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#### Specialized Section on Standardization of Fresh Fruit and Vegetables

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Item 5 of the provisional agenda

**Sustainable Development Goal 12 and sustainable practices:  
food loss and waste prevention related to standards**

## Good practices in harvest and post-harvest handling of root vegetables

**Submitted by the secretariat**

### *Summary*

In 2021, a second edition of the *ECE Code of Good Practice – reducing food loss and ensuring optimum handling of fresh fruit and vegetables along the value chain* was developed by an ad-hoc drafting group under the Specialized Section for Standardization of Fresh Fruit and Vegetables and presented to the 76<sup>th</sup> session of the Working Party on Agricultural Quality Standards. The Code of Good Practice contains recommendations for optimal handling of fresh fruit and vegetables along the supply chain avoid food loss. For ease of use, it has separate chapters for different supply chain actors: primary producers, traders, transporters, and retailers.

In addition, to increase the uptake and use of the Code of Good Practice, it was proposed to develop hands-on guidance material with illustrative pictures for practical use (informal document ECE/CTCS/WP.7/2021/Inf.2). Thus, with funding from a United Nations Development Account (UNDA) project, such recommendations have been developed covering four groups of vegetables for which common guidelines and recommendations apply, namely: floral vegetables; immature fruit vegetables; leafy vegetables; and root vegetables.

The present document covers root vegetables.

The Specialized Section for Standardization of Fresh Fruit and Vegetables is invited to review the draft. It is also invited to consider the merits of covering a wider range of products by similar guidance material, and if so, if it should cover product groups or specific products in line with the trade standards.



## **Code of Good Practice: Good practices in harvest and post-harvest handling of root vegetables**

### **I. Introduction**

The use of good practices, when vegetables are harvested and subsequently handled, are central in reducing losses and waste. These recommendations, that cover root vegetables, aim to provide practical guidelines for handling this group of products and thereby to supplement the recommendations given in the Code of Good Practice.<sup>1</sup>

Good practices during harvest and postharvest are important to assure food safety and keeping quality. In this document, emphasis is given to keeping quality, with practices that keep the produce sound, extends shelf life and reduce food loss and waste.

One must have in mind that keeping the produce sound is important to guarantee its safety, but it is not enough. A high-quality carrot root can look good and yet be unsafe due to its contamination with food-borne pathogens or toxic chemicals. On the other hand, a wilt and sprouted carrot, although a low-quality produce in terms of flavour, can be safe.

The recommendations listed in this guidance do not guarantee food safety. More specific guidelines are available at Codex Alimentarius.<sup>2</sup>

### **II. Good practices for keeping quality**

There is more than one way to implement good practices in the root vegetables supply chain, depending on the size of the business, the technological level and the market demand on quality and presentation of the produce.

In all cases, the following conditions should be met:

1. Handle the produce as little and as carefully as possible to avoid physical damage.
2. Protect the produce from damaging environmental conditions like direct exposure to sunlight, wind and dust, inappropriate temperature and air humidity and rain or hail, all the way from producer to point of sale.
3. Protect the produce from exposure to ethylene.
4. Keep hygiene in all steps of the supply chain to avoid contamination by plant and foodborne pathogens.
5. Coordinate operations to assure fresh product arrives in the market as soon as possible after harvest.

### **III. Primary Producers**

The root vegetables covered in this text are carrot, beetroot, turnip, radishes, parsnips and rutabaga. They are of temperate origin and not suited for long term storage at room temperature, where they can be kept only for a few days. On the other hand, they can be stored for weeks or months under refrigerated storage.

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<sup>1</sup> Code of Good Practice – reducing food loss and ensuring optimum handling of fresh fruit and vegetables along the value chain, available at: [https://unece.org/sites/default/files/2021-11/WP7\\_2021\\_INF1\\_0.pdf](https://unece.org/sites/default/files/2021-11/WP7_2021_INF1_0.pdf)

<sup>2</sup> Codex Alimentarius (2017). Code Of Hygienic Practice for Fresh Fruits and Vegetables: [https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXC%252B53-2003%252FCXC\\_053e.pdf](https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXC%252B53-2003%252FCXC_053e.pdf)

## A. Maturity at harvest

Maturity of root vegetables at harvest is mainly defined by size. Some, like carrot, can be harvested at various stages of development and provide good eating quality. When carrots have stopped growing, carbohydrates are stored into the root and respiration rate decreases. As a result, they then have a longer storage life. Carrots for storage should therefore be given enough time in the field to enter this mature stage in order to optimize storability.

Early season root vegetables have a short shelf-life. Smaller roots have a larger surface-to-volume-ratio and are therefore more prone to water loss. In addition, their respiration rate is higher. Hence, they should be sold without delay. Keeping the leaves further reduces shelf-life by increasing water losses from the roots.

Harvesting too late on the other hand decreases eating quality due to splitting of roots and development of hollow or spongy tissue. If harvest is delayed, it is important that foliage diseases are managed, and the level of root diseases is monitored to prevent crop losses before harvest. Over-mature radishes tend to develop harsh flavours, while rutabagas are an exception since they can have a bitter taste when immature.<sup>3</sup>

## B. Harvest methods and tools

Root crops can be harvested manually, semi-mechanically or mechanically. In fully mechanized systems, harvesters cut, dig, and lift the roots. After separating the roots from the leaves, and removing part of the soil, the roots are transferred to the ground, to large bins or to a trailer. When laid on the ground, the roots are collected by hand and transferred to harvest containers.

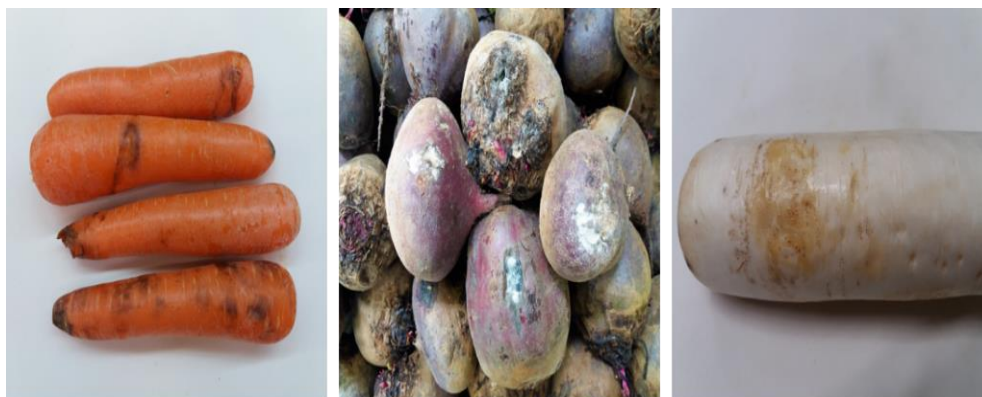
### *Semi-mechanized harvest*



Photos: Milza Moreira Lana, EMBRAPA

<sup>3</sup> Look for horticultural maturity indices for individual produce in:  
<https://www.ars.usda.gov/is/np/CommercialStorage/CommercialStorage.pdf>

Although root vegetables are more resistant to handling than leafy and immature fruit vegetables, they can be damaged during harvest, during transport from the field to the packing house and when they are dumped into washers. Excessive drop heights lead to bruising, splitting and breakage. It is important to adjust machinery in the field and on the packing line to lower the drop height. Roots dropped at the beginning of the packing line should have some padding to eliminate bruises or be water-dumped.



*Root vegetables can suffer extensive physical damage during harvest and postharvest. The cracks and abrasions serve as entry points for decay-causing fungi and bacteria*

Photos: Milza Moreira Lana, EMBRAPA

### C. Cleaning of containers, tools and equipment

Harvest containers can be washed with a pressure washer or in crate washing machines. Due to the great amount of soil that often stick to the crates, it is recommended to have a separated area to wash and store the containers.

### D. Postharvest operations

The main postharvest operations are washing, pre-cooling, drying, grading, and packaging.

Washers are available in a range of sizes and models. Small amounts of roots can be handwashed using a pressure washer and a washing table.

Small scale equipment includes barrel and cylindrical washers. Barrel washers can be used for parsnips, carrots, beets and rutabagas but are not ideal for turnips and radishes that can bruise more easily.

Small packing lines are equipped sprinklers, brushes and a selection table. Packing lines with hard brushes can cause skin damage in radishes and turnips.

Larger packing lines may include polishers, hydrocoolers, sorting devices by diameter or length, and weighers.

Washers with recirculating water systems are not recommended for root vegetables. The high content of organic material and soil in suspension makes sanitation of the water ineffective and increases the chance of cross-contamination, especially when chlorine is used as sanitizing agent. If used, a final rinse in clean water is important.

Hydrocooling is the most recommended method to remove field heat of these crops and it is usually applied after washing the roots. Forced-air cooling and package icing are also possible.

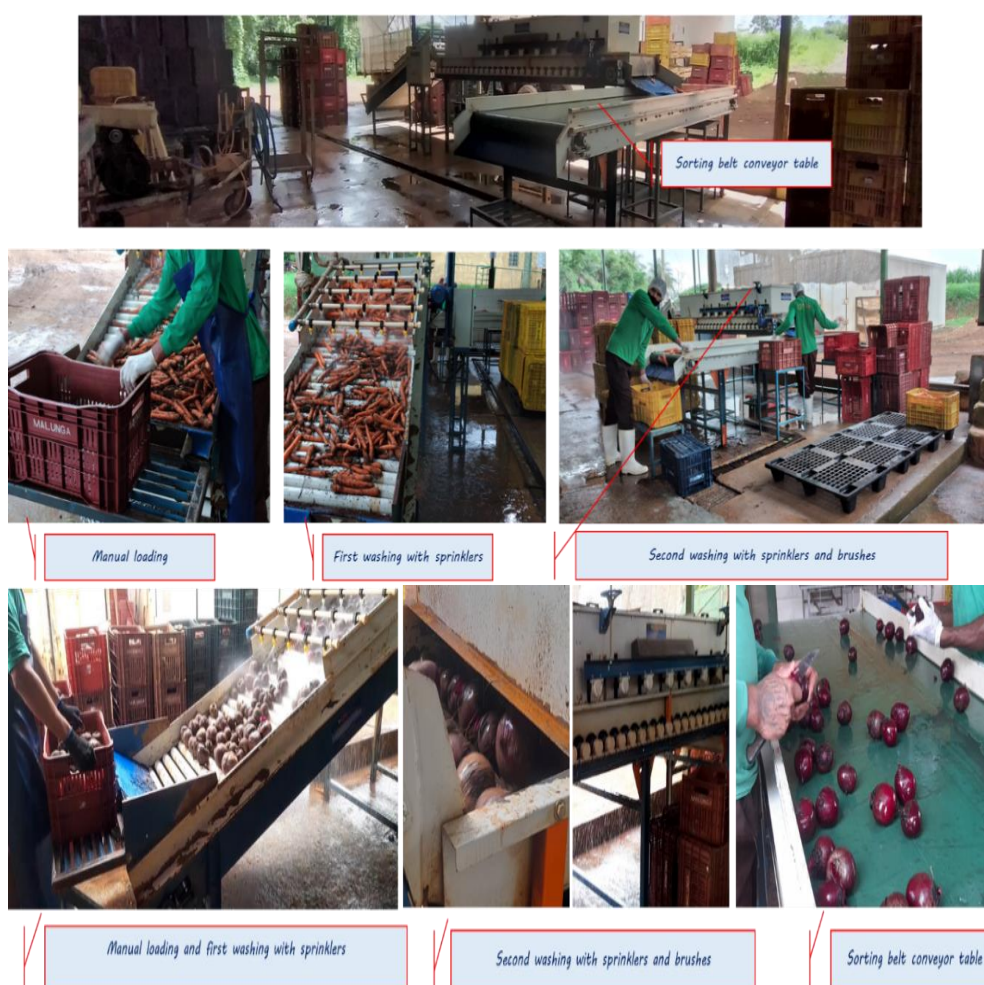
Short-term on-farm storage, to facilitate marketing, can be used. In this case, it is preferable to store the roots unwashed and wash them just before they are sent to the market.



### Cylindrical washer



### Small scale washer line



Photos: Milza Moreira Lana, EMBRAPA

## E. Postharvest infrastructure

A well-organized packinghouse for root vegetables should have at least the following sectors: reception, cleaning and storage of harvest containers, root wash and selection, packing, pallet area for packed produce, dispatch.

Depending on the scale and financial resources available, the following sectors can be added: pre-cooling facility, cold storage room, office space, stockroom for cleaning and sanitation supplies, and other materials, waste disposal.

When cold storage is not available, an air-conditioned room to keep the packaged vegetables help to keep quality for longer. Remember to stack the crates in a way that allows proper ventilation.

*Additional sectors of a packing house for root crops in medium sized farms*



Area for cleaning and storage of harvest containers



Selection tables for washed roots



Area for retail packing



Air conditioned room to store produce between packaging and delivery

Photos: Milza Moreira Lana, EMBRAPA

## IV. Traders and Transporters

Root vegetables are susceptible to rot, water loss and shrivelling during refrigerated storage. The best conditions for storage and transport are very high humidity and temperature near 0°C. Under these conditions the surface tissues of the roots maintain their integrity and are less susceptible to decay.

Use of liners during storage and transportation increases moisture retention and reduces dehydration.

Roots with leaves can be kept for 1 to 3 days at room temperature and for 2 to 3 weeks when refrigerated at optimal conditions. When the tops are removed, the roots can be kept at room temperature for few days and under refrigeration for weeks or months.

Carrots and parsnips exposure to ethylene cause the development of bitter compounds.





*Root vegetables with tops have very limited shelf life due to wilting, yellowing and deterioration of the leaves that are more perishable than the roots. Additionally, the leaves act as pumps, drawing water from the roots that lose water much faster than de-topped roots of the same size and maturity.*

Photos: Milza Moreira Lana, EMBRAPA

## V. Retail

### A. Display products appropriately<sup>4</sup>

Root vegetables may be displayed for a few days without refrigeration, but temperatures below 10°C together with pre-packaging in plastic bags or film are beneficial.

Sprinkling bunched roots with water at low temperatures prolongs the shelf life by preserving a fresh appearance of the leaves and firmness of the roots. Light sprinkling will give better results than heavy wetting, which may cause dark, water-soaked areas on the leaves.

Roots without tops have a longer shelf life if pre-packaged than if displayed in bulk, because the highly perishable tops have been removed and the roots are protected in moisture-retentive bags.

Bunched radishes are one of the most highly perishable commodities and for that they should be quickly sold.

### B. Measure the losses and waste

Recording losses and waste from production to wholesale levels will help to identify weak links and increase awareness throughout the distribution chain. Methods have been described, for example by the ECE, in its guide *Simply Measuring - Quantifying Food Loss & Waste: UNECE food loss and waste measuring methodology for fresh produce supply chains*.<sup>5</sup>

<sup>4</sup> Retail outlet display considerations for individual produce are available at USDA (2016), *The Commercial Storage of Fruits, Vegetables and Florist and Nursery stocks*, Agriculture Handbook Number 66, United States Department of Agriculture, February 2016, available at: [www.ars.usda.gov/is/np/CommercialStorage/CommercialStorage.pdf](http://www.ars.usda.gov/is/np/CommercialStorage/CommercialStorage.pdf)

<sup>5</sup> ECE (2020), *Simply Measuring - Quantifying Food Loss & Waste: UNECE food loss and waste measuring methodology for fresh produce supply chains*, ECE/TRADE/453, Geneva 2020. Available at: <https://unece.org/sites/default/files/2021-04/FoodLossMeasuringMethodology.pdf>

## Annex

### Additional information and links

#### Harvest and postharvest handling

Beet, carrot, rutabaga and turnip: <https://sites.udel.edu/weeklycropupdate/?p=14258>

Carrots: <https://www.agric.wa.gov.au/carrots/minimising-postharvest-losses-carrots?nopaging=1>

Carrot and radish:

<https://open.unido.org/api/documents/3286742/download/Root%20vegetables.pdf>

Parsnips: [PostharvestVegetables\\_HIA.pdf](#) (squarespace.com)

#### Harvest methods and tools

To know more about harvesting of root crops, see:

Small carrot harvest machine: <https://www.youtube.com/watch?v=Ft5gQNXlQY>

Mechanized harvest of carrot in large areas:

<https://www.youtube.com/watch?v=0y8MSPvJ8Gk>

#### Postharvest operations

To know more about small equipment to wash root vegetables, see:

Spray table: <https://extension.umn.edu/growing-guides/postharvest-handling-fruit-and-vegetable-crops-minnesota#spray-tables-2803210>

Spray table and barrel washers: <https://www.youtube.com/watch?v=Ft5gQNXlQY>

Hydrocooling: <https://content.ces.ncsu.edu/hydrocooling>

Vegetable and Fruit Washwater Treatment Manual:

<http://www.omafra.gov.on.ca/english/crops/pub854/pub854.pdf>

Forced air cooling: <http://www.omafra.gov.on.ca/english/engineer/facts/14-039.pdf>

#### Postharvest infrastructure

To know more on how to build a packing house, see:

Basic guidelines to build a wash Line & packing shed design for food safety: [https://rvpadmin.cce.cornell.edu/uploads/doc\\_242.pdf](https://rvpadmin.cce.cornell.edu/uploads/doc_242.pdf)

A collection of study cases on transforming pre-existing infrastructure in a packing shed is available at: <https://blog.uvm.edu/cwcallah/post-harvest-case-studies/>

<https://www.youtube.com/channel/UCwLV4LaVPtm4m3XW5Kv9w>

Instructions to build a postharvest area with cold room:

<https://resiliency.uark.edu/research/food-systems/base-yard-project/manual-for-small-scale-farmers-in-hawaii.pdf>

#### Traders and transporters

Instructions to build small cold-storage room: <https://cefs.ncsu.edu/wp-content/uploads/NCGT-On-Farm-Infrastructure-Toolkit-9-2017.pdf?x77888>

Guideline to solve cold storage problems: <http://www.omafra.gov.on.ca/english/engineer/facts/17-003.pdf>

Guideline on optimal conditions for refrigerated transport of specific produce:

<https://edis.ifas.ufl.edu/pdffiles/HS/HS132800.pdf>