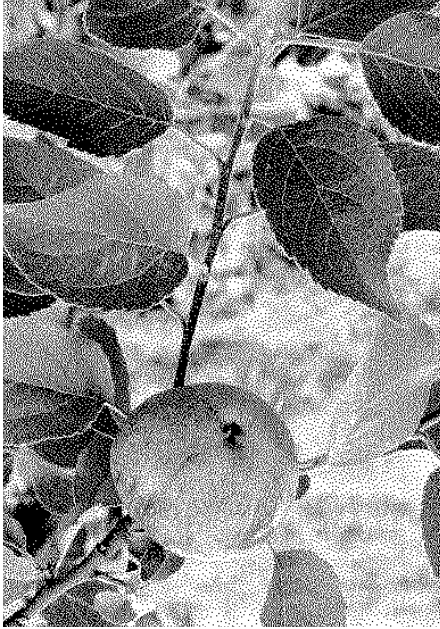




**PLANNING AND
ESTABLISHING
COMMERCIAL APPLE
ORCHARDS
IN WISCONSIN**



Teryl R. Roper and Gary G. Frank



**PLANNING AND
ESTABLISHING
COMMERCIAL APPLE
ORCHARDS
IN WISCONSIN**

◆ ◆ ◆ ◆ ◆ ◆ ◆ ◆ ◆ ◆
Teryl R. Roper and Gary G. Frank



INTRODUCTION 2

SITE SELECTION 2

Temperature 2

Elevation and Exposure 3

Previous Crops 3

Location for Marketing 3

Soil Requirements 4

ORCHARD PLANNING 4

Marketing 5

Orchard Size 5

Orchard Layout 7

SITE PREPARATION 11

Clearing and Cultivation 11

Soil Testing 11

Subsoiling 11

**ORCHARD-FLOOR
MANAGEMENT 11**

Windbreaks 12

TREE PLANTING 12

Planting Methods 12

Staking 13

TREE NUTRITION 13

IRRIGATION 13

TRAINING AND PRUNING . 14

Pruning at Planting 14

PEST MANAGEMENT 15

Insects and Diseases 15

Rodents and Deer 17

WINTER INJURY 17

RECORD KEEPING 18

COST OF ESTABLISHMENT . 18

ADDITIONAL RESOURCES . . 20

INTRODUCTION



Apple production can be a financially and emotionally rewarding venture. However, a desire to grow fruit is not sufficient reason to establish a commercial orchard. A small backyard or hobby orchard can be a satisfying avocation, but

establishing a successful commercial operation takes time, skill, experience, and capital. Commercial apple growing is an increasingly complex operation requiring operators to keep abreast of current developments in plant materials, cultural techniques, pest management, and business management. Marketing is also crucial: producing fruit without a market will lead to financial loss.

Because apples are a perennial crop, mistakes made when the trees are young can affect the orchard for many years. An apple orchard should last for 20–25 years. Proper planning of a proposed orchard can point out weaknesses in the plan and will be required by lending institutions. The orchard plan should include the site, the rootstocks and cultivars to be planted, pollination, the size of the orchard and tree spacing, the training and pruning system to be used, the method of harvest and marketing, a market analysis for the potential market, and a review of the expertise of the management team. After considering all of these factors, you can make an informed decision whether to plant the orchard, to revise the plan, or to invest elsewhere.

If you have no prior experience in orchard management or operation, consider working for a successful grower for at least a year to learn the operation. If that is not possible, be certain an experienced manager or consultant is available **BEFORE** you plant or purchase the orchard. Fruit production cannot be learned adequately from books. Nothing can replace experience in orchard management.

This bulletin outlines and briefly describes factors to consider before you invest in a commercial orchard.

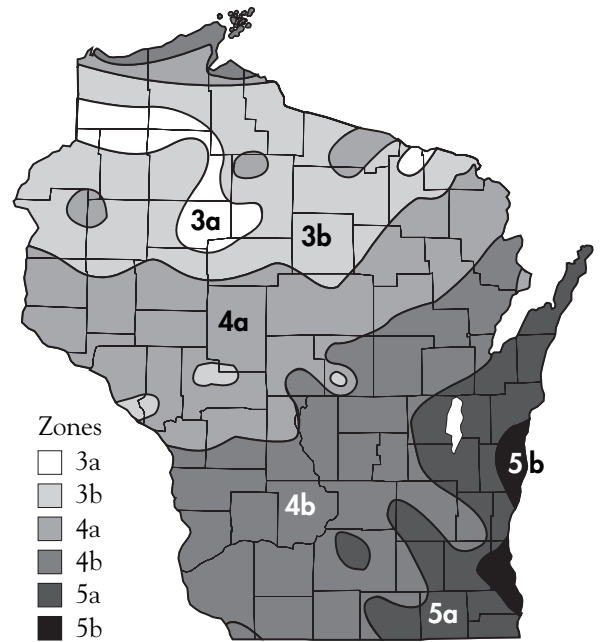


Figure 1. Wisconsin plant-hardiness zone map. Orchards located in USDA hardiness zones 4 and 5 have more cultivar options than orchards located in zone 3.

SITE SELECTION

Site selection is extremely important. Once an orchard is planted it cannot be moved to a better location. Old orchard sites are not necessarily the best sites for establishing a new orchard, although they may be used with proper preparation. You must consider several factors when deciding on a suitable orchard site.

Temperature

Temperature is the largest factor in determining where apples can be grown successfully in Wisconsin. Apple flower buds and trees can be killed in regions where winter temperatures are routinely below -35°F . Most of Wisconsin is in USDA hardiness zones 4 or 5, where winter temperatures will allow apple production on favorable sites (Figure 1). However, part of the state is in zone 3. Here apple production is marginal and site selection becomes even more important. Late spring frosts with temperatures below 28°F can kill flower buds or flowers.

Elevation and Exposure

A site for an apple orchard should be elevated above surrounding areas so that cold air can settle away from the trees on cold spring nights (Figure 2). Cold air is heavier than warm air and settles in low spots. On calm, frosty nights temperatures in valleys or coulees can be several degrees colder than on adjacent hillsides. This slight difference in temperature can mean success or failure for an orchard.

Since orchards are typically planted with some sort of cover crop, they may be planted on slopes that are steeper than would be acceptable for other crops. Slopes of hills or ridges are generally more desirable than the tops because of wind conditions. Wind can affect tree shape and anchorage, dry out soil, make spraying difficult, reduce bee activity for pollination, and cause limb rubs on fruit. Also, winter winds may hasten moisture loss from tree tissue, increasing winter injury. Windbreaks can improve tree growth and fruit quality. Windbreaks should be established well before apple trees are planted.

The exposure of the slope is also important. South-facing slopes experience more temperature fluctuation during the winter than north-facing slopes. Winter injury to tree trunks can be caused when sunlight reflecting off of snow causes trunks to warm and to lose hardiness. Bright sunny days followed by bitter cold nights can injure trunks that have lost hardiness. With the low angle of the winter sun, north-facing slopes receive less sunlight.

Previous Crops

If residual herbicides have been used on the site, for example atrazine for corn, you must wait at least one year before an orchard can be established. If the site was previously an orchard, remove the old trees along with as many roots as possible and prepare the soil for at least one year and preferably two years before planting new trees.

Location for Marketing

Method of marketing is an important consideration for locating an orchard. Pick-your-own operations and roadside stands are most successful near metropolitan areas and along heavily traveled roads. If the fruit is to be direct marketed at farmers' markets, proximity to such markets is desirable. If fruit is to be marketed through wholesale channels, then the orchard should have, or be near, a packing/processing facility. Transportation to markets can be a sizable cost of selling fruit.

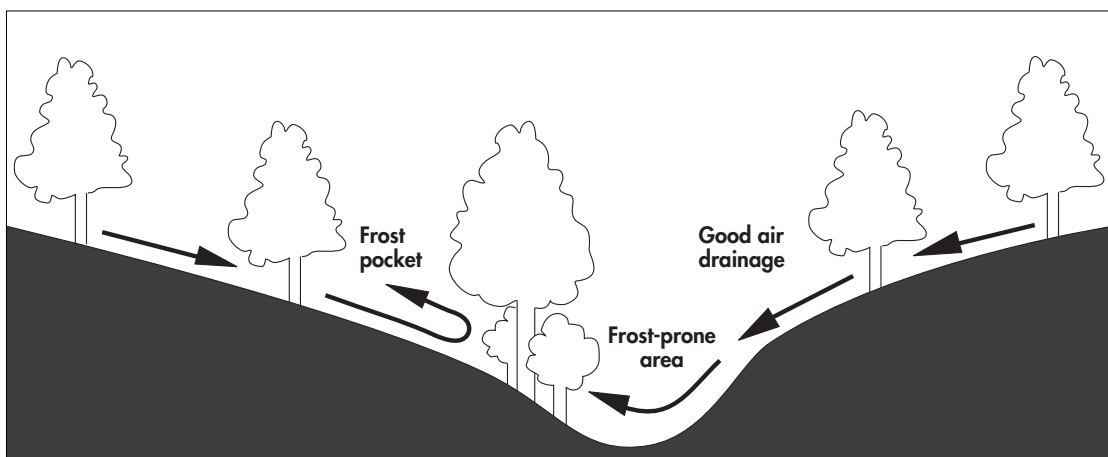


Figure 2. Cold-air drainage is an important component of site selection. Cold air settles into low areas. Avoid low areas and sites where air drainage is blocked by woods, brush, or other obstructions.

Soil Requirements

The type of soil also determines the appropriateness of a site for an orchard. The notion that soils unsuitable for production of other crops are suitable for orchards has been costly to many growers. While sites that are too steep or soils that are too rocky for other crops may be acceptable for orchards, severely eroded, low fertility, or poorly drained soils will almost certainly lead to failure.

Drainage and Aeration. Orchard soils must be well drained and aerated. Soils that remain waterlogged for extended periods of time are unacceptable for orchards. In these soils the pore spaces between the soil particles become filled with water while oxygen, which is required for root growth and survival, is excluded. Trees planted in poorly drained soils tend to have roots only in the shallow surface layers of the soil. Trees with weakened, shallow root systems will be poorly anchored and more susceptible to drought and root diseases. Although clay soils are more commonly poorly drained, even sandy, porous soils can become waterlogged if there is a tight subsoil that prevents drainage of excess water.

If you suspect poor drainage, examine the subsoil. Poorly drained subsoils typically are mottled in color and have prominent gray streaks and rusty brown spots indicating inadequate soil aeration. To detect poorly drained soil, dig test holes. If water stands within 3–4 feet of the surface for several weeks in the spring, the site is probably unsuitable for an orchard. While drainage can be improved on some soils and sites through installing tile drainage or by land reformation, it will increase the cost of orchard establishment.

Water-Holding Capacity. Soils with good water-holding capacity will retain moisture and supply water to trees during dry periods. In general, the finer the soil texture the greater its water-holding capacity. Heavy clay soils may hold as much as 30–35% of their weight as water while a coarse sandy soil may not exceed

10% of its weight in water. The amount of water a soil can hold is known as field capacity. Field capacity cannot be changed appreciably by any cultural operation. While adding organic matter increases the water-holding capacity slightly, it is usually more important in increasing water penetration into the soil.

During the summer, mature apple orchards will use about 4–6 inches of water per month, depending on the weather and orchard-floor management system. For non-irrigated orchards, if a soil can hold 8 inches of water, trees can endure a period of 4–5 weeks without rain. It has been estimated that to carry trees through a drought, a medium sandy soil will require twice the rooting depth compared to a heavier silt loam.

Acidity and Soil Fertility. Apples prefer a soil with a pH of 5.8–6.8. It is best to plant on soils with appropriate pH. However, soil pH can be temporarily raised by adding lime or lowered by adding elemental sulfur. These soil amendments should be incorporated before trees are planted, if required, and cannot be readily repeated once the trees are planted.

Fertility of soils can be amended with the addition of chemical fertilizers, so soil fertility is of secondary importance. Wisconsin soils generally have adequate amounts of potassium, phosphorus, and micronutrients. If a soil test indicates a deficiency in these elements, sufficient nutrients or lime can be incorporated prior to planting.

ORCHARD PLANNING



Before any trees are planted, a master plan for the orchard operation should be made. Components of the plan include: method of marketing; choice of cultivars, pollinizers, and rootstocks; tree spacing and layout on the land; orchard floor management; irrigation system; equipment, location of on-farm roads; etc. After you have made these decisions, you can arrange financing and order trees.

Marketing

The first decision in orchard planning is the method of marketing. This decision will dictate many other facets of the operation. There are essentially three methods of marketing apples, and most growers use more than one method. For more information about marketing, contact your county Extension office or local Chamber of Commerce.

Pick-Your-Own. Once a popular marketing method, pick-your-own has declined in favor recently. With more double-income families, customers simply have less time for picking fruit. Operations using pick-your-own marketing should plant dwarf trees to avoid the need for ladders. This should reduce liability insurance costs. Small trees allow closer spacing. Pick-your-own marketing requires easy public access, ample parking facilities, and traffic control for check-out accountability. Pick-your-own orchards will have to be “park like” in their maintenance. One of the draws of pick-your-own operations is the rural experience of being on a farm. “Agritainment” can be used to build a successful operation.

Before deciding on pick-your-own marketing you will need to determine how many potential customers you have within about 20–30 miles of the proposed orchard and how many trees would be needed to service those customers. Next, subtract from this estimate apples produced by competing orchards in the vicinity. This will provide a rough estimate of market capacity in your area. If there is an insufficient customer base for pick-your-own, you may need to consider a secondary market for the fruit or an alternative location.

Farm Markets. A second direct-marketing technique is to use roadside stands or farmers’ markets. In both instances, labor for harvesting fruit is required. Roadside stands should be established only on highways with sufficient traffic to provide enough customers for selling the crop. On-site grading facilities will need to be established or contracts made to grade the fruit off-farm. Closed containers offered for sale must comply with USDA grades.

Wholesale Markets. Marketing through produce wholesalers is used most often by larger growers who are able to consistently provide quality fruit to wholesalers. A large quantity of apples can be moved through these well-established networks. Wholesale marketing requires ample picking labor and equipment for harvesting, storing, and transporting fruit. A grading and packing facility will need to be constructed or contracts established to have the fruit packed off-farm. It is perhaps more economical to have fruit graded and packed off-farm than to build a small packing line that is run for only a few weeks each season. These decisions should be made before the orchard is planted.

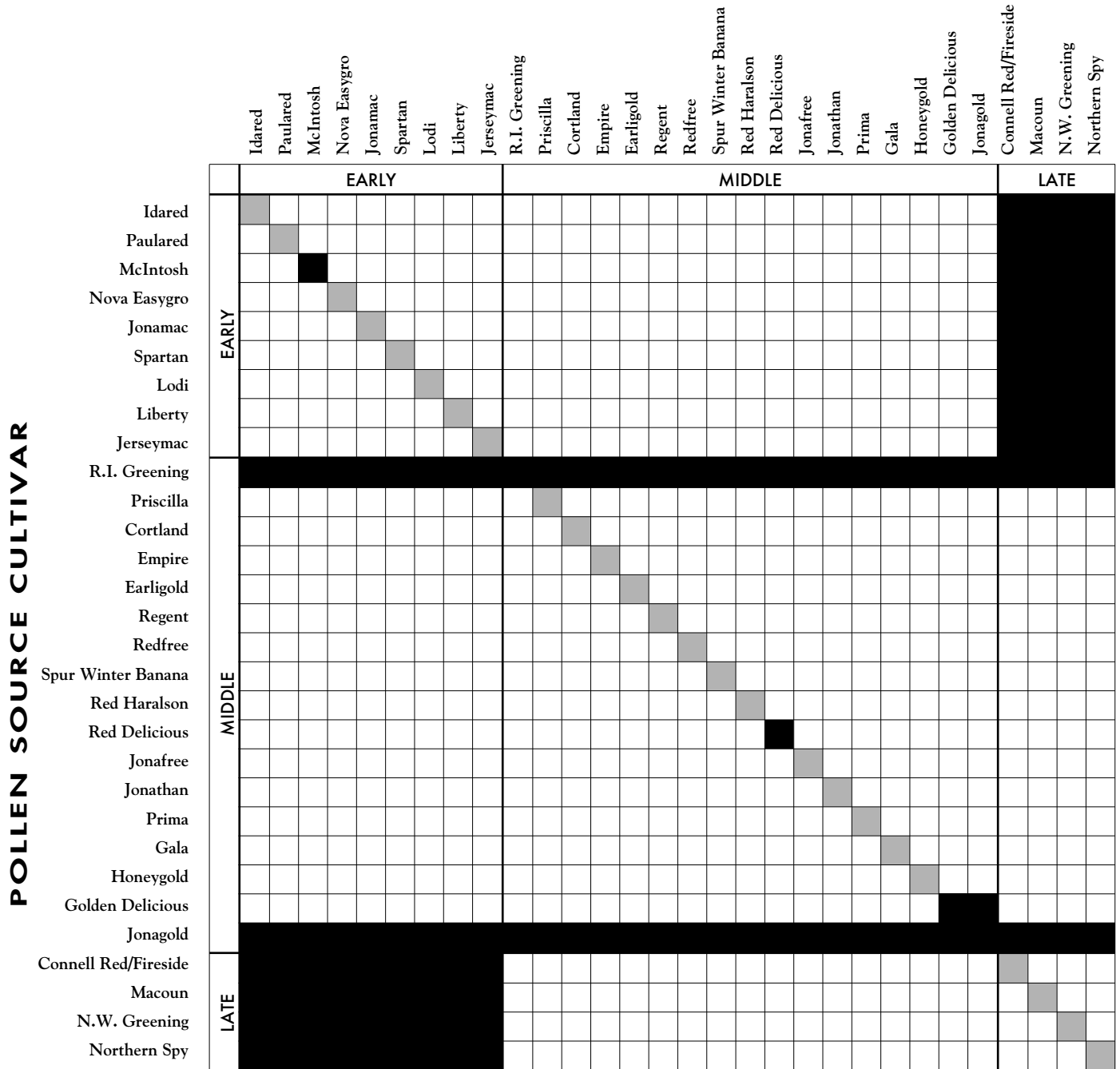
Contact produce wholesalers while the orchard is still in the planning stage. Ask if they are interested in purchasing the cultivars you intend to plant. They may be able to offer suggestions about what their customers want in terms of cultivars, grades, and packs. They may also give you a price history for apples for the last several years so that your price expectations are realistic.

Orchard Size

An orchard of 30–35 acres can provide sufficient income for a family. An orchard of this size utilizes equipment efficiently and allows one person to do most of the routine work. Additional labor will be required for pruning and harvest. When deciding orchard size, determine whether additional labor will be available.

The method of marketing may also affect orchard size. For instance, pick-your-own orchards should not be larger than the market they serve requires. Otherwise, unharvested fruit will remain on the trees and potential income will be lost.

CULTIVAR POLLINATED



- Can be relied upon to pollinate this cultivar
- Partially self-fruitful but should not be planted in a solid block
- Should not be relied upon as the only pollinizer for this cultivar

Figure 3. Apple cultivars are mostly self-unfruitful. Cultivars that are pollen compatible and that have an overlapping blossom period should be combined in an orchard. Triploid cultivars such as Gravenstein, Winesap, and Jonagold should not be used as a pollen source for other cultivars.

Orchard Layout

The orientation of the orchard can influence its productivity. North-south orientation of the rows allows for maximum light interception throughout the day. However, when planting on slopes, rows should be across the slope to minimize erosion problems and allow for safest equipment operation.

Larger orchards (over 5 acres) should be planted in discrete blocks that can be managed as individual units. In this way record keeping can be by blocks, making it easier to determine the profitability of each orchard unit. Further, partitioning the orchard allows you to renovate and replant entire blocks, leaving the rest of the orchard unaffected. Consider planting cultivars that flower together in individual blocks. By doing so chemical thinning sprays and petal-fall and post-bloom pesticide applications can be applied to entire blocks rather than to scattered rows or individual trees.

Cultivar and Rootstock Selection.

Deciding which apple cultivars to grow is an integral part of orchard planning. The cultivars and rootstocks selected will determine tree spacing, tree training, and pest management and are factors in marketing decisions. Remember that you will be providing a product for consumers and should plant what consumers buy. These may not be your favorite cultivars.

Cultivars should bloom late enough to avoid spring frosts (Figure 3) and the number of days between bloom and harvest must be short enough to consistently ripen fruit in Wisconsin. For example, Granny Smith is a very popular apple, but it requires 180–200 frost-free days to ripen properly. On average, Wisconsin has about 150 frost-free days. Northern Wisconsin has even fewer frost-free days.

Because different apple cultivars ripen over a period of 2–3 months, you should plan to plant early, mid-season, and late-ripening varieties. This will spread out the harvest season and allow you to provide fresh fruit over a longer period of time. For more information about apple cultivars, see Extension publication A2105, *Apple Cultivars for Wisconsin*.

Selecting the proper rootstock is as important as selecting the scion (cultivar). To a large degree, the rootstock determines tree size. Trees may be full sized, semi-dwarf, or dwarf (Table 1). Full-sized trees on seedling rootstocks are not recommended because they occupy substantial amounts of space, are slow to come into bearing, and provide a slower return on investment. Semi-dwarf and dwarf trees are more precocious (early bearing), occupy less space, and should provide a greater and faster return on investment. Smaller trees are easier to harvest, spray, and prune. Cultivars and rootstocks must be properly matched for desired results. Low-vigor scions, such as spur types of Red

Table 1. Characteristics of apple rootstocks suitable for Wisconsin. Listed by size, from smallest to largest.

Rootstock	Size ^a	Precocity	Hardiness	Soil adaptability	Crown rot	Fire blight
B.9	40%	Very early	Excellent	Well-drained soils		Field resistant
M.9	40%	Very early	Good	Deep, well-drained soils	Mostly resistant	Susceptible
M.26	50%	Early	Hardy	Well-drained soils	Susceptible	Very susceptible
G.30	55%	Very early	Hardy	Broadly adapted	Resistant	Resistant
M.7	60%	Early	Good	Well adapted except on clay soils	Moderately susceptible	Moderately resistant
MM.106	70%	Medium	Moderate	Well adapted, avoid wet sites	Susceptible	
MM.111	75%	Medium	Moderate	Well adapted, drought tolerant	Tolerant on most soils	
Seedling	100%	Slow	Hardy	Well adapted	Variable	Susceptible

^aSize is given as percentage of a standard apple tree.

Delicious, should not be propagated on very dwarfing rootstocks such as M.9 (Table 2). On the other hand, an overly vigorous scion can be controlled by planting on a low-vigor (dwarfing) rootstock.

Tree Spacing. Tree spacing between rows and within rows depends largely on the rootstock/scion combination and on the size of the equipment to be used. Other considerations include soil type and fertility, water availability, and level of management. General recommendations are found in Table 3.

Pollinizers. Most apples are self-unfruitful. That means that pollen from a given cultivar will not pollinate itself (won't produce viable seed). Some apples are partially self-fruitful but will produce larger crops if cross pollination is provided. As a general rule, apples should not be planted in solid blocks of a single cultivar. Pollinizers are placed in the orchard to provide pollen to the main cultivars being grown.

Pollinizers may be spaced individually throughout the orchard (for example, every third tree in every third row) or they may be planted in solid rows interspersed with the main cultivar. See Figure 4 for additional plans for placing pollinizers. Ideally, pollinizers are economically valuable so that they provide fruit as well as pollen. The number of pollinizer trees required in an orchard depends on the design. No tree should be farther than 100 feet from a pollen source. At a minimum, 10% of the trees in an orchard should be pollinizers.

The pollinizer must be selected carefully. The first criterion is that their blossoming must overlap (Figure 3). The pollinizer cultivar should blossom slightly before the main cultivar so that viable pollen is available for pollinating the first bloom or "king bloom" of the main cultivar. Triploid apple cultivars such as Winesap or Jonagold do not produce viable pollen and cannot be used as pollinizers. Different strains of the same cultivar will not adequately pollinate each other. For

Table 2. Relative tree size of common apple cultivars grown in Wisconsin.

Small	Medium	Medium-large	Large
Macspur	Connell Red/Fireside	Cortland	Earligold
Spur Red Delicious	Gala	Empire	Jerseymac
	Golden Delicious	Honeycrisp	Liberty
	Idared	Honeygold	Lodi
	Jonagold	Jerseymac	N.W. Greening
	McIntosh	Jonafree	Northern Spy
	Prima	Jonathan	Priscilla
	Red Haralson	Macoun	Red Delicious (standard)
	Redfree	Nova Easygro	
		Spartan	

Table 3. Suggested tree spacing for different rootstocks and tree sizes in Wisconsin.

Scion size	M.9/B.9	M.26/G.30	M.7	MM.106	MM.111
Small	6x12	10x14	10x18	14x20	14x22
Medium	10x16	12x16	14x18	18x20	20x22
Large	12x18	14x20	16x20	20x24	20x26

example, spur-type strains of Delicious, although carrying different names, are considered one cultivar for pollination purposes. Some growers use crabapples as pollinizers. Crabapples can be managed to occupy minimal space and to flower profusely. When used as pollinizers, crabapples must blossom slightly before the culinary apples. With crabapple pollinizers there is no confusion about what to pick at harvest.

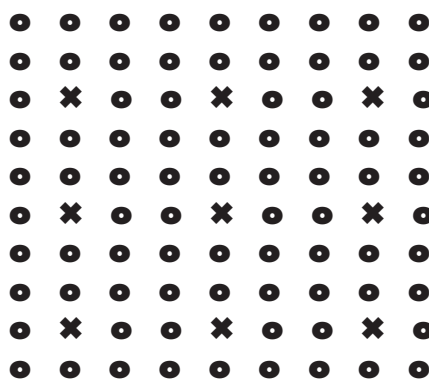
Ordering Nursery Stock. Once the rootstock, cultivar, and pollinizers have been selected, place an order with a reputable nursery well in advance of planting. If sufficient advance notice is provided (1–2 years) many nurseries will custom propagate trees, usually at a discount. By ordering early you can get the scion/rootstock combination you want and not just the one that was available. Specify a delivery date that will allow for planting at the right time (see “Tree Planting”).

Order trees only from reputable nurseries that offer the particular scion/rootstock combination you desire. Commercial nurseries are efficient and will likely produce better-quality trees for less money than doing the job yourself. Many of the newer popular cultivars are patented and must be propagated only by the nursery holding the patent or with their permission. **Propagating patented plant material without authorization is illegal!**

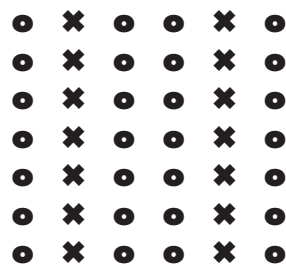
Trees are graded by their size. Size is determined by height and by caliper at 2 inches above the bud union. The most desirable trees are 1/2–3/4 inch in diameter. Trees larger than this may not transplant readily. Smaller trees may have poor graft unions or may not have received proper care in the nursery. Trees may come branched (feathered) or unbranched (whips). Well-feathered trees are usually more desirable as they set fruit at a younger age than unbranched trees.

Figure 4. Examples of different pollinizer placements in an apple orchard.

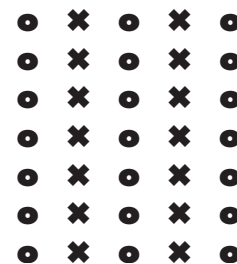
- = main cultivar
- ✕ = pollinizer
- = crab apple pollinizer



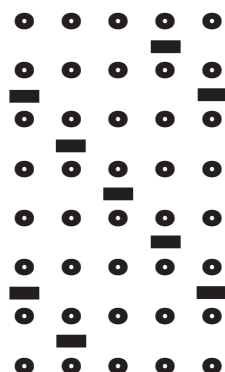
A. Every third tree every third row.



B. Every third row.



C. Every other row.



D. Crabapples trained to columnar form as pollinizers.

ORCHARD PLANNING CHECKLIST

1. GOALS

- ✍ Why do you want to begin an orchard?
- ✍ What are your long-term goals?
- ✍ What return on your investment do you expect? Can you wait 8–10 years to break even on your investment?

2. MARKETING

- ✍ How will you market your apples? (Pick-your-own, roadside stand, farmers' markets, or wholesale)
- ✍ How will the fruit be harvested, sorted, graded, and packed?
- ✍ Is your market saturated or can it absorb more fruit? Will the increase in supply lower the price?

3. ORCHARD SITE

- ✍ Is the climate correct?
- ✍ Is the location convenient to your intended market?
- ✍ Is there good air drainage?
- ✍ Are the soils adequate for orcharding?

4. ORCHARD DESIGN

- ✍ How many acres will you plant?
- ✍ Is there adequate space for equipment, roads, and buildings?
- ✍ What cultivars and rootstocks will you use?
- ✍ What tree density per acre will you use?
- ✍ Where and when will you purchase the trees?
- ✍ Draw a map showing the location of all trees, buildings, and roads.

5. MANAGEMENT

- ✍ What time and expertise can you devote to the orchard? Have you hired a competent manager or consultant?
- ✍ How will the trees be trained? Who will train and prune?
- ✍ What fertility program will you use?
- ✍ Will you irrigate the trees? Is irrigation water available?
- ✍ How will insect, disease, and weed pests be managed?

SITE PREPARATION

Begin site preparation at least a year before planting. Giving yourself a year allows proper cultivation, perennial weed control, fertility and pH adjustment, and cover crop establishment. Orchard sites can be either land that has not been planted to trees before, or sites where an orchard has just been removed. Preparation for each type of site is slightly different.

Clearing and Cultivation

Clearing operations should disturb the soil as little as possible. However, as much of the wood, roots, debris, and rock should be removed as possible. Where possible, fill all gullies, washouts, and low spots and level ridges or high places. Seed these areas with a cover crop.

Old Orchard Sites.

When planting on an old orchard site, remove as many of the old roots as possible. The ground should be planted to green manure crops for at least one year—preferably two—before replanting to apples or other fruit trees.

Soil Testing

Take a soil test of the orchard site during the year prior to planting to allow time for correcting deficient nutrients and soil pH, if necessary. Soil samples should be taken from several locations in the orchard site. Each sample should represent no more than 4–5 acres of uniform soil. If there are obvious differences in the soils across the orchard, take samples from each area. For each area to be sampled, collect at least 10 one-inch-diameter cores of soil from a depth of 0–6 and 6–12 inches. Mix these subsamples well in a non-galvanized container. Place 1.0–1.5 cups of soil from the composite sample into the bag or box from the laboratory. Information on taking soil samples is available from your county Extension office or from Extension publication A2100, *Sampling Soils for Testing*.

If the soil test indicates a deficiency in phosphorus, potassium, or micronutrients, these can be applied the year before planting. Use the maximum rates suggested because you won't be able to incorporate applications after planting. If the soil pH needs to be adjusted, apply the maximum amount of lime or sulfur recommended and incorporate it deeply.

Subsoiling

Compacted soils or soils with an impermeable hardpan should be broken up prior to planting. Such subsoiling should improve water and root penetration and water drainage. Subsoil to a depth of 2–3 feet in two perpendicular directions when the soil is dry for best results.

ORCHARD-FLOOR MANAGEMENT

Beginning site preparation a year before planting allows time to kill perennial weeds such as Canada thistle, field bindweed, and quackgrass. Tillage alone cannot control these weeds. Herbicides such as glyphosate provide successful control of perennial weeds.

Once the soil has been amended, subsoiled, and cultivated and weeds have been controlled, a permanent cover crop should be established to control erosion over the winter before planting and to provide a solid support for planting operations. Grasses are the most desirable cover crops, particularly Kentucky bluegrass, creeping red fescue, and perennial rye. Before the first killing frost in the fall, kill planting strips with a postemergent herbicide such as paraquat or glyphosate. The grass between the tree rows is maintained as a permanent part of the orchard.

After the orchard is planted, it is important to keep the area around the young trees free of weeds. The roots of young trees are at the same soil depth as the weeds and therefore must compete with weeds for water and nutrients. Weeds have been shown to substantially decrease growth and yield in young trees. The two mechanical means of weed control are cultivation and mulching.



Cultivation must be shallow to avoid damaging the tree roots. Tractor-mounted cultivators may damage tree trunks as well. Mulches work well, but they are expensive to apply each year, they may provide rodent habitat, and sufficient quantities of appropriate mulching materials may not be locally available. Herbicides provide a third option for weed control. Avoid spraying herbicides on the leaves or trunks of young trees to prevent injury to the tree. Proper application of the correct material at the recommended rate has given good results. More information about orchard-floor management and chemical weed control in apple orchards is available in Extension publications A3562, *Orchard-Floor Management for Fruit Trees*, and A3314, *Commercial Tree Fruit Spray Guide*.

Windbreaks

Wind can inhibit tree growth and training and interfere with orchard operations such as spraying and pruning. Wind can cause trees to lean in one direction, which prevents proper scaffold distribution around the central leader of the tree. Wind also increases the rate of transpiration, which may lead to excessive water use. Planting windbreaks on the windward side of the orchard can significantly improve these conditions. Avoid planting windbreaks at the bottoms of slopes to

prevent frost pockets at the bottoms of slopes. A windbreak should be planted at least two row widths away from the closest trees to prevent shading.

Ideally, windbreaks should be established three to four years prior to planting the orchard. Windbreaks usually include both evergreen and deciduous species. Consult your county Extension office for recommended species and planting densities for your location.

TREE PLANTING

The best time to plant trees in Wisconsin is in the spring. Trees planted in the fall do not have sufficient time to establish a root system and are more susceptible to frost heaving. Trees planted in the spring will have spent the winter in temperature controlled warehouses and will have no winter injury or rodent damage. Plant trees as early as possible, usually in late April. If the trees cannot be planted immediately after arrival from the nursery, keep them in a cold room at 35°F until planting. Do not store nursery stock in a cold room with fruit such as apples and pears that produce ethylene. Make sure the roots remain moist.

Planting Methods

Fruit trees may be planted by hand with a shovel, with an auger (18-inch at least), or with a tree planter. Planting trees with a shovel takes the most time but allows the most control over the placement of the tree and the size of the hole. If you use an auger, score the sides of the hole to prevent forming an impervious layer (glazing) that will interfere with subsequent root growth and water movement.

The hole should be large enough for the roots to be spread out and not bent or curled in the hole. Prune excessively long roots. The bud union on dwarfing or semi-dwarfing rootstocks should be 2–3 inches above the soil line as shown in Figure 5. If the scion on such trees is allowed to root, the size-controlling effect of the rootstock will be lost. The graft union on trees on seedling roots may be placed 2–3 inches below the ground. Backfill the hole with soil and tamp the soil firmly around the roots. Make sure the tree is upright and positioned bending slightly into the prevailing winds.

Trees should be irrigated *immediately* after planting! Do not wait to provide water for trees. A basin may be built up around the tree that will hold 2–3 gallons of water. Do not build a basin below the ground level.

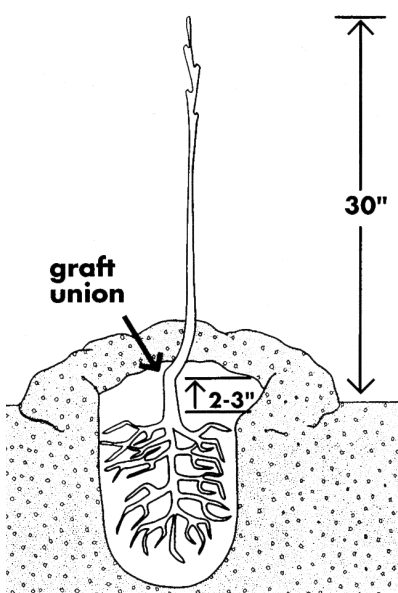


Figure 5. Properly planted “whip” apple tree showing bud union placed 2–3 inches above the soil line. A basin retains irrigation water.

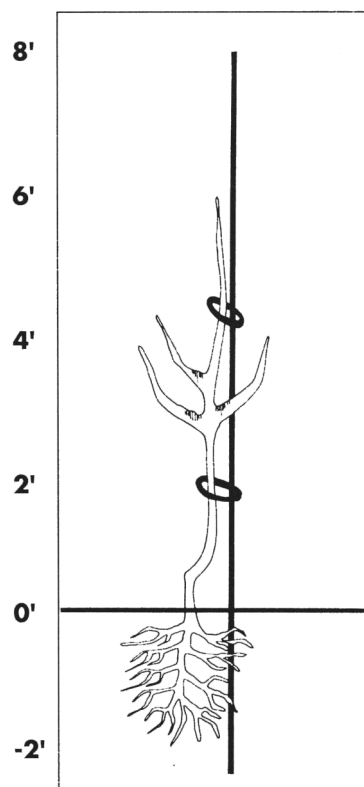


Figure 6. Young feathered apple tree tied to a permanent stake at planting for support of the central leader and tree root system.

Staking

All apple trees benefit from staking. Trees planted on dwarfing (M.9 and B.9) and some semidwarfing (M.26 and G.30) rootstocks **MUST** be staked at planting. Such trees sometimes are poorly anchored, have brittle roots, or have weak graft unions. The stake allows the tree to produce branches that will bear fruit rather than trunk caliper and it provides support to the union, roots, and leader. Stakes should be placed about 2 inches from the tree and the leader or trunk fastened loosely to the stake (Figure 6).

Suitable stakes may be pressure-treated wood stakes of 2- or 3-inch diameter or $\frac{3}{4}$ -inch electrical conduit. Bamboo stakes have not been suitable in Wisconsin. Stakes should be at least 10 feet long with 2 feet driven below ground. Place stakes as trees are planted.



TREE NUTRITION

Do not add fertilizer to the planting hole. Wait 3–4 weeks until the soil has settled and the roots have had a chance to grow before applying fertilizer.

Phosphate and potassium should have been added the fall before planting and none should be needed in the spring (see “Soil Testing” above).

Young apple trees should produce 15–30 inches of shoot growth per year. More growth than this is undesirable. Less growth than this may indicate a shortage of water or nutrients, particularly nitrogen. Nitrogen can be added as urea, ammonium nitrate, ammonium sulfate, or calcium nitrate. Spread about 3 ounces of actual nitrogen around the drip zone of each tree 3–4 weeks after planting. One or two subsequent applications during the establishment year will help to encourage strong growth if needed. Stop applying nitrogen mid-July to allow the trees to harden for winter.

IRRIGATION

Apple trees must receive sufficient water to survive summer months. Water may be provided by one of two irrigation methods: sprinkler or trickle. Sprinkler irrigation is expensive to install and operate but can also be used for frost protection. Trickle (drip) irrigation is more efficient and delivers water only to the area around trees. Only high-quality, thoroughly filtered water should be used for trickle irrigation. With the advent of low-volume and low-pressure irrigation systems, the costs of installation and operation have decreased.

Irrigation is most beneficial for young trees, which do not have extensive root systems and cannot explore large volumes of soil to get water. Trees must be watered **immediately** upon planting. Thereafter, each young tree will require about 5 gallons of water per week. As trees grow and leaf area increases, water requirements also increase.

Irrigation should be supplied beginning at bud break or blossom and continuing throughout the season as needed. Do not wait for trees to show signs of stress before irrigating. Trees on dwarfing rootstocks particularly benefit from regular irrigation because dwarfing rootstocks explore a limited volume of soil. Apple trees on standard (seedling) rootstocks traditionally have not been irrigated in Wisconsin. It was thought that once the trees were established they could explore large volumes of soil for water and nutrients. Research has shown that all apple trees benefit from irrigation.

Allowing weeds, particularly grasses, to grow right around the trees will aggravate water shortages. Weeds are very competitive for water and will limit the amount of water available to the trees. Young trees are particularly susceptible to weed competition.

TRAINING AND PRUNING

Training and pruning are conceptually some of the most difficult orchard operations. Although they are often considered separate operations, pruning is really one aspect of tree training. The method of training should be decided prior to planting the orchard as it will affect tree selection and planting density.

Experience is the best way to learn to train and prune trees properly. Establishing a vision of what a mature tree will look like makes it easier to train the trees to that form. In training and pruning, remember that light is essential to production of quality fruit. Trees with poor light penetration or distribution will produce few, small fruit of poor quality. A glossary of pruning terms and simple pruning explanations are given in Extension publication A1959, *Training and Pruning Apple Trees*.

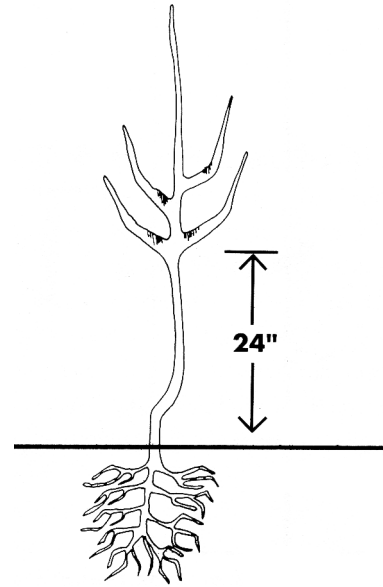


Figure 7. Properly planted branched apple tree. All lateral limbs are lower than the central leader. All usable branches were retained.

Pruning at Planting

Pruning trees at planting will have a lasting effect on the performance of the trees during their lifetime. Trees from the nursery can be either unbranched (whips) or branched (feathered). Whips should be pruned at about 30 inches above the soil to stimulate branching.

Well-feathered trees should not be severely pruned at planting, as this will delay fruiting. Remove any broken or damaged branches and all branches growing less than 24 inches above the soil (Figure 7). Select 4 or 5 well spaced branches for the first tier of scaffolds and remove the remainder. Do not cut the ends off (head) the branches!

Later in the summer after branches are developed, spread branches to produce wide crotch angles. Lateral scaffold limbs should be spread to 60° from vertical (Figure 8). Wide crotch angles maximize both fruiting potential and structural strength to support the weight of fruit. Small limbs can be spread with toothpicks or spring-type clothespins.

During the first dormant season, remove weak or damaged limbs. Select the first tier of scaffold limbs and make sure they have wide crotch angles (60° from vertical). Select the most vigorous upright limb to be the central leader. How this leader will be managed depends on the training system selected (Figure 9). In the central-leader system the leader should be headed to produce more vigorous branching. For a vertical-axis system the leader is left unheaded and is encouraged to reach maximum height quickly; such a leader must be supported with a post or a suspended string or wire. The slender spindle system requires that a weak lateral be chosen for the leader; this lateral is then tied into a vertical position, while the more vigorous branch is either removed or bent over to decrease its vegetative vigor and to pull the weaker branch into the vertical position.

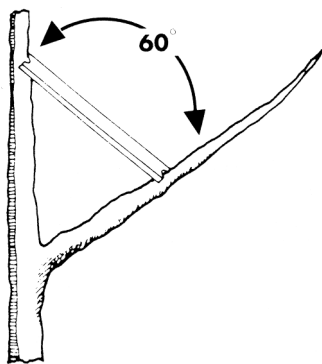
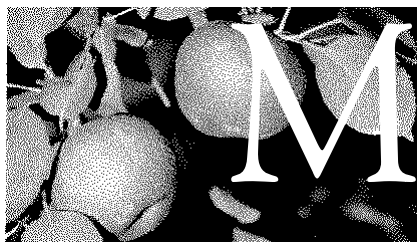


Figure 8. A piece of wood used as a “spreader” to create a wide crotch angle in an upright-growing limb.

PEST MANAGEMENT



any different pests invade apple orchards. Some injure the fruit directly, making it unmarketable. Others damage the tree, thereby reducing productivity or killing the tree outright. Others are irritating to orchard workers and customers.

Production of commercial quantities of apples in Wisconsin using organic or no-pesticide techniques is not advised for newcomers to apple production. Because of the significant insect and disease pests, it is difficult at best to produce marketable apples without pesticide treatments. Growing organic fruit requires a highly proficient level of management.

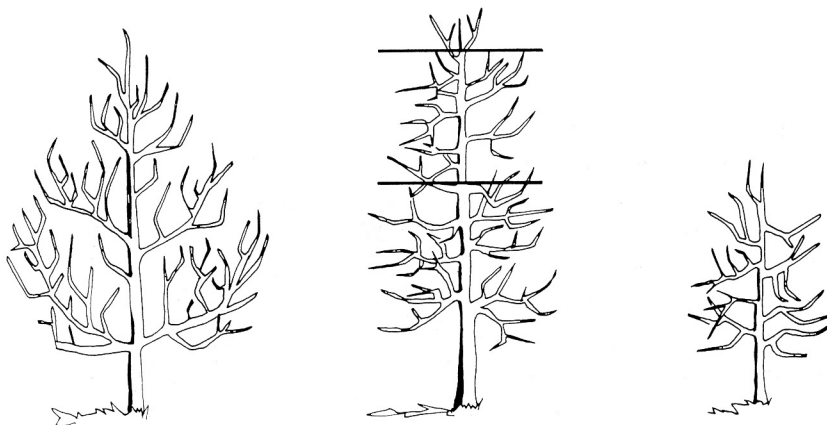
Insects and Diseases

Insect and disease problems can occur even with young non-cropping trees. Common insect pests in Wisconsin orchards include codling moth, plum curculio, leafroller, leaf miner, aphids, and apple maggot. Mites can also be a problem in apple orchards. The principal disease of apples in Wisconsin is apple scab. Other diseases, such as sooty blotch, fly speck, fire blight, and cedar apple rust, can also be problems but to a lesser degree. Orchardists will need to become familiar with these pests to identify and control them properly. More information about managing insects and diseases in apple orchards is found in Extension publication A3314, *Commercial Tree Fruit Spray Guide*.

To protect the environment, employees, and customers from pesticides, apple growers should use integrated pest management (IPM) practices. IPM training is available through your county Extension office and through annual grower meetings. Apple growers and their employees should be certified pesticide applicators.

You will need to learn and follow state and federal laws regarding pesticide use.

Figure 9. Comparison of central leader training systems for non-spur apple cultivars (after Barritt, 1984).



	PNW Head & Spread	Vertical Axis	Slender Spindle
Tree height	10–15 feet	10–14 feet	7–8 feet
Tree spread	7–10 feet	4–6 feet	4–6 feet
Spacing of single rows	16–20 feet	13–16 feet	10–12 feet
Tree density	200–400 trees/a	450–800 trees/a	700–1100 trees/a
Rootstocks	M.26, M.7, MM.106, MM.111, seedling	M.9, M.26, M.7, G.30	M.9, B.9
Tree support	None	Pole and wires	Post or stake
At planting head the tree	Yes	No	Yes
Select 3–5 permanent lower scaffolds	Yes	Yes	Yes
Head leader in dormant season	Yes	No	No
Pruning of central leader after year 1	Head into 1-yr-old wood. To maintain height, cut to lateral	No heading. To maintain height, cut to replacement leader	Head to competing lateral on older wood
Remove central leader to weaker side shoot in each dormant season	Yes	No	No
Head scaffolds in dormant season	Yes	No	No
Spread or tie down branches	Yes, 60° from vertical	Yes	Yes, to horizontal
Control limb length by cutting back into older wood	Yes	Yes	Yes, lower tier
Control limb length by removal to trunk	No	Yes, upper limbs, leaving a stub	Yes, upper limbs, leaving a stub

Rodents and Deer

Rodents are undesirable in apple orchards because they can damage tree roots and trunks, particularly of young trees. The principal rodents in Wisconsin orchards are the meadow vole and the white foot mouse. Once the trees are planted the trunks should be protected by a trunk guard. Several types of commercial trunk guards are available. The best kind do not touch the trunk. A very satisfactory trunk guard can be made from an 18-inch square piece of $\frac{1}{2}$ -inch or $\frac{1}{4}$ -inch mesh hardware cloth. The mesh is bent in a circle and wired closed around the trunk (Figure 10). Poisonous baits are available for rodents, but they may not be completely effective.

Much can be done to make the orchard unattractive to rodents. Keep grass or other vegetation mowed short in late summer and fall to limit rodent habitat and improve the effectiveness of predators. The last operation that should be completed in the fall is to mow the orchard cover crop to remove rodent habitat. In the fall, remove windfall apples from the orchard or chop them using a flail-type mower so the fruit will dry and decompose. More information is available in Extension publication A2148, *Meadow Mouse Control* and A3562, *Orchard Floor Management for Fruit Trees*.

Deer continue to be a problem for orchardists. Deer forage on the tender shoots and leaves. When a deer removes a growing point, the crop for that year is lost and production on that limb can be delayed for an additional one or two years. Deer damage to young trees is more likely and more serious than to older trees.

Many techniques for repelling deer rely on scent. These include hanging small bars of soap, bags of tankage, or human hair in trees. These materials are effective for short periods of time and must be replaced frequently to maintain the deterrence. Various types of fences have also been used. "Ribbon" electric fences baited with peanut butter can be effective if deer pressure is low. For serious deer problems, orchards have been fenced with a multi-strand high-tensile-wire electrified

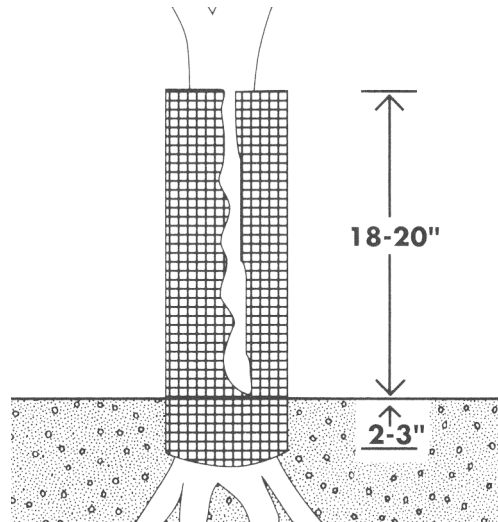


Figure 10. A trunk guard made of $\frac{1}{2}$ - or $\frac{1}{4}$ -inch mesh hardware cloth will help protect young trees from rodent injury. To be effective, the trunk guard must extend below the soil line.

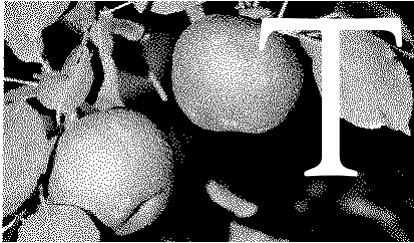
fence. This is the most effective but also the most expensive method. Some county governments will participate in the cost of installing electric fences around orchards. Contact your county conservationist for details. If you anticipate deer damage, install a deer fence before the orchard is planted. For more information about managing deer damage, see Extension publication G3083, *Controlling Deer Damage in Wisconsin*.

WINTER INJURY

Wisconsin's cold climate presents problems for keeping trees alive during the winter. Two types of winter injury are common in Wisconsin. The first type of damage is caused when the trunk warms from sunlight reflected off snow. As the trunk tissues warm, the cells become active and lose hardiness (deacclimate). When temperatures drop during the night the tissues are damaged. The second type of injury occurs during extremely cold temperatures. Apple buds and limbs can be killed when the temperature drops below -33°F . The only way to avoid these temperatures is to select an appropriate location.

You can help trees prepare for winter by avoiding late summer application of fertilizer or late summer pruning (after August 15). Both of these operations delay the onset of dormancy and may make trees more susceptible to winter injury. Painting the trunks in the fall with a dilute, inexpensive interior-grade white latex paint will reflect light and help to keep the trunks near air temperature. The paint can be thinned and spray applied. Any practice that will help the trees go into the winter without stress will help them survive the winter. Irrigation should continue into the fall if needed.

RECORD KEEPING



Two types of records must be kept in successful farm operations: production records and financial records. To some extent these records are intermingled, but they serve different functions. Production records include bloom and petal-fall dates, weather information, pruning schedules, pesticide applications, thinning applications, yield per block or acre, packout per block or acre, productivity of various cultivars and cultivar/rootstock combinations, etc. Financial records include the costs of site preparation, nursery stock, pesticides, labor, utilities, supplies, fertilizer, harvesting, professional services, etc. Also included are fixed costs such as loan servicing, taxes, insurance, operator expense, etc. While these records may be kept by hand, it is generally more efficient to keep them on a computer.

Many of the financial records are needed for tax purposes. It may be more efficient to retain a competent accountant to handle the financial records than to attempt to learn and maintain these records yourself.

COST OF ESTABLISHMENT

Commercial orchards are planted with the goal of making money for the owners. Many costs will be incurred in establishing an orchard through the operations outlined above. Costs will vary with the equipment, land, and buildings that will need to be purchased and with the amount and rate of financing to be obtained.

This section helps estimate some of the costs involved with establishing an orchard in Wisconsin. In this example, the estimates are based on trees on M.26 rootstocks planted 12 x 16 giving 226 trees per acre. A land charge is not included here since this particular cost can vary considerably depending on the intended location of the orchard within Wisconsin. For realistic orchard planning, however, you will need to include a land charge for planning financial expenditures and for determining the potential profitability of the operation. Other assumptions are explained in the table that follows.

Table 4. Estimated cost of orchard establishment in Wisconsin in 1990. Tree density is 226 trees per acre. Cost of land purchase is not included here since this can vary considerably depending upon location in the state. All figures are on a per acre basis, averaged for a 20-acre orchard.^a

	One year before planting	Planting year	Year two	Year three	Year four	Year five
Site preparation	185					
Irrigation mains	1,275					
Trees (\$6.50 each)		1,470	35			
Planting (\$1.20 each)		270				
Trunk guards (\$0.95 each)		215				
Training and pruning (labor, spreaders)		55				
Production labor and expense				320	400	480
Pest control (insecticides, fungicides)		210	210	250	250	250
Weed control (mowing, herbicides)		75	75	75	75	75
Fertilizer		50	50		5	10
Irrigation		25	25	25	25	25
Repairs, maintenance				70	80	130
Supplies (fuel, oil)				55	60	60
Utilities				50	75	125
Harvest, packing (labor, boxes)				50	640	1,755
Freight, trucking					35	140
Advertising					35	100
Interest (11% for 8 months in years 1–2 and 11% for 4 months in years 3–5)		175	30	65	125	235
Total cash costs	1,460	2,545	425	960	1,805	3,385
Fixed overhead costs ^b (operators' labor and management, taxes, insurance, capital recovery charge)		460	255	405	450	530
Current year's total cost per acre		3,005	680	1,365	2,255	3,915
Previous years' total investment		1,460	4,465	5,145	6,510	8,765
Total investment per acre (excluding land)		4,465	5,145	6,510	8,765	12,680
Current year's estimated returns per acre				(215)	(2,150)	(6,000)
Previous year's estimated returns					(215)	(2,365)
Unrecovered costs per acre at the end of current year^c	1,460	4,465	5,145	6,295	6,400	4,315

^aCost of establishment and cost of production figures are based on Apple Enterprise Budgets, 1990. Mimeo available from the Department of Horticulture, 1575 Linden Drive, Madison, WI 53706.

^bFixed overhead costs are based on the following key coefficients. Note that building and equipment investment will be 1/4 of the amount stated here in year 1, 1/2 of the amount in year 2, and the entire amount in years 3 and beyond. The capital recovery charge (CRC) refers to the ownership costs of assets with a productive life of greater than one year. The CRC percentage takes into account the ownership cost of an asset associated with obsolescence, depreciation, and opportunity interest on its remaining value.

Key Fixed-Costs Coefficients	Initial Value	CRC %
Machinery investment per acre	300	18
Building and equipment per acre	600	13
Deer fence investment per acre	165	15

^cUnrecovered costs do not reflect interest on long-term investment, which varies with amount borrowed and interest rate charged.

ADDITIONAL RESOURCES

Information about growing apples is available from many sources, a few of which are listed below. This information is provided as a convenience to our readers. It is not an endorsement by University of Wisconsin-Extension nor is it exhaustive.

Reference Books

- Barritt, B. H. 1992. *Intensive orchard management*. Yakima, WA: Good Fruit Grower.
- How, R. B. 1991. *Marketing fresh fruits and vegetables*. New York: Van Nostrand Reinhold.
- Jones, A. L. and H. S. Aldwinckle, eds. 1990. *Compendium of apple and pear diseases*. St. Paul, MN: American Phytopathological Society.
- Rom, R. C. and R. F. Carlson, eds. 1987. *Rootstocks for fruit crops*. New York: John Wiley & Sons.
- Westwood, M. N. 1988. *Temperate-zone pomology*. Third ed. Portland, OR: Timber Press.

Related Extension Publications

- | | |
|---|-------|
| Apple Cultivars for Wisconsin | A2105 |
| Commercial Tree Fruit Spray Guide | A3314 |
| Common Fruit Insects | A2116 |
| Common Tree Fruit Pests (available from Michigan State University) | NCR63 |
| Controlling Apple Maggots in Home Gardens | A1851 |
| Controlling Deer Damage in Wisconsin | G3083 |
| Direct Marketing of Farm Produce and Home Goods: Direct Marketing Alternatives and Strategies for Beginning and Established Producers | A3602 |
| Diseases of Tree Fruits (available from Michigan State University) | NCR45 |
| Fire Blight: Apple, Pear and Other Trees | A1616 |

- | | |
|---|-------|
| Growing Apples in Wisconsin | A3565 |
| Meadow Mouse Control | A2148 |
| Orchard-Floor Management | A3562 |
| Plant Growth Regulator Use in Apples | A3524 |
| Rootstocks for Fruit Trees | A3561 |
| Spotted Tentiform Leafminer: A Pest of Wisconsin Apple Orchards | A3211 |
| Training and Pruning Apple Trees | A1959 |

Trade Magazines

American Fruit Grower

37733 Euclid Avenue
Willoughby, OH 44094
(440) 942-2000

Fruit Growers News

P.O. Box 128
Sparta, MI 49345
(616) 887-9005
www.fruitgrowersnews.com

Good Fruit Grower

105 S. 18th St., Suite 217
Yakima, WA 98901
(800) 487-9946
www.goodfruit.com

Trade Associations

Wisconsin Apple Growers Association

211 Canal Road
Waterloo, WI 53594
(920) 478-4277
www.waga.org

U.S. Apple Association

8233 Old Courthouse Rd., Suite 200
Vienna, VA 22182
(703) 442-8850
www.usapple.org

International Dwarf Fruit Tree Association

14 South Main Street
Middleburg, PA 17842
(570) 837-1551
www.idfta.org

Commercial Nurseries

Plant materials may be available from other suitable nurseries.

Adams County Nursery

P.O. Box 108
Aspers, PA 17304
(800) 377-3106
www.acnursery.com

Boyer Nurseries & Orchards

405 Boyer Nursery Rd.
Biglerville, PA 17307
(717) 677-8558
www.boyernurseries.com

C & O Nursery

P.O. Box 116
Wenatchee, WA 98807-0116
(800) 232-2636
www.c-onursery.com

Cameron Nursery

1261 Ringold Road
Eltopia, WA 99330
(509) 266-4669

Columbia Basin Nursery

P.O. Box 458
Quincy, WA 98848
(800) 333-8589
www.cbnllc.com

Hilltop Nurseries, LLC

P.O. Box 578
Hartford MI 49057
(800) 253-2911

St. Lawrence Nurseries

325 State Highway 345
Potsdam, NY 13676
(315) 265-6739
www.sln.potsdam.ny.us

Stark Brothers Nurseries

P.O. Box 10
Louisiana, MO 63353
(800) 325-4180
www.starkbros.com

TRECO

Oregon Rootstock and Tree Co.
P.O. Box 98
Woodburn, OR 97071
(503) 634-2209
www.treco.nu

Van Well Nursery

P.O. Box 1339
Wenatchee, WA 98807
(800) 572-1553
www.vanwell.net

Wafler Farms

10662 Slaght Road
Wolcott, NY 14590
(877) 397-0874
www.waflernursery.com

Willow Drive Nursery

3539 Road 5 NW
Ephrata, WA 98823
(888) 548-7337
www.willowdrive.com



Some of the material in this bulletin was extracted from “Establishing and Managing Young Apple Orchards,” USDA Farmers’ Bulletin 1897, 1978, by Miklos Faust.

Authors: T.R. Roper is professor of horticulture and G.G. Frank is farm management specialist in agricultural economics, College of Agricultural and Life Sciences, University of Wisconsin-Madison and University of Wisconsin-Extension, Cooperative Extension. Produced by Cooperative Extension Publications, University of Wisconsin-Extension.

University of Wisconsin-Extension, Cooperative Extension, in cooperation with the U.S. Department of Agriculture and Wisconsin counties, publishes this information to further the purpose of the May 8 and June 30, 1914 Acts of Congress. An Equal Employment Opportunity/Affirmative Action employer, University of Wisconsin-Extension provides equal opportunities in employment and programming, including Title IX requirements.

This publication is available from your Wisconsin county Extension office or from Cooperative Extension Publications. To order, call toll-free 877-WIS-PUBS (847-7827) or visit our web site at cecommerce.uwex.edu.

