



UNECE

CODE OF GOOD PRACTICE

Reducing food loss in handling fruit and
vegetables

FOREWORD

Fruit and vegetables are sold internationally, as well as locally, regionally and nationally. They are frequently traded over large distances and involve several actors. A continuous challenge is to reduce waste and losses, and this requires great care, attention and cooperation along all the entire value chain.

The perishable nature of most fruits and vegetables means that loss and waste of products can be high. The problem of waste, in particular, has received much attention in recent years because of the impact on the environment.

Much can be gained, including economically, from taking measures to reduce the losses and the waste. According to estimates, investments in measures to reduce losses and waste in food can give a 14-fold return.¹ A clear business case for the companies involved!

The Code of Good Practice supports the United Nations Sustainability Goal 12.3 on reducing food loss and waste: "By 2030, halve per capita global food waste at the retail and consumer level and reduce food losses along production and supply chains, including post-harvest losses."

The Code was prepared by the Working Party on Agricultural Quality Standards (WP7) of the United Nations Economic Commission for Europe (UNECE). For over 50 years, UNECE standards have been facilitating international trade in agricultural produce. The Code complements the standards and is intended to help maintain quality along the supply chains. It is also aimed at strengthening the work on reducing food waste and associated costs that is already being done by many companies.

It sets out measures to be taken at the various stages before the fruit and vegetables reach the consumer, i.e. from harvest to retail. It should support continued improvement, step by step. Real improvement, however, can only be achieved if actors along the distribution chain cooperate to improve their logistics, handling and planning, both inside countries and across borders. Communication will be a key factor. Measuring waste, which is the last point in each section of the Code, will give companies feedback on how well their work progresses.

The Code consists of three distinct chapters which focus on the three major segments of the fruit and vegetable supply chain – producers, traders and retailers. The chapters can be used individually.

It is followed by two annexes and a select list of reading matter that describes in detail the processes that regulate fruit and vegetable during growth, maturation, ripening and senescence and the best handling and storage practices.

¹ Hanson, C., and P. Mitchell. 2017. *The Business Case for Reducing Food Loss and Waste*. Washington, DC: Champions 12.3.

CONTENTS

1. PRODUCERS	5
1.1 FOLLOW THE PRINCIPLES OF GOOD AGRICULTURAL, HYGIENIC AND MANUFACTURING PRACTICES	5
1.2 ENSURE PROPER TRAINING OF STAFF	5
1.3 ENSURE THAT PRODUCTION IS PLANNED AND ADJUSTED TO DEMAND, IN TERMS OF BOTH QUANTITY AND QUALITY.....	6
1.4 USE THE BEST POSSIBLE HARVEST METHODS FOR PRODUCT QUALITY AND SHELF LIFE	7
1.5 HARVEST PRODUCTS AT THE BEST APPROPRIATE CONDITIONS	7
1.6 ENSURE THAT PRODUCTS THAT ARE NOT FIT FOR LONG STORAGE ARE DELIVERED AS SOON AFTER HARVEST AS POSSIBLE ..	8
1.7 COOL PRODUCTS – WHERE APPROPRIATE – TO THEIR CORRECT TEMPERATURE AS SOON AS POSSIBLE AFTER HARVEST AND KEEP THEM AT THIS TEMPERATURE UNTIL DELIVERED.....	8
1.8 POST-HARVEST TREATMENTS MAY ALSO BE CONSIDERED IN ORDER TO INCREASE SHELF LIFE AND REDUCE FOOD LOSSES AND WASTE ALONG THE SUPPLY CHAIN.....	9
1.9 CHOOSE PACKAGING THAT PROTECTS PRODUCTS WELL DURING TRANSPORT AND DISTRIBUTION, WHILE BALANCING THE COST AND QUANTITY OF PACKAGING MATERIAL AND TAKING INTO ACCOUNT BUYER REQUIREMENTS	9
1.10 FIND OUTLETS FOR PRODUCTS THAT WOULD NOT BE HARVESTED DUE TO OVERSUPPLY	10
1.11 FIND ALTERNATIVE OUTLETS FOR PRODUCTS NOT MEETING BUYER’S QUALITY REQUIREMENTS.....	10
1.12 MEASURE THE AMOUNT OF PRODUCE THAT IS WASTED AND SPECIFY THE MAJOR CAUSES OF THE WASTE	11
2. TRADERS	12
2.1 ENSURE PROPER TRAINING OF STAFF	12
2.2 ENSURE THAT ORDERED VOLUMES OF PRODUCTS ARE PLANNED AND ADJUSTED TO DEMAND, IN TERMS OF BOTH QUANTITY AND QUALITY.....	12
2.3 IMPROVE LOGISTICS TO SHORTEN TIME FROM HARVEST OR PACKING TO RETAIL	12
2.4 COOPERATE TO ESTABLISH UNBROKEN COOL CHAINS AT THE APPROPRIATE TEMPERATURE FOR RESPECTIVE PRODUCTS..	13
2.5 PLACE ORDERS AND/OR CHANGE ORDERS WITH ENOUGH TIME TO ALLOW FOR PRODUCTS TO BE CAREFULLY HARVESTED, HANDLED AND COOLED BEFORE DISPATCH	13
2.6 AVOID CANCELLING ORDERS CLOSE TO PLANNED DISPATCH OF PRODUCTS FROM PACKER/PRODUCER.....	14
2.7 ENSURE THAT CONTRACTS INCLUDE APPROPRIATE MATURITY REQUIREMENTS.....	14
2.8 DEFINE CLEAR SPECIFICATIONS THAT WILL PREVENT FOOD LOSS AND AVOID INTERVENTIONS, BY AGREEMENT AND COMMUNICATION BETWEEN PRODUCERS, TRADERS AND RETAILERS	15
2.9 CONTROL THE ORDERED PRODUCTS AT ARRIVAL.....	15
2.10 FIND ALTERNATIVE OUTLETS FOR PRODUCTS THAT CANNOT BE SOLD ON THE INTENDED MARKET.....	16
2.11 MEASURE THE AMOUNT OF PRODUCE THAT IS WASTED AND SPECIFY THE MAJOR CAUSES.....	17
3. RETAILERS	18
3.1 ENSURE PROPER TRAINING OF STAFF	18
3.2 ENSURE THAT ORDERED VOLUMES ARE PLANNED AND ADJUSTED TO DEMAND, IN TERMS OF BOTH QUANTITY AND QUALITY	18
3.3 DEFINE CLEAR SPECIFICATIONS THAT WILL PREVENT FOOD LOSS AND AVOID INTERVENTIONS, BY AGREEMENT AND COMMUNICATION WITH THE PRODUCER AND TRADERS.....	18
3.4 ENSURE THAT CONTRACTS INCLUDE APPROPRIATE MATURITY REQUIREMENTS.....	19
3.5 CONTROL PRODUCTS AND MAKE COMPLAINTS/CLAIMS WITHIN A REASONABLE TIME AFTER PRODUCTS HAVE ARRIVED AT THE BUYER’S PREMISES (BUYER AND SELLER SHOULD HAVE A COMMON AGREEMENT ON CRITERIA AND METHOD FOR CONTROLS AND CLAIMS)	19
3.6 STORE AND DISPLAY PRODUCTS IN THE SHOPS AT THE APPROPRIATE, PRODUCT-SPECIFIC TEMPERATURE	20
3.7 HANDLE PRODUCTS CAREFULLY AND TAKE MEASURES TO REDUCE THE RISK OF PRODUCTS GETTING BRUISED	21

3.8	STORE AND DISPLAY PRODUCTS APPROPRIATELY	21
3.9	AVOID CAMPAIGNS ENCOURAGING CONSUMERS TO BUY MORE THAN THEY CAN EAT	22
3.10	FIND WAYS TO USE OR SELL DAMAGED OR SUBOPTIMAL PRODUCTS	22
3.11	MEASURE THE AMOUNT OF PRODUCE THAT IS WASTED AND SPECIFY THE MAJOR CAUSES OF THE WASTE	23
3.12	IMPROVE LOGISTICS TO SHORTEN TIME FROM HARVEST OR PACKING TO RETAIL	23
3.13	COOPERATE TO ESTABLISH UNBROKEN COOL CHAINS, AT THE APPROPRIATE TEMPERATURE FOR RESPECTIVE PRODUCTS.	23
3.14	PLACE ORDERS AND/OR CHANGE ORDERS WITH ENOUGH TIME TO ALLOW FOR PRODUCTS TO BE CAREFULLY HARVESTED, HANDLED AND COOLED BEFORE DISPATCH	24
3.15	AVOID CANCELLING ORDERS CLOSE TO PLANNED DISPATCH OF PRODUCTS FROM PACKER/PRODUCER.....	24
ANNEX I.	25
CLASSIFICATION OF FRUIT, BASED ON THEIR RESPIRATORY BEHAVIOUR, INTO CLIMACTERIC AND NON- CLIMACTERIC FRUIT	25
ANNEX II.	27
CLASSIFICATION OF FRUIT AND VEGETABLES, BASED ON THEIR SENSITIVITY TO CHILLING INJURY, I.E. INJURIES CAUSED BY LOW BUT NON-FREEZING TEMPERATURES, AND RECOMMENDED LOWEST STORAGE TEMPERATURE.	27

UNECE Code of Good Practice

for reducing food loss in handling fruit and vegetables

1. Producers

Producers adhering to the Code of Good Practice undertake to do the following:

1.1 Follow the principles of Good Agricultural, Hygienic and Manufacturing practices

The following principles are designed to help reduce food loss and waste:

- **Good Agricultural Practices** – including dedicated farm techniques, such as conventional, organic or Integrated pest management principles that maximize yield and minimize food losses on the field – are a collection of principles to apply for on-farm production and post-production processes, resulting in safe and healthy food and non-agricultural products, while taking into account economic, social and environmental sustainability.
- **Good Hygienic Practices** are a set of quality assurance practices to ensure that hygienic processes are rigorously set and monitored.
- **Good Manufacturing Practices** are a set of quality assurance practices to ensure that manufacturing processes are rigorously set and monitored.

It is highly recommended to proceed in accordance with these principles at all stages from harvest to retailer.

1.2 Ensure proper training of staff

Staff working with fresh fruit and vegetables at all stages of the distribution chain should be trained in how to handle the products and have a good knowledge of the consequences of shortcomings in handling and storing products. They should understand the impact of poor handling and storing practices on quality, shelf life and waste, and on loss of profit for the company.

1.3 Ensure that production is planned and adjusted to demand, in terms of both quantity and quality

Production should meet market demand. This means planning the produced volume to the expected demand, at different times, of a species, variety, size, colour and quality, as well as price level. It is also important to consider maturity stage at harvest, expected shelf life and type of product.

Some products may continue to develop added taste and aroma after harvest (climacteric fruit) whereas others do not (non-climacteric fruit).² Harvesting at the right stage of maturity is particularly important for tropical fruit (e.g. mangoes), as direct contact of immature fruit with more mature fruit can cause physical damage and quality losses. Harvesters should therefore be trained on how to harvest produce items at the right stage of maturity.

On local markets, the direct communication between producer/seller and buyer will give the producer valuable information on the buyers' preferences and demands. In value chains stretching over country borders or even continents, good communication along the chain will help convey information on market demand to producers located far away from the final market.

Trade standards, which are drawn up with major input from the market, are commonly agreed descriptions of the quality expected of products sold as Class Extra, I or II and therefore provide valuable information on quality requirements. There may also be more detailed and often more stringent requirements in the specifications from the buyer.

By collecting information on market demand and planning production based on the quality standards and specifications, producers reduce the risk of products remaining unsold at the farm, of products being rejected upon arrival at wholesale level or of not being chosen by the consumer and therefore remaining unsold.

Collecting market information, using crop estimation tools as well as training in grading according to trade standards, can help to decrease losses.

² A climacteric fruit is a fruit with a clear continuing ripening stage when many characteristics of the fruit change: for example, fruit texture, content of sugar and aroma substances, increased respiration rate and production of ethylene. Non-climacteric fruit lack this stage. A list of climacteric and non-climacteric fruit is provided in annex I.

1.4 Use the best possible harvest methods for product quality and shelf life

Unless products are carefully handled and the correct equipment is used properly, products can easily be damaged during harvest. All mechanical impact on products – cuts, bruises, tearing, breakages, etc. – will reduce their quality, shorten their storage and shelf life, and increase waste.

For mechanical harvesting, it is very important to choose equipment that does not damage products. The quality of the harvested product will be influenced not only by the way the harvesting equipment is used but also by the experience and skill of the driver of a harvester. Raising awareness and training staff in correct use of the equipment will also help reduce losses.

If products are harvested manually, staff must be trained to handle products carefully. When products are cut, the use of sharp, disinfected knives or scissors that cut through a thin layer of cells will give a better result than blunt edges damaging a greater area in the cutting zone. And if boxes, bins and harvest bags are lined, potential damage to products will be minimized.

Soft-skinned fruit is particularly easy to damage. The careful handling at harvest and adherence of staff to personal hygiene is important. Studies have shown that even protruding fingernails can easily cause damage to soft-skinned fruit, reducing quality and increasing waste. The use of gloves when harvesting sensitive fruit can therefore help considerably.

1.5 Harvest products at the best appropriate conditions

Time of day and weather conditions at harvest can affect the post-harvest quality of products. An early harvest while products are still cool from the night and before the sun is high and temperatures have risen is likely to limit water losses and reduce the rate of senescence (i.e. the ageing of the fruit and vegetables). Leafy products and other products with a high surface to volume (e.g. broccoli) that easily lose water benefit most from this. The shorter the normal shelf life of a product, the greater the benefit. Higher temperatures will also speed up the ripening process.

Sunshine, high temperatures and wind will increase water losses and speed up the ageing of products. Products should therefore be taken to a storehouse as soon as possible using a means of transport that minimizes damage and maintains the quality of the products in the best possible way. While still in the field, products need to be protected from sun, wind, rain, dust and any other factors affecting their quality by, for example, being placed in covered containers or under a tree or in a shed. Humid weather makes fruit more water saturated (high turgor pressure), and this in turn

makes fruit bruise more easily. For many fruits, harvesting in humid weather conditions should be avoided if possible.

1.6 Ensure that products that are not fit for long storage are delivered as soon after harvest as possible

Delivering harvested products without delay to warehouses or cooling facilities decreases waste throughout the distribution chain.

Harvested products that are normally not fit for long-term storage have a limited shelf life. The length of the shelf life depends on the climatic conditions in which they are harvested, transported, graded, packed, distributed, stored and displayed. Temperature has the greatest effect, but humidity and air circulation may also play a role.

The “age” of a product is largely determined by temperature and time. The shorter the time from harvest to retailer, the better the quality and the longer the shelf life.

Although a large share of food waste takes place at consumer level, part of this waste is caused by too short a shelf life remaining when products reach the consumer.

1.7 Cool products – where appropriate – to their correct temperature as soon as possible after harvest and keep them at this temperature until delivered

The single most important factor for retaining product quality after harvest is temperature.³ Suboptimal cool or cold chain processes and management account for much food loss.

There is thus much to gain from rapid and efficient cooling of products after harvest. The higher the temperature at harvest and the more sensitive the products, the greater the benefit from cooling.

Products that contain much air – for example, leafy vegetables – take a long time to cool. Certain cooling techniques such as forced air and vacuum cooling speed up the cooling process and reduce the risk that the interior of pallets remains uncooled after harvest cooling.

Products with a large surface-to-volume ratio – for example, leafy vegetables and broccoli – easily lose water during harvest cooling. Most

³ Temperature has a direct effect on shelf life by affecting respiration rate, the rate with which carbohydrates in a product are converted into carbon dioxide and water. In asparagus, for example, respiration at 20 °C is 10 times higher than at 0 °C. Temperature also has an indirect effect by affecting air humidity, ethylene production and the effect of existing ethylene.

products, but these in particular, benefit from high air humidity during cooling to prevent them from rapidly losing water.

Subtropical and tropical products develop chilling injuries when kept at lower, though non-freezing, temperatures. Attention should therefore be paid to ensuring appropriate storage temperatures so that products sensitive to chilling are not subjected to temperatures below those that may cause chilling injury (See annex II for recommended lowest storage temperatures).

1.8 Post-harvest treatments may also be considered in order to increase shelf life and reduce food losses and waste along the supply chain

Post-harvest treatments to increase shelf life and reduce losses and waste are available for both organic and non-organic production of fruit and vegetables. When used, they must be authorized by the producing country and the country of destination.

Post-harvest treatments may have several effects, such as:

- Reducing water loss, and thereby delaying weight loss and loss of freshness
- Limiting the exchange of oxygen and carbon dioxide between the product and the surrounding air (creation of a modified atmosphere), which delays ripening and senescence and may delay loss of the nutritional value of products.

1.9 Choose packaging that protects products well during transport and distribution, while balancing the cost and quantity of packaging material and taking into account buyer requirements

Packaging is often chosen as the result of a dialogue between seller and buyer. The wish to fill packages and thereby use space in storage and transportation efficiently should be weighed against the risk of causing damage to the products when packages are put on top of each other in a pallet. Careless stacking of boxes during storage and transportation can easily lead to extra losses, especially when dealing with soft-skinned fruit.

Packages must be of a quality, strength and characteristic to protect the produce during transport and handling and maximize air circulation for effective cooling. Clean materials should be used to protect the produce from foreign matter such as leaves, sand or soil, which could negatively affect the produce and its presentation. A visible lack of cleanliness in several packages could result in the goods being rejected. Bruising caused by vibration during the transport and distribution can be minimized by using appropriate packaging as well as such simple things as properly inflated vehicle tyres.

For products that bruise easily, the use of trays should be considered. For many products, modified atmosphere may extend shelf life and reduce waste.

1.10 Find outlets for products that would not be harvested due to oversupply

Weather conditions may cause more products to be ready for harvest at the same time than was planned. These products meet buyer quality requirements but face a saturated market.

Alternatives that can be considered may include:

- Find alternative outlets, new markets or destinations
- Change the presentation
- Reduce the price. In some countries, electronic market places for unsold/ surplus products are being developed
- Increase the amount of produce sold to the processing industry (if relevant for the product in question and if such an industry exists)
- Donate products to charity (see EU Guidelines⁴).

1.11 Find alternative outlets for products not meeting buyer's quality requirements

Not meeting buyers' requirements should of course be avoided. A continuing dialogue with buyers is therefore important to know clearly what the buyer expects but also to increase the buyer's knowledge and understanding regarding certain defects.

On many markets, especially with large retailers, buyers mainly demand Class I products. Class II products are however subject to the same requirements on good eating quality as Class I products, but the allowance for defects is larger. Products that today are marketed as so-called ugly fruits/vegetables can largely be accommodated within the quality requirements and tolerances of Class II. If Class II products are going to be harvested and traded to a greater extent than today, they need to fetch a higher price than is now the case. If demand for Class II increases, and these products fetch a higher price, the share of products that can be sold for human consumption would increase.

The alternatives under 1.10 above can also be considered.

⁴ The EU Food Donation Guidelines, for example, provide valuable advice:
<https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:C:2017:361:FULL&from=EN>

1.12 Measure the amount of produce that is wasted and specify the major causes of the waste

Companies in food production that understand the causes of food waste and measure it have a greater capacity to reduce waste at the source. This implies that most companies acknowledge there is a problem, measure the loss, identify hotspots and manage the food losses through targeted interventions. Companies that regularly measure waste can identify more easily the hotspots for this waste (where it happens) and review the results to start a learning process. This is an important tool for finding measures that lead to reduced waste.

The results can be used not only for future planning but also for the implementation of measures related to handling, temperatures, transport, logistics etc. Apart from the aspect of reducing waste, there is a strong business incentive to carry out this work since money spent on reducing waste is reported to give an estimated 14-fold return on the money spent.⁵

⁵ Hanson, C., and P. Mitchell. 2017. *The Business Case for Reducing Food Loss and Waste*. Washington, DC: Champions 12.3.

2. Traders

Traders – buyers, wholesalers and sales departments of retail chains – adhering to the Code of Good Practice undertake to do the following:

2.1 Ensure proper training of staff

Your staff need to know how to handle products and to understand the impact of handling on quality, shelf life and waste, and possible loss of profit for the company. Staff working with fresh fruit and vegetables, at all stages of the distribution chain, need to be trained in how to handle the products and have a good knowledge of the consequences of shortcomings in handling and storing the products.

2.2 Ensure that ordered volumes of products are planned and adjusted to demand, in terms of both quantity and quality

Planning and adjusting ordered volumes to demand ensures that products can be delivered to retailers without unnecessary delay. Products that arrive at retail level with a larger part of their shelf life remaining will be fresher and thus have a better quality leading to reduced waste of these products at retail level and at consumer level.

Demand for products will vary according to the weather, season, holidays and celebrations. Some high-demand periods can easily be foreseen, whereas others are unpredictable, thereby making planning more difficult. An efficient chain from harvest to retailer requires market knowledge and careful planning.

Planning involves estimating sales volumes of different products, but also for example trade types, varieties, sizes, quality categories, colour categories and level of maturity/stage of ripeness. Good communication along the distribution chain will help coordinate market demand with supply.

2.3 Improve logistics to shorten time from harvest or packing to retail

An efficient logistics chain that reduces the time from producer or packer to retailer is important for ensuring that a larger share of a perishable products' shelf life is retained for retail and consumer levels. Such efficiency reduces quality losses and waste.

An efficient logistics chain has no more stops and reloading points than necessary. Stops are short and reloading quick. At reloading points, a strict “first-in, first-out” principle is applied.

2.4 Cooperate to establish unbroken cool chains at the appropriate temperature for respective products

Suboptimal cold chain processes and management lead to considerable food losses. Temperature is one of the most important factors for retaining product quality during distribution. It increases shelf life by affecting respiration rate and thereby the ageing of the fruit and vegetables. Shelf life is highly influenced by temperature deviations during transport and storage.

An appropriate temperature shall be kept all the time from harvest to retail. The money and effort put into cooling products to the appropriate temperature is quickly lost if products are kept at too high a temperature later in the chain. Frequent change in temperature also reduces shelf life. A good dialogue along the distribution chain should therefore include discussions on how to establish an unbroken cold chain.

There is thus much to gain in terms of reduced waste and improved quality from keeping products in appropriate climate conditions throughout distribution and retail. The higher the temperature is and the more sensitive products are, the greater the gain from an unbroken cool chain. For example, lettuce has an estimated shelf life of up to 12 days at zero degrees Celsius but only 2 days at 20 degrees; leek and cauliflower may be stored over 40 days at zero degrees but only 2 days at 20 degrees. This only refers to products that are not chilling sensitive (see annex II).

Subtropical and tropical products develop chilling injuries when kept at low, though non-freezing, temperatures. Attention should therefore be paid to appropriate storage and transport temperatures to ensure that chilling sensitive products are not subjected to temperatures below those that may cause chilling injury (see annex II).

The cool chain should be established from harvest and retained all the way through retail, including, where possible, during display for the consumer.

2.5 Place orders and/or change orders with enough time to allow for products to be carefully harvested, handled and cooled before dispatch

Producers need to be given enough time to be able to cool products to the appropriate temperature and to sort and pack according to specifications given. If orders are placed or changed shortly before time of dispatch, producers may have to send products that are not properly cooled. This will reduce the shelf life of the products. It may also lead to sorting and packing

having to be done too quickly to allow for careful handling and for quality assurance to be carried out properly.

2.6 Avoid cancelling orders close to planned dispatch of products from packer/producer

When orders of perishable products are cancelled at short notice and close to dispatch, it is difficult to find a new buyer for these products and the products are often wasted.

The reason for late cancellations is often that market demand for a product, at a given time, is lower than when the buyer originally placed the order. Products may therefore still be wasted even if the order is kept. In these cases, the buyer should consider measures to promote the sale of these products.

The negative impact of a cancellation will be particularly severe if an order is cancelled for example after a producer has opened a cold store or a Controlled Atmosphere (CA) store and removed the products from the storage room. Once a CA store has been opened, the fruit has to go into the distribution chain.

2.7 Ensure that contracts include appropriate maturity requirements

Produce need to have reached an appropriate stage of development and/or maturity to have good eating quality and shelf life. This should be respected and developed by agreement and communication between producers, traders and retailers.

Consumers may be very eager to buy products when these first appear on the market at the beginning of the season. They may also be willing to pay a high price for these first products. It may therefore be tempting to sell products as early in their season as possible. If, however, products are marketed before they have reached the appropriate level of maturity, they may not be able to mature and ripen into a product with good eating quality, but remain hard, lack the desired taste and deteriorate quickly. These immature products will then, most likely, be thrown away by the consumer and the (disappointed) consumer may avoid buying this product again for some time.

The different varieties of many fruits, for example apples and pears, mature and ripen at different times and should therefore be marketed at different times. It is important that each variety is placed on the market at the appropriate time with respect to harvest and storage period to avoid low

eating quality and products being wasted. The best way to avoid this is to have a good communication with producers and respect the advice given by them.

2.8 Define clear specifications that will prevent food loss and avoid interventions, by agreement and communication between producers, traders and retailers

Specifications should be clearly defined, in a dialogue with producers, in such a way that they avoid causing unnecessary waste. Trading parties should be mindful of specifications that might require trimming of produce to the same size or length to fit into a specific package. This type of intervention often leads to food waste.

2.9 Control the ordered products at arrival

- Apply an agreed inspection procedure
- Set up a control protocol specifying the defects and the percentage of non-conforming products
- Communicating complaints/ claims to the seller in a report format and within a reasonable time after products have arrived at the buyer's premises
- Establish, if possible, the likely reason for the non-conformity.

Rejection of products at wholesale level with reference to products not fulfilling the requirements of a quality standard or the requirements that have been agreed by buyer and seller constitutes a major cause of waste.

An added difficulty is that buyers and sellers do not always agree on whether products are in conformity. When the complaint is fair, and is justified by photos and additional supporting evidence, common agreement is facilitated.

In obvious cases, for example if all products are dirty or overripe, non-conformity is easy to establish and it may not be necessary to apply an agreed control method. Instead, photographs may suffice to communicate the extent of non-conformity to the seller. Products may be judged by the buyer to not be in conformity because the tolerances set out in the standards have been exceeded. When such non-conformity is not excessive and the complaint less easy to see from a photograph, a common control method needs to be agreed on and applied to give a replicable and objective control result. With an agreed control method, the buyer can establish the percentage of products with different defects and communicate the result to the seller. The communication of non-conformity is a difficult topic, as is

the understanding between the two parties concerned. Using a commonly agreed control/inspection method can also avoid products being rejected erroneously.

To guarantee a reliable and repeatable inspection result, the OECD has developed an inspection method to be used for conformity controls of fresh fruits and vegetables.

The method defines the number of boxes in a sample – depending on the size of the lot – that needs to be taken randomly and inspected and the method of inspection for products in consumer packages and for products loose in the package [\(link to OECD Guidelines on quality inspection\)](#).

The buyer should use a control protocol that specifies the percentage of products with different defects as found in the control that has been made.

The control and the results should be communicated to the seller within a reasonable time. Depending on the sensitivity of the products and how they are kept and handled after arriving at the buyer's premises, their quality may diminish quickly.

Control results are therefore only a valid judgement of the quality of delivered products if made in connection to the arrival of these products at the buyer's premises. What is judged to be "a reasonable time" will vary according to the product and how it is stored and handled after arrival.

Areas considered high risk and likely to cause problems should be defined in the contracts in advance or otherwise by a common agreement between buyer and seller.

When products do not meet specifications, this should be communicated to the dispatcher immediately and the reason for the non-conformity should be sought. This will help the actors involved to take measures to avoid this problem in the future. If, for example, products show symptoms of chilling injury and there has been a known deviation from the appropriate temperature during transport, this is important information to those involved. The buyer, in agreement with the seller, should always try to find ways to avoid returning the respective product.

2.10 Find alternative outlets for products that cannot be sold on the intended market

Even with the most careful planning, there will invariably be products that cannot be sold to the intended buyer. Companies in the fruit and vegetable trade should therefore have in place alternative outlets and uses for products that cannot be placed on the intended market and/or sold to the intended buyer.

The following alternatives are examples that might be considered:

- Find alternative outlets, new markets or destinations
- Reduce price and sell as
 - Category II (if applicable)
 - “for home processing”
 - “for immediate consumption”
- Process (industrial)
- Donate to charity (see EU Guidelines)⁶

2.11 Measure the amount of produce that is wasted and specify the major causes

Companies in food production that understand the causes of food waste and measure it have a greater capacity to reduce waste at the source. This implies most companies acknowledging there is a problem, measure the loss, identify hotspots and manage the food losses through targeted interventions. Companies that regularly measure waste can identify more easily the hotspots for this waste (where it happens) and review the results to start a learning process. This is an important tool for finding measures that lead to reduced waste.

The results can be used not only for future planning but also for the implementation of measures related to handling, temperatures, transport, logistics etc. Apart from the aspect of reducing waste there is a strong business incentive to carry out this work since money spent on reducing waste is reported to give an estimated 14-fold return on the money spent.⁷

⁶ The EU Food Donation Guidelines, for example, provide valuable advice:
<https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:C:2017:361:FULL&from=EN>

⁷ Hanson, C., and P. Mitchell. 2017. The Business Case for Reducing Food Loss and Waste. Washington, DC: Champions 12.3.

3. Retailers

Retailers and retailer chains adhering to the Code of Good Practice undertake to do the following:

3.1 Ensure proper training of staff

Your staff need to know how to handle products and to understand the impact of handling on quality, shelf life and waste, and loss of profit for the company. Staff working with fresh fruit and vegetables need to be trained in how to handle the products and have a good knowledge of the consequences of shortcomings in handling and storing the products.

3.2 Ensure that ordered volumes are planned and adjusted to demand, in terms of both quantity and quality

If you plan and adjust your ordered volumes to demand, the products will not need to be kept in storage or on display longer than necessary, thus retaining their quality and not producing waste.

Demand for products will vary according to the weather, season, holidays and celebrations. Some high-demand periods can easily be foreseen, whereas others are unpredictable. To ensure a steady flow of products through your shop, you need to have good market knowledge and plan carefully.

Planning involves estimating not only the sales volumes of the various products but also types, varieties, sizes, quality categories, colour categories and stage of ripeness. And campaigns promoting the sale of one product may also influence the sales volumes of other, similar products. Good communication with the supplier or distribution centre should help coordinate demand and supply.

A “first-in, first-out” approach to the stock will contribute to minimizing wastage.

3.3 Define clear specifications that will prevent food loss and avoid interventions, by agreement and communication with the producer and traders

Specifications should be clearly defined in a dialogue with producers, in such a way that they avoid causing unnecessary waste. Trading parties should be mindful of specifications that might require trimming of produce to the same

size or length to fit into a specific package. This type of intervention often leads to food waste.

3.4 Ensure that contracts include appropriate maturity requirements

Produce needs to have reached an appropriate stage of development and maturity to have good eating quality and shelf life, and this should be respected.

Consumers may be very eager to buy products when these first appear on the market at the beginning of the season. They may also be willing to pay a high price for these first products. You may therefore be tempted to sell products as early in their season as possible. If, however, products are marketed before they have reached the appropriate maturity, they may not be able to ripen properly and will remain hard and tasteless. The consumer will then probably throw these products away and avoid buying such products again in the near future.

As the different varieties of many fruits, for example apples and pears, mature and ripen at different times, they should be also marketed at different times. Each variety should be placed on the market at the correct time to avoid low eating quality that leads to products being wasted. The best way to avoid this is to have good communication with producers, and seek and respect their advice.

3.5 Control products and make complaints/claims within a reasonable time after products have arrived at the buyer's premises (buyer and seller should have a common agreement on criteria and method for controls and claims)

Rejection of products at wholesale level because they fail to fulfil the requirements of a quality standard or the requirements agreed to by buyer and seller is a major cause of waste.

The added difficulty is that buyers and sellers do not always agree on whether products are in conformity with standards. When the complaint is fair, and is justified by photos and additional supporting evidence, common agreement is facilitated.

In obvious cases – for example, if products are dirty or overripe – non-conformity is easy to establish. Photographs usually suffice to communicate the extent of non-conformity to the seller. In less obvious cases, there may be a need for a more thorough check. Buyer and seller should have a common agreement on methods for controls and claims and also on how claims are communicated and what documentation they should be based on.

The checking and the results should be communicated to the seller within a reasonable period of time. Depending on how sensitive products are and how they are kept and handled after arriving at the buyer's premises, they may quickly lose quality.

The results of the checking are therefore only a valid judgement of the quality of delivered products if made in connection with the arrival of these products at the buyer's premises. What is judged to be "a reasonable time" will vary depending on which product it is and how it is stored and handled after arrival. Areas considered high risk and likely to cause problems should be defined in the contracts in advance or otherwise by a common agreement between buyer and seller.

When products are found not to meet specifications, this should be communicated to the dispatcher immediately and the reason for the non-conformity should be identified. This will help the involved actors to take measures to avoid this problem in the future. If, for example, products show symptoms of chilling injury and there has been a known deviation from the appropriate temperature during transport, this is important information for those involved. The buyer, in agreement with the seller, should always try to find ways to avoid returning the product.

3.6 Store and display products in the shops at the appropriate, product-specific temperature

Inadequate cold-chain processes and management cause a considerable share of food losses. Temperature is a vital factor in retaining product quality during distribution. It increases shelf life by affecting respiration rate and thereby the ageing of the fruit and vegetables. The shelf life is highly influenced by deviations in temperature during transport and storage.

An appropriate temperature must be kept all the time from harvest to retail. If products are kept at too high temperatures later in the chain, the money and effort put into cooling products to the appropriate temperature is quickly lost.

Frequent change in temperature also reduces shelf life. A good dialogue along the distribution chain shall therefore include discussions on how to establish an unbroken cold chain.

The higher the temperature and the more sensitive the products, the greater the gain from an unbroken cool chain. For example, lettuce has an estimated shelf life of up to 12 days at zero degrees Celsius but only 2 days at 20 degrees; leek and cauliflower may be stored over 40 days at zero degrees but only 2 days at 20 degrees. This, however, only refers to products that are not sensitive to chilling (see annex II).

Subtropical and tropical products develop chilling injuries when kept at low, though non-freezing, temperatures. Attention should therefore be paid to ensuring that chilling-sensitive products are not subjected to temperatures below those that may cause chilling injury [\(link to list\)](#).

Products must be stored and displayed at their appropriate, product-specific temperature to retain the visible quality, the keeping quality and the nutritional quality, and to reduce waste. When possible, there should be different temperature zones to accommodate the different temperature requirements of products. The volume of products displayed at unfavourable temperatures should be limited to avoid shortening shelf life.

Taking products from cool storage and back should be avoided as frequent changes in temperature reduces shelf life. When products are offered for sale in the open, measures should be taken to protect them from unfavourable weather conditions.

Retailers who have no cooling facilities may prolong shelf life by covering their fresh produce overnight with wet cloth or tissue.

3.7 Handle products carefully and take measures to reduce the risk of products getting bruised

Bruising causes damage, reduces quality and often leads to products being wasted. Products may become bruised not only when being transferred from boxes into display areas but also when consumers handle and squeeze them.

Products that are packed individually on trays in the packages (boxes) will be less bruised if displayed for sale in these boxes.

Products should be handled as carefully as possible when transferred into display. Your staff should be well instructed and fully understand the consequences of not handling the products carefully.

Consider taking measures that limit the damage caused by careless consumers, such as limiting the volume displayed at any given time and thereby the number of times each product is scrutinized by a consumer until finally chosen.

3.8 Store and display products appropriately

Products should be stored and displayed appropriately, taking into account their specificities and the facilities available. In addition to temperature, you should take into consideration any other aspects of the presentation of the

produce that are important to retain the visible quality, the keeping quality, the nutritional quality and that would reduce waste.

You should present the products in such a way as to:

- minimize a negative impact of fruit with a clear ripening stage (climacteric fruit,⁸ such as bananas) on other produce
- maintain adequate humidity.

3.9 Avoid campaigns encouraging consumers to buy more than they can eat

Promotional campaigns such as “buy three, pay for two” encourage consumers to buy more products than they may be able to consume, thus causing a waste of food. Although there may be good intentions behind such campaigns – such as increasing consumption for health reasons or helping producers sell an unexpected overproduction due to a period of hot weather – it is, however, better to decrease the price instead.

Consider, also, that when you encourage consumers to buy more of a certain product, they may quite likely buy less of other similar products: for instance, a campaign to promote pears may lead to decreased sales of apples, thus leading to possible waste of apples.

Therefore, in the long run, a stable volume and price decreases waste.

3.10 Find ways to use or sell damaged or suboptimal products

Even with the most careful planning, storage and handling, you will find that some of your products cannot be sold as you originally intended. You should therefore have some alternative solutions for selling or giving away these products:

- Reduce price and sell as
 - Category II (if applicable)
 - “for home processing” (if applicable)
 - “for immediate consumption”
- Highlight for the consumer alternative uses of products (at point of sale)
- Process to juices, jams, smoothies, etc.
- Give to charity (see EU Guidelines)⁹

⁸ A climacteric fruit is a fruit with a clear continuing ripening stage when many characteristics of the fruit change, for example fruit texture which becomes softer, content of sugar and aroma substances, increased respiration rate and production of ethylene. Non-climacteric fruit lack this stage. A list of climacteric and non-climacteric fruit is found in annex I.

⁹ The EU Food Donation Guidelines provide valuable advice:

<https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:C:2017:361:FULL&from=EN>

3.11 Measure the amount of produce that is wasted and specify the major causes of the waste

Companies that understand the causes of food waste and measure it have a greater capacity to reduce waste than companies not making this effort. Companies that regularly measure waste, identify the specific causes for this waste and hold discussions on the results start a learning process that is an important tool for finding measures that reduces waste. The results can be used for future planning but also for measures related to handling, temperatures, transport, logistics etc. Apart from the aspect of reducing waste there is a strong economic incentive to carry out this work since money spent on reducing waste is reported to give an estimated 14-fold ¹⁰ return on the money spent.

Retailers buying directly from producers should also undertake the following:

3.12 Improve logistics to shorten time from harvest or packing to retail

As fresh fruit and vegetables have a limited shelf life, the time that elapses from harvest to retail, or for long-term stored products from packing to retail, should be as short as possible. A strict “first-in, first-out” principle should be applied.

3.13 Cooperate to establish unbroken cool chains, at the appropriate temperature for respective products

An appropriate temperature shall be kept at all times from harvest to retail. The money and effort put into cooling products to the appropriate temperature is quickly lost if products are exposed to unfavourable and/or fluctuating temperatures later in the chain. Therefore, a good dialogue by all participants along the distribution chain shall include discussions on how to establish an unbroken cool chain.

The cool chain should be established from harvest and retained all the way through retail, including, where possible, during display for the consumer.

3.14 Place orders and/or change orders with enough time to allow for products to be carefully harvested, handled and cooled before dispatch

Producers need to be given enough time to be able to cool products to the appropriate temperature and to sort and pack according to specifications given. If orders are placed or changed shortly before time of dispatch producers may have to send products that are not properly cooled. This will reduce the shelf life of the products and increase waste. It may also lead to sorting and packing having to be done too quickly to allow for careful handling and for quality assurance to be carried out properly.

3.15 Avoid cancelling orders close to planned dispatch of products from packer/producer

When orders of perishable products are cancelled at short notice and close to dispatch, it is difficult to find a new buyer for these products and the products are often wasted.

The reason behind late cancellations is often that market demand for a product, at a given time, is lower than when the buyer originally placed the order. Products may therefore still be wasted even if the order is kept. In these cases, the buyer should consider measures to promote the sale of these products.

The negative impact of a late cancellation will be particularly severe if an order is cancelled for example after a producer has opened a cold store or a Controlled Atmosphere (CA) store and removed the products from the storage room. Once a CA store has been opened, the fruit has to go into the distribution chain.

Annex I. Classification of fruit, based on their respiratory behaviour, into climacteric and non-climacteric fruit

Climacteric fruit		Non-climacteric fruit	
Apple	<i>Malus domestica</i>	Blackberry	<i>Rubus fruticosus</i>
Apricot	<i>Prunus armeniaca</i>	Cacao	<i>Theobroma cacao</i>
Avocado	<i>Persea americana</i>	Carambola	<i>Averrhoa carambola</i>
Atemoya	<i>Annona squamosa</i>	Cashew apple	<i>Anacardium occidentale</i>
Banana	<i>Musa paradisiaca</i>	Cherry	<i>Prunus avium</i> , <i>Prunus cerasus</i>
Biriba	<i>Rollinia deliciosa</i>	Coconut	<i>Cocos nucifera</i>
Blueberry	<i>Vaccinium cyanococcus</i>	Cranberry	<i>Vaccinium occycoccus</i>
Bitter melon	<i>Momordica charantia</i>	Cucumber	<i>Cucumis sativus</i>
Breadfruit	<i>Artocarpus altilis</i>	Date	<i>Phoenix dactylifera</i>
Cantaloupe	<i>Cucumis melo</i>	Dragon fruit	<i>Hylocereus undatus</i>
Cape gooseberry		Eggplant	<i>Solanum melongena</i>
Cherimoya	<i>Annona cherimola</i>	Grape	<i>Vitis vinifera</i>
		Grapefruit	<i>Citrus x paradisi</i>
		Java plum	<i>Syzygium cumini</i>
Durian	<i>Durio zibethinus</i>	Jujube	<i>Ziziphus jujuba</i>
Feioja	<i>Feijoa sellowiana</i>	Langsat	<i>Aglaia spp</i>
Fig	<i>Ficus carica</i>	Lemon	<i>Citrus limon</i>
Guava	<i>Psidium guajava</i>	Lime	<i>Citrus aurantifolia</i> ; <i>Citrus latifolia</i>
Honeydew melon	<i>Cucumis melo</i>	Longan	<i>Dimocarpus longan</i>
Jackfruit	<i>Artocarpus heterophyllus</i>	Loquat	<i>Eriobotrya japonica</i>
Japanese pear		Lychee	<i>Litchi chinensis</i>
Jujube	<i>Zizyphus jujuba</i>	Okra	<i>Abelmoschus esculentus</i>
Kiwifruit	<i>Actinidia deliciosa</i>	Olive	<i>Olea europea</i>
Mammee apple		Orange	<i>Citrus sinensis</i>

Mango	<i>Mangifera indica</i>	Pea	<i>Pisum sativum</i>
Mangosteen	<i>Garcinia mangostana</i>	Pepino, melon pear	<i>Solanum muricatum</i>
Muskmelon	<i>Cucumis melo</i>	Pepper	<i>Capsicum annuum</i>
Nectarin	<i>Prunus persica</i>	Pineapple	<i>Ananas comosus</i>
Papaw		Pitaya	<i>Stenocereus ssp.</i>
Papaya	<i>Carica papaya</i>	Pomegranate	<i>Punica granatum</i>
Passion fruit	<i>Passiflora spp.</i>	Prickly pear	<i>Opuntia stricta</i>
Peach	<i>Prunus persica</i>	Rambutan	<i>Nephelium lappaceum</i>
Pear	<i>Pyrus communis</i>	Raspberry	<i>Rubus idaeus</i>
Persimmon	<i>Diospyros kaki</i>	Rose apple	<i>Syzygium ssp.</i>
Plantain	<i>Musa paradisiaca</i>	Star apple	<i>Chrysophyllum cainito</i>
Plum	<i>Prunus domestica</i>	Strawberry	<i>Fragaria ananassa</i>
Quince	<i>Cydonia oblonga</i>	Summer squash	<i>Cucurbita pepo</i>
Rambutan	<i>Nephelium lappaceum</i>	Surinam cherry	<i>Eugenia uniflora</i>
Sapodilla, chiku	<i>Achras sapota</i>	Tamarillo, Tree tomato	<i>Cyphomandra betacea</i>
Soursop	<i>Annona muricata</i>	Tangerine and mandarin	<i>Citrus reticulata</i>
Sweetsop	<i>Annona squamosa</i>	Watermelon	<i>Citrullus vulgaris</i>
Tomato	<i>Lycopersicon esculentum</i>		

Sources: Kader, A.A. 2002. *Postharvest Technology of Horticultural Crops*. University of California, Publication 3311; Kays, S.J. and Paull, R.E. 2004. *Postharvest Biology*. Exon Press, Athens, GA, USA.

Annex II. Classification of fruit and vegetables, based on their sensitivity to chilling injury, i.e. injuries caused by low but non-freezing temperatures, and recommended lowest storage temperature

Chilling-sensitive fruits	Lowest storage temperature	
	°C	°F
Annona , <i>Cherimoya</i> , <i>Atemoya</i> <i>Annona ssp.</i>	13	55
Avocado , var. Hass, <i>Persea americana</i>	3-7	37-45
Banana , <i>Musa paradisiaca</i>	13-15	56-59
Breadfruit , <i>Artocarpus altilis</i>	13-15	55-59
Carambola , <i>Averrhoa carambola</i>	9-10	48-50
Cranberry , <i>Vaccinium macrocarpon</i>	2-5	35-41
Cucumber , <i>Cucumis sativus</i>	10-13	50-55
Dragon fruit , <i>Hylocereus undatus</i>	10	50
Durian , <i>Durio zibethinus</i>	4-6	39-42
Feijoa , <i>Feijoa sellowiana</i>	5-10	41-50
Grapefruit , <i>Citrus paradisi</i>	10-15	50-60
Guava , <i>Psidium guajava</i>	5-10	41-50
Jackfruit , <i>Artocarpus heterophyllus</i>	13	50
Jujube , <i>Zizyphus jujuba</i>	2.5-10	36-50
Lemon , <i>Citrus limon</i>	10-13	50-55
Lime , <i>Citrus latifolia</i> , <i>Citrus aurantiifolia</i> , <i>Citrus limettioides</i>	9-10	48-50
Longan , <i>Dimocarpus longan</i>	4-7	39-45
Lychee , <i>Litchi chinensis</i>	1-2	34-36
Mandarin , <i>Citrus reticulata</i> , <i>Citrus unshiu</i> , <i>Citrus clementina</i> , <i>Citrus deliciosa</i> , <i>Citrus tangerina</i>	4-7	40-45
Mango , <i>Mangifera indica</i>	13	55
Mangosteen , <i>Garcinia mangostana</i>	13	55

Melon, Canary , <i>Cucumis melo</i>	10	50
Melon, cantaloupe , <i>Cucumis melo</i>	2-5	36-41
Melon, casaba , <i>Cucumis melo</i>	7-10	45-50
Melon, Crenshaw , <i>Cucumis melo</i>	7-10	45-50
Melon, honey dew , <i>Cucumis melo</i>	5-10	41-50
Melon, Persian , <i>Cucumis melo</i>	7-10	45-50
Olive , <i>Olea europea</i>	5-10	41-50
Orange , <i>Citrus sinensis</i>	3-9 (dry areas) 0-2 (humid regions)	38-48 (dry areas) 32-36 (humid regions)
Papaya , <i>Carica papaya</i>	7-13	45-55
Passion fruit , <i>Passiflora spp.</i>	10	50
Pepino , <i>Solanum muricatum</i>	5-10	41-50
Pepper, sweet , <i>Capsicum annuum</i>	7-10 (sweet) 5-10 (hot)	45-50 (sweet) 41-50 (hot)
Pineapple , <i>Ananas comosus</i>	7-13	45-55
Plantain , <i>Musa paradisiaca</i>	13-15	56-59
Pomegranate , <i>Punica granatum</i>	5-7.2	41-45
Prickly pear , <i>Opuntia stricta</i>	5	41
Pomelo [also Pummello], <i>Citrus maxima</i>	7-9	45-48
Rambutan , <i>Nephelium lappaceum</i>	12	54
Sapodilla , <i>Achras sapota</i>	15-20	59-68
Squash , <i>Cucurbita pepo</i>	7-10 (summer) 12-15 (winter)	45-50 (summer) 54-59 (winter)
Tamarind , <i>Tamarindus indica</i> TO BE INSERTED AFTER TAMARILLO	2-7	36-45
Tamarillo , <i>Cyphomandra betacea</i>	3-4	37-40
Tomato , <i>Solanum lycopersicum</i>	10-13 (mature-green) 8-10 (firm-ripe)	50-55 (mature-green) 46-50 (firm-ripe)
Watermelon , <i>Citrullus lanatus</i>	10-15	50-59
Chilling-sensitive vegetables		
Basil , <i>Ocimum basilicum</i>	12	54

Beans, green , <i>Phaseolus vulgaris</i>	4-7	40-45
Beans, lima , <i>Phaseolus lunatus</i>	5-6	41-43
Bitter gourd , <i>Momordica charantia</i>	10-12	50-54
Cassava , <i>Manihot esculenta</i>	0-5	32-41
Chilli peppers , <i>Capsicum annuum</i> , <i>C. baccatum</i> , <i>C. chinense</i> , <i>C. frutescens</i> and <i>C. pubescens</i>	5-10	41-50
Courgettes , <i>Cucurbita pepo</i> , Zucchini Group	7-10	45-50
Cucumber , <i>Cucumis sativus</i>	10-12	50-55
Eggplant, aubergine , <i>Solanum melongena</i>	10-12	50-54
Ginger , <i>Zingiber officinalis</i>	13	55
Luffa gourd , <i>Luffa spp.</i>	10-12	50-54
Okra , <i>Abelmoschus esculentus</i>	7-10	45-50
Peppers , <i>Capsicum annuum</i>	7-10	45-50
Potato , <i>Solanum tuberosum</i>	10-15 (early crop) 4-12 (late crop)	50-59 (early crop) 40-54 (late crop)
Pumpkin , <i>Cucurbita maxima</i>	12-15	54-59
Sweet potato, yam , <i>Ipomea batatas</i>	13-15	55-59
Tomato , <i>Solanum lycopersicum</i>	10-13 (mature-green) 8-10 (firm-ripe)	50-55 (mature-green) 46-50 (firm-ripe)
Non-chilling-sensitive fruits		
Apple , <i>Malus domestica</i>	-1.1	30.0
Apricot , <i>Prunus armeniaca</i>	-0.5-0	31-32
Bilberries , <i>Vaccinium myrtillus</i>	-0.5-0	31-32
Blackberry , <i>Rubus sect. Rubus</i>	-0.5-0	31-32
Blueberry , <i>Vaccinium corymbosum</i> , <i>Vaccinium formosum</i> , <i>Vaccinium angustifolium</i> , <i>Vaccinium virgatum</i>	-0.5-0	31-32
Cloudberry , <i>Rubus chamaemorus</i>	0	32
Cherry , <i>Prunus cerasus</i> , <i>Prunus avium</i>	0 (sour) -1-0 (sweet)	32 (sour) 30-32 (sweet)

Coconut , <i>Cocos nucifera</i>	0-2	32-36
Cowberries, lingonberries , <i>Vaccinium vitis-idaea</i>	-0.5-0	31-32
Cranberry , <i>Vaccinium macrocarpon</i> , <i>Vaccinium oxycoccos</i>	2-5	35-41
Currant, black , <i>Ribes nigrum</i>	-0.5-0	31-32
Currant, red, white , <i>Ribes rubrum</i>	-0.5-0	31-32
Date , <i>Phoenix dactylifera</i>	-18-0	0-32
Dewberry , <i>Rubus spp</i>	-0.5-0	31-32
Elderberry , <i>Rubus spp</i>	-0.5-0	31-32
Fig , <i>Ficus carica</i>	-0.5-0	31-32
Gooseberry , <i>Ribes uva-crispa</i>	-0.5-0	31-32
Grape , <i>Vitis vinifera</i>	-0.5-0	31-32
Kiwifruit , <i>Actinidia chinensis</i> , <i>Actinidia deliciosa</i>	0	32
Loganberry , <i>Rubus loganobaccus</i>	-0.5-0	31-32
Loquat , <i>Eriobotrya japonica</i>	0	32
Nectarine , <i>Prunus persica</i>	-0.5-0	31-32
Peach , <i>Prunus persica</i>	-0.5-0	31-32
Pear , <i>Pyrus communis</i>	-1.5-0.5 (European)	29-31 (European)
Persimmon , <i>Diospyros kaki</i>	0	32
Plum , <i>Prunus domestica</i> , <i>Prunus salicina</i>	-0.5-0	31-32
Quince , <i>Cydonia oblonga</i>	-0.5-0	31-32
Raspberry , <i>Rubus idaeus</i>	-0.5-0	31-32
Strawberry , <i>Fragaria spp</i>	0	32
Non-chilling-sensitive vegetables		
Artichoke , <i>Cynara cardunculus</i>	0	32
Asparagus , <i>Asparagus officinalis</i>	2.5	36

Bean sprouts	0	32
Beetroot , <i>Beta vulgaris</i> L. subsp. <i>vulgaris</i>	0	32
Broccoli , <i>Brassica oleracea</i> var. <i>italica</i>	0	32
Brussels sprouts , <i>Brassica oleracea</i> var. <i>gemmifera</i>	0	32
Cabbage , <i>Brassica oleracea</i> var. <i>capitata</i>	0	32
Carrot , <i>Daucus carota</i>	0	32
Cauliflower , <i>Brassica oleracea</i> var. <i>botrytis</i>	0	32
Celeriac , <i>Apium graveolens</i> var. <i>rapaceum</i>	0	32
Celery , <i>Apium graveolens</i> var. <i>dulce</i>	0	32
Chinese cabbage , <i>Brassica rapa</i> subsp. <i>Pekinensis</i>	0	32
Cilantro , <i>Coriandrum sativum</i>	0-1	32-34
Corn, sweet , <i>Zea mays</i>	0	32
Dandelion , <i>Taraxacum officinale</i>	0-2	32-36
Dill , <i>Anethus graveolens</i>	0	32
Endive , <i>Cichorium intybus</i> , Foliosum Group	0	32
Fennel , <i>Foeniculum vulgare</i> var. <i>azoricum</i>	0-2	32-36
Garlic , <i>Allium sativum</i> var. <i>sativum</i>	0	32
Ginger , <i>Zingiber officinalis</i>	13	55
Ginseng , <i>Panax ginseng</i>	0	32
Horseradish , <i>Armoracia rusticana</i>	-1-0	30-32
Kale , <i>Brassica oleracea</i> var. <i>acephala</i>	0	32
Kohlrabi , <i>Brassica oleracea</i> var. <i>gongylodes</i>	0	32
Leek , <i>Allium ampeloprasum</i>	0	32
Lettuce , <i>Lactuca sativa</i>	0	32
Onion , <i>Allium cepa</i>	0	32
Parsley , <i>Petroselinum crispum</i>	0	32
Parsnip , <i>Pastinaca sativa</i> L. subsp. <i>sativa</i>	0	32

Peas , <i>Pisum sativum</i>	0-1	32-34
Radish , <i>Raphanus sativus</i> , Radicula Group	0	32
Rhubarb , <i>Rheum rhabarbarum</i>	0	32
Rutabaga , <i>Brassica napus</i> var. <i>napobrassica</i>	0	32
Salsify , <i>Tragopogon porrifolius</i> , subsp. <i>porrifolius</i>	0	32
Scorzonera , <i>Scorzonera hispanica</i>	0	32
Shallots , <i>Allium cepa</i> , Aggregatum Group, <i>Allium oschaninii</i>	0	32
Spinach , <i>Spinacia oleracea</i>	0	32
Swede , <i>Brassica napus</i>	0	32
Turnip , <i>Brassica rapa</i>	0	32
Watercress , <i>Nasturtium officinale</i>	0	32

Sources: Kader, A.A. 2002. *Postharvest Technology of Horticultural Crops*. University of California, Publication 3311; Kays, S.J. and Paull, R.E. 2004. *Postharvest Biology*. Exon Press, Athens, GA, USA.

Further reading

Food and Agriculture Organization. 1989. *Prevention of Post-harvest Food Losses: Fruits, Vegetables and Root Crops*. (Training manual).

Gross, K.C., Wang, C., Saltveit, M. Revised 2016. *The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks*. USDA Agricultural Handbook No. 66.

Jacob John, P., 2008. *A Handbook on Post Harvest Management of Fruits and Vegetables*. Daya Publishing house.

Kader, A.A. (Ed.) 2002. *Postharvest Technology of Horticultural Crops*. University of California, Publication 3311.

Kays, S.J. and Paull, R.E. 2004. *Postharvest Biology*. Exon Press, Athens, GA, USA.

Wills, R.B.H., McGlasson, B., Graham, D., Joyce, D. 2007. *An Introduction to the Physiology and Handling of Fruit, Vegetables and Ornamentals*. **UNSW Press**.