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# AGRICULTURAL ALTERNATIVES

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agalternatives.aers.psu.edu

## Apple Production

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Apples may be grown in many parts of the country and lend themselves well to part-time farming operations. The initial investment for apples can be high depending on the production method chosen, land preparation, and initial investment in the trees. The life of the orchard is expected to be at least 20 years, so this investment will be spread over a longer period of time than many crops. Depending on the amount of land devoted to the orchard, production method, and tree size, equipment costs may be held to a minimum. If the orchard is a part of an existing agricultural operation, you may already have much of the needed equipment.

Apple production will require many hours of labor, depending on the size of the orchard. Land preparation and planting will require at least two people. During the summer months, the orchard will require mowing, pesticide application, and fruit thinning. Depending on the mix of varieties and orchard size, additional labor may be required at harvest time. Although you may be able to accomplish these tasks with family members and local part-time labor, use of transient labor may be necessary.

Pennsylvania produces 400 to 500 million pounds of apples per year and ranks fifth in the nation for apple production. The majority of the production is centered in the southcentral part of Pennsylvania (due in large part to the topography of the land), but apples can be found commercially throughout the Commonwealth.



## Marketing

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Depending on the apple varieties produced (commonly referred to as “cultivars”), apples may be marketed from late August through October. If regular cold storage is available, the marketing season may be extended through March. If controlled-atmosphere (CA) storage is available, the marketing season may be extended through July. Apples may be marketed wholesale or directly through a roadside market or to individuals.

Apples marketed wholesale are traditionally sold to a processor or fruit packer. Processors use apples to make apple sauce, apple juice, and a variety of other products. Fruit packers grade and pack apples for the fresh market. Fresh-market apples typically yield a higher return than processed apples. It is recommended that you explore the

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*This publication was developed by the Small-scale and Part-time Farming Project at Penn State with support from the U.S. Department of Agriculture-Extension Service.*

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marketing options prior to ordering the trees from the nursery so the cultivars that best fit your marketing options may be ordered.

Apples sold through a roadside stand need to be of the highest quality. This will ensure repeat customers from year to year. Roadside marketers need a wide variety of cultivars so the marketing season is not interrupted. Roadside marketing is time consuming, but it can also be very financially rewarding. For more on marketing, refer to *Agricultural Alternatives: Fruit and Vegetable Marketing for Small-scale and Part-time Growers*.

## Site Selection

The success of any orchard is directly related to planning and preparation. The ideal site for an orchard consists of rolling or sloping land to enhance air drainage during periods of spring frosts. The best site is south facing with a slope of between 4 and 8 percent because operating equipment on steeper slopes may be difficult. Sites with deep, well-drained soils are preferred because shallow, poorly drained soils cause root system problems. Consult a county soil map prior to site selection. Soil maps may be obtained at your county extension office or the Farm Service Agency.

Another consideration when choosing a site is irrigation. Regardless of the type of irrigation system used, locating the orchard close to a water source will simplify setting up the system and reduce operating expenses. For more information on overhead and drip irrigation for tree fruit production, consult *Agricultural Alternatives: Irrigation for Fruit and Vegetable Production*.

## Land Preparation

The land should be prepared as if planting a traditional field crop. The soil should be plowed and leveled with a disk and harrow. Starting with an even orchard floor will reduce the possibility of standing water and make fruit harvesting and transportation easier. Establishing an orchard in well-prepared soil rather than established sod will also aid in keeping the tree rows and row middles free of broadleaf weeds.

Prior to planting trees, a soil fertility test and nematode survey are recommended. These test kits may be obtained from your county extension office. The two tests may be taken at the same time, but the samples must be handled differently. Consult the instructions on both kits to ensure accurate results.

The results from the soil test provide recommendations for any soil amendments such as lime and/or fertilizer needed prior to orchard establishment. Soil amendments should be incorporated into the soil prior to planting trees. The nematode survey will determine if any treatments are needed for harmful nematodes. Left untreated, nematodes may damage the root system of the tree and can stunt or kill the tree prior to bearing fruit. This will result in uneven tree growth and delayed production.

## Ordering Trees

Trees should be purchased from a reputable nursery to ensure trueness to variety and disease-free trees and because most provide a guarantee of survivability. Check for this guarantee when ordering trees. The nursery can also offer advice concerning tree and row spacing. Trees should be ordered at least one year prior to orchard establishment.

The size of the mature tree will depend on the cultivar and rootstock of the tree. The rootstock, however, is the dominant factor that controls tree size. Most commercial growers utilize either dwarf or semi-dwarf rootstocks because they are much easier to prune and harvest. Trees planted on dwarfing rootstocks will need to be supported by a trellis or individual posts, while those on semi-dwarf rootstocks usually do not need support. Another advantage of dwarf rootstocks is their earlier production. They usually produce fruit in the third season after planting as compared to 5 years for the larger trees. Recommended dwarf rootstocks include Malling 9 (M.9) or Budagovsky 9 (B.9). Semi-dwarf rootstocks in order of increasing size are Malling 26 (M.26), Malling 7 (M.7), or Malling Merton 111 (MM.111). A third alternative is to utilize interstem trees, which have a vigorous rootstock with a dwarfing rootstock grafted onto it, followed by the cultivar. The result is a three-part tree that is slightly smaller than a semi-dwarf tree but does not normally need support. Interstem trees are, however, more expensive than the standard two-part tree. A number of other rootstocks may be available, but they have not yet been fully tested for all cultivars grown in Pennsylvania.

The apple cultivars you choose to plant will depend largely on how you intend to market your fruit. Most apple growers who sell fruit directly to the consumer will need to choose five to six cultivars that spread their harvest out over a period of time. Growers who sell their fruit through a packing house or to a processor may only want to plant two or three different cultivars. Recommended fresh-market cultivars for Pennsylvania include Braeburn, Gala, Fuji, Ginger Gold, Golden Delicious, Honeycrisp, McIntosh, and Red Delicious with new varieties continuously being developed. The most common processing cultivars planted in Pennsylvania are Golden Delicious and York Imperial. Other cultivars that can be grown for processing include Granny Smith, Gravenstein, Idared, McIntosh, Northern Spy, and Rome Beauty. Not all of these cultivars can be grown in all areas of Pennsylvania. Consult your local county extension office to determine which cultivars are best suited for your area and if any cultivars are in higher demand for your region.

Certain cultivars of apples are resistant to apple scab. Apple scab is the most serious disease problem in producing fruit in Pennsylvania. Using scab-resistant apple cultivars can reduce the amount of fungicides that need to be applied. Some of the cultivars that are resistant to apple scab include Enterprise, Freedom, GoldRush, Liberty, and Redfree. Consult your local extension office for additional scab-resistant cultivars.

# Layout and Planting

Regardless of whether you are laying out an orchard on level or sloping land, care should be taken to make the rows as evenly spaced as possible. The distance between the rows should be the same throughout the orchard. Placing stakes in the rows prior to planting will help to ensure the distance between the rows is the same throughout. This should be strived for whether planting in straight rows or on a contour. The maximum size of the tree will determine the distance between the rows and the distance between the trees in the row. The number of trees required per acre for various tree spacings can be found in Table 1.

When planning the orchard, early blooming cultivars that are most susceptible to frost should be placed in areas with the best air drainage. Later blooming and ripening cultivars can be placed lower on hillsides or in areas more prone to frost. If possible, orchard rows should be laid out so they are oriented running north to south to maximize exposure to sunlight. If this is not possible due to slope consideration, position the rows on the contour to facilitate safe spraying and machinery operation.

# Pollenizers and Pollination

To pollinate trees in the spring, planting more than one cultivar in the orchard is necessary. Apple cultivars are self-unfruitful, which means they will not pollinate themselves and you need to plant at least two different cultivars that have overlapping bloom periods. Some cultivars have nonviable pollen, so at least three different cultivars will be required. Planting several cultivars will also ensure having marketable fruit throughout the harvest season since cultivars mature at different times.

Pollenizers can be placed as solid separate rows (but no more than two to three rows from a cultivar that is to be pollinated) or in the row with other cultivars. If the pollenizers are placed in the rows, use cultivars that look different so that the harvesters do not accidentally pick the fruit with the main cultivar. Bees traditionally move down the row when pollinating and not across rows. By placing pollinating cultivars in the row, better pollination is possible. Your nursery can recommend cultivars that will pollinize other cultivars.

A large honey bee population is essential for complete pollination and fruit set. One hive per acre is recommended for maximum fruit production. If you do not have your own honey bees, you will need to contact a beekeeper to provide hives. Care must be taken with insecticides applied at flowering because they can adversely affect pollinating insect populations, especially honey bees. Honey production may provide an additional diversification opportunity for orchardists. More information on bees and honey production can be found in *Agricultural Alternatives: Beekeeping*.

**Table 1. Number of trees per acre at various tree spacings.**

		Spacing (in feet) between trees																		
		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Spacing (in feet) between rows	8	1,089	907	777	680															
	9	968	806	691	605	537														
	10	871	726	622	544	484	435													
	11	792	660	565	495	440	396	360												
	12	726	605	518	453	403	363	330	302											
	13	670	558	478	418	372	335	304	279	257										
	14	622	518	444	388	345	311	282	259	239	222									
	15	580	484	414	363	322	290	264	242	223	207	193								
	16	544	453	388	340	302	272	247	226	209	194	181	170							
	17	512	427	366	320	284	256	232	213	197	183	170	160	150						
	18	484	403	345	302	268	242	220	201	186	172	161	151	142	134					
	19	435	382	327	286	254	229	208	191	176	163	152	143	137	127	120				
	20	414	363	311	272	242	217	198	181	167	155	145	136	128	121	114	108			

## Production Considerations

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In the United States, anyone desiring to purchase restricted-use pesticides is required to have a pesticide applicator's license. Even some materials used in organic production now require a license. In Pennsylvania, the licensing procedure is handled by the Pennsylvania Department of Agriculture. Please check with your state regarding these requirements.

Because of the complexity of apple production and the large number of pests and diseases that attack both trees and fruit, this publication cannot cover all necessary production practices and procedures. For more information on the diseases and conditions affecting apples, please consult the *Pennsylvania Tree Fruit Production Guide*, which can be purchased from your local extension office in Pennsylvania or accessed online at <http://tfpg.cas.psu.edu/>. This valuable guide describes appropriate cultural and chemical treatments for the control of insects, diseases, and weeds.

### Thinning

Once the fruit has set, thinning of the fruit is required to ensure large, marketable fruit and return bloom for the following year. Thinning may be accomplished chemically or by hand. The earlier thinning is completed, the larger the fruit will be at harvest and the better the return bloom you will have in the following year. If chemical thinning is used, follow all label directions for rate and timing of the applications. If the thinning is completed by hand, begin thinning no later than mid-June. This allows for a natural phenomenon called "June drop" to occur so less time will be required for hand thinning. June drop occurs approximately 3 to 4 weeks after bloom when a small percentage of the apples that did not begin to grow will naturally drop.

### Fertilization

Nutritional requirements of apple trees vary through out their lifetimes and are influenced by such factors as rootstock, crop load, soil type, and weather conditions. In addition to nitrogen, phosphorus, and potassium, apple trees need adequate levels of calcium, boron, copper, and zinc to maintain the health of the tree and produce quality fruit. After planting, soil tests and leaf analyses are recommended at least once every 3 years. A leaf analysis is the most accurate way to check if applied soil amendments are being used by the tree. Leaf analysis test kits can be purchased at your county extension office.

### Pruning and Training

There are many different pruning and training systems used in apple production. Your choice of rootstock and tree spacing will have a large impact on the system you use. Common training systems used in Pennsylvania include the central leader system, vertical axe, and various forms of trellising. Regardless of the system you use, you will need to prune and train the trees annually from the day you plant the trees

throughout the life of the orchard. Most pruning is done during late winter before the trees leaf out in the spring. Some growers also prune trees during the summer to increase light penetration into the trees to increase fruit color.

## Harvest and Storage

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Whether apples are marketed fresh or processed, they are traditionally harvested by hand into large wooden or plastic bins that vary in size from 20 to 25 bushels each. Extreme care must be taken not to bruise or damage the fruit during the harvest process because this reduces quality and storability and will reduce the returns realized from the sale of the apples.

Even if some family labor is used for harvest, outside labor may be necessary to harvest the crop in a timely manner. If you use hired labor, you are required to follow all laws and regulations concerning hired labor. More information concerning hired labor can be found in the *Pennsylvania Tree Fruit Production Guide*, *Agricultural Alternatives: Starting or Diversifying an Agricultural Business*, and *Agricultural Alternatives: Agricultural Business Insurance*.

There are two methods of storing apples. The first is regular cold storage, which involves refrigerating apples at 30 to 36°F. Water is traditionally used to increase humidity to slow loss of moisture from the apples. The second method used is controlled-atmosphere (CA) storage, which requires removing oxygen from a sealed, refrigerated room and adding of carbon dioxide to slow the maturation process. Apples stored in CA storage can be held until June or July before use.

## Sample Budget

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Included in this publication are sample fresh-market apple budgets for land preparation and planting and mature production. The budgets summarize the receipts, costs, and net returns at various stages of an apple enterprise. The sample budget should help ensure that all costs and receipts are included in your calculations. Costs and returns are often difficult to estimate in budget preparation because they are numerous and variable. Therefore, you should think of these budgets as approximations and make appropriate adjustments in the "Your Estimate" column to reflect your specific production and resource situation. More information on the use of crop budgets can be found in *Agricultural Alternatives: Enterprise Budget Analysis*.

## Sample Apple Budget—Land Preparation and Planting

Per-acre costs for land preparation and establishment based on 272 trees per acre.

Items	Land Preparation	Your Estimate	Planting	Your Estimate
<b>Variable Costs</b>				
Lime	\$75.00	_____		_____
Fertilizer	\$64.25	_____	\$14.50	_____
Custom machinery	\$42.10	_____	\$5.00	_____
Grass seed	\$45.00	_____		_____
Trees*		_____	\$1,904.00	_____
Herbicides		_____	\$55.63	_____
Insecticides		_____	\$30.63	_____
Fungicides		_____	\$54.02	_____
Bar soap		_____	\$27.20	_____
Tree guards		_____	\$54.40	_____
Rodenticide		_____	\$10.00	_____
Labor	\$276.69	_____	\$230.76	_____
Diesel fuel	\$6.00	_____	\$16.22	_____
Repairs and maintenance		_____		_____
Tractors	\$3.25	_____	\$8.20	_____
Equipment	\$6.33	_____	\$4.55	_____
Interest on capital	\$18.20	_____	\$115.16	_____
<i>Total Variable Costs</i>	\$536.82	_____	\$2,530.27	_____
<b>Fixed Costs</b>				
Tractors	\$7.11	_____	\$16.95	_____
Implements	\$11.14	_____	\$8.13	_____
Land charge	\$150.00	_____	\$150.00	_____
<i>Total Fixed Costs</i>	\$168.25	_____	\$175.08	_____
<b>Total Costs</b>	<b>\$705.07</b>		<b>\$2,705.35</b>	

\*Tree cost based on standard cultivars on semi-dwarfing rootstocks for quantities over 100 trees.

Royalties are charged on many of the newer cultivars of up to \$1.50 per tree.

## Profitability Analysis

Returns above annual specified growing and harvesting costs under various price and yield combinations.

Orchard block price* (\$/bu)	Yield (bu/A)					
	200	400	600	800	1,000	1,200
\$2.00	-\$1,376	-\$1,246	-\$1,116	-\$986	-\$856	-\$726
\$3.00	-\$1,176	-\$846	-\$516	-\$186	\$144	\$474
\$4.00	-\$976	-\$446	\$84	\$614	\$1,144	\$1,674
\$5.00	-\$776	-\$46	\$684	\$1,414	\$2,144	\$2,874
\$6.00	-\$576	\$354	\$1,284	\$2,214	\$3,144	\$4,074
\$7.00	-\$376	\$754	\$1,884	\$3,014	\$4,144	\$5,274
\$8.00	-\$176	\$1,154	\$2,484	\$3,814	\$5,144	\$6,474
\$9.00	\$24	\$1,554	\$3,084	\$4,614	\$6,144	\$7,674
\$10.00	\$224	\$1,954	\$3,684	\$5,414	\$7,144	\$8,874

\*Picked in bins in orchard. Average price received for all apples.

## Sample Apple Budget—Mature Production

Per-acre costs for 1 year of production based on 272 trees per acre.

Items	Costs	Your Estimate
<b>Variable Costs</b>		
Lime	\$12.50	_____
Fertilizer	\$37.90	_____
Herbicides	\$23.95	_____
Fungicides	\$224.04	_____
Insecticides	\$289.68	_____
Labor		
Scouting	\$3.67	_____
Thinning	\$200.00	_____
Operator	\$58.90	_____
Pruning	\$272.00	_____
Harvesting	\$1,080.00	_____
Diesel fuel	\$11.83	_____
Repairs and maintenance		
Tractors	\$5.78	_____
Equipment	\$8.14	_____
Other		
Bee rental	\$25.00	_____
Insect traps	\$5.00	_____
Plant growth regulators	\$100.00	_____
Rodenticide	\$10.00	_____
Interest on operating capital	\$42.81	_____
<i>Total Variable Costs</i>	\$2,411.20	_____
<b>Fixed Costs</b>		
Tractors	\$11.09	_____
Implements	\$13.98	_____
Land charge	\$150.00	_____
<i>Total Fixed Costs</i>	\$175.07	_____
<b>Total Specified Costs</b>	<b>\$2,586.27</b>	_____

### Initial Resource Requirements

- Land: 1 acre
- Labor
  - Land preparation: 27 hours
  - Planting: 22 hours
  - Production labor (scouting, thinning, pruning, spraying, and mowing harvest labor): 48 hours
- Capital
  - Equipment: \$20,000 to \$30,000
  - Land preparation and planting: \$3,200 to 3,600/A
  - Production years: \$2,400 to \$3,000/A
- Equipment
  - Tractor (45 horsepower minimum)
  - Airblast orchard sprayer
  - Herbicide sprayer
  - Rotary mower
  - Tillage equipment
  - Containers (bulk bins, bushel crates, boxes)
  - Pruning equipment
  - Harvesting equipment

## For More Information

Bradford, H., and L. Tukey (1978). *Dwarfed Fruit Trees for Orchard, Garden, and Home: With Special Reference to the Control of Tree Size and Fruiting in Commercial Fruit Production*. Ithaca, N.Y.: Cornell University.

Crassweller, R. M., ed. (2004). *Pennsylvania Tree Fruit Production Guide 2004–2005*. University Park, Pa.: The Pennsylvania State University.

Dunn, J. W., J. K. Harper, and G. L. Greaser (2000). *Agricultural Alternatives: Fruit and Vegetable Marketing for Small-scale and Part-time Growers*. University Park, Pa.: The Pennsylvania State University.

Ferree, D. C., and I. J. Warrington, eds. (2003). *Apples: Botany, Production, and Uses*. Cambridge, Mass.: CABI Publishing.

Greaser, G. L., and J. K. Harper (1994). *Agricultural Alternatives: Enterprise Budget Analysis*. University Park, Pa.: The Pennsylvania State University.

Jackson, D., et al, eds. (1999). *Temperate and Subtropical Fruit Production*. 2nd ed. Cambridge, Mass.: CABI Publishing.

Lamont, W. J. Jr., J. K. Harper, A. R. Jarrett, M. D. Orzolek, R. M. Crassweller, K. Demchak, and G. L. Greaser (2001). *Agricultural Alternatives: Irrigation for Fruit and Vegetable Production*. University Park, Pa.: The Pennsylvania State University.

Salunkhe, D. K., ed., and Kadam, S. S. (1995). *Handbook of Fruit Science and Technology: Production, Composition, Storage, and Processing (Food Science and Technology, No. 70)*. New York: Marcel Dekker.

Schlabach, D. R. (2001). *Backyard Fruit Production*. Revised edition. Walnut Creek, Ohio: Carlisle Press.

Sommerville, W. (1997). *Pruning and Training Fruit Trees (Practical Horticulture)*. Woburn, Mass.: Butterworth-Heinemann.

Teskey, R. J. E. (1978). *Tree Fruit Production*. 3rd ed. New York: Van Nostrand Reinhold.

## Associations

Many states have horticultural societies or fruit growers associations. Many of these may be found through the following sources.

American Society for Horticulture Science  
7931 East Boulevard Drive  
Alexandria, VA 22308  
<http://www.ahs.org/>

North American Fruit Explorers  
1716 Apples Road  
Chapin, IL 62628  
<http://www.nafex.org/>

State Horticultural Association of Pennsylvania  
697 Mountain Road  
Orrtanna, PA 17353  
<http://www.shaponline.org/index.html>

## Web Sites

ID-137: Total Quality Assurance: Apple Production: Best Management Practices  
<http://www.ca.uky.edu/agc/pubs/id/id137/id137.htm>

Organic and Low-Spray Apple Production  
<http://attra.ncat.org/attra-pub/apple.html>

Ohio State University Organic Apple Disease Spray Guide  
<http://www.caf.wvu.edu/kearneysville/organic-apple.html>

The Penn State Small-Scale Fruit Production Guide  
<http://ssfruit.cas.psu.edu/>

Pennsylvania Tree Fruit Production Guide  
<http://tffpg.cas.psu.edu/>

The Virtual Orchard  
<http://www.virtualorchard.net/>

University of Vermont Virtual Orchard  
<http://orchard.uvm.edu/>

Virginia Apples  
<http://www.ento.vt.edu/Fruitfiles/VirginiaAppleSite.html>

Prepared by Robert M. Crassweller, professor of horticulture; Lynn F. Kime, extension associate in agricultural economics; and Jayson K. Harper, professor of agricultural economics.

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Produced by Information and Communication Technologies in the College of Agricultural Sciences

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