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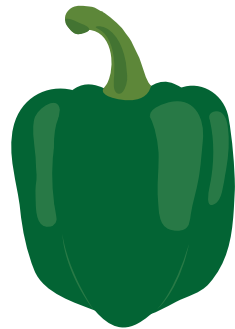
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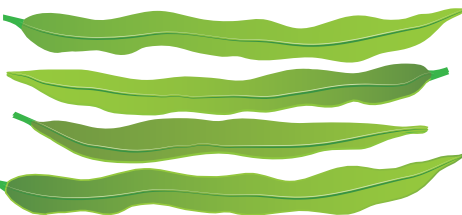
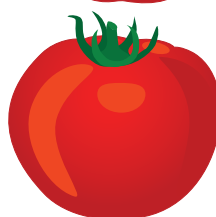
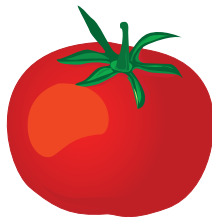
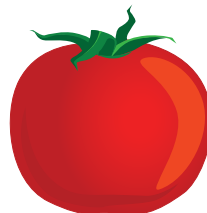
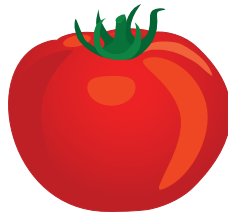
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HARVESTING, PACKING HOUSE OPERATIONS, STORAGE AND TRANSPORT OF FRUIT VEGETABLES



CAPSICUM



GREEN BEANS

TOMATO



CUCUMBER

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Cover design: Lisanne Brummelhuis.

ABBREVIATIONS

1-MCP	1-methylcyclopropene
ppm	Parts per million
RH	Relative humidity
LDPE	Low density polyethylene
VIAEP R3	Ethylene absorbent created by VIAEP

PREFACE

Under the framework of the Joint Program for Vietnam “UN Support to National Target Programme on New Rural Development” funded by One Plan Fund, the United Nations Industrial Development Organization (UNIDO) aims to support the strengthening of the supply capacity of the fruit and vegetable sector by applying proper technologies along the value chain.

UNIDO and the Vietnam Institute of Agricultural Engineering and Post-harvest Technology (VIAEP) collaborated in the development of a set of four handbooks on Harvesting, Packing House Operations, Storage and Transport of Leafy, Root, Spicy and Fruit Vegetables. The four handbooks give practical information and describe simple low-cost and practical post-harvest technologies.

This handbook covers four fruit-vegetables: tomato, cucumber, capsicum and green beans. These vegetables are called fruit-vegetables because from a scientific or botanical point of view they are fruits. However, in the market place they are classified as vegetables.







Fruit vegetables are valuable in the human diet and rich in minerals, vitamin A and vitamin C. They often suffer big post-harvest losses because of diseases and infestation from insects and fruit-worms. Rainy weather, high storage temperatures and lack of knowledge in storage technologies also contribute to post-harvest losses.

TOMATO

Harvesting

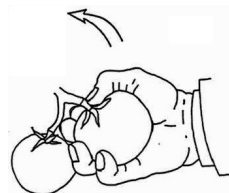
Harvest maturity: The most widely used index of tomato maturity is skin colour (as shown in the table below). Tomatoes are harvested at different stages of maturity. For maximum market life, tomatoes should be picked at the mature-green stage. Some are harvested when the fruit is physiologically mature but still green. Others are harvested at commercial ripe stage, which is when the skin changes into a reddish colour. Tomatoes are also harvested when they are fully ripe. Maturity chosen for harvesting depends on market requirements and the distance, time and means of transport to the market place.

Ripening stages of mature tomatoes

Stage	Color	Description
1	Green	 The surface is completely green in color. The shade of green may vary from light to dark.
2	Breakers	 There is a definite "break" in color from green to tarnish-yellow, pink or red on less than 10% of the surface.
3	Turning	 10% to 30% of the surface shows a change in color from green to tarnish-yellow, pink, red or a combination thereof.
4	Pink	 30% to 60% of the surface shows pink or red in color.
5	Light Red	 60% to 90% of the surface shows pinkish-red or red.
6	Red	 More than 90% of the surface is red.

Harvest time: Tomatoes are best harvested in cool, dry mornings when the dew has just gone. If it is essential to harvest during or after rain, they must be washed and dried off before packing to avoid rapid spoilage, as bacteria will grow on any surface water.

Harvest methods: Tomatoes are harvested by hand, jerking up as shown in the figure to the right. The stem attached to the fruit should be less than 1 cm. Harvested tomatoes are gently placed in a crate with



soft padding to avoid bruising. It is recommended to fill not more than 10 kg of fruit in each crate. The fruit should be immediately transported to the packing house. If this is not possible, tomatoes are temporarily kept in a cool, dry, airy place away from direct sunlight.

Packing house operations

Sorting/Grading: Tomatoes with defects, cracks, decay and mechanical injuries are eliminated. The acceptable ones are graded by size, weight and maturity then packed in crates.

Cleaning: Tomatoes may be cleaned manually with a soft cloth. Sometimes a specialised machine as shown to the right is used to wash them and its wash water should be changed regularly to avoid causing harmful bacterial contamination.



After washing, tomatoes are allowed to drain dry or are blown dry with a jet of compressed air.

Treatment of fungal diseases: Fresh tomatoes are often dipped in 2% calcium chloride solution or 5% acetic acid solution for 5 minutes to sanitize the surface. They are later wiped dry before storage.

To restrict ripening, tomatoes are treated with an ethylene inhibitor such as 1-MCP (1-methylcyclopropene) at 300-600 ppm for 6 hours at 20°C.

To encourage ripening, tomatoes are stored at room temperature or treated with 50-100 ppm ethylene for 6 hours at 20°C.

Chilling: Tomatoes are cooled by forced air or cold water to reduce the temperature to 15°C before storage.

Caution: Green tomatoes cannot ripen if they are chilled to below 10°C.

Packaging: Small crates or trays, as shown in the photos below, made of smooth plastic are recommended. This avoids injury. Bamboo baskets or wooden boxes with soft padding can also be used. Each crate can contain up to 15 kg, but not more to avoid physical damage.

Tomatoes with the same maturity should be packed together and packed firmly to avoid collisions during transport.



Storage

Tomatoes keep ripening during storage at a rate that depends on temperature. Optimal storage temperatures depend on fruit maturity, time of storage required and distribution conditions.

Ambient storage: After being treated with 2% calcium chloride or 5% acetic acid solution for 5 minutes and packed in perforated (0.25%) polyethylene bag, tomatoes can be stored for 7 days when kept in a dry, cool, airy place.

Chilled storage: Mature green tomatoes can be stored up to 21 days at 12-13°C, and about 90% RH. Mature red tomatoes can be stored up to 7 days at 6-8°C and about 90% RH.

Transport to market place

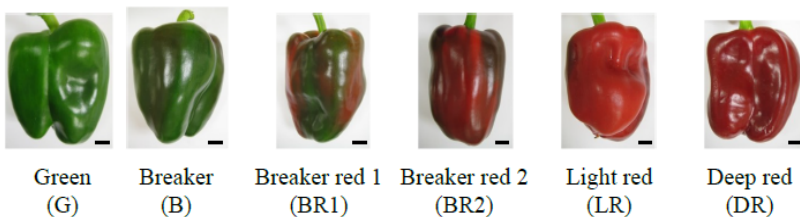
Normal precautions should be taken. Avoid overloading, ensure ventilation and avoid bumps. Tomatoes should be kept at 6-15°C during transport and transport time should not be more than 12 hours if the tomato temperature is over 25°C.

Note: Ripe tomatoes can ripen green ones during transport. If possible keep green and ripe tomatoes separate.

CAPSICUM (BELL PEPPER)

Harvesting

Harvest Maturity: Mature capsicums are harvested at different stages of colour development: green, breaker and red as shown in the photos below. Colour at harvesting depends on the market requirements.



The fruit is manually harvested, ensuring that some stem remains attached as shown in the photos below.



Harvest time: Capsicums should be harvested in cool, dry mornings or afternoons.

Harvest method: Capsicums are harvested by hand, jerking up. Harvested fruits are gently placed in a crate with soft padding to avoid mechanical injuries and immediately transported to the

packing house. If this is not possible, they are temporarily kept in a cool, dry, airy place away from direct sunlight.

Packing house operations

Sorting/Grading: It is recommended to keep capsicums the same size and colour together as shown in the photos. Capsicums with decay and mechanical injuries should be discarded.



Cleaning: If necessary, capsicums can be wiped with a soft cloth while sorting. If they are mechanically washed, the wash water should be changed regularly to avoid dirt and harmful bacterial contamination.



Packaging: Capsicums are loaded directly into 5-10kg cartons lined with 0.03-mm-thick LDPE film. Cartons must be carefully filled to avoid injury.



Storage

Ambient storage: When packed in perforated polythene bags and kept in a dry cool and airy place, capsicums can be stored for one week.

Cool storage: Recommended storage conditions are 4-6°C and 90-95% RH for red capsicums and 7-8°C for green ones. The expected shelf life is 19-30 days. Cartons should be well ventilated to give even distribution of air flow.

Transport to market place

Normal precautions should be taken. Avoid overloading, ensure ventilation and avoid bumps. Capsicums should be transported in rigid plastic containers to protect fruits from cracking and splitting because these allow bacteria and mold to grow fast, leading to rapid decay.

CUCUMBER

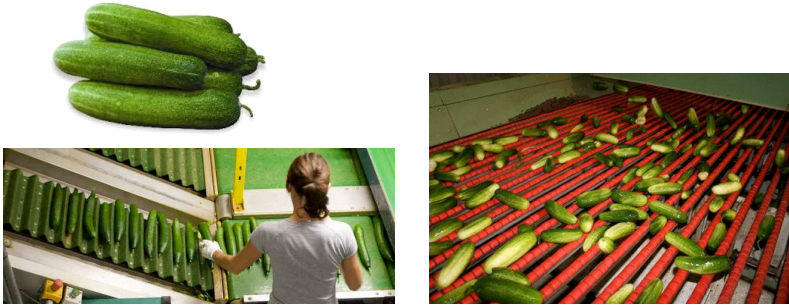
Harvesting

Cucumbers are harvested 20-30 days after the fruit is formed and at different sizes depending on market requirements. During the harvest, cucumbers are picked every second day and peak time, every day. Cucumbers are picked carefully to avoid damage, especially around the stalk. Harvesting should be done in cool dry mornings.



Packing house operations

Sorting/Grading: Different varieties of cucumbers have their own grades. Typically, they are graded according to their colour, lack of defects and straightness (but they may have a curvature less than 1 cm for each 10 cm body length). The following photos show cucumbers being graded by size.



Cleaning: Any soil or surface stains should be removed at the time of harvest by rubbing the surface with a soft damp cloth or cotton gloves. Washing may be necessary if cucumbers are too dirty.

Treatment: Cucumbers can be treated to control disease by immersing in water at 47°C for 5 minutes then dipping in 50ppm chlorine solution.

Packaging: Cucumbers should be packed 5-10 kg in well-ventilated plastic or wooden containers for the domestic market. For export, cucumbers should be packed in strong well-ventilated 25kg fiber board cartons.



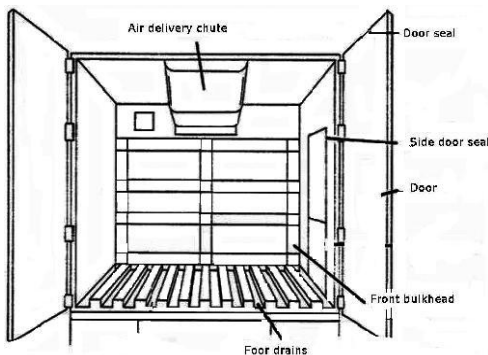
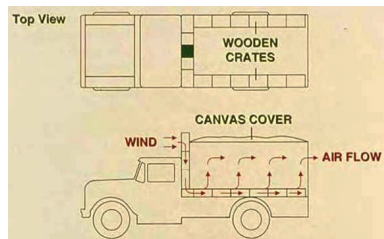
Storage

Cucumber is best stored for 2 weeks at about 10°C. To avoid chilling injury, which leads to development of watery pits on the skin, cucumber should not be stored below 10°C.

Transport to market place

Normal precautions should be taken. Avoid overloading, ensure ventilation and avoid bumps. Cucumber should not be stored or transported with ethylene producing fruit as it is sensitive to that gas, changing the cucumber skin to a yellowish colour.

Pictures of ordinary and built-in cooling transport vehicles are shown below.



GREEN BEANS

Harvesting

Green beans can be harvested 14 days after the bean is first formed. They are best picked before tough fibre starts to develop. Beans should be picked in the early mornings or in the dry, cool afternoons. The beans are gently hand picked and put into suitable containers. They should not be put directly on the ground to avoid microbial contamination.

Packing house operations

Sorting/grading: Beans are selected to have the same maturity and size and without mechanical injuries or diseases.



Cleaning: Beans should be washed no more than 8 hours after harvest with clean water and then rinsed with water containing 50 ppm chlorine per liter. The chlorine-water should be renewed after 2-3 batches.

Draining/drying: The beans are spread in thin layers on shelves, work tables or held in metal baskets to drain naturally and dry off. A hand held blower can also be used for drying. Draining and drying should not exceed 4 hours to avoid the beans withering.

Packaging: Beans are often packaged in 0.03-mm-thick LDPE film with weight according to customer requirements. The beans are carefully placed and lined up as shown in the photos below. The bagged beans are placed 5-10 kg into plastic crates or ventilated cartons.



Storage

Beans must be stored in a dry, cool, hygienic place. The crates and cartons are staggered with no more than 2 layers of crates on each rack of the stand to ensure good ventilation. Beans can be stored at 25⁰C and 90-95% RH, but the temperature should not exceed 30°C. If necessary, a small packet of VIAEP's R3 ethylene absorbant can be put in with the beans at the rate of 1-3 g per kg of beans.

Transport to market place

Normal precautions should be taken. Avoid overloading, ensure ventilation and avoid bumps. Green beans should be kept away from products that generate ethylene.

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