



ORGANIC FIELD CORN PRODUCTION

CURRENT TOPIC

By **George Kuepper**
NCAT Agriculture Specialist
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The term *organic farming* describes systems that work to mimic and optimize natural processes for the production of crops. Organic growers utilize a wide range of cultural practices and natural inputs to manage crops in a manner they consider safe for the environment and the consumer. Synthetic pesticides and standard commercial fertilizers are not consistent with the organic approach and are prohibited. For more information on organic farming and the current regulations that govern it, please ask for ATTRA's [Overview of Organic Crop Production](#) and [Organic Certification and the National Organic Program](#) publications.

Corn is not especially difficult to produce using organic methods, though focusing on this single crop is a poor starting point and leads to a misunderstanding of how organic farming works. When it comes to the production of agronomic and vegetable crops, organic growing typically entails an integrated rotation of different crops that (ideally) complement or compensate for each other. Such production systems are further enhanced when livestock enterprises that involve grazing and that generate manures are also part of the scheme.

FERTILITY

Compared to other crops, corn is a moderate to heavy consumer of most nutrients, especially nitrogen (N). At a yield level of 150 Bu., the harvested grain is estimated to contain at least 135 lbs. of N (1). Supplying adequate nitrogen is one of the top challenges for organic corn producers.

Crop Rotation

The use of planned crop rotations that include forage legumes is the key means by which nitrogen is supplied to an organic system. The most effective of these legumes in most U.S. locations is alfalfa, though other species are also effective. A well-established alfalfa stand, left in place for two or more years, can supply a high level of residual, biologically-fixed nitrogen for corn and other non-leguminous crops.

Non-forage legumes – such as soybeans – are only moderate nitrogen-fixers and do not supply the amounts of N needed for sustainable rotations. Furthermore, most of the nitrogen that soybeans fix is removed with the harvested portion of the crop, leaving very little residual N for subsequent crops. This is not to downplay soybeans' contribution to nitrogen fertility; the following crop often exhibits some residual benefit. (One traditional rule of thumb suggests that there is a residual nitrogen gain of only 1 lb. N for each bushel of harvested soybean yield.) The key point of this discussion is that soybeans should not be considered an equal substitute for legume forages in standard rotations.

To get a good idea of how to design crop rotations for optimum fertility (and pest management), see the enclosed article "Planning Crop Rotations" and the ATTRA publication [Sustainable Corn & Soybean Production](#).

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Cover Crops & Green Manures

Growing legumes as green-manure crops is another means of getting more biologically-fixed nitrogen into the rotation to support corn production. Green-manuring fell out of favor with farmers who could not afford to dedicate a full cash-crop season to this soil-improving practice. Fortunately, green-manuring has been revived in recent years as new interplanting and off-season cover-cropping schemes have emerged. These allow the farmer to grow and use green-manure crops with minimal disruption to the cash-crop cycle.

Numerous species and mixtures of species can be used as effective cover crops/green manures. For example, research from the University of Maryland has suggested that a fall-seeded mix of a legume and a grass (e.g., vetch and rye) may be optimal. Such cover-crop mixtures self-adjust according to residual soil nitrogen levels. Where natural soil nitrogen or fertilizer nitrogen levels are high, grasses will dominate and serve as a “catch crop.” Where nitrogen levels are low, legumes will outgrow grasses and fix additional nitrogen for use by subsequent crops (2).

Some cover-cropping schemes entail ridge-tillage and no-till planting strategies, in which a winter cover crop is either winter-killed or mechanically killed prior to establishing the crop. ATTRA has additional information on no-till, ridge-till, and non-chemical methods for killing cover crops. For additional information on cover crops, please request ATTRA’s [Overview of Cover Crops & Green Manures](#).

Livestock Manures

Farms that produce livestock or are in proximity to confinement operations have the advantage of access to animal wastes that contain nitrogen, other major nutrients, and organic matter. The precise amount of nitrogen in manure varies considerably, depending on livestock species, feed formulation, and manure handling. Proper application and soil incorporation of fresh manures assures the maximum capture and delivery of nitrogen to the crop. Therefore, manuring is often done just prior to corn planting in crop rotations.

Generally, manures have their strongest effect on the corn crop if applied just in advance of planting. To achieve maximum recovery of nutrients from spread manure, sheet composting is the best option. Sheet composting entails plowing or otherwise incorporating the manure into the soil as soon as possible after spreading. Research has shown that solid raw manure will lose about 21% of its nitrogen to the atmosphere if spread and left for four days; soil incorporation reduces that loss to only 5% (3). However, since excessive tillage is discouraged in sustainable systems, options for sheet composting may be limited on some farms. The next best option appears to be spreading onto growing cover crops in advance of the corn crop. This reduces the chances of loss to surface erosion and cuts leaching significantly.

Application of raw manure is prohibited within 90 days of corn harvest when the crop is to be used for human consumption (4)—usually not a problem, considering corn’s long growing season and the fact that most field corn is produced for livestock feed.

The 1990 Organic Foods Production Act mandates that manure not be applied in any way that could significantly contaminate water resources with nitrates or bacteria (4). Composting is a means of stabilizing and enhancing livestock wastes for storage, which avoids certain problems inherent in applying fresh manure. Composts, though lower in total nitrogen, are a more balanced fertilizer and

are more useful in building soil fertility over time. For additional information on composting, please ask for ATTRA's [Farm-Scale Composting Resource List](#), [Biodynamic Farming and Compost Preparation](#), and [Vermicomposting](#) publications.

For additional information on manure, including nutrient analyses, hazards, spreader calibration, and other details, please request ATTRA's [Manures for Organic Crop Production](#).

Supplementary Nitrogen Fertilizers

Some organic growers provide supplemental nitrogen in the form of approved animal or plant by-products, though this is typically too expensive for regular field corn production. Among the materials occasionally used are:

- **Cottonseed meal.** Approximate nutrient analysis of 7-2-2. Releases nutrients at a medium to slow rate; tends to make soil acidic. Because of heavy chemical use in cotton culture and the use of solvents to extract the meal, there are severe restrictions on its use in certified organic production.
- **Feather meal.** Approximate nutrient analysis of 13-0-0. A slow-release material.
- **Blood meal.** Approximate nutrient analysis of 12-1.3-0.7. Medium-release. Typically very expensive.
- **Fish meal.** Approximate nutrient analysis of 10-2-2. Slow- to medium-release.

Various blended commercial organic fertilizers are sometimes used in certified production to provide nitrogen. Many of these are listed in ATTRA's [Sources of Organic Fertilizers & Amendments](#). Note that many commercial and "waste" products may have restrictions on their use in organic farming. Organic growers should check with their certifying agency before purchasing and applying new products.

The Benefits of an Organic System

Crop rotation, cover cropping, green manuring, use of livestock manures, and composting are all soil-building practices that do much more than provide nitrogen. By adding organic matter and stimulating biological activity in the soil, these practices make mineral nutrients more available to plants, generate the microbial production of plant-beneficial chemicals (e.g., streptomycin), and improve soil tilth. Manuring, in particular, cycles essential macro-and micronutrients back onto the fields.

Rock Minerals—Lime

Because manures are imbalanced fertilizers, and because not all soils are equally rich in native fertility, organic farmers often need to import supplementary mineral nutrients to assure balanced crop nutrition. These inputs are commonly in the form of moderately priced, minimally processed rock powders.

The most commonly used rock powders in organic systems are various agricultural liming materials. Agricultural lime is used to neutralize the acidity of soils and to provide plant nutrients—mostly calcium and magnesium. There is considerable disagreement in agronomic circles as to which liming materials are most appropriate under different circumstances. Most of the controversy centers on the use or possible overuse of dolomitic lime, which contains high percentages of magnesium relative to calcium. Excessive soil magnesium levels are believed to have detrimental effects on soil structure and also to produce nutritionally imbalanced livestock feed.

The most conservative approach to lime recommendations – one popular among many organic growers – is based on measuring the ratios of positively charged ions in the soil. This is known as the Albrecht or CEC (Cation Exchange Capacity) System. It is based on the philosophy that the primary reason to add lime is to supply essential nutrients and that soil acidity will reach a desired level when all minerals are present in proper balance. The possible overuse of dolomitic lime is avoided when this approach is followed.

Lime and other rock-mineral powders should only be applied with the guidance provided by soil testing. To determine what type of recommendation one will receive from a soil testing laboratory, it is often necessary to ask in advance. A listing of laboratories that use the Albrecht System is provided in the ATTRA publication [Alternative Soil Testing Laboratories](#). ATTRA also has additional information on the Albrecht philosophy for managing soil fertility.

Rock Minerals – Other Major Sources

When supplementary phosphates are required in an organic system, they are usually supplied as rock phosphate. Rock phosphates are of several types and grades. It is most common to speak in terms of colloidal soft-rock phosphate and hard-rock phosphate. Hard-rock phosphate is available from several geological sources and varies considerably in appearance and soil reactivity. Black rock phosphate, from North Carolina, is one form of natural phosphate rock that has a reputation for good performance in the field, is easy to handle, and is reasonably easy to find in the marketplace.

Soft-rock phosphate or colloidal phosphate is a dried clay-based by-product of hard-rock mining. Although powdery and difficult to handle, it has a good reputation as a phosphate source on a wide range of soils.

Gypsum (calcium sulfate) is often referred to as a liming material because of its calcium content. However, since it does not neutralize soil acidity, this designation is technically incorrect. Gypsum can be used to supply calcium and sulfur. It is especially useful on high pH and sodic soils, and is reputed to improve soil structure under some conditions.

Supplemental potassium is generally supplied in the form of sulfate of potash-magnesia, select sources of mined potassium sulfate, or various sources of fly ash in blended organic fertilizers.

There are other rock mineral powders available for agricultural use, including greensand, lava sand, granite dust, etc. Generally speaking, most are relatively expensive and not economical for agronomic crops.

Unique Soil Products

Several other soil additives are available to organic growers as soil fertility enhancers. These include humates, humic acids, surfactants, bioactivators, Biodynamic preparations, and others. These products are often expensive and performance can be highly specific to circumstances. For more details, please ask for the ATTRA publications [Alternative Soil Amendments](#) and [Sources of Organic Fertilizers & Amendments](#).

Foliar Fertilization

Though the practice is somewhat controversial, some conventional and organic growers routinely supplement crop nutrition via foliar feeding. There are several approved organic fertilizers and ma-

terials that can be used. Please ask for ATTRA's *Foliar Fertilization* publication if you want more details.

Summary Comments on Organic Fertility Management for Corn

Organic management of soil fertility is most economical when it is based on biologically fixed nitrogen, recycled nutrients (e.g., livestock manures) and a biologically active soil. Importing nutrients from off-farm can be expensive and must be done with careful planning to assure optimum use of physical and financial resources. Strongly suggested as a basic guide is ATTRA's *Sustainable Soil Management* publication.

WEED MANAGEMENT

Reasonable control of weeds must be maintained to assure economic corn yields. As this information is discussed in detail in other ATTRA materials, it will not be covered here. Please request *Sustainable Corn & Soybean Production* and *Principles of Sustainable Weed Management*. ATTRA also has detailed information available on flaming as a weed control technology.

INSECT PEST MANAGEMENT

Insect pests can be a major problem in corn production. While corn may be attacked by a wide number of insects, we will here focus on those that are considered a major problem in most areas of the country. These include European corn borer, corn rootworm, and cutworms. A few of the technologies that will be discussed are too expensive for use with standard field corn, but may be economical for production of high-value specialty corns.

European Corn Borer

The European corn borer, *Ostrinia nubilalis*, overwinters as a fully grown larva in the stems and ears of corn plants, usually just above the ground surface. As the weather warms in the spring, the larvae pupate, emerging later as adult moths. The adults mate, and the females lay eggs on the underside of the corn leaves (5). The smallest larval stages of the first generation feed on leaves and on other exposed plant tissues. After the larvae are half-grown, they bore into the stalk, ear, or the thicker parts of the leaf stem. Once inside the plant, European corn borers (ECB) are difficult to control, so most management efforts are directed toward the egg and early larval stages.

Effects of Crop Management

It is interesting to note that ECB is one pest problem directly affected by soil management and fertilization. Research done at Ohio State University found that ECB adults laid 18 times as many eggs on corn plants grown on conventionally managed soils as on corn raised on organically managed soils (6). This confirms similar observations made in the late 1970s during research comparing organic and conventional farms in the western corn belt (7). The precise modes of action that hinder ECB remain a matter of speculation, but clearly, corn under organic management schemes suffers less damage from this pest.

Cultural Controls

Since ECB has been found to feed on over 200 species of plants (including potatoes, beans, celery, beets, spinach, and rhubarb), **crop rotation** is only marginally effective for suppression. However,

rotation can be somewhat successful when most of the acreage involved is in non-susceptible crops. Forage legumes (with the exception of cowpeas) suffer little damage from ECB and are quite useful in such rotation schemes.

Since the pest overwinters in above-ground crop residue, **sanitation procedures** are useful in reducing the number of corn borers that emerge the following spring. Standard disking and plowing of residues do not appear adequate, however. Specific sanitation techniques that have demonstrated efficacy for reducing ECB populations include:

- Ensiling the corn crop while leaving two inches or less of stubble
- Thoroughly shredding all crop residue prior to plowing
- Clean plowing to thoroughly bury all corn residues
- Burning corn residues in the field

Note that most of these sanitation practices – while effective at reducing emergence from the field – will not guarantee reduction of damage in a subsequent crop, because of the mobility of this pest. Also, these practices are inconsistent with emerging concepts of sustainable farming that promote the maintenance of soil cover and the conservation of crop residues. Growers are encouraged to view these solely as transition practices and to focus on other strategies.

In regions where only one generation of ECB occurs (principally the North Central states), **late planting** can be effective.

Biological Controls

A number of natural parasites, including *Ichneumonid*, *Braconid*, and *Trichogramma* wasps, help to control ECB populations in healthy agroecosystems where pesticide use is minimal. Several generalist predators such as assassin bugs, damsel bugs, mantids, and spiders also assist. Populations of these beneficials can be enhanced by management practices designed to support their presence and activity. Such practices include cover cropping, strip cropping, and the management of adjacent vegetation to provide *refugia* for predators and parasites. Details on refugia management are provided in the ATTRA publication [Farmscaping for Biological Control](#).

In higher-value sweet corn or specialty corn crops, there may be economic justification for the introduction of insectary-reared parasites (8). Insectaries have additional information about timing, release rates, and the preferred *Trichogramma* species for a specific area. Farmscaping strategies – such as interseeded cover crops – can add significantly to the effectiveness of released beneficials. Research on irrigated seed-corn fields found that annual ryegrass, overseeded two days after corn planting, moderated soil surface temperatures and created a desirable environment for *Trichogramma* (9).

Please note that making the best use of parasite release (and other controls for that matter) requires field monitoring and record keeping. Trapping of adult moths using pheromone traps is one tool that can be used. Also, effective monitoring should include the inspection of areas adjacent to the field, in addition to scouting the field itself (10). For more information on monitoring, trapping, and related technologies, ATTRA's [Biointensive Integrated Pest Management](#) publication is suggested.

Alternative Pesticides

Bacillus thuringiensis (Bt) is a biological pesticide capable of killing many lepidopterous larvae, including European corn borer. Bt must be ingested in adequate amounts to be effective, however.

Larvae that bore directly into the stalk may not eat enough of the material to be affected. Some of the most effective formulations are granular – applied so that they collect on the leaves and roll into the whorls (5). Bt products are widely available and can usually be found through local sources under a variety of trade names including Javelin™, Dipel™, and Thuricide™.

Research has also found ECB to be susceptible to the fungus *Beauveria bassiana*, which has become increasingly available as a commercial biopesticide for other crops. The fungus, which already exists at low populations in healthy corn agroecosystems, is capable of “infecting” the corn plant. Through this infection an *endophytic relationship* is established between the fungus and plant. Corn yield and performance are not compromised. However, any European corn borer feeding on the plant will contract the fungus, resulting in the insect’s eventual demise. Preliminary research involving applications of *B. bassiana* at the whorl stage appears to reduce ECB tunneling by about 50% (11, 12). Further research indicates that combining Bt with *B. bassiana* can provide higher levels of ECB control than either product alone (13).

Other sources suggest that several botanical pesticides – **pyrethrin**, **ryania**, and **sabadilla** – are also effective against ECB larvae (14). However, these are rarely used in field-corn production because of their high cost and the fact that botanicals are more hazardous to beneficial organisms than biologicals.

Varietal Resistance

Selecting varieties resistant – or at least tolerant – to attack by European corn borer is one means of reducing damage by this pest. While this strategy has been advised for decades, the release of genetically engineered varieties has added another dimension. What separates these new varieties from traditional resistant cultivars is the presence of a gene capable of producing the *Bacillus thuringiensis* biotoxin, obtained originally from the bacterium with the same name. Called **Bt corn**, these transgenic plants simply poison any caterpillar pest that feeds on them.

Bt corn does not provide a simple solution, however. Just as plants can evolve or be bred to resist certain pests, pests can evolve resistance to the natural and synthetic poisons humans use to control them. One of the major concerns raised with Bt corn is that widespread use can easily set the stage for resistance to develop in ECB and other lepidopterous pests. The mechanisms for resistance are the same as those that occur when a chemical pesticide is too widely used – surviving, resistant pest individuals are able to concentrate, interbreed, and multiply, thereby producing a generation with much less sensitivity to the pesticide. Growing genetically engineered Bt crops is comparable to a sustained 7- to 10-day schedule of spraying with the same pesticide, beginning at planting and ending when the crop residue decays sometime after harvest – a full season’s sustained exposure to *Bacillus thuringiensis*.

The conventional agriculture community is not unaware of the risk. Bt corn growers are advised to plant a percentage of their corn acreage to non-Bt varieties – recommendations vary from as low as 5% to as much as 30% of corn acreage on each farm (15, 16). The objective is to create a corn borer “refuge” from which a large number of susceptible moths will emerge to mate with the non-susceptible individuals that develop in Bt fields, thereby preventing or at least delaying the development of resistance (17). It is unclear whether this strategy will work (16).

If ECB strains resistant to BT corn emerge, then commercial Bt dusts and sprays would also be rendered largely ineffective, thereby eliminating an environmentally friendly control option – one which both organic and conventional farmers rely on. The use of Bt corn and other genetically engineered crops is controversial, especially in the sustainable and organic agriculture communities. Damage to non-target organisms, including beneficial predatory insects such as the lacewing (*Chrysoperla* spp.)

has been documented; and concerns about natural gene transfer to wild plant species is also a concern (16, 18).

For the foreseeable future, Bt corn and other genetically engineered varieties will not be permitted for certified organic production (19). Non-certified growers should do additional research before selecting this option. For more information on Bt corn and other genetically engineered crops, request the ATTRA publication *Genetic Engineering of Crop Plants*.

Corn Rootworm

The corn rootworm (*Diabrotica* spp.) is a beetle whose larvae attack corn roots, reducing yield and causing stalks to blow over easily (lodge) in high winds or heavy rains. Adults feed on corn leaves and clip corn silks, thus inhibiting pollination.

There are three common species of corn rootworm. The northern (*D. barberi*) and western (*D. virgifera*) rootworm species are primarily pests of corn, though the larvae can survive on a few other grass species. The southern corn rootworm (*D. undecimpunctata*), also known as the spotted cucumber beetle, can attack more than 200 plant species including soybean, and is a major pest of cucurbits (5).

The females of the northern and western species lay eggs in late summer, which overwinter to hatch the following spring. By contrast, the southern variety overwinters in the adult form, hibernating at the bases of plants and other shelters. They become active very early in spring, with some of the adults migrating northward. Egg laying begins roughly two weeks later. The larvae develop on the root system of the host plant. There is usually only one generation each year, but in the southern part of its range there may be two (5).

Cultural Controls

Crop rotation has little or no effect on the southern corn rootworm because it overwinters as an adult and has a varied diet. However, it has been the most effective non-chemical means of controlling the northern and western species until recently. There were reports in the late 1980s from several northern states of northern corn rootworm emerging in corn fields that followed soybeans in rotation. This was the result of *extended diapause*—a phenomenon in which rootworm eggs, which normally hatch the year after they are laid, spend an additional year in the soil before hatching. This delayed hatch effectively defeated the simple but highly common corn-soybean-corn-soybean rotations used by many conventional row-crop farmers in the region (20).

The western corn rootworm has also developed means to overcome the corn-soybean-corn-soybean rotation pattern. A strain of the species has apparently evolved that “chooses” to lay eggs in soybean fields under certain circumstances. One of these circumstances appears to be the increasing number of early-maturing corn varieties that the western corn rootworm adult finds less attractive than still-succulent soybean fields (21).

For crop rotation to be a successful tool in managing the northern and western species, longer rotations, featuring greater crop diversity (including forages, small grains, etc.) are becoming necessary.

The southern corn rootworm can be controlled by **late planting**, and by fall and early-spring plowing accompanied by frequent cultivation to keep vegetation down (5). **Sanitation** to remove and destroy crop residues also works to suppress the numbers of overwintering beetles (14), though a heavy immigration of egg-laying adults may counterbalance any gains made.

Biological Controls

Populations of all three rootworm species are suppressed by predatory ground and rove beetles, *Tachinid* flies, *Braconid* wasps, mantids, spiders, and parasitic nematodes. Like the beneficials that act to control ECB, these are supported by **farmscaping strategies** and reduced pesticide use.

Alternative Pesticides & Applications

Feeding baits that attract and kill southern corn rootworm and other cucumber beetles, developed through years of research, are now available to commercial growers. Researchers determined that buffalo gourd extract is a rich source of cucurbitacin. Adios™ contains buffalo gourd extract and carbaryl insecticide. Adios AG™ contains buffalo gourd extract, floral volatile attractants, and carbaryl insecticide. Note that carbaryl is a synthetic pesticide—often marketed under the tradename Sevin™—and, therefore, is not approved for certified organic production. However, the effectiveness of the bait strategy is encouraging for the development of materials (e.g., physical traps, botanicals, etc.) that could be used by organic growers.

The larval stages of all *Diabrotica* species are susceptible to attack by **parasitic nematodes**. The Rateavers (22) recommend parasitic nematodes applied three weeks after planting at 90,000 per lineal foot. Since most nematode formulations are still rather costly, this practice would be affordable only for high-value specialty corn crops.

Adult beetles can be controlled by sprays of the botanicals **pyrethrin** or **rotenone**, or a combination of the two (14), though their use would not be economical for standard field corn.

Monitoring

Strategies for rootworm management are most effective and economical if some pest scouting is undertaken. (This is often left to professional IPM scouts where conventional pesticides are employed.) Cooperative Extension is a good source of published materials to aid in identification of the different species and for advice on when to begin scouting. Generally, scouting can begin as soon as the crop begins to silk. Since adult rootworm beetles feed on the silks, a tally is made by carefully approaching an ear and counting all adults that are observed on or flying away from it. The entire ear zone, as well as the point where the ear joins the stem, should also be checked. Direct damage to the silks should be noted. Sampling should be done on two ears in each of 25 randomly selected locations in a field—a process that should take about 45 minutes in a 40-acre field. Such checks should be made weekly (23).

If beetles have clipped the silks within a half-inch of the husks, spraying to control the adults is often recommended under conventional management to protect pollination. Rotation away from corn or next-season soil treatment with insecticide is advised when beetle populations reach .5 beetle per plant on first year corn or .75 beetle per plant on corn-after-corn (23).

Finally, the presence of lodged corn in the characteristic “goose-neck” curve is an indicator of rootworm problems in a field. However, by the time such damage is apparent, it is far too late to do anything for the “standing” crop.

Cutworms

There are several species of cutworms. Most overwinter as larvae in “cells” in the soil, in crop residues, or in clumps of grass. Feeding begins in spring and continues to early summer when the larvae burrow more deeply into the soil to pupate. Adults emerge from the soil one to eight weeks later, or sometimes overwinter. Most species deposit eggs on stems or behind the leaf sheaths of grasses and weeds. Eggs hatch from two days to two weeks later.

The worms are gray to dull-brownish in color; smooth-skinned; with various markings depending on species. They readily curl into a C-shape when disturbed (24). They are known to feed on nearly all non-woody plants, and are serious pests on corn, onions, beans, cabbage, cotton, tomatoes, tobacco, and clover (5). Most species damage the crop by severing the seedling at or just below the soil line, sometimes pulling the plant into the ground as they feed. Climbing cutworms may sever the seedling at higher levels and damage foliage.

Cultural Controls

Cutworms are a particular problem in crops that follow sods, pastures, or weedy fields in rotation. They are discouraged by **clean tillage**(5, 24). Clean tillage to remove all weedy vegetation, at least ten days prior to planting, reduces the number of cutworm larvae. **Control of weedy vegetation** at field borders also reduces the number of invading larvae. As with traditional cultural practices used to suppress European corn borer, these methods are not consistent with modern sustainable farming. They should be treated as transitional.

Biological Controls

Cutworm larvae have a number of natural enemies. Predators include several species of ground beetles. Parasitoids include tachinid flies and braconid wasps. Cutworms may also be attacked by fungi, bacteria, and nematodes (25). As with other pests discussed, **farmscaping** is a recommended means of increasing the numbers of beneficial predators and parasites that help to keep cutworms under control.

Alternative Pesticides & Applications

Scout for the presence of cutworm larvae early in the season, and after destruction of adjacent habitats. Cutworms are best scouted at night, when they are most active, using a flashlight. Look for cut-off or damaged seedlings and dig around the base of the plant to locate the larvae (24).

Bait formulations (sometimes using bran) containing *Bacillus thuringiensis* var. *kurstaki* have been known to effectively control cutworm species when applied to the soil (14). Sprayed formulations may have variable results with cutworms, as the worms may not ingest enough of the toxin for it to be effective.

Research on the **parasitic nematode** species, *Steinernematidae carpocapsae*, has shown it to be a very successful control agent for cutworms (26). However, this option is probably too expensive for field corn at the present time. It deserves mention because it may become more available and economical in the near future.

DISEASE MANAGEMENT

Fortunately, a good crop rotation and proper fertility management appear to suppress many plant disease problems common to field-corn production. For example, studies done in the late 1970s demonstrated that *Diplodia* stalk rot was measurably less severe on organically managed corn fields when compared with conventional production (27).

Varietal selection is also a key tool for addressing common diseases in field corn. Since organic and conventional growers tend to select the same corn varieties based on regional performance, they often find resistance or tolerance to common pathogens already “bred into” the cultivars they choose.

New tools for organic disease management are also becoming available. For example, formulations of the beneficial fungus *Trichoderma harzianum* (e.g., T-22™) are now available and can be used to protect corn from infection by *Pythium* and *Rhizoctonia* species that cause seedling diseases (28).

ECONOMIC AND MARKETING CONSIDERATIONS

Limited information has been developed on the economics of organic crop production. The enclosed budget information from Rutgers University is intended for the northeastern U.S. However, it is concise and should serve as a starting point in determining production costs elsewhere. Please note that two additional sources for budget information are provided at the end of the **Additional Resources** section of this publication.

It is important to consider organic production economics in light of a whole-crop mix – a mix dictated in significant part by rotation requirements. To assist in this planning, the Rutgers information also includes information on organic soybean and alfalfa production – crops that commonly rotate with corn in many production regions.

When estimating crop yields under organic management, many factors need to be considered, including the current fertility status of the soil, whether or not manure resources are available, and the ability of the whole-farm ecosystem to provide natural, biological pest control. The process of conversion to certified organic farming can be challenging and disconcerting. ATTRA’s publication [Making the Transition to Sustainable Farming](#) does a good job of addressing these concerns and is recommended.

In post-transition organic systems, experience has indicated that organic corn yields are usually somewhat lower than those obtained under conventional management. Soybean and legume hay yields appear to be about comparable to conventional yields. Like corn yields, small-grain yields are generally somewhat lower in organic systems because of limited nitrogen availability. Often, however, organic production costs are lower, compensating for revenues lost to yield reduction, even when organic crops are marketed through conventional channels (27).

Market premiums are a significant motivating factor for transitioning to organic production. Premiums for organic corn appear to average about 20 to 50 percent above conventional prices, and have been fairly stable historically. At present, the demand for organically grown grains is increasing steadily. This should continue with new markets opening for organic meat and the subsequent need for certified organic feeds. While all this suggests that premium pricing should also increase, the number of certified organic farmers is likewise expanding. Future prices, therefore, cannot be predicted with any accuracy and organic growers are well advised to keep production costs modest. Historically, reduced production costs have allowed organic producers to be competitive in conven-

tional markets (27) and organic producers continue to have the option of selling there. Conventional growers, however, cannot access organic markets.

ATTRA's *Organic Marketing Resources* publication is a list of resources to help you sell organic crops through established channels. *Direct Marketing* is another ATTRA publication that deals with marketing strategies that eliminate the "middle man" by selling directly to the end user. A new ATTRA publication, *Marketing Organic Grain*, will be available in 2002.

Specialty Corns

In some circumstances, it is specialty corns, organically or conventionally grown, that command the more attractive prices in the marketplace. Among the better-known specialty corns are sweet corn and popcorn. ATTRA's publication *Organic Sweet Corn Production* has already been mentioned. ATTRA also has additional information on sustainable popcorn production and marketing.

Other specialty corns include blue and white flour corns, decorative "Indian" corns, baby corn, and cob corn, which is used to make corn cob pipes. Many of these specialty corns – especially those destined for food processors – should not be planted without first securing a market. Such specialty grains are commonly grown under contract and considerable market research should be done in advance.

There is also interest in open-pollinated varieties of field and sweet corn. An open-pollinated variety, in this context, refers to a non-hybrid variety. The seed of open-pollinated varieties can be saved for replanting to produce offspring similar to the parent plants.

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This website, prepared by the College of Agricultural, Consumer, and Environmental Sciences at the University of Illinois at Urbana-Champaign, features a "value-added calculator" and other budget information for organic corn production. Practical production details are also provided.

By George Kuepper

NCAT Agriculture Specialist

Edited by Richard Earles

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The electronic version of **Organic Field Corn Production** is located at:
PDF
<http://www.attra.org/attra-pub/PDF/fieldcorn.pdf>

