



Apples

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Introduction

Over the past 60 years Kentucky growers have produced apples (*Malus domestica*) using freestanding trees in low- to medium-density plantings. While these larger trees on semi-standard rootstocks are hardy, long-lived and widely adapted, they are also lower yielding and less efficient to manage. Today's high-density orchards have closely planted trees on dwarfing rootstocks requiring permanent support structures. Earlier production, quicker returns on investment, and improved fruit quality are just a few of the many benefits of new high-density systems.

Growers, however, who do not have an excellent site or a source of water for drip irrigation should not consider high-density plantings. Additionally, because high-density systems require a significantly greater level of grower expertise and cultural management they may be less suitable for producers who are new and inexperienced. Semi-dwarfs are an alternative for beginners who desire the benefits of smaller trees, without the more exacting growing requirements of full dwarfs.

Marketing and Market Outlook

Kentucky's fresh apple production is mainly intended for retail, with very few growers selling a large percentage of production at wholesale prices. Wholesale apple production is likely profitable in Kentucky when growers receive a fresh price over \$0.25 per pound. The national average fresh apple grower price ranged from \$0.30 to \$0.45 from 2006 to 2016. Farm retail (direct marketing) prices in Kentucky were in the \$1.50 range. Both wholesale and retail price trends point to likely profitabil-



ity for well-managed and excellently marketed apple plantings in Kentucky.

There is a strong demand for locally grown, full-flavored, quality apples, especially varieties not commonly available in supermarkets. Direct marketing, value-added processing (cider), and entertainment farming are market channels that often contribute to apple profitability. Farmers markets, U-Pick, and roadside stands are good direct markets for selling apples. Value-added apple products (fried apple pies, preserves, etc.) are very popular with Kentucky consumers. Restaurants are interested in local apples, and apples have been successfully wholesaled in farm-to-school marketing programs. Apple producers may maximize profitability by developing multiple market channels based on their production volume, location and marketing preferences. Diversifying sales between different market



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channels helps guard against product oversupply to any one channel.

Production Considerations

Cultivar selection

Select cultivars that produce quality fruit, perform reliably, and satisfy the characteristics demanded by potential customers. Cultivars differ in such horticultural traits as fruit characteristics (e.g. size, color, flavor and intended use), harvest period (early, mid- and late-season), as well as disease and insect resistance. Tree size, which is determined by the rootstock, may be dwarf, semi-dwarf, semi-standard or standard. Consult University of Kentucky Extension horticulture specialists and state research trial results for information on cultivars best suited for your locale and market.



Site selection and planting

Select an orchard site that is considerably higher than surrounding areas and has excellent air drainage for spring frost protection. Apples 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. Irrigation is essential for high-density plantings; the orchard should be located near a ready source of water.

Apple planting stock may need to be ordered as much as 24 months in advance of planting to obtain commercial quantities (275 to 1,000 trees per acre) of the desired cultivars and rootstocks. While more costly per tree than conventional unbranched whips, planting well-branched or feathered trees can be well worth the investment by bringing the orchard into full production one year earlier. Trees are best planted in fall or early spring in rows ideally running north and south.

Orchard maintenance

Pruning and training methods employed in high-density plantings are considerably different from those in conventional orchards. The goal in high-density orchards is to promote rapid establishment and early fruiting while at the same time discouraging exces-

sive vegetative growth. Training limbs to develop tree structure, rather than pruning is the primary focus of early efforts. Pruning is mostly employed after the trees begin bearing to ensure canopy openness and to renew older fruiting wood. A permanent support system is essential and should be in place as soon after planting as possible because dwarf trees have brittle graft unions that can break. Trellises with 10- to 12-foot

posts and five to six wires are common and helpful when training limbs. Other training systems and trellis styles exist for high-density orchards; UK Extension horticulture specialists can aid with design selection. Dwarf trees have smaller rooting zones and carry heavier crop loads; fertility must be closely monitored with regular soil tests and plant tissue analysis

throughout the life of the planting. Crop loads must also be closely monitored and in balance with vegetative vigor, especially during the first four years to avoid biennial bearing or excessive devigoration before the trees fill their allotted space.

Pest management

There are a large number of insects and diseases to control on apples. These include San Jose scale, codling moth, oriental fruit moth, plum curculio, stink bug, aphid and leafhopper insects, and scab, cedar apple rust, fire blight, sooty blotch, flyspeck and fruit rot diseases. The brown marmorated stink bug is a new difficult to control invasive pest on apples that has moved into the state. The Integrated Pest Management (IPM) approach helps growers determine exactly when pesticide applications are needed. Using IPM in Kentucky can reduce the number of pesticide applications by about one third when compared with a calendar-based program. IPM involves collecting detailed data regarding the crop, pests and weather conditions to make sound pest management decisions. Growers can access insect and disease predictive models on the UK Ag Weather Center site that use the Kentucky Mesonet or National Weather Service station closest to their orchard to make informed spraying decisions. Organic apple production is unlikely to be economically feasible in Kentucky because of

the large number of pests and lack of OMRI-approved controls for many of those pests. Deer browsing and rubbing causes considerable damage to trees and will need to be managed through electric fencing or hunting. Voles will need to be controlled during the winter to prevent root and trunk feeding.

Harvest and storage

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

A medium-density system will require nearly 300 hours of operator labor per acre per year. Trees take four to six years to reach full bearing. A high-density system can require more than 2,000 hours per acre over four years.

An experienced apple picker can harvest about 12½ bushels of apples per hour. At a yield of 450 bushels per acre, this will require about 36 hours of harvest labor. On-farm packing and grading will require additional labor (15 to 25 hours per 450 bushels), depending on packaging used. Field sorting and having customers select their own apples from retail bins can minimize packing labor.

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 medium-density plantings of 300 trees; more than \$15,000 for high-density plantings of 600 trees per acre; and more than \$20,000 over the first four years for a 1,000 tree per acre system. Initial investments include land preparation, purchase of trees, tree establishment, installation of an irrigation system, and construction of a tree support system. Next to the cost of the apple trees, construction of the tree support system is the greatest expense in establishing a high-density planting. Pest control equipment and pesticides, including tree guards, fencing for deer control, plus an air blast sprayer for insect and disease control and a boom

sprayer for weed control, will also be needed. Total capital expenses may vary significantly depending on the amount of equipment investment.

Annual pre-harvest production costs for each production system can come to approximately \$1,500 per acre. Harvest costs will vary depending on the wage rate paid to labor and the availability of harvest equipment, but can be estimated between \$1.50 and \$2 per bushel. Returns on apple production for retail sales will vary widely depending on the price consumers are willing to pay, the yields and prices received, and cost of marketing the apples. At a price of \$25 per bushel, returns to land, labor and management from the central leader (medium-density) and tall spindle high-density systems may fall in the \$5,000 to \$10,000 range. Returns to land, labor and management from wholesale production on a medium-density planting in Kentucky (2018) were estimated in the \$2,500 per acre range, assuming a price of \$0.40 per pound. Returns from tree fruit production vary widely according to production system and manager experience.

Selected Resources

- Ag Weather Center (University of Kentucky) <http://www.agwx.ca.uky.edu/>
- Apple Cultivar Performance, HortFact-3006 (University of Kentucky, 2007) <http://www.uky.edu/Ag/Horticulture/masabni/Publications/applecultivar.pdf>
- Apple Production: Best Management Practices (ID-137) (University of Kentucky) <http://www2.ca.uky.edu/agcomm/pubs/id/id137/id137.pdf>
- IPM Scouting Guide for Common Problems of Apple (ID-219) (University of Kentucky, 2014) <http://www2.ca.uky.edu/agcomm/pubs/ID/ID219/ID219.pdf>
- IPM Scouting Guide for Common Problems of Apple (mobile website, University of Kentucky) <http://applescout.ca.uky.edu>
- Apple Integrated Pest Management (University of Kentucky) <http://ipm.ca.uky.edu/content/fruit-ipm-apple>
- Kentucky Mesonet (Western Kentucky University) <http://www.kymesonet.org/index.html>
- Commercial Apple Fungicide Schedule Worksheet, PPFS- FR-T-19 (University of Kentucky, 2016) <http://plantpathology.ca.uky.edu/files/ppfs-fr-t-19.pdf>

- Effectiveness of Apple Disease Management Fungicides, PPFS- FR-T-15 (University of Kentucky, 2016) <http://plantpathology.ca.uky.edu/files/ppfs-fr-t-15.pdf>
- Midwest Tree Fruit Pest Management Handbook, ID-93 (University of Kentucky, et al., 1993) http://www2.ca.uky.edu/agcomm/pubs/id/id93/ch_1.pdf
- Midwest Fruit Pest Management Guide, ID-232 (University of Kentucky, et al., 2017) <https://ag.purdue.edu/hla/Hort/Documents/ID-465.pdf>
- Training and Culture of Dwarf Apples Using the Vertical Axis System, HortFact-3501 (University of Kentucky, 2008) <http://www.uky.edu/hort/sites/www.uky.edu/hort/files/documents/appletraining.pdf>
- Apple Production (Penn State University, 2017) <https://extension.psu.edu/apple-production>
- Penn State Tree Fruit Production Guide (Pennsylvania State University, 2018-19) <http://tfpg.cas.psu.edu/default.htm>
- Profile of Commercial Apple Production in Kentucky 2017 (17 MB) https://ipmdata.ipmcenters.org/documents/cropprofiles/KY_Apple_CropProfile.pdf
- Additional University of Kentucky apple publications available at [http://plantpathology.ca.uky.edu/extension/publications - TREEFRUIT](http://plantpathology.ca.uky.edu/extension/publications-TREEFRUIT)
- The New Tall Spindle Apple Orchard System (YouTube videos, Dr. Terence Robinson, Winter Apple School, Blue Ridge Community College, N.C., 2013)
- <https://www.youtube.com/watch?v=08phlXqzkwU> (Keynote address)
- <https://www.youtube.com/watch?v=r11-9AIA1g8> (Tying down young trees)
- <https://www.youtube.com/watch?v=pngepwJFZGI> (Honeycrisp pruning)
- <https://www.youtube.com/watch?v=gJF4wLgXnK8> (Field demonstration lecture)
- <https://www.youtube.com/watch?v=2eIDZeKCOQE> (Goldrush pruning)

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