Introduction
Apples (*Malus domestica*) are probably one of the most challenging crops to grow organically in Kentucky. High insect, disease, and weed pressure, along with consumer demand for cosmetically perfect fruit, present significant obstacles to success. While conventional orchardists face the same issues, organic growers must battle them with a much more restrictive, less effective chemical arsenal and at higher costs. With few exceptions, organic growers may not use synthetic compounds for pest management, fertilization, or crop load management (thinning) operations. Growers producing and selling their fruit with an organic label must also be certified by a USDA-approved state or private agency and follow production standards regulated by the National Organic Program (NOP).

The purpose of this profile is to provide an overview of organic methods for establishing a high density apple orchard. While more efficacious organic insect management strategies, the development of disease-resistant varieties, and the high demand for organic produce make organic apple production more attractive, it is still a demanding, labor intensive enterprise. It is not recommended for growers new to organic production or for the inexperienced orchardist.

Marketing
Organic apple costs of production may require producers in climates like Kentucky to market apples direct to consumers. Kentucky’s current fresh apple market is almost exclusively retail, with less wholesale volume each year. Direct marketing, value-added processing (cider, baked goods), and entertainment farming (or agritourism) are the most likely ways for Kentucky apple orchards to be profitable. Farmers markets, U-Pick, and roadside stands are also good outlets for selling apples. Organic apples may be very appealing to community supported agriculture (CSA) customers. Restaurants are interested in local apples, and value-added apple products (fried apple pies, preserves, etc.) are very popular with Kentucky consumers. Apple producers may maximize profitability by developing multiple market channels based on their production volume, location, and marketing preferences.

Market Outlook
There is a strong demand for locally grown, full-flavored, quality apples, especially varieties not commonly available in supermarkets. However, organic apples from Washington and California are now widely available and combine pricing advantages with attractive appearance.

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Organic apples from these more favorable, arid, low humidity climates can be grown in a manner that minimizes exterior blemishes.

Organic apple growers in Kentucky and other Eastern climates need to be creative marketers to obtain the market premiums needed to turn a profit from this crop. Excellent production and pest management are also essential for marketing quality organic apples.

**Production Considerations**

* Cultivar selection and planting stock

Organic apple growers should select marketable cultivars with high levels of resistance in order to reduce the dependence on chemical applications for disease control. Many of the more resistant cultivars are not in the mainstream and may be unfamiliar to consumers.

Rootstock determines hardiness and tree size at maturity; high density production necessitates a dwarfing rootstock. Choose a rootstock that will also enhance disease and insect resistance. Consult University of Kentucky Extension horticultural specialists and state research trial results for information on cultivars best suited for Kentucky.

Organic production generally requires the use of certified organic planting stock that has not been treated with synthetic materials. However, in the case of a perennial crop, NOP regulations permit planting untreated conventionally produced stock on certified land as long as trees are managed organically for at least one year before the crop is sold as organic. Since apples generally do not produce a significant crop load for 3 years, a grower could plant an orchard into transitional land with conventional stock. In this case, any fruit harvested before the end of the transition period could not be marketed as organic, even though it has been under an organic management system.

* Site selection and preparation

Only land that has been free of prohibited substances (e.g., synthetic pesticides and artificial fertilizers) for 3 years can be certified for organic production. Select a site that is considerably higher than surrounding areas and has excellent air drainage. Apple trees perform best on deep, friable, fertile soils with good internal drainage. Avoid heavy, poorly drained soils, as well as those with impervious hardpans close to the surface. The orchard should not be planted within a few hundred yards of woodlots, wild brush, or any area where unmanaged apple trees grow that could increase insect and/or disease pressure. Locate the orchard near a ready source of water since trickle irrigation is essential to the success of high density plantings. Ideally, site preparation should begin 2 years prior to planting to allow sufficient time for planning, correcting problem areas at the site, managing weeds, and soil-building. Soil fertility is enhanced through cover crops, composts, green manure, animal manure, and approved natural fertilizers. Any cover crop, green manure, or smother crop planted in a certified organic field must be grown from organic seed; however, the use of untreated conventional seed is permitted if attempts to acquire organic seed fail. Growers planting their orchard at the beginning of the 3-year transitional period can use conventional fertilizers to adjust their soil while those planting into certified land will need to use only organically approved amendments.

* Orchard layout, planting, and maintenance

Trees are best planted in fall or early spring in rows running north and south. Planting the orchard in a square layout reduces the perimeter, making trapping and monitoring insect pests easier. Grouping trees with like-ripening dates together is also advantageous for pest management and harvest operations. Tree spacing is determined by tree size at maturity, as well as the size of farm equipment that will be used.

A permanent tree support system is essential in a high density planting and should be in place as soon after planting as possible. Any wooden support posts and stakes that are used cannot be treated with arsenate or other prohibited materials.

Ground covers planted between rows should be low-growing, non-invasive, and not compete with trees for water and nutrients. Typically, a grass (such as fescue) is used. This area will need to be mowed regularly during the growing season.

* Crop load management

Thinning operations are carried out after petal fall when the danger of frost has passed. Synthetic chemical thinners are not permitted in organic orchards; however, researchers at UK have found that lime sulfur combined with fish oil has potential as a chemical thinning agent. Refer to the 2008 Fruit and Vegetable Crops Research Report for test results.
Hand thinning by manually removing individual fruits is very labor intensive and is cost-prohibitive in a commercial orchard.

Pest management

Apples are host to a number of potentially destructive diseases and insect pests. Significant crop losses and damage to tree health result when these problems are not properly managed. Pest management in organic plantings emphasizes prevention through good production and cultural practices. Integrated Pest Management (IPM) strategies, which are widely used in conventional orchards, may also be used to manage pests in organic systems. Scouting, monitoring, forecasting, and record keeping are IPM tools that can assist growers in making sound management decisions. IPM integrates various biological, cultural, physical, and chemical control methods together to minimize pest damage and maximize yields. Because chemical controls are just one part of the overall pest management program, they are implemented only when pest pressure, scouting, and disease forecasts indicate the need. However, multiple OMRI-approved pesticide sprays are required for organic production because of the wide variety of pests that attack foliage and fruit throughout the growing season. Many of these sprays are less effective than conventional sprays and in some cases effective organic alternatives are limited.

Diseases

The primary diseases affecting apples are apple scab, fire blight, powdery mildew, and cedar-apple rust. Growers may also encounter the so-called summer diseases that affect fruit: bitter rot, black rot, white rot (bot rot), sooty blotch, and flyspeck. While cultivars are available with various levels of disease resistance to the primary apple diseases, there is limited, if any, resistance to the summer diseases. Thus, resistant cultivars will reduce, but not eliminate, the need for fungicide/bactericide sprays in organic apple production.

Cultural practices are a critical part of disease management for both organic and conventional orchards. Suitable site selection and promotion of tree health through proper soil fertility and irrigation can help plants protect themselves from infections and disease spread. Sanitation, weed management, eradication of alternate hosts, and therapeutic pruning are also important.

Monitoring (scouting) and disease forecasting systems (disease warning systems) provide growers with disease risk evaluations and warnings for diseases such as apple scab and fire blight. They utilize weather data from local weather sources to analyze risk for infection and disease spread. Growers are then able to limit applications of disease-preventative products (i.e. organically approved fungicides) to periods of high risk. Most Kentucky commercial apple growers take advantage of the county-specific disease forecasting site produced by the UK Ag Weather Center, but the Kentucky Mesonet is also available for many locations within the state.

Organic apple producers are restricted to specific fungicides that are approved by the NOP. The predominant products are copper and sulfur, both of which have broad spectrum applications. Other organically approved products that have potential as fungicides include Surround (kaolin clay) and Regalia (Japanese knotweed extract). While copper and sulfur products are effective against both fungi and bacteria, antibiotics are most effective against the bacterial pathogen that causes fire blight. Streptomycin and tetracycline are synthetic antibiotics that have been allowed (with restrictions) for fire blight control on organic apples. However, due to concerns over the potential development of resistant bacterial strains of human pathogens, the National Organic Board is recommending the removal of these antibiotics from the national list effective October 2014. Alternatives to these antibiotics are currently being researched.

Insects

The primary insect problems on apple are codling moth and plum curculio. Other pests include potato leafhopper, wooly apple aphid, mites, and San Jose scale. NOP-approved pheromones, biological control via natural predators, sanitation, and weed management are some of the pest control tactics available to organic growers. Effective insect control will also necessitate the incorporation of NOP-approved insecticides; these include botanicals, Bt, oils, and insecticidal soap. Kaolin clay is a naturally occurring mineral that has been successfully used to protect trees from a wide range of insect pests, including plum curculio and codling moth.

Weeds

If left unchecked, weeds compete with trees for water and nutrients, harbor insect and disease pests,
and provide habitats for undesirable wildlife. Site selection, along with site preparation, should be aimed at making sure existing weeds are under control prior to planting. Other pre-plant strategies include tillage, crop rotation, and cover or smother crops. Once the orchard is planted, it is particularly important to suppress weeds in tree rows during establishment. Mowing, cultivating, organic mulch, organic herbicides, flame weeder, and string trimmers can be used to manage weeds in the understory.

**Wildlife**

Undesirable wildlife such as deer, rodents, and rabbits can cause considerable damage in new and established orchards. Electrical fencing is a costly, but effective means of deterring deer and rabbits. Organically approved repellents have had variable success. Regular mowing, along with the removal of nearby brush, rock piles, and other protective cover eliminates habitats attractive to rabbits and rodents. White plastic tree guards, used to prevent root and trunk feeding by voles during the winter, should be replaced annually. Vole control is a serious problem for organic growers as there are no certified organic poisoned baits available.

**Harvest and storage**

Products grown organically and harvested during the transition period cannot be marketed as organic; only those crops that have met NOP production and certification standards, including the 3-year minimum transition period, can be marketed and sold as certified organic or organic. Harvest equipment, storage areas, and packaging materials must comply with NOP standards. Growers with split operations must either use separate equipment and facilities for these operations or decontamination protocol must be followed before use in the organic end of the enterprise. Packaging materials must be protected against potential contamination from prohibited substances.

The optimum maturity level for harvest will depend on the cultivar, intended market, and whether the fruit will be stored. Color, starch level, sugar content, and firmness are important harvest indicators. Fruit is hand-picked and handled carefully to avoid bruising. Cold storage will be needed to extend the marketing season.

**Labor requirements**

High density conventional apple establishment can require more than 2,000 hours per acre over 4 years. Trees take 4 to 6 years to reach full bearing. Organic apple production labor requirements after establishment are higher than a conventional system due to more machine operations and greater manual labor time.

An experienced apple picker can harvest about 12½ bushels of apples per hour. At a yield of 400 bushels per acre, this will require about 32 hours of harvest labor. On-farm packing and grading will require additional labor (15 to 25 hours), depending on packaging used. Packing labor can be minimized by field sorting or having customers select their own apples from retail bins.

**Economic Considerations**

The cost of establishing a high density orchard is greater than that of a lower density orchard. Total (variable and fixed) costs for establishing an apple orchard can range from $7,500 per acre for plantings of 300 trees to more than $14,000 for high density plantings of 600 trees per acre. Initial investments include land preparation, purchase of trees, tree establishment, installation of an irrigation system, and construction of a tree support system. Pest control equipment and pesticides, including tree guards and deer repellents, plus a good sprayer for insect and disease control, will also be needed.

Producers may choose to establish organic apple orchards using conventional methods during the first 2 years of production and then use certified organic practices for the following 3 years to gain certified organic status when the apple orchards reach full bearing potential. Producers can typically expect total apple establishment costs during the first 2 years to approach or exceed $20,000 per acre. Conventional establishment costs are generally less than certified organic practices.

Annual pre-harvest production costs for organic apples will fall in the $1,500 range per acre. Harvest and handling costs will vary depending on the wage rate paid to labor and the availability of harvest equipment. Harvest labor can be estimated between $1.50 and $2 per bushel, with total harvest and handling costs also approaching or exceeding $1,500, depending on yield. Positive returns to capital and management from organic apple production in Kentucky will require a price premium for organic
apples. At a retail price of $40 per bushel, returns to land, labor and management from an organic apple planting could exceed $5,000 per acre in a full production year. Four to 6 years at this full production level may be required to recoup the initial investment level.

Selected Resources

• Ag Weather Center: Plant Disease Models (University of Kentucky)
  http://wwwagwx.ca.uky.edu/plant_disease.html
• Apple Cultivar Performance, HortFact-3006 (University of Kentucky, 2007)
  http://www.uky.edu/Ag/Horticulture/masabni/Publications/applecultivar.pdf
• Apple Integrated Pest Management (University of Kentucky)
  http://www.uky.edu/Ag/IPM/appleipm/appleipm/index.php
• Assessing Lime Sulfur as an Organic Fruit Thinning Agent for Apples, pp. 33-34 (University of Kentucky Fruit and Vegetable Research Report, 2008)
  http://www.ca.uky.edu/age/pubs/pr/pr572/pr572.pdf
• Establishment of an Organic Apple Orchard at the UK Horticulture Research Farm, pp. 52-53 (University of Kentucky Fruit and Vegetable Research Report, 2007)
  http://www.ca.uky.edu/age/pubs/pr/pr555/pr555.pdf
• Kentucky Mesonet (Western Kentucky University)
  http://www.kymesonet.org/index.html
• Midwest Tree Fruit Pest Management Handbook, ID-93 (University of Kentucky et al.)
  http://www.ca.uky.edu/age/pubs/id/id93/id93.htm
• Midwest Tree Fruit Spray Guide, ID-92 (University of Kentucky et al., 2012) 1.15 MB
• Organic Apple Production (University of Kentucky and Kentucky State University, 2010) 6.26 MB
  http://organic.kysu.edu/OrganicApple.pdf
• Organic Apple Production Update, pp. 17-18 (University of Kentucky Fruit and Vegetable Research Report, 2010) 1.21 MB
  http://www.ca.uky.edu/age/pubs/pr/pr608/pr608.pdf
• Rootstocks for Kentucky Fruit Trees (University of Kentucky, 2011)
• Total Quality Assurance: Apple Production: Best Management Practices, ID-137 (University of Kentucky, 2001)
  http://www.ca.uky.edu/age/pubs/id/id137/id137.htm
• Apples: Organic Production Guide (NCAT-ATTRA, 2011)
• Disease Management Guidelines for Organic Apple Production in Ohio (Ohio State University, 2008)
  http://www.caf.wvu.edu/kearneysville/organic-apple.html
• Grower’s Guide to Organic Apples (Cornell University, 2009) 1.29 MB
  http://nysipm.cornell.edu/organic_guide/apples.pdf
• Organic Matters: Considerations in Organic Apple Production (ATTRA, 2001)
  http://www.agmrc.org/media/cms/omapple_5E5179AB39A2E.pdf
• Planning the Organic Orchard (MOSES, 2012) 1.28 MB
• Tree Fruits: Organic Production Overview (NCAT-ATTRA, 2004)
  http://attra.ncat.org/attra-pub/fruitover.html

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