest Management* for more information on this subject.

Two important factors that contribute to developing a sustainable and profitable farming system are willingness to experiment with new or different farming practices and the ability to observe how management practices influence the farm ecosystem. Talk with growers experienced in using sustainable techniques to find what methods will work in your region. This publication includes three profiles of growers throughout the country who are producing organic potatoes. There is also a list of experienced organic growers in the **Further resources** section of this publication. These growers agreed to be a resource for new farmers or farmers interested in transitioning to organic potato production.

Organic potato stock is required by the National Organic Program unless you demonstrate the same variety, quantity or quality is not available from an organic seed supplier. Photo by Neva Hassanein, courtesy of Community Food and Agriculture Coalition.

Related ATTRA Publications

Sustainable Soil Management

Biointensive Integrated Pest Management

Guide to ATTRA's Organic Publications

Farm-Scale Composting Resource List

Overview of Cover Crops and Green Manures

Intercropping Principles and Production Practices

Principles of Sustainable Weed Management for Croplands

Flame Weeding for Agronomic Crops

Nematodes: Alternative Controls

Colorado Potato Beetle: Organic Options

Farmscaping to Enhance Biological Control

Notes on Compost Tea

The National Organic Program certification standards require producers to grow potatoes from organically certified seed potatoes. The limited availability of organic potato seed stock may limit the selection of specific varieties and larger quantities.

Organic seed potato stock must be sourced for certified organic production unless organic seed stock is not available in the same quality, quantity or form as nonorganic stock. Examples of the quality, quantity and form clauses are:

Quality: The same quality, such as non-certified seed or disease-free seed, of potato seed is not available .

Quantity: The desired variety is not available as in commercial quantities.

Form: The same variety that you typically grow is not available.

If you source nonorganic seed due to any reason listed above, you must document that you researched at least three different seed sources to find organic seed and that the same quality, quantity or form is not available from those sources. Also, all non-certified seed must be sourced as untreated if organic seed is not commercially available (King, 2006).

Another consideration when buying seed is ensuring that the seed is certified as disease free (Charlton, 2008). If certified disease-free seed is not available in the organic form, seed can be purchased from a nonorganic source as allowed in the quality stipulation of the National Organic Program (NOP, 2006).

An excerpt from the National Organic Program regulations states:

§ 205.204 Seeds and planting stock practice standard

(a) The producer must use organically grown seeds, annual seedlings and planting stock, except that,

(1) Nonorganically produced, untreated seeds and planting stock may be used to produce an organic crop when an equivalent organically produced variety is not commercially available, except that organically produced seed must be used for the production of edible sprouts;

(2) Nonorganically produced seeds and planting stock that have been treated with a substance included on the National List of synthetic substances allowed for use in organic crop production may be used to produce an organic crop when an equivalent organically produced or untreated variety is not commercially available;

(3) Nonorganically produced annual seedlings may be used to produce an organic crop when a temporary variance has been granted in accordance with § 205.290(a)(2);

(4) Nonorganically produced planting stock to be used to produce a perennial crop may be sold, labeled or represented as organically produced only after the planting stock has been maintained under a system of organic management for a period of no less than one year; and

(5) Seeds, annual seedlings and planting stock treated with prohibited substances may be used to produce an organic crop when the application of the materials is a requirement of federal or state phytosanitary regulations (2006).

Certified seed and certified organic seed stock: What's the difference?

The Western Organic Potato Pest Management Strategic Plan offers clarification to some confusion about certified disease-free seed. This excerpt from the plan explains the difference between certified disease-free seed and certified organic seed stock:

Certified disease-free seed stock:
"It is important that organic potato growers plant high-quality, early generation, certified seed to manage diseases. Certification of seed does not guarantee that the seed potatoes are disease free, but that the disease levels fall within certain tolerable levels. Certification means that the seed potatoes have met the standards of a grower-supported state certification agency. Seed purchased from different states and countries are subject to different certification rules. As such, each certification agency has its own set of tolerances, or allowable amounts, for each disease."

Certified organic seed stock:
"Certified organic seed is not necessarily certified at the same specifications required for certified disease-free seed that meets stringent disease and virus-free specifications and other physiological requirements. Certified organic potato seed is grown in accordance with the National Organic Program regulations (Miller et al., 2008)."

Fertility and nutrient management

Potatoes have high nitrogen and potassium requirements. These can be met by using manures, compost and crop rotations, which are detailed in the later sections. You can assess soil nutrient levels with a soil test. If nutrient levels are deficient, apply organic amendments.

Most organic potato growers should consider producing their crop with 120 pounds of nitrogen, 25 pounds of phosphate and about 140 pounds of potash per acre (Sideman and Johnson, 2006).

Seed sources for organic potato production

This is only a partial list. Your local organic certification organization may know of local seed sources.

Wood Prairie Farm
49 Kinney Road
Bridgewater, ME 04734
1-800-829-9765
1-800-300-6494 FAX
orders@woodprairie.com
www.woodprairie.com
Order: Online, e-mail, fax, phone
Catalog: Online, print
Quantity: Retail and wholesale
Notes: Organic seed potatoes

FEDCO Seeds/Moose Tubers
PO Box 520
Waterville, ME 04903
(207) 872-8317 FAX
www.fedcoseeds.com
Order: Mail, fax
Catalog: Online, print request through Web site or send $2.
Quantity: Retail and wholesale

Ronnigers Potato Farm
2101 2135 Rd,
Austin CO 81410
(877) 204-8704
info@ronnigers.com
www.ronnigers.com
Order: Online, e-mail, fax, phone
Catalog: Online, print
Quantities: Up to 50 pounds available
Notes: Organic potatoes, garlic and onions

Healthway Farms
PO Box 49
Malin, OR 97632
(541) 723-4725
scott@healthwayfarms.com
www.healthwayfarms.com/index.html
Order: E-mail, phone
Catalog: Online, print
Quantities: Smaller quantities of certified potato and organic fingerling seeds up to 10 pounds.

Note that nutrient requirements vary by potato variety and yield goals. Lowering the soil pH will help prevent common potato scab problems, but not powdery scab. A soil pH of 5.0 to 5.2 is recommended for preventing scab, but this pH level may affect other crops in the rotation, as well as nutrient availability (Charlton, 2008).

Sulfur is an organically acceptable way to lower soil pH. Contact your local Cooperative Extension Service office to determine the correct quantities to apply based on your current pH, soil type and region. Before purchasing any sulfur amendment, contact your certification agent to obtain a list of organically acceptable sulfur amendments. Some amendments have inert ingredients that are not acceptable by NOP standards.

Nutrient requirements vary by potato variety and yield goals.

The ATTRA publication *Sustainable Soil Management* provides information about nutrient management and references that are useful to the organic grower. Please contact ATTRA at 1-800-346-9140 if you would like a copy of this publication or search the ATTRA Web site at *www.attra.ncat.org*.

Organic matter

You can organically manage nutrient requirements with animal manures and composted materials. Annual application of these materials can provide a well-balanced, stable form of nutrients and help build organic matter in the soil.

In a multiyear study of sustainable potato cropping systems, researchers from the University of Maine demonstrated yield increases with the application of 10 tons of compost per acre. The researchers also studied the economic considerations of applying compost and determined that buying compost would require a price premium on potatoes to make the compost purchase cost-effective (Porter, 2002).

This study predates recent increases in conventional fertilizer prices. The cost of compost may now be comparable to other soil amendments, but no current studies support this claim. Compost that is available on the farm should be considered as a soil amendment. The ATTRA publication *Farm-Scale Composting Resource List* has more information about this topic.

Rotations

The most important step in organic potato production is planning a crop rotation scheme that allows a few years between potato crops on the same land. For organic production, a lengthy rotation from four to seven years generally assures good plant and soil health. A lengthy rotation also reduces long-term reliance on expensive inputs and increases the percentage of marketable potatoes.

Longer rotations can be thought of as a form of crop insurance because the rotations help prevent plant pathogens in the soil from building up to economically damaging levels. Growers must consider rotation plans with crops that are not hosts for potato pathogens or insects. The key consideration for the long-term viability of organic production is preventing problems through maintaining good soil quality.

Rotations that include cover crops have the advantage of adding organic matter and nitrogen to the soil. This generally will reduce input costs over time. Organic matter helps soils resist compaction, allows for better root penetration, stores more soil moisture and allows more water penetration. Cover crops and green manures may include legumes, sudan grass and mustards. Mustards also have been shown to play a positive role in soil pest management (McGuire, 2003).

Useful characteristics for a cover crop or green manure in a potato rotation include:

- The ability to tolerate frost and grow well under cool fall conditions;

- The ability to quickly produce substantial amounts of biomass as a weed suppressant;
- The ability to fix nitrogen and suppress soilborne potato pests;
- A compatibility with the management requirements of other crops in the rotation;
- The availability of seed and a lack of planting restrictions, such as the restriction of rapeseed production in canola districts; and
- The ability to avoid producing and shedding seed, which leads to problems with volunteer plants.

A good rotation includes crops that are not hosts to common potato pests. A good rotation also includes green manures that add nutrients and organic matter to the soil (Hutsinger, 1995).

The ATTRA publications *Overview of Cover Crops and Green Manures* and *Intercropping Principles and Production Practices* provide more detailed information about these subjects. Small grains, corn and sorghum sudangrass may benefit a potato crop that follows. In Maine, some growers have used Japanese millet as a cover crop in the year prior to potatoes in an effort to reduce *Rhizoctonia*. The skin of potatoes with the *Rhizoctonia* fungus appears to be covered in dirt that won't wash off (Grubinger, 2005). In parts of the West, producers rotate potatoes with mustard cover crops to prevent root knot nematode and Verticilium outbreaks. More information about using mustard as a disease and nematode suppressant is provided in the **Nematode management** section below.

Dr. Gregory Porter at the University of Maine developed a two-year reduced-tillage rotation for potatoes and barley. The rotation uses red clover as a cover crop. Porter builds planting ridges in the spring of the first year of the rotation and then seeds the entire field to barley and red clover. He harvests barley in the fall and allows the red clover to continue as a winter cover. In the spring of the

Mustards used in a rotation can be a disease and nematode management strategy. Photo by Peggy Greb, courtesy USDA/ARS.

second year, Porter uses an adapted potato planter to scrape the clover from the ridge and plants potatoes from 2 to 3 inches deep. One week later, he kills the clover with a flail chopper to prevent competition with the potatoes. Only one hilling is required, occurring six weeks from planting time. A second cover crop could be seeded at this time, although harvesting operations are not refined to assure survival of a cover (Porter, 2006).

Porter estimates that he saves from \$50 to \$60 per acre in energy costs as a result of reduced tillage. His research also assesses the nutrient savings that result from the nitrogen-fixing legume. He mentioned that wheat could be substituted for barley. For more information on Porter's research, see the final report of their Sustainable Agriculture Research and Extension Project Report, *Soil Amendment and Crop Rotation Effects on Productivity and Soil Properties within Potato Production Systems* under **Further resources.**

Table 1: Potato rotation chart

Location	Rotation sequence	Comments	Contact/reference
Pacific Northwest	*7-year crop rotation:* Year 1-3: Alfalfa; Year 4: Row crop*; Year 5: Grain; Year 6: Row crop*; Year 7: Grain ** Dry beans, squash, potatoes and field corn are row crop options depending on market*	This rotation works well under organic production practices.	Mike Heath (208) 539-4107 Buell, ID
Michigan	*2-year rotation:* Year 1: Potato and then rye planted as winter cover; Year 2: Snap bean. *3-year rotation:* Year 1: Potato and then rye/vetch planted as winter cover; Year 2: Corn; Year 3: Wheat and then clover	Research in MI has shown that poultry compost added to the soil under these two-year conventional rotations in combination with use of cover crops can increase soil quality and at least maintain yields compared to no cover crops. The three-year rotation had a marketable yield nearly the same as the two-year rotation for comparing single harvest years, but less than half of the scab of the two-year rotations.	Annual report (2005) of the Southwest Michigan Research and Extension Center. *www.maes.msu.edu/swmrec/publicationsfolder/Annualreports/05annualrpt/snappenvfriendveg.pdf*
Maine	*4-year rotation:* Year 1: Potatoes; Year 2: Spring wheat or oats, undersown with clover or timothy grass; Year 3: clover sod, plowed down, year 4); Year 4: Buckwheat, plow down and then plant rapeseed as biofumigant	This rotation is used for organic seed potatoes.	Jim Gerritson Wood Prairie Farm *www.woodprairie.com*
Maine	*3-year rotations, various crops :* Year 1: Soybean/sweet corn/green bean/canola; Year 2: Canola/soybean/sweet corn/ barley and then clover; Year 3: Potato	This research on various three-year rotations that all included potato found that continuous potatoes decreased soil microbial activity. Overall microbial activity were highest following barley, canola and sweet corn. Potato crops following canola, barley or sweet corn provided the lowest levels of *Rhizoctonia* disease and best tuber quality, whereas potato crops following clover or soybean resulted in disease problems in some years.	Robert P. Larkin and C. Wayne Honeycutt U.S. Department of Agriculture – Agricultural Research Service, New England Plant, Soil and Water Laboratory Orono, ME 04469 (207) 581-3367 *bob.larkin@ars.usda.gov* (207) 581-3363 *wayne.honeycutt@ars.usda.gov*
Wisconsin	*3-year rotations:* Year 1: Potato; Year 2: White oats underseeded with clover; Year 3: Field peas*; or Year 1: Potato; Year 2: Oats underseeded with clover; Year 3: Alfalfa	These rotations are used on a 200-acre organic farm. **Peas are determinant grain pea, not a forage pea, and can be used directly as animal feed without processing.*	Igl Farms Antigo, WI (715) 627-7888 *iglfarms@verizon.net*
Canada	*2-year rotation:* Year 1: Potato and then rye planted as winter cover; Year 2: Spring cereal with legume underseeding, legume incorporated before potato		

It is important to note that legumes such as peas, beans and crimson clover are hosts to some races of *Rhizoctonia* (Ceresini, 1998) and can encourage scab in certain regions. Red clover may be a host of *Rhizoctonia* as well.

As often happens in agriculture, there is no clear-cut answer to the question of what rotation a farmer should use. It is a matter of evaluating the costs and benefits of a particular practice or combination of practices. In this case, producers must weigh the risk of these crops hosting and possibly increasing *Rhizoctonia* against the soil fertility advantages and other benefits of planting a legume.

Table 1 (page 6) provides some examples of potato rotations used around the country. It is not meant to be exhaustive, simply because there are so many factors that influence the choice of rotations, including economics of the crops in the rotation, available land, weather and climate, farmer skills and knowledge, pest management and soil quality goals. Since many of these factors are moving targets, implementing a good crop rotation is as much an art as a science because so much depends on the knowledge, skill and creativity of the farmer.

When making rotation decisions, it is helpful to have additional information from local experts — be they farmers, extension agents or researchers — who know about the pest pressures and soil and climate considerations for your particular region.

Weed management

Organic potato producers control weeds largely by cultivation. Good field preparation, timely pest control and proper seed spacing provide a satisfactory stand that can also reduce weed competition. In areas with lots of weed pressure, farmers should choose specific potato varieties that put on a canopy quickly. Hilling, either with an implement or by hand, is a good way to control weeds and is a necessary component of potato production. In larger operations, an implement called the dammer-diker hills and cultivates at the same time. Complete all hilling by the time the plants are 10 inches high (Sideman and Johnson, 2006). Your chances of stolon pruning are high after the plant reaches 8 inches. Stolon pruning is a condition that causes the underground stems to die-back, reducing yields and increasing disease incidence. (Charlton, 2008).

Cover cropping is also a good way to reduce weed populations in your soil and add soil organic matter. Results from the Maine Potato Ecosystem Project demonstrate that cover cropping with red clover and adding soil amendments such as compost and manure reduced weeds and enabled the potato crop to better compete with weeds (Porter, 2002). Fast-growing cover crops such as buckwheat and sorghum sudan grass add organic matter and compete with weeds. For smaller farmers, mulching with clean straw is an option that builds soil organic matter and helps with weed populations.

Flame weeding is another technique used by some growers. Flaming is also used in management of the Colorado potato beetle. Stale seed bedding draws down the weed seed bank. Irrigate or wait until after a rain to let weed seeds germinate, and then flame weed or cultivate. Crop rotation is another measure that helps keep weed problems from becoming severe (Gallant, 1998). Producers can also significantly reduce weed populations by using a drip irrigation system combined with bed planting instead of sprinkler irrigation (Mirabelli et al., 2005). For more details on these techniques, refer to the ATTRA publications *Principles of Sustainable Weed Management for Croplands* and *Flame Weeding for Agronomic Crops*.

Root knot nematodes are common in Western organic potato systems and are the leading cause of soil fumigation in commercial potato production in the Northwest. Photo by Jack Kelly Clark. Courtesy University of California-Davis Statewide IPM Program.

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Nematode management

Nematodes are microscopic roundworms found in many habitats. Nematodes are the most abundant multicellular organisms on Earth. Most are beneficial members of their ecosystems, but a few are economic parasites of plants. The Columbia, stubby and northern root knot nematodes are common in Western organic potato systems and are the leading cause of soil fumigation in commercial potato production in the Northwest.

Root knot nematode feeding reduces the vigor of plants and causes blemishes on tubers (Westerdahl, 2007). Infection of tubers by the Columbia and stubby root knot nematode often results in the formation of galls that appear as knobs or swellings on the tuber surface and affect marketability. Root knot nematode larvae invade roots or tubers, establish feeding sites and develop into the adult stage. Adult females are swollen, sedentary and lay eggs in a gelatinous matrix on or just below the root surface. These eggs hatch and larvae invade other roots and tubers. Feeding by root knot nematode eliminates the possibility of exportation since infected potatoes are banned in many countries.

There are recent promising developments with biofumigation using brassica mustard cover crops in a rotation before potatoes. Brassica crops such as rapeseed and mustard contain active chemicals called glucosinolates. The breakdown of these chemicals has been shown to suppress some soilborne diseases, nematodes and weed seeds. The best strategy for the ultimate suppression of soilborne diseases and nematodes is selecting a species of mustard that produces large amounts of biomass and glucosinolates. Also, before incorporating, chop the green manure with a rotary mower or a high-speed flail chopper. The breakdown of the biofumigant seems to be better in moist soils, so irrigate following incorporation or time incorporation to occur with a rain (McGuire, 2003).

Jack Brown, a plant breeder specializing in brassicas at the University of Idaho, has released two biofumigant varieties: Humus rapeseed and IdaGold mustard. Each variety contains elevated levels of glucosinolates. For more information on these varieties, see the ATTRA publication *Nematodes: Alternative Controls.*

Severe early blight symptoms. Photo by Cynthia M. Ocamb, courtesy Oregon State University.

Disease management

Organic management of viral, bacterial and fungal diseases begins with using certified seed, employing proper sanitation practices, controlling other plant and insect vectors and using crop rotations. The two integrated pest management (IPM) guides listed in the **Pest management** portion of the **Further resources** section cover these topics. What follows is a brief summary of the diseases that are the most troublesome to organic potato growers and some preventative and control measures.

Early blight (Alternaria solani)

Early blight is basically a disease of older plants or plants that experienced stress, such as infection by some other plant pathogen or deficiencies of nitrogen or water. Excessive irrigation can also cause susceptibility. The lower leaves of the plant are generally infected first. Early blight may appear early in the season, but the rate of infection accelerates rapidly after flowering. Tomato and other solanaceous plants are hosts to early blight. The disease has also been reported on other plants such as some brassicas. There are several races of this pathogen. Some races are highly pathogenic while others are saprophytic and live in the soil on dead organic matter. The pathogen can survive on crop debris, as a saprophyte in the soil, in infected tubers and on other hosts.

The most severe damage generally occurs on early maturing potato varieties. However, some varieties within each maturity group have greater resistance to foliar infection by early blight. Infection begins as small dark brown spots on lower leaves. As the infection spreads, the spots are restricted by the leaf veins and take on an irregular, angular look. Close inspection of the infection will reveal a series of dark, concentric lines within the infected area. These lesions will enlarge and may coalesce as the disease progresses. Tubers may also become infected and will have irregular-shaped, sunken lesions with somewhat darker borders. The infection is shallow and causes a brown discoloration of the tuber flesh. These lesions can increase in size during storage and reduce the marketability of the crop. Lesions are most troublesome on white, red-skinned and chipping varieties.

Growers should select a marketable cultivar with the greatest resistance to early blight. *Table 2* lists the susceptibility of several cultivars. The cultivar should also fit in with other aspects of an IPM program. Water management for early blight prevention walks a thin line. Too much water will leach soil nitrogen. Nitrogen and phosphorus deficiencies can create susceptibility to early blight, but too much nitrogen can reduce crop yields and delay maturity.

Growers should closely monitor soil fertility, especially nitrogen levels. This can be done with petiole analysis. Insufficient soil moisture will stress the plant and cause early senescence. This is a condition conducive to early blight development. Overhead irrigation creates ideal situations for infection and the spread of foliar pathogens such as early and late blight. Pay close attention to the frequency, duration and timing of irrigation during possible infection periods, since too much water can lead to early and late blight. Overhead irrigation should be timed so plants dry prior to dew formation in the late evening and early morning. Also, the plants should also be allowed to dry early in the morning, prior to the start of irrigation.

A 1994 study concluded that compost teas can be as effective as copper fungicide treatments to reduce disease symptoms. The study examined the use of compost teas for controlling early blight. Results of this study indicate that spraying the plants with 14-day-old compost extract prepared in a 1:5 ratio of compost to water (volume: volume) provided a level of early blight control similar to that of copper fungicide treatments (Lahkim, 1999). It should be noted that compost teas can be highly variable and inconsistent. Commercial compost teas may provide more consistency. For more information on making compost tea on your farm, see the ATTRA publication *Notes on Compost Tea*.

Table 2: Susceptibility to early and late blight.

Highest susceptibility → Lowest susceptibility

**Note: Certified seed for some of these varieties may not be available.*

Early- and mid-season cultivars	Late-season cultivars	Very late cultivars
Norland	Russet	Butte
Redsen	Burbank	Nooksack
BelRus	Kennebic	Ontario
Norchip	Katahdin	
Norgold	Rosa	
Russet		
Early Gem		
Superior		
Monona		
LaChipper		
Atlantic		

Table adapted from: (Stevenson, 1993).

Lowest susceptibility to early and late blight

Late blight (Phytophthora infestans)

Late blight is the most serious fungal disease of potatoes worldwide, according to the authors of *Integrated Pest Management for Potatoes in the Western United States* (Strand, 2006).

New, more virulent strains of late blight cause serious losses in potato varieties previously considered resistant to the fungal disease. Late blight is usually of little

Late blight in potato tuber. Photos by Neil C. Gudmestad, courtesy North Dakota State University.

concern in the western United States, except in the coastal valley regions where late blight occurs regularly. Its occurrence in other regions of the United States is dependent on both the presence of the pathogen and cool, damp weather. Blight forecasting still occurs quite regularly to help alert growers when conditions are conducive to the disease. For more information on blight forecasting, contact your local Cooperative Extension System office.

Sanitation is the best defense against late blight. Eliminate all cull piles and control volunteer potato sprouting the following spring in areas where there was an incidence of late blight.

Copper products are currently allowed by NOP standards and are the most effective means of controlling and preventing late blight. Recent studies from the OSPUD farmer participatory research project at Oregon State University show promising late blight management using compost teas and Oxidate, a hydrogen dioxide and peroxyacetic acid product from BioSafe Systems, a manufacturer of biodegradable disease-control products.

Some commercially available U.S. potato varieties that demonstrate resistance to late blight are the New York 121, a mid- to late-season variety; two Hungarian Sarpo varieties: the Sarpo Mira, a medium- to late-tablestock and the Sarpo Axona, a processor potato; and Remarka, an all-purpose potato (Perry, 2002). Defender is a new late blight-resistant potato cultivar that was released in Idaho, Oregon and Washington by the Tri-State Potato Variety Development Program in 2004. Useful levels of field resistance to both late blight and early blight were observed in Defender in the absence of fungicide sprays and reduced fungicide input programs (Stevenson et. al., 2007).

Rhizoctonia (Black scurf, Stem canker, Rhizoctonia solani)

Rhizoctonia is a pathogen present in all potato-growing areas. Most damage occurs during the early part of the growing season, particularly when infected tubers are planted. Cold, wet soils can increase problems with this disease.

The fungus survives in the soil either as mycelia associated with decomposing plant residues or as sclerotia, the dirt that won't wash off unharvested tubers. Soilborne infections, known as the chronic phase of the disease, generally will not infect sprouts. Instead, soilborne infections cause a decrease in tuber quality and yield by pruning tubers and causing reddish-brown lesions that may develop into cankers.

Tubers may also be malformed, cracked, pitted or display stem-end necrosis. Young plants that develop from infected seed pieces are most severely affected. Sprouts may be completely girdled by lesions and killed. Partially girdled stems will slow growth and development and may result in stunting and rosetting of plant tops; purple pigmentation of leaves; upward leaf roll; and chlorosis, which is usually most severe at the top of the plant.

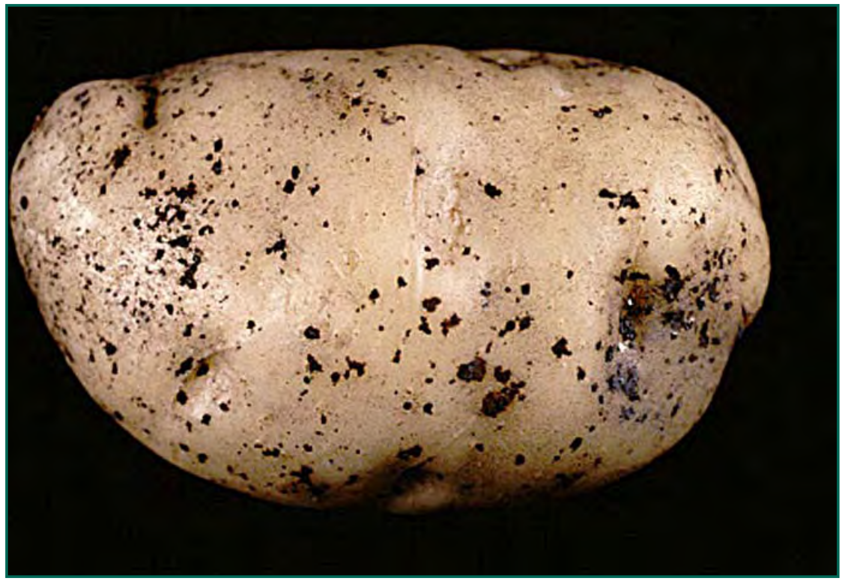
Potato growers can manage *Rhizoctonia* with monitoring. It is useful to keep good records of the existence and severity of black scurf problems in each field. This way, fields with economically damaging levels of black scurf can be managed through appropriate rotations and other methods.

Cultural controls

Avoid growing sugar beets prior to potatoes because sugar beets tend to increase *Rhizoctonia* problems. Avoid a rotation with buckwheat before potatoes because *Rhizoctonia* colonizes mature buckwheat stems (Leach and Specht, 1987). Crop rotation to nonhost crops such as cereals for at least two years can reduce disease incidence. A three- to five-year rotation away from potatoes is recommended if disease incidence is severe (BASF Canada, 2005).

It should be noted that recent protein- and DNA-based studies of *Rhizoctonia* found considerable genetic diversity in *Rhizoctonia* and its hosts (Ceresini, 1998). Growers should be careful when selecting rotation crops. Generally speaking, cereals are a safe bet. Crops closely related to potatoes, such as tomatoes, eggplants and peppers, along with volunteer potatoes, may host *Rhizoctonia* and should not be used in a potato rotation. Likewise, related weeds such as black nightshade and Jimsonweed should be kept out of the field.

Planting certified seed significantly reduces poor stands and sprout death associated with *Rhizoctonia*. For a definition of certified seed, see the box on page three. However, using certified seed will not eliminate *Rhizoctonia* problems since the fungus survives in the soil either as mycelia associated with decomposing plant residues or as sclerotia on unharvested tubers. The sclerotia may form on the surface of tubers under cool, moist conditions, usually after the vine starts to die.



***Rhizoctonia* (Black Scurf) in tubers of potato. Photo by Neil C. Gudmestad, courtesy North Dakota State University.**

Biological management options

Research in greenhouses and in the field shows that dusting seed pieces with fungal antagonists of *Rhizoctonia* can significantly reduce stem canker and black scurf (Beagle-Ristaino and Papavizas, 1985). This reduces *Rhizoctonia* infection and decreases the viability of sclerotia on the potato. The commercially

Cultural management options for *Rhizoctonia*:

- Plant potatoes when soil temperature is above 60 degrees Fahrenheit.
- Avoid irrigation before the expected harvest.
- Plant seed pieces no more than 2 inches deep. The temperature of the soil is warmer at this depth.
- Harvest potatoes as soon as skin set occurs after vine kill to avoid development of sclerotia on mature tubers in the soil (Rowe et al., 1995).

available fungal antagonists featured in the study include *Trichoderma viride* and *Trichoderma virens*. There is a list of commercial products formulated with fungal antagonists of *Rhizoctonia*, as well as contact information for manufacturers of the microbial pesticides, in the **Further resources** section of this publication. The ATTRA publication *Biointensive Integrated Pest Management* has more information on using fungal antagonists.

Many scientific investigations have examined various aspects of biological control of *Rhizoctonia* (Jager and Velvis, 1986; Lewis and Papavizas, 1987; Howell, 1987). More recent research shows that some readily available commercial biocontrol products reduce the development of stem lesions in the field, with control comparable to that of a standard chemical treatment. However, no treatments, including chemical control, substantially reduced black scurf on potato tubers. Some treatments resulted in higher total yield, as well as higher yield of larger potatoes. Although no treatments effectively controlled black scurf, all biocontrol treatments controlled stem canker and some resulted in greater overall yield and larger potatoes (Larkin and Talbot, 2002).

Recent studies in Washington show that mustard green manures may offer farmers an equally effective but less expensive alternative to fumigants for control of soilborne pests (McGuire, 2003). The findings from this study suggest potential for mustard green manures to replace the fumigant metam sodium for potato production in some cropping systems. The practice can also improve water infiltration rates and provide substantial savings for farmers. While *Rhizoctonia* is not mentioned in the above study, another recent study found that mustard biofumigants reduced incidence of *Rhizoctonia* in a greenhouse setting.

Insect management

Colorado potato beetle (CPB, Leptinotarsa decemlineata)

Many insect pests are associated with potato production. Because the Colorado potato beetle (CPB), *Leptinotarsa decemlineata*, is a major insect problem in potatoes, we focus on acceptable approaches to control this pest in organic production. The ATTRA publication *Colorado Potato Beetle: Organic Control Options* provides more detail about managing this pest. ATTRA also has information about control techniques for other pests, such as the blister beetles and aphids.

Immature Colorado potato beetle. Photo by Tom Murray.

Adult Colorado potato beetle. Photo by Tom Murray

Colorado potato beetle eggs are bright orange and typically located on the undersides of leaves. Photo by Whitney Cranshaw, courtesy Colorado State University.

The CPB is native to the United States. Its original range was restricted to the eastern part of the Rocky Mountains. In the Rockies, the beetle fed on buffalo burr, a plant of no economic importance. Once the potato was introduced to this region, the beetle moved to the crop and spread eastward from potato patch to potato patch and reached the East Coast by 1874. The beetle is now found throughout North America, except in parts of Florida, Nevada, California and eastern Canada. By 1935 the CPB was established in France and is now widespread in Eurasia.

The CPB is the most economically threatening pest of potatoes in the northeastern United States. If left uncontrolled, this pest can completely defoliate a potato crop by late July (Hollingsworth et al., 1986). Although the potato is its favorite food, the beetle may also survive on tomato, eggplant, tobacco, pepper, ground cherry, thorn apple, Jimsonweed, henbane, horse nettle, belladonna, petunia, cabbage, thistle, mullein and other plants (Metcalf and Flint, 1962). The CPB is resistant to most registered pesticides, making the beetle one of the most difficult insect pests to control in cultivated crops (Hollingsworth et al., 1986).

The life cycle of the beetle varies according to where it is found. In northern Maine, the CPB completes one generation per year. Farther south, the CPB completes three generations per year. The adult beetle overwinters in the potato field, from 12 to 18 inches below the soil surface and in protected sites around the field. The beetles emerge in late spring, move to the field and mate once established on a plant. Females lay egg masses on lower leaf surfaces in batches of approximately 25 eggs. A single female may lay up to 500 eggs. Because the eggs are laid in clumps, the larvae tend to be found in clumps rather than randomly throughout the field (Hollingsworth et al., 1986). You can find good life cycle information for the CPB in the book *Destructive and Useful Insects*, by Metcalf and Flint, 1962. The book is available from most agricultural libraries.

A combination of several strategies can help keep CPB populations under control. Crop rotation, preferably with field corn, wheat or some other crop that can tolerate a pH of 6.0, can delay CPB population buildup. Ideally, rotated fields should be isolated from the previous year's potato planting.

Cultural techniques to manage the CPB

The effect of crop rotation on populations of CPB and on the incidence of early blight caused by *Alternaria solani* is quantified in a 1994 study (Weisz). The study noted that infestations of both pests are inversely related to the distance between rotated fields and the nearest location where potatoes were planted in the previous season. In other words, the farther you plant this season's potatoes from last season's potato field, the fewer pest problems will occur.

The Colorado Potato Beetle is also the most economically threatening pest of potatoes in the northeastern United States.

Research at Cornell University demonstrated the efficacy of flame technology in controlling overwintering CPBs. The most effective time for flaming is between plant emergence and when the plant reaches 8 inches in height. Taller plants are less heat tolerant and their canopy shields many of the pests. The best control is achieved on warm, sunny days when beetles are actively feeding on top of the plants. In trials, flaming provided 90 percent control of overwintering adult CPBs, contrasted with from 25 to 50 percent with chemical insecticides. Flaming also reduced egg hatch by 30 percent (Moyer, 1992).

The CPB can be excluded from crops with the use of floating row covers. Floating row covers are thin fabrics spun from a synthetic material. The product allows air and moisture to pass through while preventing pest species access to the plants. The floating row covers should be put on either shortly after planting or emergence.

Straw mulch of wheat or rye in potato fields may reduce the CPB's ability to locate potato fields and alter the microenvironment in favor of CPB predators (Brust, 1994). In the first half of the season, soil predators — mostly ground beetles — climb potato plants to feed on second- and third-stage instar larvae of the CPB. In the second half of the season, lady bird beetles and green lacewings are the predominant predators and feed on eggs and first and second instars. The increased number of predators in mulched potato plots compared to non-mulched plots resulted in significantly less defoliation from the CPB and one-third higher tuber yields.

Varietal resistance to the CPB

Some potato varieties, such as Russet Burbanks, seem to be more tolerant to the CPB, but no varieties are completely resistant.

Some potato varieties, such as Russet Burbanks, seem to be more tolerant to the CPB, but no varieties are completely resistant. The April 1989 issue of *National Gardening* highlighted research on planting early maturing varieties that develop potato tubers before CPB populations explode. It listed seven varieties that mature from 75 to 88 days. The varieties are the Caribe, Norland, Pungo, Redsen, Sunrise, Superior and Yukon Gold. The issue also illustrated the growth stages of the potatoes and how the stages coincide with CPB emergence and larval development (Ruttle, 1989). This practice of using early maturing varieties may prove beneficial to growers in northern regions of the United States, where cooler temperatures slow insect development.

Biological controls of the CPB

There are several natural enemies of the CPB, but these enemies are rarely seen in commercial potato fields because of heavy pesticide use. Even under organic growing conditions, when natural enemies are abundant, the beetle can still cause defoliation. The general predators, such as lady bird beetles, lacewings and stink bugs, provide some control of the CPB, as do several parasites. Doryphorophaga doryphorae and D. coberrans, two species of fly that invade the larvae; and Edovum puttleri, a wasp that parasitizes CPB eggs; were recently introduced and are commercially available.

Increasing habitat for natural enemies by providing pollen and nectar sources along field borders or by planting insectary strips in the field can increase the effectiveness of these biological controls. ATTRA has more information on this technique in the publication *Farmscaping to Enhance Biological Control*.

Several plants, such as tansy and catnip, are reported to repel the CPB. Two journal abstracts from The *IPM Practitioner* discuss interplanting trials conducted at Rodale Institute Research Center in cooperation with USDA researchers (Olkowski, et al., 1992). The experiments show tansy and catnip were from 58 to 100 percent effective in repelling the CPB from potatoes. However, a European study shows that companion planting did not significantly reduce plant defoliation by the CPB. In the European study, companion plants were smaller than the potatoes in the beginning of the season. The study's authors speculated that more mature companion plants might be more effective (Moreau et al., 2006). In 1992, The *IPM Practitioner* published a special report specifically addressing potato IPM for the CPB. The issue can be ordered as a photocopy from the publisher. See the **Further resources** section for ordering information.

Parasitic nematodes are another control option. Commercial formulations of *Heterorhabditis* species are available and have been shown to be more pathogenic (Berry, et al., 1997) to the CPB than *Steinernema* species, which is also commercially available. The Ohio State University Web site portal for beneficial nematodes, available at *www.oardc.ohio-state.edu/nematodes*, provides helpful information on how to use and where to obtain beneficial nematodes.

Biorational controls for the CPB

Commercially available M-One is a product manufactured by the Mycogen Corporation of California. See contact information in the **Further resources** section for ordering information. This biopesticide is made from *Bacillus thuringiensis (Bt)* var. 'San Diego', a naturally occurring bacterium, and is effective for controlling CPB without disrupting beneficial organisms. It is, however, a genetically engineered product and is not acceptable in organic certification programs.

Some research indicates that sprays of *Bacillus thuringiensis* species tenebrionis (Bt) will cause significant mortality of CPB larvae upon emergence from their eggs. This is because the beetles gnaw out of the eggs and continue eating the shells afterward, therefore also ingesting Bt particles (Ghidiu et al., 1994).

Mycotrol-O, a formulation of the parasitic fungus *Beauveria bassiana*, is available from Laverlam International, based in Butte, Mont. This product is an effective control of the CPB by itself or when used in combination with *Bacillus thuringiensis* var. tenebrionis (Jones, 1999). Some formulations use different strains of *B. bassiana*. Each strain has the greatest efficacy against a slightly different group of insects, so be sure to read the label or ask a sales representative about which formulations are most effective against the CPB. Since these are all formulations with a fungus as the active ingredient, the materials will work best in situations with moderate to high relative humidity.

Entrust is a new formulation of Spinosad manufactured by Dow AgroSciences. It is registered for use on organically managed farms to control the CPB and is popular with organic farmers. The contact information to find a distributor near you is listed at the end of this publication in the **Further resources** section.

Several neem-derived products are registered for use against the CPB. Soft-skinned larvae of CPB are reportedly killed on contact. In a two-year study of various organic techniques for controlling CPB in the United Kingdom, a 2-percent formulation of Neemix increased yield and lowered beetle densities and the occurrence of defoliation significantly.

The ATTRA *Biorationals: Ecological Pest Management Database*, available at *www.attra.ncat.org/attra-pub/biorationals/biorationals_main_srch.php*, lists several organically acceptable biorational pest management materials for the CPB. Several of these materials are listed

Table 3:

Reduced Risk Pest Management	Manufacturer	Active ingredient	OMRI listed*
Agroneem	Agro Logistic Systems	Azadirachtin	Yes
AgroneemPlus	Agro Logistic Systems	Azadirachtin	Yes
Ecozin	AMVAC Chemical Corp.	Azadirachtin	
Ornazin	AMVAC Chemical Corp.	Azadirachtin	
Biorin	Biotech International	*Beauveria bassiana*	
Azatin XL Plus	Certis USA, LLC	Azadirachtin	
Neemix 4.5	Certis USA, LLC	Azadirachtin	Yes
Diatect V	Diatect International	Diatomaceous Earth (Silicon Dioxide)	
Conserve sc turf and ornamental	Dow AgroSciences LLC	Spinosad	
Entrust	Dow AgroSciences LLC	Spinosad	Yes
Spintor 2sc	Dow AgroSciences LLC	Spinosad	
Success	Dow AgroSciences LLC	Spinosad	
Fortune Aza	Fortune Biotech Limited	Azadirachtin	
Pyola	Gardens Alive!, Inc.	Pyrethrins	
Anti-pesto-o	Holy Terra Products, Ltd.	Azadirachtin	

** OMRI is the Organic Materials Review Institute. If a product is OMRI approved, it is allowed for use in certified organic systems. Contact your certifier before using any organic pesticide to ensure it is approved by the National Organic Program.*

above in *Table 3*. The database also provides information about using cultural controls to prevent pest problems.

Potato leafhopper (Empoasca fabae)

The potato leafhopper, *Empoasca fabae*, does not overwinter in the northern United States and must migrate annually. The potato leafhopper is one of several closely related leafhoppers in this genus. The potato leafhopper feeds on more than 200 cultivated and wild plants including beans, potatoes, eggplant, rhubarb, celery, dahlia, alfalfa, soybeans, clovers and sweet clover. A high migration rate and wide host range make control of the potato leafhopper difficult.

Both nymphs and adults feed on the undersides of potato leaves. By extracting the sap, potato leafhoppers cause stunting and leaf curl. Potato leafhoppers also bring on hopperburn, a disease caused by the injection of a toxic substance. Hopperburn is characterized by a yellowing of the tissue at the tip and around the margin of the leaf. The yellowing increases until the leaf dies. Symptoms are sometimes confused with drought stress (Bennett et al., 2007).

The ATTRA publication *Farmscaping to Enhance Biological Control* describes how to design your farm to favor predatory organisms. These techniques can be integrated in a biointensive IPM program and can help make your cropping system friendlier to beneficial organisms.

Potato leafhoppers cause hopperburn, a disease with symptoms that are sometimes confused with drought. Photo by Art Hower, courtesy Pennsylvania State University Department of Entomology.

Biological control

Leafhoppers have several parasites and predators. The mirid bug, *Cyrtorhinus* species and specifically *Cyrtorhinus lividipennis*, is an effective predator. Some members of the wasp family are parasites of leafhopper eggs. Some species of *Trichogramma* are generalist egg parasites and have a wide host range. Other species of *Trichogramma* are more selective. *Anagrus* species of trichogrammatid wasps might be available at a local insectary and are effective against leafhopper eggs in inundative releases.

Even if this particular species is not available, you might consider an inundative release of a generalist *Trichogramma* egg parasite, as *Trichogramma* species tend to parasitize whatever eggs are available. Make sure you check with the insectary about parasite host ranges. Other beneficial insects are green lacewing, lady beetle, minute pirate bug, assassin bug, syrphid fly, hover fly, robber fly, spiders, damsel bugs and big-eyed bugs.

The Department of Pesticide Regulation, part of the California Environmental Protection Agency, publishes a booklet called *Suppliers of Beneficial Organisms in North America*. The most recent version, from 1997, lists 143 commercial suppliers of more than 130 beneficial organisms used for biological control. It is available for free download at *www.cdpr.ca.gov/docs/ipminov/bscover.htm*.

Neem

Neem works best when ingested by pests and is effective for controlling leaf-eating pests. Although neem is not effective for controlling sucking insects such as leafhoppers, it appears that it still could be part of a biocontrol strategy targeted against the insect. Neem shows considerable anti-feedant and growth-regulating effects on leafhopper nymphs (National Research Council, 1992). Neem is primarily an insect growth regulator and should be applied early in the crop cycle. It is essential to get good leaf coverage and to see that the neem product adheres to the leaf surface. If not, the nymphs, which feed on the undersides of the leaves, will not contact the active ingredient. The nymphs should be targeted because leafhoppers are most vulnerable in this stage.

The *IPM Practitioner* notes that garlic sprays can significantly reduce leafhopper populations, although the resulting numbers are still unacceptably high. Garlic may increase the efficacy of other leafhopper pest management strategies. Insecticidal soap penetrates the insect's cuticle, disrupts the cell membranes and causes death by dehydration. This method is likely to work best against nymphs (Olkowski et al., 1992). Efficacy is variable with this method as well.

Alternatively, a water spray directed at the plant, especially under the leaves, will wash off the insects. This treatment is not recommended in humid weather because of possible disease problems. Take care not to use excessive force. Spray early in the morning, especially in hot weather (Bradley and Ellis, 1992). Other physical controls include the use of floating row covers during the first month to keep leafhoppers out. Pyrethrin, rotenone and sabadilla are recommended only as a last resort. Rotenone is not approved by the NOP standards and has heavy restrictions from the Environmental Protection Agency.

A new variety of potato called King Harry, and the earlier Prince Harry, are the result of three decades of work by Cornell University potato breeder Bob Plaisted. The potatoes have shown resistance to small insects such as leafhoppers and flea beetles. Starting in the late 1970s, Plaisted began crossing *Katahdin* and other mainstream varieties with *Solanum berthaultii,* a wild potato from Bolivia. The most successful of these interspecies crosses, including King Harry, protect themselves from pests by arming their leaves and stems with hairs filled with sticky fluids. These trichomes explode when touched, miring small insects such as leafhoppers and flea beetles in goo. The trichomes also ruin the appetites of hungry Colorado potato beetles, reducing or eliminating the need to use other pest control measures (Pleasant, 2007). King Harry seed potatoes are available in limited quantities from Wood Prairie Farm in northern Maine. See the **Potato seed stock box** on page 3 for more information.

OSPUD

A new kind of research and information sharing

Eleven organic farmers in Oregon and Washington are working closely with Oregon State University faculty members to improve potato quality and profitability through a participatory learning process and on-farm, farmer-directed research.

This project encourages an exchange of existing knowledge of integrated management techniques and promotes farmer innovation. OSPUD's goal is to learn more about the wide variety of management issues, including soils, nutrients, insects, diseases, weeds, tuber quality and profitability, facing small organic potato farmers in the Northwest.

This project has generated a number of useful publications for organic potato production. For more information and access to these publications, visit *http://ospud.org*.

Section III

Harvesting

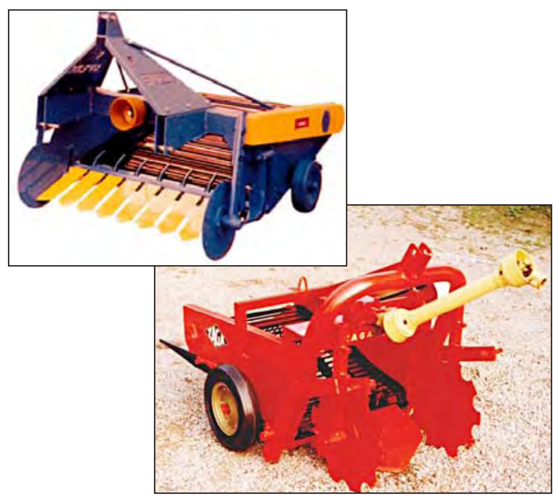
Timely vine killing is essential for good tuber separation from stolons, tuber skin set, and efficient harvest. But many farmers do not prematurely kill vines (Vales, 2004). Harvesting procedures for organic potatoes require alternatives to chemical desiccants. Mechanical destruction is one method and flaming technology is an alternative. Flame weeding is used successfully to top-kill the potato vines. Woody Gerritsen of Wood Prairie Farm does two passes with a propane flame weeder to top-kill the potato vines before harvest. Many growers also use a flail chopper that, if the equipment is present on your farm, can reduce propane costs associated with flaming.

Immediately after harvest, healthy potatoes should be cured by holding them for 10 to 14 days at 50 to 60 degrees and high relative humidity with good air movement to permit suberization and wound periderm formation, or the healing of cuts and bruises. Although wound periderm formation is most rapid at about 70 degrees, lower temperatures are recommended to reduce decay. Curing reduces subsequent weight loss and decay by preventing the entry of Fusarium, soft rot and other decay organisms. The relative humidity should be about 95 percent (Vales, 2004).

Seed cutters, planters, harvesters, washers and storage rooms make large-scale potato production a significant financial commitment for any larger-scale grower. The Igls family, who farms 43 acres of potatoes in Antigo, Wis., customized and adapted almost all of their equipment to refine their organic operation (Padgham, 2002). Most medium-scale mechanized organic producers have one or two pieces of used equipment; potato diggers are most common. Auctions and dealers located in traditional small-scale potato production areas, such as south of Montreal, are good sources for equipment. Increased mechanization allows farmers to grow on more acres. That often, but not always, reduces the unit cost of production (Caldwell, 1999).

Some mechanical options for planting and harvesting on a medium scale are available from Market Farm Implement Company at *www.marketfarm.com/index.cfm*. The Spedo Potato Planter is a cup-type potato planter that automatically plants cut or graded seed potatoes and other similar-size tubers. It is imported from Italy. The Spedo Potato Planter plants the tubers from 6 to 13 inches apart in the row and hills the row at the same time. It is available as a one- and two-row model. Row spacings are adjustable from 26 inches plus.

US Small Farm, formerly Afiveplus, from Torrington, Wyo., is also a source for small- to medium-scale potato planting and harvesting equipment. In 1998 Afiveplus began manufacturing and selling small-scale potato equipment. Owners Larry and DeeDee Anderson, along with their son Eric, make potato planters specifically suited for the small farm. After the first year of digging their own potatoes, the family developed a small digger to add to the product line. Smaller products developed over the years include a small table-model seed cutter and hilling discs. Contact information is listed in the **Further resources** section of this publication.



The Spedo brand has a potato digger that is a two-row, three-point hitch-mounted digger for tractors (above left). This model straddles two rows of hilled potatoes. The potatoes must be grown in a hill for the digger to work properly. Also, the Zaga Potato Digger (above right) is a one-row, three-point hitch-mounted power-take-off (PTO) powered digger. It is designed for use on tractors that straddle one row of potatoes centered under the tractor since the digger cannot be offset. It will only dig hilled potatoes because the shoe cannot be adjusted to go below ground level.
Photos courtesy of Market Farm Implement, www.marketfarm.com

Contents

Profile organic potato grower: Ivy Donovan

This is an excerpt used with permission from The Natural Farmer Fall 2006 newsletter.

Ivy Donovan currently has about two and a half acres in potatoes. The potatoes are planted in long rows near the house, each row about a quarter of a mile long. Donovan does all the work himself and has specialized equipment for each stage. For planting, he uses a two-row planter that opens up the row, puts the organic fertilizer in, drops in the seed and covers it up. He cuts potatoes for seed by hand, sitting on a seed cutting horse with the radio on.

For cultivation Donovan uses a spring-tooth weeder. After awhile the potato plants get so big Donovan can't use the cultivator any more because he'd do too much damage. So every morning he spends the first half hour walking through the potatoes picking weeds.

When Donovan harvests potatoes he takes the tops off and waits two weeks for the skins to get tougher and the potatoes to cure before digging them. For taking the tops off, he also uses his father's equipment:

"Back in the (1950s) we'd use a roto-beater to take the tops off. It had rubber fingers and you would go through and beat the tops off," Donovan said. "Then the vines would die back and in two weeks you could dig them. Well, I got that out and we're using it. I had to take my chain saw to get it out of where it was."

Donovan also built a weed flamer. Once the tops are off the potatoes, the weeds will start growing. Then, when it comes time to harvest he has to pick through weeds. So Donovan goes through with the flamer once the weeds start poking up and kills them while the potatoes are still under cover.

Ivy Donovan. Photo by Jack Kittredge, courtesy of The Natural Farmer.

Donovan's two-row harvester cuts under the potatoes and brings the entire hill up and over the moving rods. The dirt falls between the rods and the potatoes are carried to the back and dropped onto the ground. Photo by Jack Kittredge, courtesy of The Natural Farmer.

Donovan and his father used a regular harvester when they were harvesting 60 acres of potatoes. But when Donovan started growing organic he got the old two-row digger out. He explains: "The big harvester would bruise a lot of the potatoes on this kind of ground. And all your smaller ones would shake right through and you'd lose them. But today those small potatoes are an excellent item. A lot of people want them. We'll mix all different colors of creamer size and sell them. People will pay extra."

The two-row digger brings the spuds up, the dirt falls through properly spaced rods and the potatoes are carried to the end and laid on the ground behind the digger for hand picking. The bar cuts just to the bottom of the hill, lifts the whole hill up and shakes the potatoes free. The sprockets have removable long and short arms that can raise and lower the rods rapidly to shake the dirt free. That shaking is great if the ground is wet, but if it is too dry and Donovan doesn't want to drop the dirt too soon he can take those arms out and the shaking stops.

Donovan's digger has a gearbox mounted on the shaft coming from the PTO. "They don't come through from the factory with a transmission on it," he laughs. "That was the first thing my father did was put that transmission on. It gives you more control to run it faster or slower, depending on the conditions of the field. Nowadays you have more gears on your tractor so you don't need the transmission as much."

Donovan also has a potato washer and a grading machine to screen out the smaller potatoes so he can pack them separately. Potato grades are A, or full size; B, the smaller potatoes; creamers, which are golf ball size; and babies, which are the size of a thumbnail.

There is also a storage building, built in 1956. Donovan's father insulated it and used wood stoves for heat. Some winters, he recalls, it got 10 degrees below zero and they had all the stoves going.

Storage

Good storage should prevent excessive dehydration, decay and sprouting. Maintaining good sanitation, adequate humidity and appropriate temperatures in storage facilities, combined with adequate curing of harvested potatoes, are important considerations, particularly since organic growers do not have the array of chemical controls available that conventional growers have. Helpful practices include:

- Thoroughly clean the storage space and machinery of all potato debris and excess dirt, using a pressure washer and steam as needed.
- Disinfect equipment and the storage structure with organically approved materials and methods. Contact your certifier for more information.
- Perform routine maintenance and repairs on ducts and structure as needed.
- Clean dust, dirt and sprout inhibitors from fan blades.
- Check dampers and louvers for free movement and function of limit switches.
- Be certain all motors are lubricated and working and that belts are in good condition.
- Check all thermostats, humidistats and controls.
- If needed, wet the storage floor to help maintain high humidity.
- Humidify and pre-cool the storage area to from 55 to 60 degrees a few days before introducing the potatoes (Brust, 1994).

The following figures should be considered when building or renting storage facilities (Vales, 2004):

1 hundredweight (cwt) of potatoes occupies 2.3 cubic feet.; 1 cubic foot of storage holds 0.42 cwt of potatoes

total cwt of bulk stored potatoes = (pile length x pile width x pile height)* / 2.3

**Pile dimensions in feet.*

A major component of managing potato quality in storage is effective sprout inhibition. Sprouting causes increased weight loss, reduces tuber quality and impedes air movement through the potato pile. Prevention of sprouting is one of the Achilles' heels of storing large quantities of organic potatoes. The use of essential oils and hydrogen peroxide is a recent development in sprout inhibition and is approved by the NOP.

Mint and clove oils applied through wick application are effective at suppressing sprouts. The oils appear to work by burning the sensitive meristimatic sprout tissue. Although both oils have suppressive qualities, peppermint oil tends to cause less problems with culinary and palatability concerns. Clove oil is a more effective suppressant when applied as a thermal aerosol. Hydrogen peroxide is also allowed by NOP standards, however some products may contain adjuvants that are not allowed. Check with your certifier to make sure products are approved by the NOP. Oils are typically applied through the humidification system in storage. Frequent and repeated applications are necessary for long-term sprout control. These products also demonstrate the ability to inhibit postharvest diseases in laboratory studies, but this research has not been extended to storage facilities (Frazier et. al., 2004).

Good storage should prevent excessive dehydration, decay and sprouting.

Economics and marketing of organic potato production

Evaluating economics and markets

Background

The conventional potato industry is distinguished by large-volume production of a fairly uniform commodity crop produced by farmers who are highly specialized in potato production. The biggest segment of the market is potatoes grown for direct consumer consumption and potatoes that are processed. The rapid increase since the end of World War II in the consumption of the dehydrated potatoes, frozen potatoes, potato chips and the ubiquitous French fry led to enormous demand for the processed potato. In 2004, more than 41 billion pounds of potatoes were sold by farmers in the United States. In 2005, according to the USDA Economic Research Service, U.S. per-capita use of frozen potatoes was 56 pounds per year, compared with 45 pounds for fresh potatoes, 17 pounds for potato chips and 16 pounds for dehydrated products (2005).

Table 4:

Certified organic potato acreage by state, 1997-2004*

Year	2004	2003	2002	2001	1997
Alaska	36			85	
Arkansas				100	1
California	3,654	3,057	2,434	3,734	1,091
Colorado	1,260	1,370	1,457	1,604	905
Connecticut	11				
Delaware	4				
Hawaii	23				5
Idaho	298	357	357	565	618
Illinois	3				39
Indiana				0.1	
Iowa	1	9	8	4	1
Kansas				0.3	
Maine	165	160	160	78	10
Massachusetts	36				
Michigan	1	70	43	39	1
Minnesota	5	7	124	45	127
Missouri				6	
Montana	11				
Nebraska	1	2	1		
Nevada		20			
New Hampshire				5	10
North Carolina	186			2	
North Dakota	122	111	427	167	88
Ohio	6	7	74	14	4
Oklahoma		10			
Oregon	520	76	148	222	68
Pennsylvania	5	17	10	29	1
Rhode Island	1	1	1		
South Dakota	2	1	1	0.3	
Texas		41	113	64	407
Utah					142
Washington	846	1,142	1,122	599	645
Wisconsin	103	113	114	172	173
Total U.S	7,300	6,569	6,593	7,533	4,336

***ERS data for organic potato acres for 1997 and 2000 to 20004 at www.ers.usda.gov/Data/Organic/index.htm#tables.*

Like all commodity crops, the structure of the conventional potato industry is a concentrated market situation with many producers but so few buyers that the buyers can exert considerable control over market price. For a good discussion of this kind of market and the famous Idaho potato industry, see *Fast Food Nation*, 2001, by Eric Schlosser. For another interesting example see *Market Power for Farmers* by Richard Levins, 2005.

Over time, this commoditization and concentration of market power in the potato industry led to a decrease in the number of smaller conventional producers. The margin for profitable production is increasingly narrow and more acreage is required to maintain income from production. Average seasonal prices to farmers during the last 20 years ranged from a high of $10.80 per cwt in 1989 to a low of $5.05 per cwt in 1996 for table-grade potatoes. Processing potatoes fetch less in the conventional potato market, with a high of $5.21 per cwt in 1995 and a low of $3.85 per cwt in 1987. To get a sense of just how tight margins are in the conventional potato market, consider that even at $5.21, the highest seasonal price for processing potatoes over the last 20 years, researchers at the University of Idaho estimate that the average producer in 2005 would not likely see a significant positive return from production (Patterson et al., 2005).

One countering effort to this situation is the fairly recent development of farmer-based supply management cooperatives that are attempting to counter buyer market power by balancing supply and demand to restore and maintain profitability for its farmer members.

Organic potato industry

National-level data and information on the organic potato industry in the United States are presented in *Table 4* on page 24. There are no national statistics on prices and estimates of costs of production are limited. The information presented here will draw on a few sources from the United States, Canada and Europe.

Emerging organic market structure

The organic potato market is not highly structured and is not currently in a situation with few buyers and a large number of suppliers. Demand for organic potatoes is growing, as is the general demand for all organic food. A lack of adequate supply to meet this growing demand has kept organic potato prices generally high. The organic potato market may grow rapidly if larger processors develop new organic product lines and supply can meet the market demands in this emerging sector. Seth Pemsler of the Idaho Potato Commission summed up the state of the expanding organic potato market when he recently said, "the [organic] market is there — the challenge is you have to be able to walk in and say 'I can supply you'"(Cavener, 2003). This statement was in reference to a 2005 announcement by international food manufacturer Frito-Lay that the company would soon begin producing organic potato chips. Current options for marketing organic potatoes include direct, retail and the newly emerging organic processing sector.

Market segments

Unlike the conventional potato industry, most organic potatoes are probably sold fresh and directly to consumers. Since farmers' markets are expanding nationwide and because a significant number of vendors at these markets are organic, this is one important outlet for organic potato production (USDA ERS, 2006). Since these potato producers are not highly specialized in potato production, they can more easily shift production annually as local and regional market prices change.

Direct sales to retail markets are another market segment. Sales to restaurants may be another steady outlet, though many restaurants can purchase organic products through specialized wholesale distributors. Wholesale and direct marketing of organic potatoes to national specialty retail grocery chains like Whole Foods Market, Inc., are other options. Here again, such chains tend to access larger wholesale distributors rather than local or regional farmers. Finally, as noted above, a relatively new market is emerging for food processing of organic potatoes by such national branded manufacturers as Cascadian Farms, Kettle Chips and Amy's Kitchen. These food processors are developing new organic food lines often by entering into specific contracts with individual specialized organic producers.

Marketing difference

Whatever market segment you enter, organic potato production, unlike conventional production, offers a unique product. Not only are organic potato producers selling their distinct, ecologically sound system of production, they generally offer consumers a potato product of greater variety and flavor. As noted in the story below, Gene Thiel offers 20 different kinds of potatoes directly to consumers. Indeed, one way for farmers to demand a higher price and capture a greater market share in direct marketing systems is to offer something unique and special. For instance, a purple Caribe potato variety might fill such a niche. Even the conventional potato industry is noting this desire by consumers for new colors, flavors and textures and these attributes may not remain unique to the organic industry (Wilkens, 2006). Processing potatoes led to greater uniformity of product to maintain product consistency. As more farmers enter the processing segment of the market, there may be some diminishing of the flavor and color differentiation. Although some processors such as Kettle Chips developed product lines that promote color as a unique differentiation, there may be implications for production since disease-resistant varieties don't exist in all colors and flavors.

Whatever market segment you enter, organic potato production, unlike conventional production, offers a unique product.

Price premiums and cost of production

One of the motivations for transitioning to organic production is an expectation of a price premium. Price premiums for most organic food are significant and appear to be holding (USDA ERS, 2006). Less understood is the basis of the organic price premiums for specific products like potatoes and, more importantly, how and if premiums can be maintained.

There appears to be a significant price premium for organic potatoes based on recent data on wholesale market prices as presented in *Table 5*.

Profile of organic potato grower: Gene Thiel

Excerpt from Capital Press Agriculture News (July 2006)

Specializing in spuds, grower makes regular deliveries to urban markets

JOSEPH, Ore. — Gene Thiel, aka Potatoman, has earned his place of prominence in the world of carefully grown organic produce.

Born in Idaho Falls to a major potato-growing family, Thiel raises vegetables the way he thinks they ought to be raised and sells them on a weekly basis to people who appreciate the quality.

"Between parents, uncles and cousins, my family had 7,000 acres of potatoes in Idaho during the years when there were 70,000 acres in production in the entire state," Thiel said. "However, when big business started telling us to how to grow them based on size and conformity rather than flavor and quality, I left the state in search of a quieter place and a quieter time. In 1970, I moved to Troutdale, Ore., and started raising the first certified organic carrots and potatoes in the West."

Thiel, working with the secretary of state's office, wrote the organic rules and set up the statute for growing organic produce.

Gene Thiel in his organic potato fields in Joseph, Ore. Photo by and courtesy of Jan Jackson.

"It was hard going because those were the days before criteria were established for organics certification, and we were competing with a lot of counterfeits," Thiel said. "I spent so many hours giving depositions that it felt like I was on the stand myself, but we managed to establish criteria to reward value. By 1974, Oregon Tilth came along, and since then conditions have steadily improved."

Today, in fields at the base of the Wallowa Mountains just outside of the small town of Joseph, Thiel grows organic garlic, asparagus, beets, tomatoes, carrots, rat-tail radishes and 20 kinds of potatoes. Every Friday morning he drives west with about 6,000 pounds of harvest.

"It takes me a half a day to deliver produce from Hood River to the east side of Portland," Thiel said. "Then on Saturday morning, I get up at 5 a.m. to set up the Portland Farmers Market in the Park Blocks booth by 8 a.m. Our son, Patrick, makes the rest of the deliveries for downtown and west Portland while I run the market.

"After the market we both finish any delivering that still needs to be done and head for home. When the majority of our produce is still growing, we can make it home by about 10 p.m. on Saturday night, but during peak harvest season it is already Sunday morning before we get back to Joseph."

Thiel, who can tell you the attributes of each of the 20 kinds of potatoes he grows and the drawbacks of the ones he doesn't grow, is often sought out for his expertise. He was recently featured in a book by Michael Ableman called *Fields of Plenty, A Farmer's Journey in Search of Real Food and the People Who Grow It* (Chronicle Books) and is scheduled to appear along with local chefs at the Western Culinary Institute in Portland.

`"When my family started raising potatoes, they were all organic farmers," Thiel said. "I've seen evolution to revolution, and I'm proud to be successfully farming land that has been organic since the Nez Perce were here. I started out with an old pickup and a shovel and built the business from there. I plant, harvest, pack, deliver and sell vegetables I consider to be the very best."

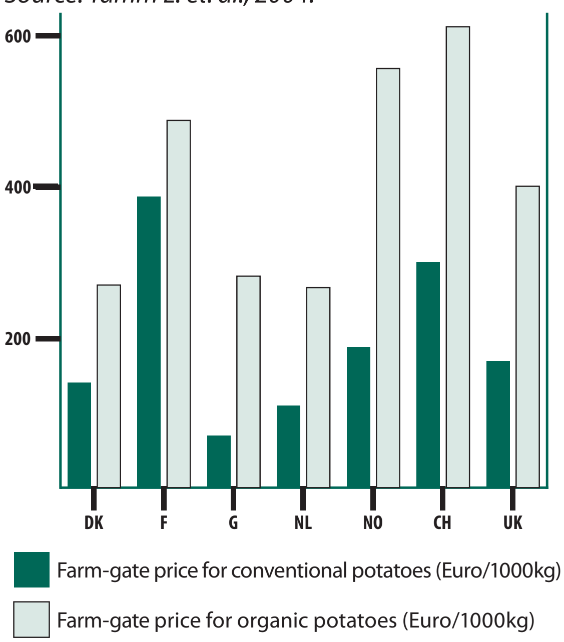
Information:
Prairie Creek Farm or OTC Certified Organic Produce
Gene Thiel, P.O. Box 549, Joseph, OR 97846
(541) 432-2361, potatoman@eoni.com

Table 5. Wholesale organic and conventional potato prices for September 2006

	Potato type			
	Yukon Gold		Red A	
	price per lb for 50-lb sacks			
Market	Org.	Con.	Org.	Con.
Philadelphia	n/a	$0.60	$0.70	$ 0.40
Boston	n/a	$0.56	$0.71	$ 0.54
San Francisco	n/a	$0.49	$0.86	$ 0.44
Seattle	$0.67	$0.46	$0.67	$ 0.36

n/a- not available
Source: Adapted from Rodale's New Farm online Organic Price Index

Figure 1. Average farm-gate prices of organic and conventional ware potatoes (1998-2000; Euro per ton).
Source: Tamm L. et. al., 2004.



(DK-Denmark; F-France; G-Germany; NL-Netherlands; NO-Norway; CH-Switzerland; UK- United Kingdom).

An excellent study, published in 2002, of the European organic potato industry indicates significant price premiums in Europe. *Figure 1* presents data from that report for seven European countries.

As the graph indicates, farm-gate prices of organic potatoes in Europe, with the exception of France, were at least double conventional prices during the 1998 to 2000 crop years.

Finally, there seems to be evidence that potato price premiums may hold over time in the United States. According to two surveys done by the Organic Farming Research Foundation in 1997 and 2001, U.S. organic farmers said median prices of organic potatoes appear to be comparable to those in 2006, as shown in *Table 5*.

In 1997, the median wholesale price reported by the OFRF survey was 40 cents per pound. By 2001, it rose to 52 cents per pound. These are reported prices for 50-pound sacks of potatoes, as are the prices in *Table 5*. The OFRF data are from only four respondents in 1997 and six respondents in 2001 and the values are the median of the reported prices. The price data in OFRF's report do not specify if these prices are wholesale or retail, though at the 50-pound sack size it is assumed to be a wholesale price. The data reported in *Table 5* are from actual reported prices at major wholesale markets in the respective cities.

The two OFRF studies noted a median price of $1 per pound in 1997 and a price of $1.51 per pound in 2001 for direct sales to consumers. However, the range in price in the direct consumer markets is quite wide in these two surveys with a low of 25 cents per pound reported in 1997 and a high of $5 per pound in 2001 (Waltz).

There are at least three possible reasons for significant price premiums in organic potato production. First and most obvious is that supply is limited and demand is high. This is often referred to as a sellers' market. Supply and demand vary across the country, by season of availability and the segment of the market (wholesale, retail, direct) the producer is selling to. For instance, the supply of organic potatoes for direct sales in farmers' markets may meet growing demands in that market segment, but supply for wholesale distribution and processing may not be sufficient relative to growing demand. This may be major source of the general upward pressure on prices.

Second, even though higher prices for organic potatoes should invoke a supply response over time, there are high costs and risks associated with transitioning to organic potato production that dampen this response. Farmers already take on a high degree of risk and the adoption of a new system of production adds even more risk. Higher prices alone may not induce many farmers to change production systems. Given growing demand for organic potatoes, the supply may not catch up to demand very quickly.

The cost of producing organic potatoes may be higher than conventional potato production.

Finally, the cost of producing organic potatoes may be higher than conventional potato production. This means the price premium is really a reflection of that cost difference. The exposure to crop failure may be higher when there are significant pest management problems associated with the production of a crop like potatoes. There are many studies of the costs of conventional potato production, but they reflect large-scale, highly specialized systems of production that are not easily compared to most organic systems of potato production.

Two comparative studies of organic and conventional potato production costs

A 2002 study by the British Columbia Ministry of Agriculture, Food and Fisheries presents information on production cost differences in conventional and organic potato production systems. The study compares conventional and organic farms, each with 10 acres of potato production. The study does not use cost data from actual farms, but is based on reasonable approximations of costs made by government experts with some farmer input. Still, there are several results from the study that can help determine production cost differences.

According to this study, the major differences in input costs for conventional and organic potato production relate to increased labor, equipment, certification and marketing costs. An expected cost difference is the organic certification cost. On a 10-acre farm, for example, certification would be about $500 (in U.S. dollars). The other cost differences are not as simple to understand. Higher labor costs are related to an assumption that weed control is more often done by hand in organic systems and that hand labor is more expensive than the use of synthetic herbicides, which are not available to organic producers. Higher labor costs may also be due to the use of hired labor for harvesting. This may be less true for producers who moved to a more specialized and larger volume of production where tillage equipment is available. However, hand labor crews are occasionally used when potato plants become too large to cultivate (BC-MAFF, 2002).

The bottom line of this cost comparison study is that organic potato production in British Columbia results in slightly lower yields, improved gross return on expenses and higher production costs. But organic potato production also results in a higher net return per acre of production. In this analysis, organic production provides about $81 (in U.S. dollars) more in per acre return than a conventional farm of the same 10-acre size (BC-MAFF, 2002). There is no analysis of indirect expenses including depreciation, interest, insurance or economic profit.

A University of Wisconsin research team did another study on input cost differences between organic and conventional potato production. The study included two commercial growers in Coloma, Wis., in 1990. While the report does not provide detailed data, the one-year study found that organic potato yields per acre were 6 percent lower and overall production costs were about $146 more per acre. The researchers noted that prices would have to be close to double conventional prices to make up for costs and yield losses from organic production.

In summary, the price premium for organic potato production comes mostly from an imbalance of supply relative to demand. The general difficulties and high risk associated with transitioning to organic production have limited a supply response to this high demand over the last few years. Costs of production may be higher for organic potatoes, but there are not enough data and careful analysis of these costs for different scales, locations and systems of production to know for sure. Higher costs and higher price premiums may be due to the lack of appropriate-scale machinery to replace high labor costs associated with small- to medium-scale organic potato production. Finally, it may be that the processing and packing facilities available to organic potato producers are inadequate, forcing organic producers to invest more in packing equipment than conventional growers. This certainly increases costs.

Estimating costs and profitability for organic potato production

Enterprise budgets are an important tool for planning and on-going farm financial management, but budgets only represent one set of many possible cultural and management practices and do not account for geographic differences. Given that so few studies of enterprise budgets for organic potato production are available, it is probably best to either develop your own budget or modify conventional potato production enterprise budgets. Conventional enterprise budgets for potatoes are available for many states from the Ag Risk Education Library at *www.agrisk.umn.edu*. The budgets are not all recent, but are good starting points. The University of Idaho does a good job providing conventional potato production budgets. The budgets are available at *www.ag.uidaho.edu/aers/crop_EB_05.htm*.

The emerging processed organic potato industry

Those who watch the rapid development of organic food markets fear that the pattern of development will simply follow the pattern of the conventional food market. How the infant organic processed potato industry develops in the future will depend on a few emerging trends.

If major food manufacturers continue to tap the rising demand for organic food, more farmers will likely specialize in organic potato production to meet those processor needs. This is a positive outcome in the sense that more potato production will be done organically. In general it has positive environmental and energy-saving implications for society as a whole. The downside is that the organic potato industry may develop the same kind of concentrated structure as the conventional potato industry, with ultimate loss of price premiums, tight profit margins and fewer but larger producers. There does appear to be some growth of larger and specialized organic potato farmers interested in tapping these processed food markets (Cavener, 2003).

The price premium for organic potato production comes mostly from an imbalance of supply relative to demand.

The ongoing expansion of local direct-market opportunities, including farmers' markets and intrastate sales of local food through community-supported agriculture and schools, prisons, hospitals and other institutional markets, may provide for a more diversified production capacity including organic potatoes. There could be a move to create more regionally specific and specialized production of organic potatoes tied to regionally and farmer-owned cooperative processing and storage facilities.

The future of the organic potato market, like organic food production, involves issues beyond the simple capacity to produce food organically. More and more, the challenge of organic food production will be addressing issues around the greater socioeconomic implications of market structure and general control in the food system. Carolyn Christman and Michael Sligh addressed some of these issues in a 2003 publication entitled *Who Owns Organic?*

> "The question debated now is how to both protect and expand the value of organic food. It is especially important to consider whether the value rests solely in a narrow

agricultural framework or could be based in a broad ideological framework as being good for the Earth, the water, the air, the animals, the workers, the farmers, the consumers and their communities"(Christman and Sligh, 2003).

Special thanks to our reviewers

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Profile of organic potato grower: Mike Heath, M&M Heath Farms

Mike Heath of Buhl, Idaho, plants from 20 to 100 acres of organic potatoes a year. In recent years he has planted between 45 and 50 acres per year. He grows about 10 different varieties, including reds, yellows, russets, fingerlings and purples. He also grows other crops in addition to potatoes, including some vegetables, and raises livestock.

Seed sources

Idaho doesn't have any organic seed growers, so Heath uses untreated conventional seed pieces. He buys some and others he cuts and prepares himself. His commercial source comes out of Ashton, Idaho, and is shipped in 2,000-pound totes of seed pieces. These seed pieces are pre-treated with fir bark flour, which helps suberize them. The fir bark flour treatment is what growers used prior to the advent of modern fungicides. Heath will generally plant when he receives the seed pieces, but if the weather is not good he will hold these seed pieces for up to three weeks without any problems.

Rotation

Heath uses a seven-year crop rotation: three years of alfalfa, one year of row crop, one year of grain, one year of row crop, one year of grain and then back to three years of alfalfa. The alfalfa is sold to local dairies and has the added benefits of weed control and building up the soil. Dry beans, squash and potatoes are some of the row crops Heath grows. He also grows feed corn, depending on the market.

The only cover crop Heath has used so far is alfalfa. He notes that water is an important consideration for a cover crop.

Pest management

Potato beetles have become more of a problem pest in recent years. In early spring Heath will try to pick adult potato beetles prior to egg laying. Heath also uses Entrust, an organically approved formulation of Spinosad that is very expensive, but also effective. He buys Entrust as a powder in 12-pound box for about $4,200 and uses 2 ounces per acre. Heath shares the box with two other growers, which helps alleviate some of the expense. In 2006, he sprayed twice for potato beetles. The cost of material per application is just less than $44 per acre, or $21.88 per ounce.

In past years, Heath notes that he hasn't had enough cold weather to kill volunteer potatoes in rotated crops. That can create a minor pest haven, especially for disease. Although Idaho occasionally has late blight, Heath has never seen it in his fields. To promote potato plant health, Heath uses a compost tea delivered through his irrigation system. He doesn't have any problems with aphids and thinks the pests are controlled by a good population of beneficial insects. Heath promotes beneficials by planting the field edges with annuals, such as sunflowers, peas, grains, vetch, buckwheat and sunflowers. He supplements his homegrown beneficial insects with purchases of ladybugs from Peaceful Valley Farm Supply in Grass Valley, Calif.

For weed control, Heath does blind cultivation, or cultivating before the crop emerges, on part of the acreage. He also does conservation tilling with a chisel plow. Noxious weeds cause Health's biggest headaches. Morning glory, which might be a result of his crop rotations, is his biggest problem. Heath is considering some deep chiseling in the fall for morning glory control, and is considering grazing with sheep or goats.

Heath has very few storage disease problems. Early Yukons occasionally have a few problems with rot, mainly caused by the heat in the field at harvest in August.

Harvesting

Prior to harvest, Heath uses a flail mower to chop down the potato plants. Timing is important. When Heath is trying to hit an early market and farmers' markets, he uses a windrower to loosen the ground and then picks up the potatoes by hand. For the bulk market, he uses a windrower and a two-row harvester simultaneously, so he works four rows at once. He always washes the fresh pack immediately.

Heath generally harvests 400 50-pound sacks per acre following alfalfa ground. He usually budgets for 300 sacks, noting that in this part of the county, that's OK, but most conventional growers would shoot for from 350 to 400 sacks. Colored potatoes, which are smaller, will give a yield of around 250 to 275 sacks per acre.

Heath has noticed some real improvement in soil quality, especially on the ground that has been under organic production the longest. He notes that on any soil test measure, his ground will show a higher functioning soil than his neighbors with land in conventional production.

Specialized equipment

Heath has an old four-row John Deer spike-type planter that he uses for really small potato pieces. He also has a Logan four-row cup-type planter. Heath observed that now four-row planters are very cheap because growers are switching to six-row planters.

Marketing

Half of Heath's crop is processed and half is fresh-packed. He has his own packing shed, and shares a bag that is labeled as "Organically Grown in Idaho" through the Idaho Organic Cooperative. Heath and other potato growers market this product to grocery stores and CSAs in the region. A new company is setting up a packing line dedicated to organics, so that might provide some more options. Heath noted that he does not sell Russets by fresh pack. Heath receives about $10.50 per cwt on a contract for processing. He always keeps some potatoes in stock for local sale and receives about $40 to $50 per cwt.

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http://eap.mcgill.ca/Publications/EAP71.htm.

OSPUD Oregon State Organic Potato Project.
http://ospud.org
This is a participatory project with organic potato farmers and university scientists. The farm-based research is published regularly on their Web site.

Contacts

Organic Potato Growers

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An organic potato grower and marketing coordinator for a Colorado organic potato grower cooperative. Hamilton can share production practice information.
23242 Highway 371
La Jara, CO 81140
(719) 274-5998

Jim and Megan Gerritsen
Well-known organic potato growers who produce certified seed potatoes in Maine.
Wood Prairie Farm
R.F.D. #1, Box 164
Bridgewater, ME 04735

Igl Farms
W9689 Cherry Road
Antigo, WI 54409
(715) 627-7888
www.sustainusa.org/familyfarmed/profile_iglfarms.html

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Specialized potato equipment suppliers

US Small Farm
5428 Road 57
Torrington, WY 82240
1-888-522-1554
(307) 534-1818
ussmallfarm@yahoo.com

Market Farm Implement
257 Fawn Hollow Road
Friedens, PA 15541
(814) 443-1931
www.marketfarm.com

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Products for organic potato pest management

Colorado Potato Beetle

Spinosad
Dow AgroSciences LLC
9330 Zionsville Road
Indianapolis, IN 46268
(317) 337-3000

Mycogen Corporation
5451 Oberlin Drive
San Diego, CA 92019
(619) 453-8030

Mycotrol
Laverlam International
117 South Parkmont
Butte, MT 59701
(406) 782-2386
(406) 782-9912 (FAX)
www.laverlamintl.com

Rhizoctonia

Trichoderma viridi
Manufacturer Iinformation:
Binab Bio-Innovation AB
Florettgatan 5
Helsingborg SE-254 67
Sweden
46-42163704
46-42162497 (FAX)
www.algonet.se/~binab
info@binab.com

Trichoderma virens (formerly *Gliocladium virens*)
Manufacturer Information:
Certis USA, LLC
9145 Guilford Road, Suite 175
Columbia, MD 21046
USA
1-800 -847-5620 (toll-free)
www.certisusa.com

Insect biological controls

See ATTRA Publication ***Integrated Pest Management for Greenhouse Crops*** for a comprehensive listing of Biological Control Suppliers.

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University of Massachusetts
Cooperative Extension Service
Amherst, MA 01003
(413) 545-6538

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PO Box 7414
Berkeley, CA 94707
(510) 524-2567

Cover crops and rotations

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The American Phytopathological Society
3340 Pilot Knob Road
St. Paul, MN 55121-209

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