TECHNICAL GUIDE

FiBL

Dwarf Tree Orchard Maintenance

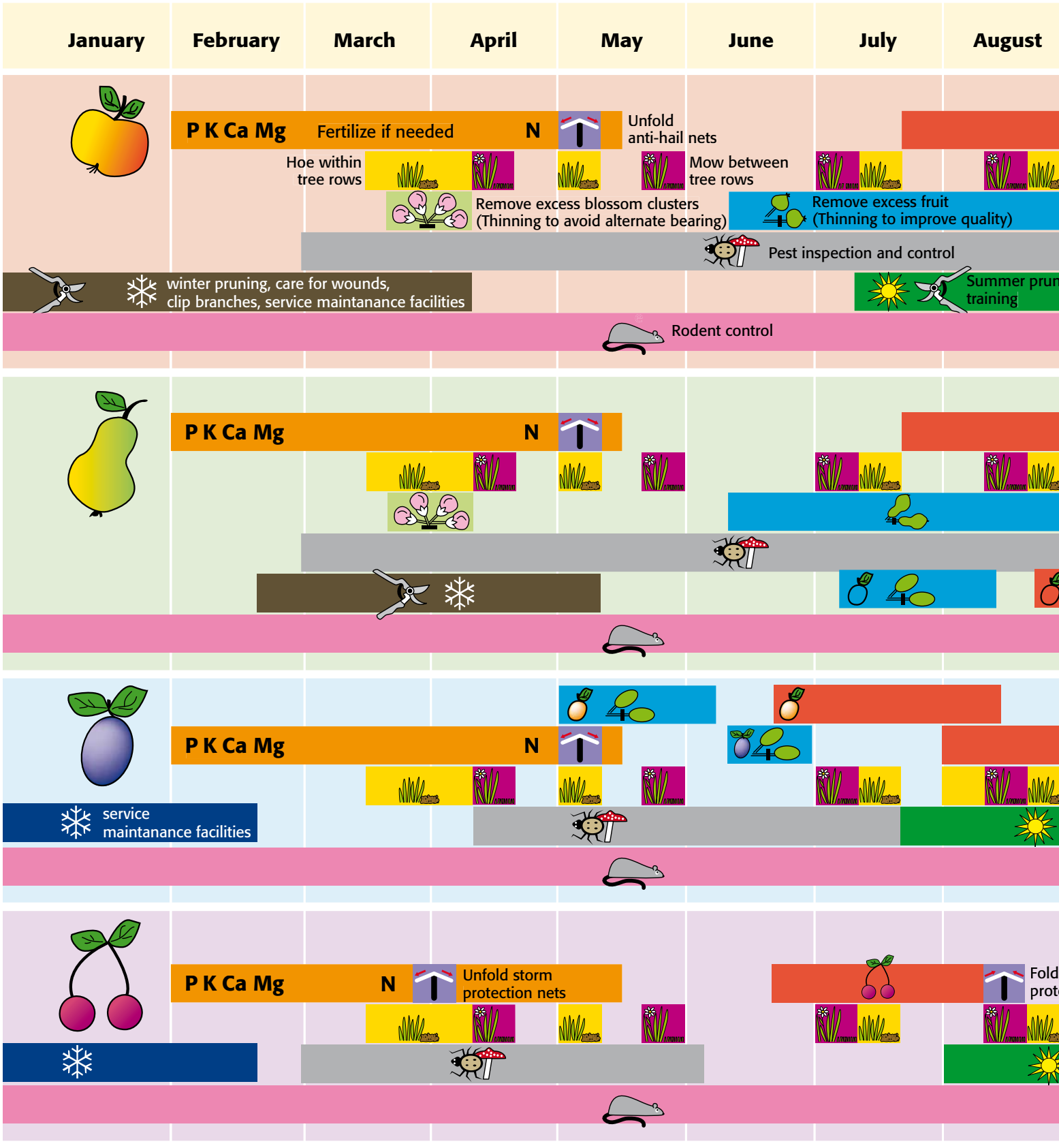
Organic Fruit Growing, Part 2:

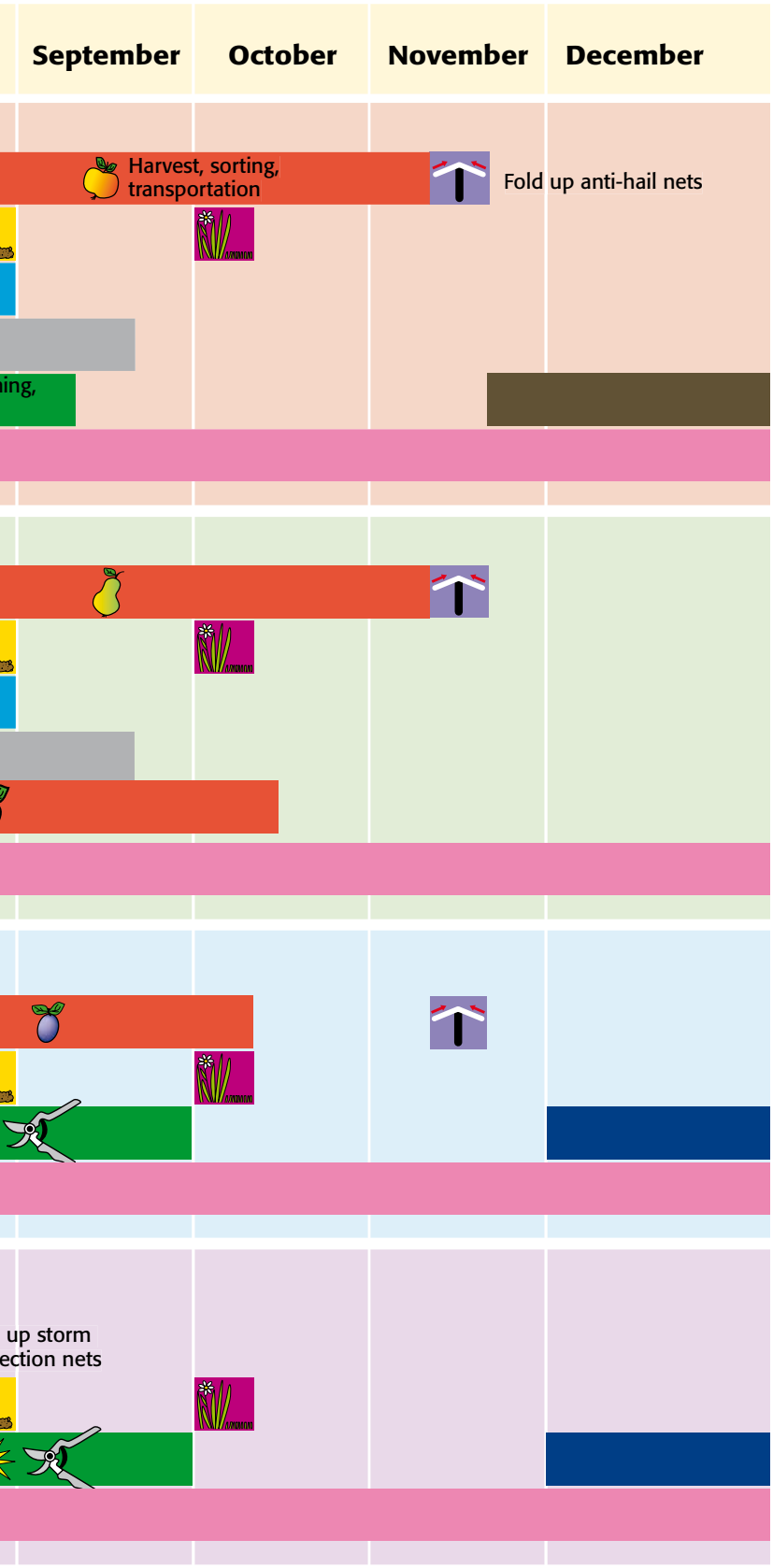
Fruit trees that developed under excellent growing conditions are less susceptible to disease and pests, and offer high yields and quality fruit. Beside pest control measures (not treated in this guide), dwarf orchard maintenance includes proper fertilization, ecologically sound soil use, appropriate weed control and training to ensure proper canopy aeration.
This technical guide focuses on the information currently available on dwarf-tree orchard maintenance. It also provides advice on maintenance scheduling.

2005, English Translation of the Swiss Version

Made available in English by: OACC Organic Agriculture Centre of Canada

Calendar for Maintenance Work





Maintenance tasks may occur earlier or later depending on the growing seasons for particular varieties, and thus this calendar does not specify exact dates. Some tasks may be carried out at different times than those depicted on the calendar. For example, the date for nitrogen fertilization may vary depending on soil requirements, and hoeing within tree rows is dependent on proper weather conditions.

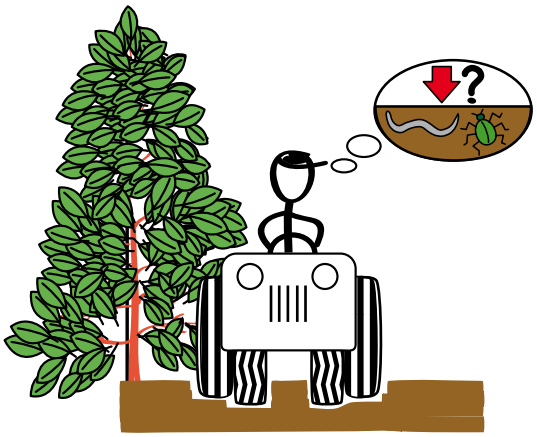
Fertilization

The Four Stages of Optimum Fertilization

Optimum fertilization is essential in order to obtain high, consistent yields, quality fruit and vigorous trees that can withstand environmental stressors like pest infestation. Successful fertilization requires healthy soil that is well structured and biologically active. Manure can only partially compensate for poor soil.

Environmentally sound use of the soil ecosystem is necessary in order for roots to properly absorb nutrients.

In a healthy system, foliar fertilizers are not a necessity. They short-circuit roots' nutrient absorption process and should only be used in an emergency situation.



Optimize cultivation techniques to best use the nutrients available in the soil

Why	How
■ Adjust row maintenance to meet the trees' nutritional needs.	The nutrients already available in the soil can be better utilized.
■ Use strong enough rootstock.	Vigorous rootstock can generally occupy a larger volume of soil and thus better absorb available nutrients.
■ Use virus-resistant plants.	These plants use less nitrogen.
■ Only work the soil under ideal weather conditions. ■ Use machines that are gentle on the soil; avoid friction-driven equipment. ■ Use lightweight machines with low-pressure tires.	In well-structured soils, there is greater microbial mobilization of nutrients and thus better root absorption.
■ Cultivate scab-resistant varieties.	These varieties require fewer anti-scab treatments. As a result, there is less need to use tractors during unfavorable weather conditions, which results in less soil damage.

Take soil samples

When should soil samples be taken?

- In producing orchards:
  Every five years, in the fall
- In new orchards: Before planting
  (see technical guide «Creating a Dwarf-Tree Orchard»)

How should soil samples be taken?

- On a plot of land with homogeneous soil, take at least twenty samples using an augur. Take samples equally from between the rows, within the rows and in the intermediary areas.
- Sample depth:
  Before planting a new orchard: From the topsoil (0–25 cm) below the vegetation layer and from the subsoil (25–50 cm)
  For successive analyses: Only from the topsoil

What analyses should be conducted?

- Minimum variant: pH (H_2O), soil organic matter levels, reserve elements (P_2O_5, K_2O, Ca, Mg)
- Optimum variant (especially recommended for new plantings or if nutrient deficiencies exist): pH (H_2O), soil organic matter levels, reserve and short-term elements (P_2O_5, K_2O, Ca, Mg)

Observing

The general appearance of the tree (leaf color and size, twig growth, blossom formation) provides precise information on its nutritional state, and particularly its nitrogen and trace element deficiencies. Content of other important elements is generally highlighted by soil analyses.

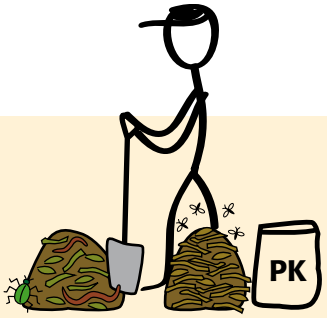
A tree needs additional nitrogen when:

- The tree bears excess fruit;
- The shoots develop poorly;
- The leaves turn from dark green to light green or even yellow;
- The blossoms have been mediocre for several years.

When soil conditions are ideal and nitrogen-rich fertilizers have been applied, there is generally no need for additional nitrogen. Ideally, in fall and winter nitrates are immobilized in the tree row vegetation. In the spring, after the first row cultivation, the nitrogen again becomes available for the trees. If nitrogen deficiency is identified, immediate fertilization is not necessarily the appropriate response:

- Simply tilling the soil can increase the mineralization of nitrogen.
- In dry weather, irrigation can be more effective.
- If the soil is damp or cold, symptoms of nitrogen deficiency may appear even when the soil is rich in nitrogen.

Fertilize as needed



How to fertilize?

Nitrogen requirements are at their highest from bloom to the end of July.

- The quantities of P_2O_5, K_2O, Ca and Mg are determined by the laboratory analyses, or in some cases by foliar analyses. When leaves are submitted for analysis, a control sample must also be included that consists of properly nourished leaves of the same variety and from the same orchard or region.
- The dosage is maintained until the next soil analysis.
- Spread nitrogen rich fertilizer (compost) on the tree row, and other fertilizers on the whole area (keeping the inter-row vegetation in mind).
- Application dates:
  - Nitrogen-rich commercial fertilizers: Mid-March through May, depending on the availability of the nitrogen
  - Compost, manure and slurry: See below.
  - Other commercial fertilizers: February to Mid-March (trees should have no leaves)

Do not spread fertilizer on frozen or wet soil.
The elements should be applied in organic form to encourage good soil structure with high biological activity.

Bitter pit occurs more frequently when excess potassium is present in the soil, which competes for Ca uptake.

Photo: Franco Weibel

Soil organic matter levels

Soil organic matter levels should be greater than 2,5 % and should not decrease over time.

- If the soil organic matter level is lower than 2,5 %, carry out several applications of fertilizer that is rich in organic matter (manure, mushroom substrate or compost) and/or cover the tree rows with miscanthus or bark shavings (take extra K into account)

Nitrogen (N)

- Commercial fertilizers (take the availability of nitrogen into account). Use slurry only if there is an equal need for potassium (risk of bitter pit, see potassium section).
- Manure, mushroom substrates or compost. Issue: It is not possible to precisely determine when nitrogen is mineralized (see below).

Important note:

Excess nitrogen results in excessive vegetative growth, encourages the development of harmful organisms and lowers yields and fruit quality. It is harmful from both an economic and an environmental standpoint (potential ground water contamination). More information on nitrogen-rich fertilizer is included under section C, "Observing".

Phosphorus (P_2O_5)

- Manure, mushrooms substrate, compost: do not incorporate into the soil, or do so only to a shallow depth.
- Mineral phosphate fertilizers: incorporate moderately deeply or deeply.

Potassium (K_2O)

- Mushroom substrate, slurry, manure, compost, organic materials (rapeseed straw, miscanthus, sedge or bark shavings): do not incorporate into the soil, or do so only to a shallow depth.

Nutrient content in compost, manure and slurry (in kg per cubic meter of fresh substance) **and optimum application periods**

	Nutrient content						Optimum application period
	N_{total}	$N_{available}$	P_2O_5	K_2O	Mg	Ca	
Compost (1 m³ ~ 700 kg)	4,9	0,5	2,8	4,0	2,2	20,0	February – mid-April
Manure (1 m³ ~ 700 kg)	3,4	0,7	2,2	4,6	0,6	2,6	mid-March – mid-April
Mushroom substrate (1 m³ ~ 500 kg)	3,5	1,5	2,5	4,0	1,5	2,7	mid-March – mid-April
Slurry	4,3	2,2	1,7	5,2	0,7	1,3	April – Mai

Photo: Andi Schmid

Magnesium deficiency in an apple leaf

- Combination fertilizers (some fertilizers also contain potassium) and and potassium-rich rock powder.

Note: Excess potassium in the soil encourages bitter rot in apples.

Calcium (Ca)

- Various calcium-rich fertilizers are available. Consider their effect on pH.
- Compost: Do not incorporate into the soil, or only into the topsoil.
- Soluble calcium fertilizers (calcium chloride) to treat bitter rot: Their use is subject to certain regulations.

Magnesium (Mg)

- Rock and algae powders (consider their effect on pH).
- Compost, manure, slurry and other organic materials (ex: rapeseed straw, miscanthus, sedge, bark shavings): do not incorporate into the soil or do so only to a shallow depth.
- The use of magnesium sulfate is subject to specific conditions.

Trace elements

There are many products available on the market to compensate for deficiencies. However, their use is subject to specific conditions.

pH

pH can be increased by adding calcium fertilizer.

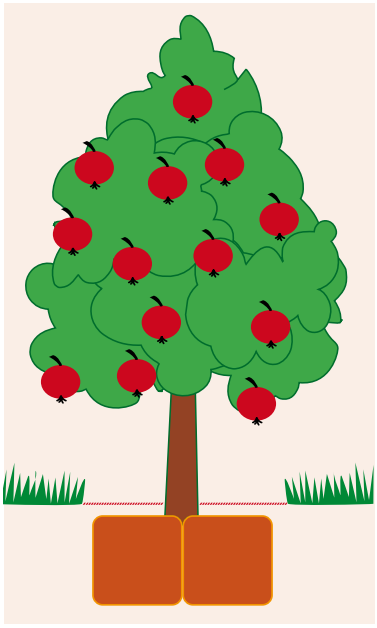
Tree Row Maintenance

Adapting maintenance for soil and weather conditions

When vegetation is grown within tree rows, an adequate supply of water and nutrients to the trees is not guaranteed. Young trees, even those on vigorous rootstock, as well as trees bearing a large amount of fruit are particularly sensitive to water and nutrient shortage.

However, from an environmental and economic standpoint the removal of inter-row vegetation is not justifiable. Winter vegetation may increase the danger of rodent damage, but it also helps retain nutrients and stabilize the soil structure. After the first inter-row cultivation in the spring, the nutrients tied up in that biomass become available for the trees once again.

Sometimes rain-permeable black plastic strips are used to cover the rows. There are differing opinions of this method. On one hand, the effective weed control and the constant humidity caused by the plastic encourage the development of young trees. On the other hand, installation costs are high, as are maintenance requirements (the plastic is often damaged by branches). The method also lacks environmental soundness, as recycling facilities are not yet available in all areas, and it often results in tree loss from rodent damage.

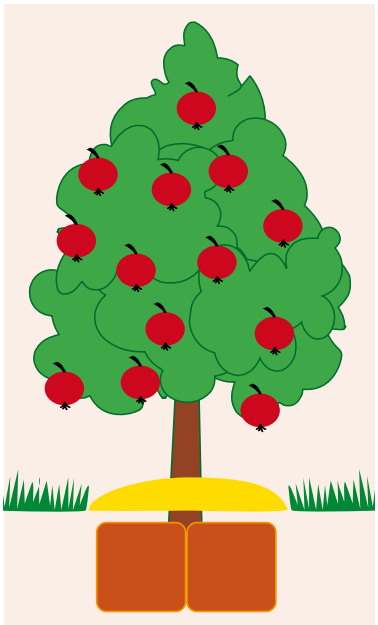


Plan for standard soil and climate conditions:

Cultivation

- Cultivate an area 0,80–1,20 meters wide and 5–7 cm deep within the rows.
- Cultivation should begin 2–4 weeks before bloom and continue until August or September if necessary.
- If the trees grow too quickly, lengthen the intervals between the cultivation or allow the vegetation between the trees to grow on its own (regular mulching).
- Frequent cultivation could result in a reduction in the volume of earth.

Photo: Andi Schmid



= important area for soil and nutrient sampling

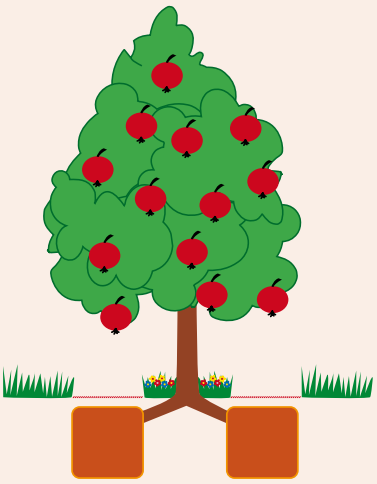
Plan for light soils that are deficient in organic matter and potassium in a dry climate:

Using mulch

- Mulches (bark shavings, rapeseed straw or miscanthus) effectively combat annual weeds, conserve a significant amount of soil moisture and increase its level of organic matter.
- After planting, cover a 0,8–1,20 meter wide section of the tree row with a 10 cm layer of packed mulch.
- Remove weeds manually.
- When the mulch has sufficiently decomposed, after 1,5–3 years, determine based on soil organic matter and potassium levels if a new layer of mulch is needed.
- If this is not the case, till the rows shallowly (to a maximum depth of 5 cm).
- If necessary, only cultivate on one side of the trees.
- Later on cultivate both sides (5–7 cm deep), each time starting 2–4 weeks before bloom and stopping in August or September.

Photo: Andi Häseli

The sandwich system: a new method still in the experimental phases of development



In this system, a row looks like a sandwich when seen from above. On both sides of the tree are 50 cm wide cultivated strips of land, while the trees themselves are in a 20–30 strip of vegetation.

The open space is as large as that of a traditional maintenance system, thus allowing the trees plenty of water and nutrients. The middle strip is covered with small plants that do not require mowing, or grasses that must be cut periodically. If the trees are weak and need more vigor, the middle strip can be covered with manure, compost, miscanthus or bark shavings.

The advantage of this system is that the rows can be maintained using simpler and less costly machines. Initial testing of the sandwich system has been promising.

Note: the sandwich system is still in the experimental stages and it is thus too early to provide detailed recommendations. For more information on the current development of this technique, contact the FiBL in Frick.

Irrigation

Sometimes a necessity

Lack of water slows growth and reduces fruit size. Young trees growing in light and/or shallow soils are particularly at risk. Good water supply is also important for nutrient absorption.

Precipitation is sufficient for pome and stone fruit trees only in eastern and central Switzerland. In other regions, if the issue cannot be solved using cultivation techniques, then an irrigation system is necessary. Examples of possible cultivation solutions include choosing more vigorous rootstock (though in the beginning, these are also sensitive to inadequate water supply), cultivating more frequently during dry periods or covering the tree rows with mulch.

Irrigation methods:

- To determine when irrigation is necessary, take soil samples and evaluate them by touch or use a measuring apparatus such as a tensiometer. The grower's expertise is very important in this area.
- Each irrigation session requires a minimum of 20–30 liters/sq. meter within the tree rows.
- Newly planted trees can be irrigated with a treatment pump, though this method is labor intensive.

Three existing irrigation methods

Drop-by-drop

Advantages:
- Inexpensive
- Low water consumption

Disadvantage:
- Localized water distribution (not targeted at the roots) that is not well suited for fruit trees during production

Under-tree sprinkling (micro-jet)

Advantage:
- Water distribution targeted at the roots

Disadvantages:
- Costly compared with drop-by-drop irrigation
- Significant maintenance as it breaks easily

Over-tree sprinkling

Advantage:
- Can also be used for frost prevention.

Disadvantages:
- Costly
- High water consumption
- Increases susceptibility to disease (fire blight, scab, brown rot, and sooty bark) and rinses away treatment products applied under the trees.

Photos: Andi Schmid

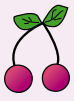
Pruning and training

Striking a good balance

Pruning reduces vegetative growth and increases fruit production. The grower must find a balance between the two such that both yields and quality are good. Pruning and training must be adjusted to suit the variety and the physiological condition of the tree.

Generally speaking, winter pruning stimulates growth and summer pruning impedes it. Pruning and bud pruning during the vegetative period and training reduces the time that must be spent pruning during the winter.

Once a method of pruning has been chosen, there are different guidelines that can be followed to reach the intended goal. The techniques listed below are only suggestions. Simple pruning methods are advantageous in that they can be carried out without extensive training.

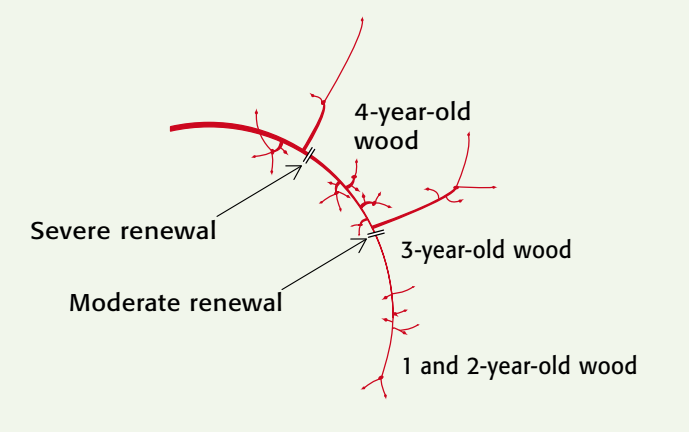
Pruning during planting	Pruning and bud pruning during the vegetative growth period	Tying	Winter pruning
Central leader and Solaxe systems ■ Not necessary in most cases ■ Otherwise trim the central leader to 1,0–1,3 meters. ■ If using the Solaxe system, remove all branches within 0,80–1,00 m of the ground and shorten other branches to 20–25 cm (if they are too weak). 	■ Date: During or just after branch lignification ■ Especially necessary for vigorous trees with poor fruit exposure. ■ Remove any new growth that is not an essential part of the tree structure. ■ For varieties that tend to thin, leave 2–4 leaves, and for other varieties remove the whole branch. ■ Remove suckers and root suckers. **Important:** Avoid pruning and removing buds during the vegetative period if there is an increased threat of infection with fire blight.	■ Date: From branch lignification until October ■ Tie fruiting branches below a lateral position. Use biodegradable weight or string.  Photo: Andi Schmid	■ Possible starting in fall up until bloom. ■ Remove excess organs.
Drilling system ■ Trim the graft to 0,4 m from the ground. Well-positioned secondary shoots can be used to create the tree structure.	■ Remove excess organs. 	■ During growth, add 1–2 ties on scaffold branches.	■ From the end of winter until after bloom (reduces the risk of frost damage) ■ Prune long branches in the canopy and any scaffold branches that are too weak (re-balancing).
Managed shrub system ■ Cut the graft to within 0,60 to 0,80 m from the ground. ■ Otherwise, same as for the drilling system ■ The number of scaffold branches depends on the tree's vigor.	■ Same as for the drilling system ■ Use only in dry conditions to avoid the risk of spreading bark diseases.	■ Same as for the drilling system 	■ Same as for the drilling system ■ See pruning during the vegetative growth period. 
Marchand system ■ Not desirable ■ Remove unneeded branches and coat pruned surfaces with a healing product. ■ A 1 cm long, 2 mm wide cut located 1,5 cm above the bud encourages the development of knots (end of February)	■ Date: Late May to late June, removal of poorly located branches. ■ Leave a branch stump of approximately ten times the diameter of the branch. ■ Conduct only in dry weather to avoid the risk of spreading bark diseases.	■ As soon as development allows, tie branches needed for fruiting to a 45° angle. 	■ Normally not necessary. Remove overly vigorous branches that grow into the paths. If necessary, a 1 cm long, 2 mm wide cut located 1,5 cm above the bud encourages the development of knots (end of February) ■ See pruning during the vegetative growth period.

Managing fruiting branches

As trees approach maturity, limiting the number of branches is often necessary.

The grower has a choice of two methods:

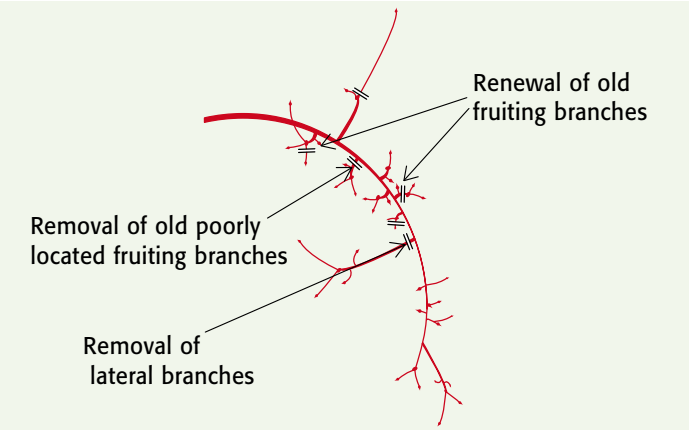
Renewal pruning:



Weakened parts are removed and replaced with younger ones, promoting good vegetative growth. In compensation for the weakened branch, a young shoot developing higher in the tree gradually grows thicker.

This method is advantageous in that it promotes growth, but it also increases the development of lateral blossoms on cluster bases, which yield lower quality fruit.

Long pruning:



Branches are never shortened. Only organs that upset the vegetation/fruit balance are removed. The only aspect of this pruning that reduces the tree's load is the renewal of old, weakened fruiting branches.

This thinning allows more light to penetrate the canopy and keeps the rest of the tree productive. However, the fruit is distributed along the entire length of the branch, which can reduce the tree's vigor.

Frost damage prevention

Also wards off alternate bearing

A good location and hardy varieties as well as properly timed pruning all help reduce the risk of frost damage. However, late frosts consistently result in a significant decrease in yields, which then leads to alternate bearing in following years.

Immature fruit are generally more sensitive to frost than blossoms and open buds. The best way to avoid frost damage is by sprinkling with water. Jets with a range of approximately 15 meters are currently the most widespread, but the use of microjets is being considered as well. In either case, the nozzles must be specifically designed for frost prevention.

Photo: Leonhard Steinbauer

Energy released by ice formation protects blossoms and young fruit from frost damage.

Frost prevention process

When the wet-bulb temperature, measured at 50 cm above the ground (using a special thermometer), is near 0 °C (±1 °C depending on the species) start the process.

The jet should irrigate at a rate of 3–4 mm of water per hour.

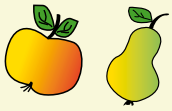
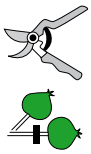
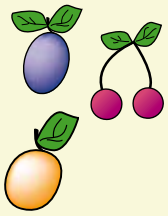
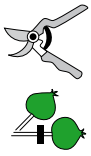
Stop the process when a morning reading indicates a dry temperature of 0 °C or more for at least 30 minutes and a layer of water has formed between the flowers and the layer of ice (the ice becomes opaque). It is not necessary to let the system run until the ice has fallen off the trees.

Critical temperatures at different phenological stages

	D–E Closed buds	F–G Full blossom	H–I Start of fruit setting
Apple tree	-4,5 °C	-3 °C	-2 °C
Pear tree	-4,5 °C	-3 °C	-1 °C
Apricot tree	-4 °C	-2 °C	0-0,5 °C
Cherry tree	-4 °C	-4 °C	-1 °C
Peach tree	-4 °C	-3,5 °C	-1 °C

Fruit load management

A challenge, because in organic orchards, only mechanical techniques are authorized

	Blossom and Fruit Load		Thinning techniques	Requirements
	**High – Very high**	 **In every instance**	■ Pruning fruiting branches more severely if growth is slow ■ More intensive removal of fruiting branches using long pruning	
		 **Variant A**	■ Use of a nylon string trimmer.  	■ Regular, thin foliage with short fruiting branches and few vertical branches (not useful when using long pruning). ■ Use on a large operation or in cooperation with other farms.
		 **Variant B**	■ Thin blossom clusters by hand (completely remove the clusters from the underside of the branches). The goal: At bloom, 1/2 of the branches (2/3 for alternate bearing varieties) should not have blossoms.	■ Enough available labor in a short period of time. ■ The work is justifiable (especially for special varieties).
		 **Variant C**	■ Thin blossom clusters by hand for one-half of each trees (one side of each row). The next year, repeat the process for the other half of the trees, and then continue to alternate in subsequent years. This reduces alternate bearing by reducing fruit loads for the tree. ■ This thinning technique has not been adequately tested for pears.	■ Enough available labor in a short period of time. ■ The work is justifiable (especially for special varieties).
		 **In every instance**	■ Remove fruit that is deformed, damaged or too tightly clustered together (in two stages). Desirable ratio of leaves to fruit after fruit setting (in June): 1 piece of fruit for 15–30 leaves, depending on the condition of the leaves, the variety and the soil and climate conditions.	
	Low		■ Little to no pruning (fruiting branches). ■ Remove fruit that is deformed, damaged or too tightly clustered together (in two stages). Desirable ratio of leaves to fruit: See above.	
	**High – Very high**		■ More severe pruning if growth is slow. ■ Plums and apricots: Remove fruit from branches that are overloaded and lacking adequate sunlight. 	■ Finish thinning before the pit hardens. When possible (late-ripening varieties) wait until there is no longer any risk of frost. 
	Low		■ Little to no pruning (fruiting branches)	

Pruning date	Advantages	Disadvantages
During the winter months		
Pink bud stage E2	■ Increased labor capacity	■ If the shape of the trees is not suitable, the results can be deceiving (often selective thinning of the best positioned fruit). ■ Increased danger of spreading infectious diseases like fire blight ■ Late intervention (at full blossom) can cause deformed fruit and damage to clusters (which are important for fruit development). ■ Individual treatment of trees is difficult.
Pink bud stage E2	■ Individual treatment for trees ■ Compared with variant C, the fruit receives more light and dries faster.	■ Time-consuming (70–400 hours of labor/ha) and thus costly. Another factor is the possibility that the work cannot be completed in time for the whole orchard.
Pink bud stage E2	■ Can also be carried out by unskilled personnel. ■ Individual treatment of trees is possible. ■ Sometimes a single treatment can bring a tree into balance, breaking the cycle of alternate bearing.	■ Time-consuming (around 250 hours of labor/ha for the first year and around 70/ha thereafter). ■ As the pieces of fruit are all concentrated on one side of the tree, they are very close together (hence sooty mold can be an issue as short stemmed fruit tend to be pressed together) ■ Increased risk of broken branches.
After pre-harvest drop		
During the winter months After pre-harvest drop		
After harvest After pre-harvest drop		
After harvest		

Fruit load management has two purposes:
Eliminating alternate bearing (especially important for pome fruit), thus ensuring regular yields over the years. To do this, early intervention is necessary and must occur before petal fall at the latest. After this time, blossom removal has little effect on the next year's blossom formation as hormones control the process.

Improving fruit quality. Eliminating excess fruit, even several weeks before harvest, can improve the quality of the remaining fruit.

Pruning is an influential process, affecting not only alternate bearing, but also fruit and bud quality.

Photos: Andi Schmid, Käthi Weibel, Franco Weibel

Harvest

Finishing the job right

The harvest date and technique have a large effect on quality, and should be high priorities for growers.

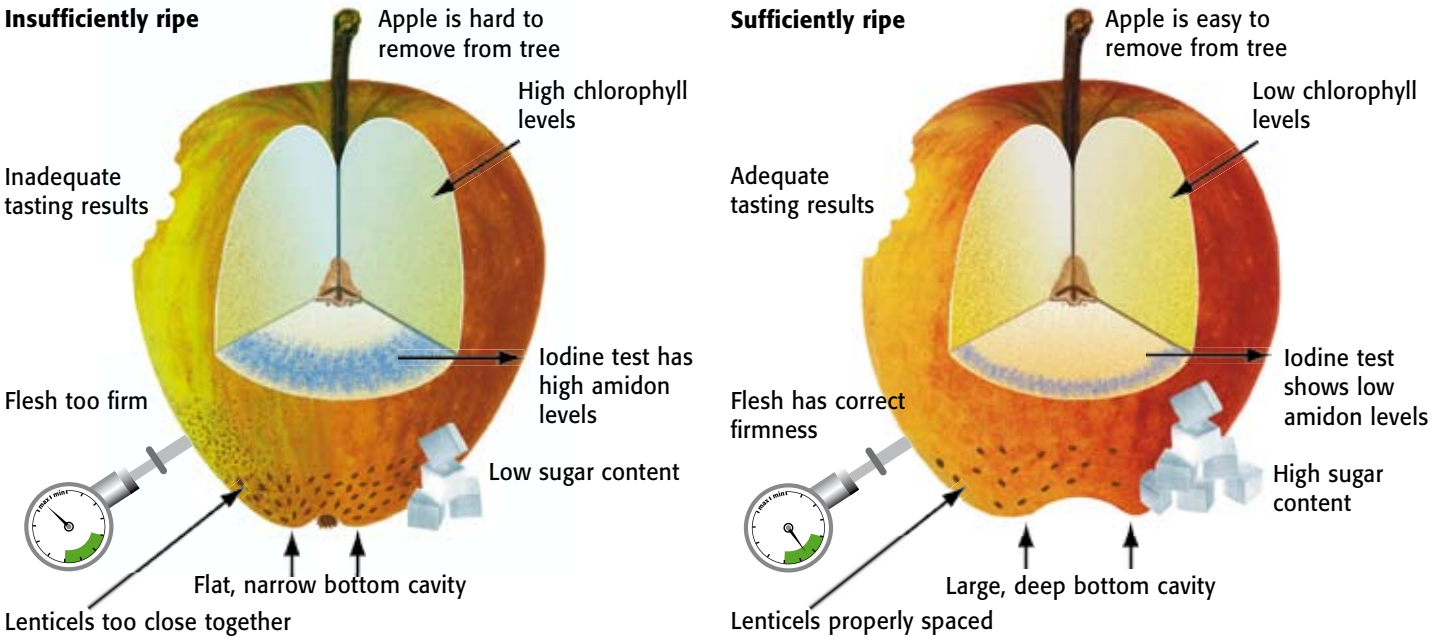
Organic fruit must meet the appropriate organic certification standards as well as the buyer's standards.

For wholesale deliveries, the external appearance is not the only factor considered. Sugar content and the firmness of the flesh re also measured at collection centers (primarily for apples).

	Criteria for determining harvest dates	Notes	Harvest techniques
	■ Number of days from the T stage (different for each variety) ■ Optimum Streif Index (different for each variety, see industry publications for details) ■ Other criteria: See illustration below.	■ Depending on the length and type of storage, fruit is harvested at different stages of maturity. A second harvest is often necessary. It is important to discuss the issue with the storage company. ■ Seed color is not an indication of when to harvest.	■ Depending on the destination for the fruit, place it in a clean crate or other container. ■ Harvest fruit from higher branches using a basket or from a harvesting platform. ■ Pre-sort fruit before storage. ■ Handle gently to avoid creating marks or bruises.
	■ Same as for apples, except for the shape of the bottom. Also pears have no T stage.	■ Same as for apples. The harvest date is more difficult to determine, however.	■ Same as for apples
 	■ Tasting ■ Detach easily from tree. ■ Firmness (penetrometer) ■ Sugar and acid levels (different for each variety) ■ Color, also different for each variety and care must be taken with varieties that change color early or not at all.	■ Depending on the delay between harvesting and sale, the fruit is harvested at different stages of maturity. Multiple harvests are often necessary.	■ Place the fruit directly in small baskets for selling or in larger collection baskets. ■ Sort the fruit if they are being placed in larger baskets, using a second basket for inferior fruit. ■ Place 5 cm or thicker foam pads under the trees and shake to release the fruit. ■ As a general rule, try to keep the bloom on the fruit intact, wearing gloves if necessary.
	■ Tasting ■ Color (different for each variety)	■ In general, harvest the fruit when they are completely ripe.	■ In baskets ■ Sort the fruit. ■ Use a second basket for inferior fruit.

[1] *Streif Index = firmness of the fruit flesh (kg/cm²) / (sugar content (degrees Brix) x iodine test result)*

When is an apple ripe?

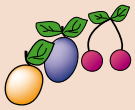
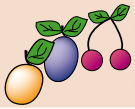
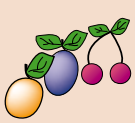


Storage

Multiple techniques are available

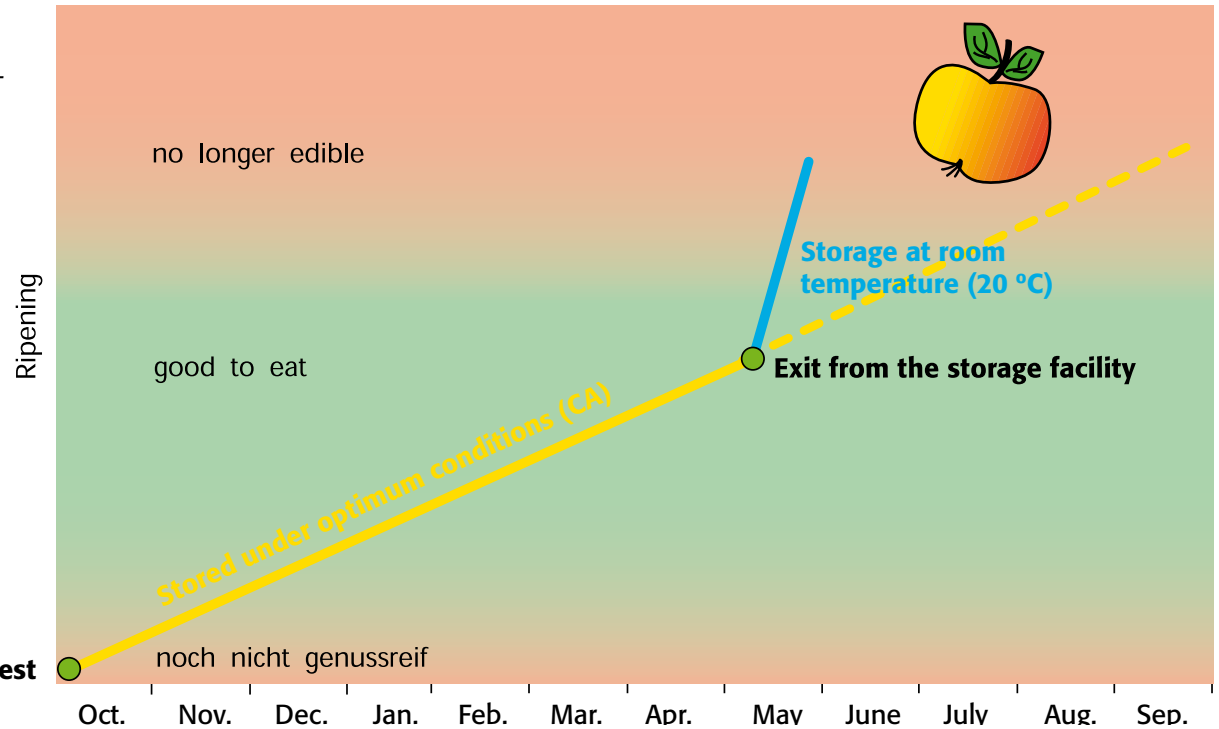
Good storage is important. The greatest degradation in quality often occurs before and after storage (see diagram below). It occurs when the fruit is not taken to the storage warehouse right after harvest or after it leaves storage and passes several days at room temperature on store shelves or at the consumer's residence. During this period, an apple loses more sugar and acids via respiration than when it was stored, even though storage can last for months. Thus, the time between harvest and storage and the time between storage and consumption should both be as short as possible. Ideally, only healthy fruit of the highest quality is put in storage. As this is not always possible in practice (for example, in years where the incidence of scab is high), it is advisable to conduct regular inspections in cellars and walk-in refrigerators to detect spoiled fruit.

Fruit storage areas must be kept clean, and be carefully kept separate from vegetable storage areas.

Storage technique	Description	Optimum storage conditions	Length of storage
Natural cellar	■ Room with a packed dirt floor and/or partitions ■ The climate can vary greatly, as there is little or no regulation ■ Primarily for storing products for internal use	■ Low temperatures in fall, but no freezing during the winter ■ High humidity levels (90–93 % relative humidity) ■ Good ventilation	 ■ 2–5 months  ■ Several days
Walk-in refrigerators	■ Temperature can be regulated, and generally humidity as well.	■ 1–6 °C ■ 90–93 % relative humidity ■ Optimum storage conditions vary based on the species and variety.	 ■ 3–7 months  ■ Up to 5 weeks ■ Up to 4 weeks ■ Up to 3 weeks
Temperature controlled room	■ Airtight room ■ Temperature, humidity as well as the atmospheric content of the room can be controlled. ■ In addition to increased CO_2 levels, decreased oxygen levels are also possible (ULO = Ultra Low Oxygen).	■ 0,5–4 °C ■ 92–94 % relative humidity ■ 1,5–4 % CO_2, 1–3 % O_2 ■ Optimum storage conditions vary based on the species and variety [1)]	 ■ Up to 10 months  ■ Insufficient data – this type of storage is generally not cost-effective.

Ripening process for an apple after harvest

An apple ripens eight times faster at room temperature than when it is stored under cold temperatures.



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This FiBL guide has been translated to English by OACC from its original Swiss German Edition. It was written and produced by FiBL for European organic producers, and reflects European conditions and terminology. Therefore, OACC recommends that Canadian growers consider the suitability of the information for their farms and adapt it only with awareness of the context of the original conditions. It is hoped that Canadian organic producers will nevertheless find much of the information beneficial.

The English translation was made available through the collaboration of FiBL and OACC.