WFP United Nations World Food Programme 联合国世界粮食计划署

WFP SSTC Field Pilot Project in Peru supported by China

Good Practices in Fresh Food Production
——fruits and vegetables

XIAO Hongmei, Ph.D. ,Professor

WFP Centre of Excellence for Rural Transformation

Nanjing Agricultural University

Cloud School

Sharing for Learning

Personal profiles

- **Work experience**

- 1994.08~ Nanjing Agricultural University
- 2014.03~2015.03 Wageningen University And Research, Netherland
- 2003.02~2004.02 Heriot-Watt University, England
- 2019.07~2019.10 Department of Agro-Industry, Ministry of Agriculture, Forestry and Fisheries, Cambodian

- **Research interest**

- Food Storage and Process
- Detection of Transgenic Food

CONTENTS

Questions before introduction

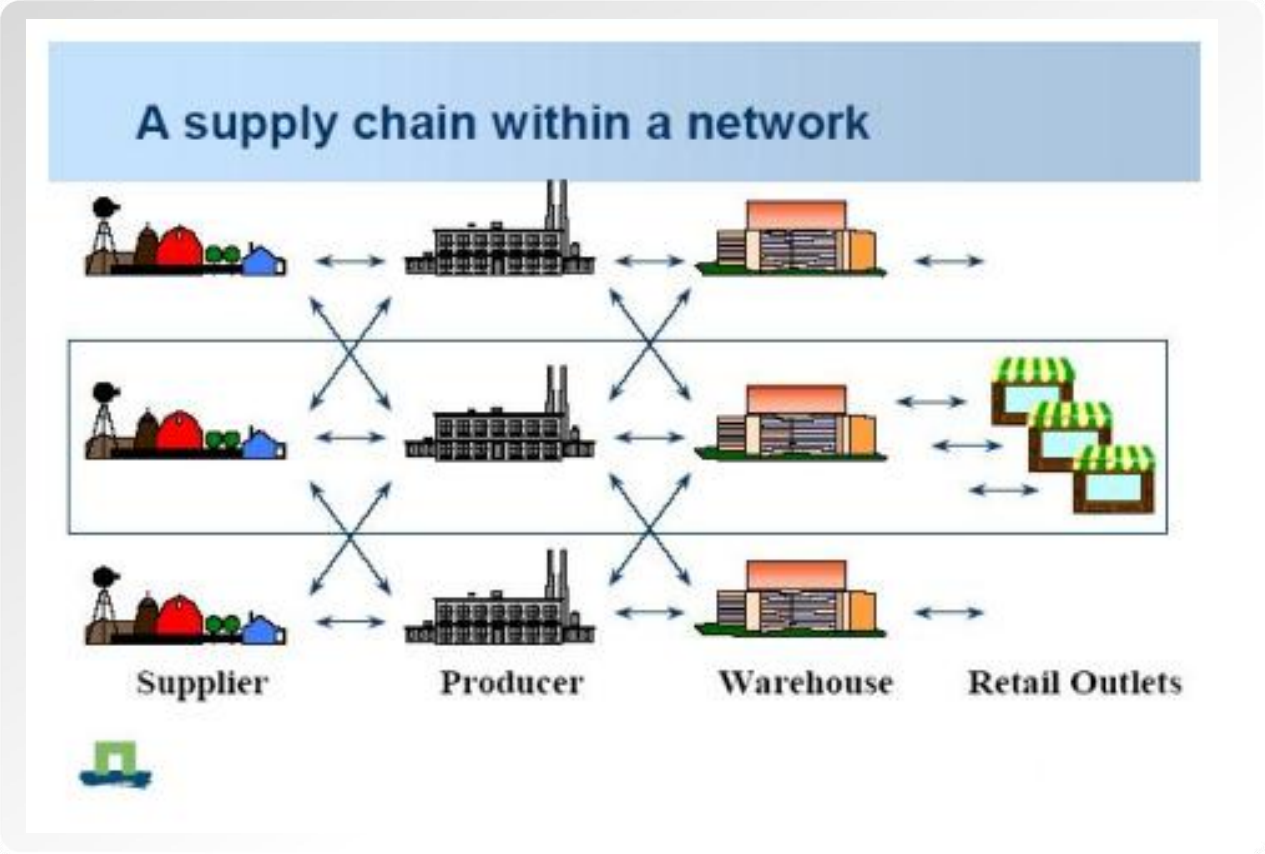
- What are the internal and external factors for fresh food production supply chains in our two countries？
- How can farmers or growers and related organizations gain and maintain insight into changing consumer demands, especially during COVID-19.
- How to improve production quality and food safety from farm to table?
- How to strengthen the local competitive of fresh food production to link with public purchases？

01

Supply Chain

Concept of supply chain

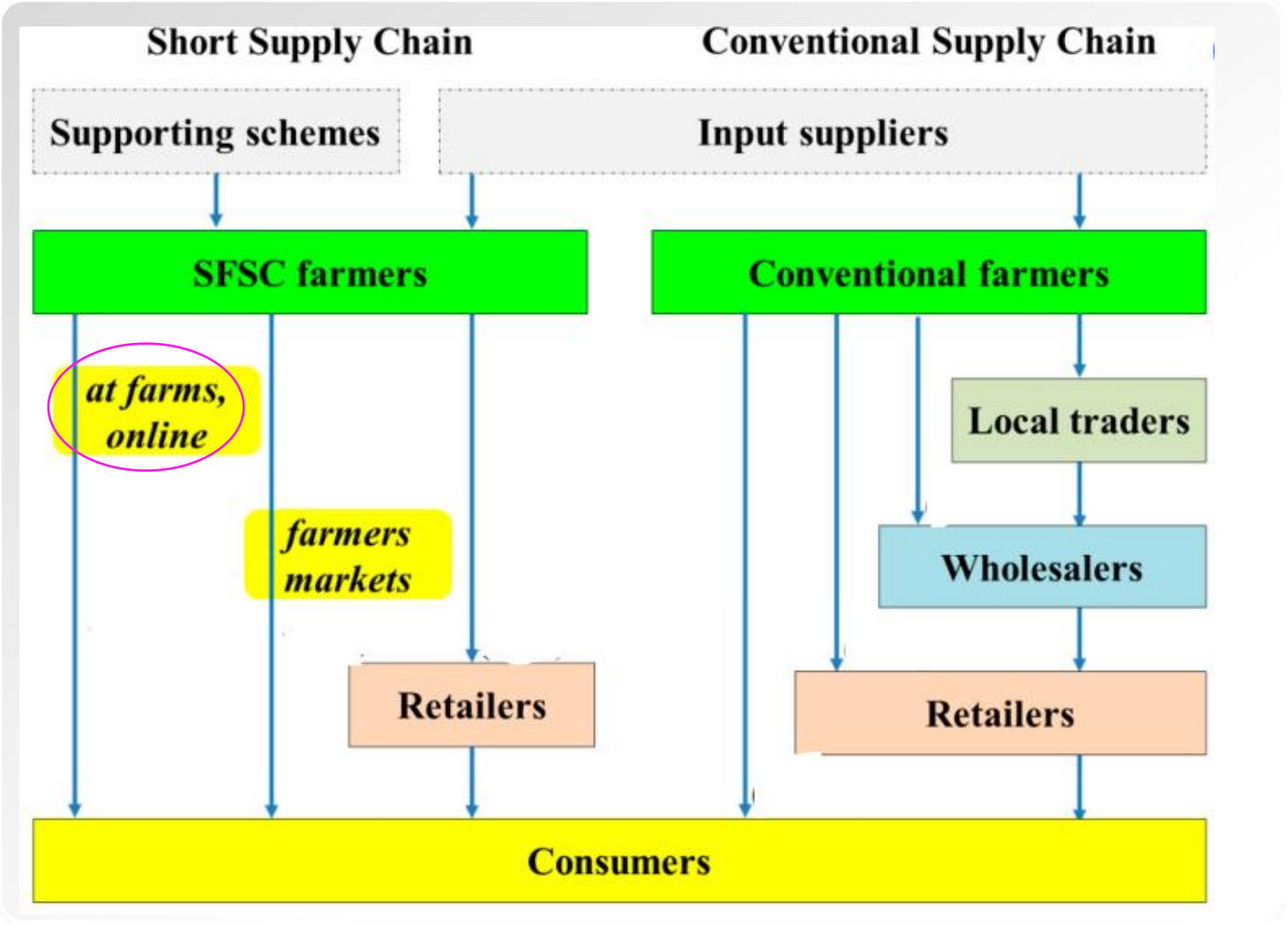
- A supply chain in a network of (physical and decision making) activities connected by **material**, **information** and **money** flows that cross organizational boundaries.
- All the stages involved in satisfying **customer demand**.



- In the last century, Chinese typical traditional supply chain for small farmers' fresh fruits and vegetables consists of three main stages:
  - ✓In the first stage, small farmers offer their small harvests to traders in the village markets or first assembly points.
  - ✓The second stage involves the movement of the accumulated product along the supply chain to secondary collection centers.
  - ✓The product is then moved in the third stage to central wholesale markets in urban centers.
- There is the critical need for improved pre-processing systems such as precooling, washing, cleaning, grading, packaging, refrigerated transport and cold chains for perishable product for better product quality and food safety.

Supply chain

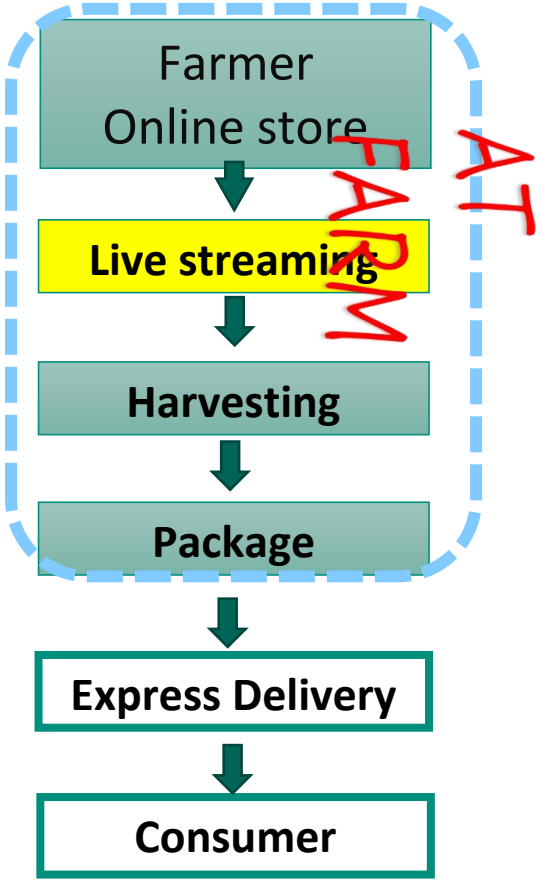
- The rapid increases in Chinese economy, environmental pollution, urbanization, health concerns, and technological progress enhance the demand for greener, healthier, and fairer food production and consumption nowadays.
- The short food supply chain (**SFSC**) becomes one of the crucial solutions for these issues.
  - Such as perishable fruits and vegetables supply chain



Example:

At farms, online market

Chinese online market develops very rapidly. There are plenty of online stores.



Example: A female farmer is introducing the growth environment, taste and cooking methods of asparagus lettuce in the field, through live WeChat video frequency.
Meanwhile, consumers may order the lettuce by WeChat directly if they fancy the product, and they will normally get the product in 3 days.

The product flow in SFSC

Harvesting
- Uprooting
- Cutting roots
- Other activities

Pre-Processing
- Washing
- Cleaning
- Classifying

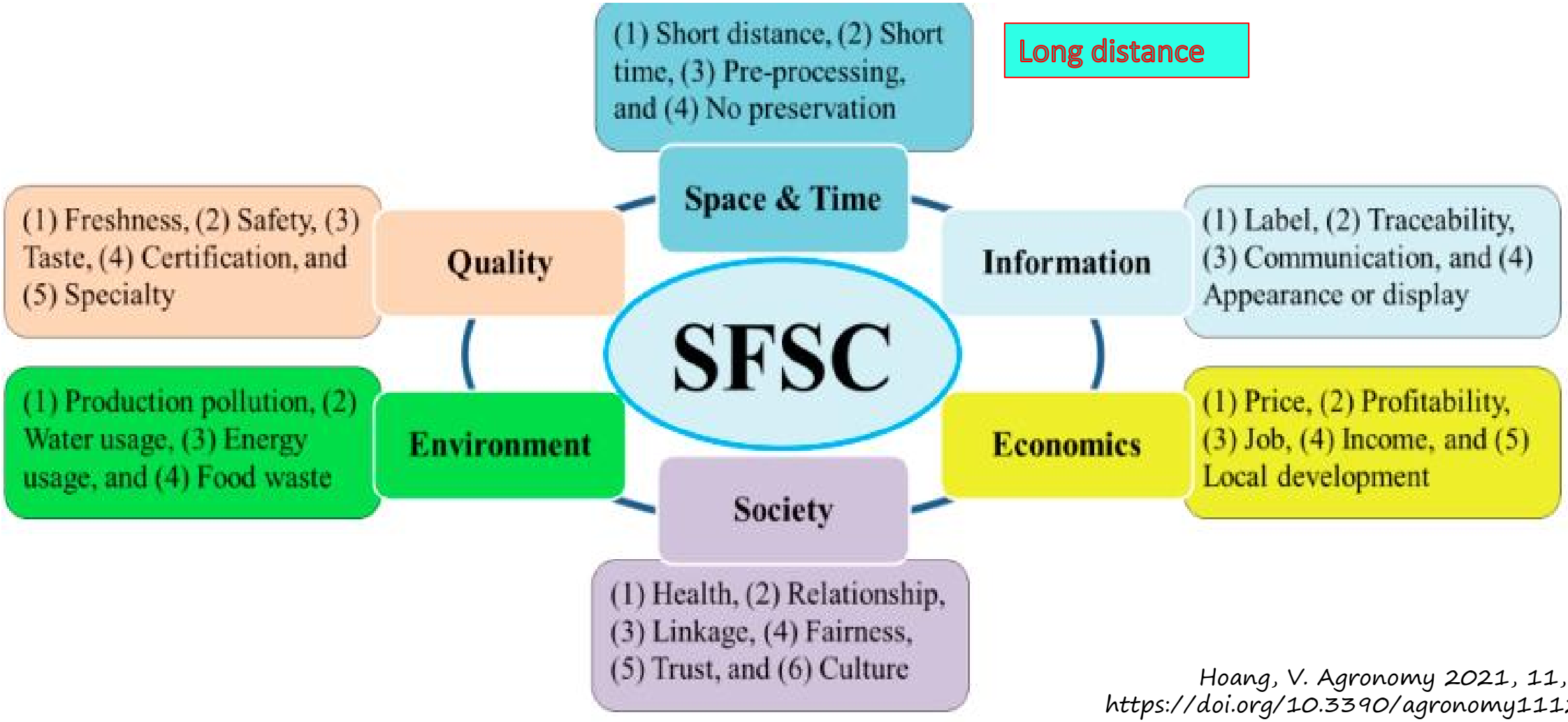
Packaging
- Packaging vegetables as regulated

Labelling
- Labeling with formation, logo, brands as ruled

Delivering
- At farms
- At bus stations
- At farmer markets

Hoang, V. Agronomy 2021, 11, 2408. https://doi.org/10.3390/agronomy11122408

The framework of SFSC



Hoang, V. Agronomy 2021, 11, 2408. https://doi.org/10.3390/agronomy11122408

Long distance and long time product flow

harvesting

classify

cool

transport

refrigerated

Market storage

02

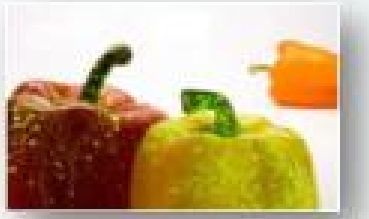
Good Practice of fruits and vegetables

2.1 Quality of fruits and vegetables

- The quality of fruits and vegetables constitutes a dynamic composite of their physicochemical properties and consumer perception.
  - ✓ intrinsic characteristics inherent to the nature of the products, dictated by genotypic, agroenvironmental and postharvest factors, and
  - ✓ extrinsic characteristics influenced by socioeconomic and marketing factors which condition consumer perception of the products and formulate quality standards.
- The potential quality of fresh fruits and vegetables in the supply chain is defined in the period preceding harvest, however the full development of quality characteristics can be optimized through the use of appropriate postharvest technology.
- Postharvest recommendations for harvesting, packaging and handling produce along the supply chain aim at maximizing the period of acceptable quality.
- Storage and shelf-life extension are closely associated with the preservation of quality in fresh fruits and vegetables.

Hygiene & Sanitation

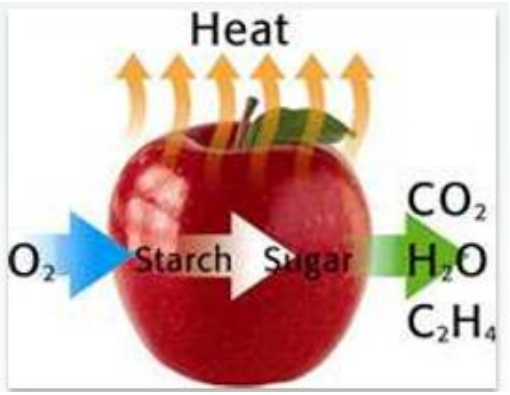
- Safe sanitation, hygienic conditions and abidance with laws of food regulatory authorities is a must.
- Prudent care is applied to keep the fresh produce clean dirt, insect & microorganism infestation.
- All water used to be pre-treated.
- Anti fungal treatments are regularly applied.
- Between subsequent uses, the cold room space sanitisaton is required.
- To identify and apply controls, HACCP (Hazard Analysis and Critical Control Points) procedures are useful.
- Regular internal quality audits, checks and training is a must.



2.2 Postharvest metabolic changes of fruits and vegetables

- After the initiation of harvest, several biochemical changes occur in fruits and vegetables, while they are **living** organisms, even after harvest, and they must remain alive and healthy until they are either processed or consumed.

Physiological respiratory processes of fresh produce continues after harvesting. This requires oxygen (O_2) and in turn generates heat and releases carbon dioxide (CO_2) and ethylene.



2.3 Good practice of postharvest perspective on quality

Postharvest recommendations for harvesting, packaging and handling produce along the supply chain aim at maximizing the period of acceptable quality.

- Harvesting
- Postharvest treatment (cleaning is the basic work)
  - Precooling/Cooling
  - Sorting and grading
  - Curing
  - Chemical treatment
  - Package
- Transportation
- *Etc.*

2.3.1 Harvest

- No matter manual harvesting or mechanical harvesting, it should be done carefully at proper time without damaging the produce.
- In general, harvesting should be done in sunny day at lower temperature, the early morning hours to **minimize** field heat.
- For long period storage, stop irrigation 7days to 2~3 weeks before harvest which hastens and enhances skin set and improve storability.




2.3.2 Precooling

- Precooling is done just after harvest and before transportation, storage or market to remove the **field heat** of the harvested produce, which is detrimental to keeping quality of fruits and vegetables and it is done to retard ripening and senescence processes.
- Prompt cooling conserves the weight and extends the storage life in produce.
- Several effective methods for rapid removal of heat from produce are in commercial use. The choice of method depends largely on the perishability and refrigeration equipment of the produce its adaptability to a specific method and the availability of facilities.
  - ✓ Hydro Cooling
  - ✓ Air –cooling or Room Cooling
  - ✓ Vacuum Cooling

Attention:

① Precooling ASAP after harvest
② Choice proper cooling method
③ Good cooling speed and final temperature
④ When cooling completed, the product must be moved to a cold room.

Hydro Cooling:

- Cooling with cold water is rapid and effective method of precooling used for cooling a wide range of fruits and vegetable in bulk before packing.
- Its use is limited for packed commodities because of the difficulty of achieving sufficient water flow through the containers.
- Flooding, spraying or immersion accomplishes hydro cooling.
- A properly designed flood system is more efficient than either the spray or immersion system because it combines a great volume of water with rapid movement of cooling medium over the product.

Slurry ice

- Slurry ice can be used directly for rapid chilling of precooling for vegetables that can tolerate water such as asparagus, cauliflower, broccoli, green onions, cantaloupes, leafy greens, carrots, sweet corn, spinach, parsley, sprouts.

Handling of slurry ice

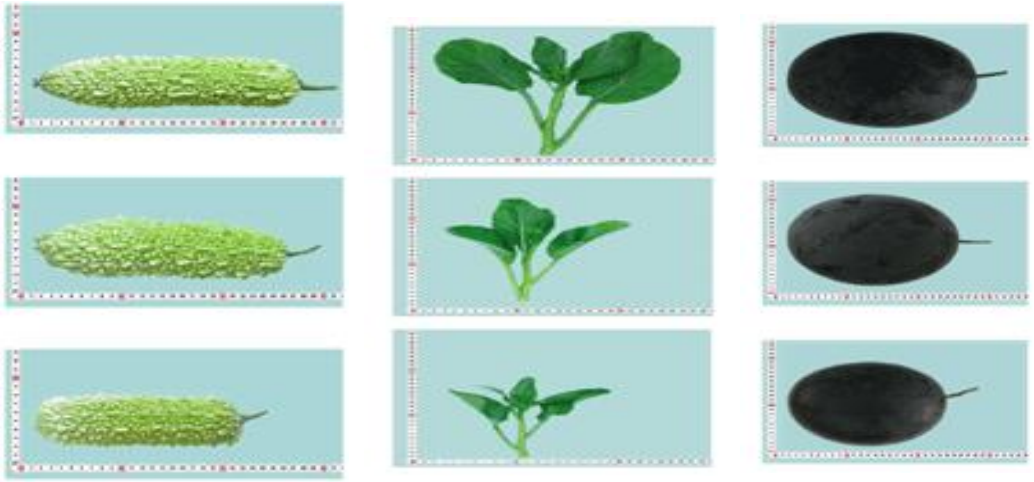
Icing pre-cooling

These products can be iced	These items are damaged by direct contact with ice
Artichokes，sparagus，Beets，Broccoli，Cantaloupes，Carrots，Cauliflower，Endive，Green Onions，Leafy Greens，Radishes，Spinach，Sweet Corn，Watermelon	Strawberries，Blueberries，Raspberries，Tomatoes，Squash，Green Beans，Cucumbers，Garlic，Okra，Bulb Onions，Romaine Lettuce，Herbs

2.3.3 Grading and sorting

- Grading on the basis of physical characteristics like weight, size, colour, shape, specific gravity, freedom from diseases depending upon agroclimatic conditions, and volume to fetch high price in market.
- The known methods of grading of fruits and vegetables are manual grading , mechanical grading.
- The equipment used for sorting is referred to as a sorting line.
- Graders are the third party inspectors who evaluate whether or not the packed lot complies with requirements of a grade standard for a predetermined grade classification.
- Inspection of samples for this quality control process is more precise than, and differs from, the dynamic inspection of product necessary for sorting.

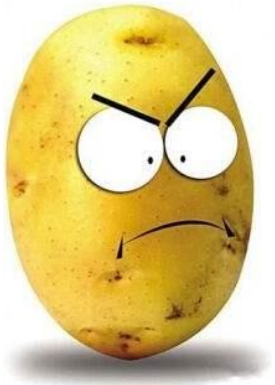
Sizing according to length, weight,diameter



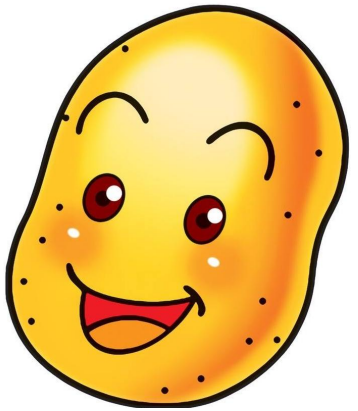
2.3.4 Curing

- Curing is performed immediately after harvest on root, tuber and bulb products, in which the product is exposed to relatively high temperature and relative humidity.
  - In root and tuber products, curing causes wound healing with the development and suberization of new epidermal tissues, which act as an effective barrier against infection and water loss.
  - In bulb products, curing is the process of drying of neck tissues and of the outer leaves to form dry scales.
  - Onions and garlic can be cured in the field. These products can be undercut in the field and left there to dry for 5-10 days.
- The products can be cured either in the field or after packing into large fiber or net sacks.
  - The produce must be checked daily until outer skin and neck tissues have properly dried.

products



Crop	Temperature (℃)	Relative humidity(%)	Duration (days)
Cassava	30-40	90-95	2-5
Onion and Garlic	27-35	60-75	1-2
Potato	15-20	85-90	5-10
Sweet Potato	30-32	85-90	4-7
Yam	32-40	90-95	1-4



2.3.5 *Chemical treatment:* prevent decay, reduce water loss, inhibit biological reactions, etc.

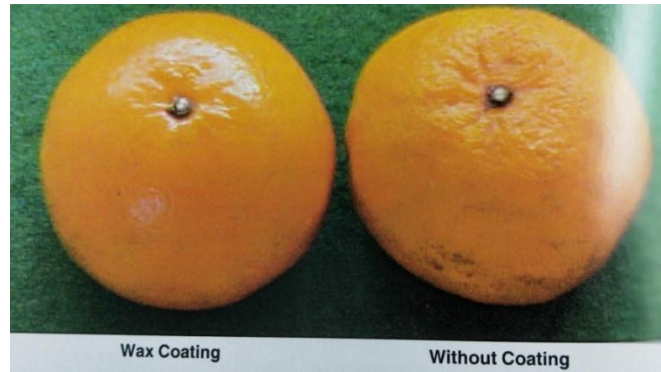
***Commonly used chemicals*:**

- Fungicide: Carbendazim, Benalaxyl, Tetraconazole, Thiabendazole, SO_2 , ClO_2 , etc.
- Plant growth regulators: CK, GA, IAA, Ethylene,1-Methylcyclopropene(1-MCP), etc.
- Coating materials: starch, [illegible]tin, etc.
- [illegible]d

Waxing

- Edible coatings are a simple technology by which produce can be physically protected and have their respiration and in some cases, ripening regulated as with passive modified atmospheric packaging (MAP).

- Food grade waxes are used to replace some of the natural waxes removed during harvesting and sorting operations.
  - It can help reduce water loss during handling and marketing.
  - It also helps in sealing tiny injuries and scratches on surface of produce.
  - It improves cosmetic appearance by providing shine and prolongs the storage life of produce.

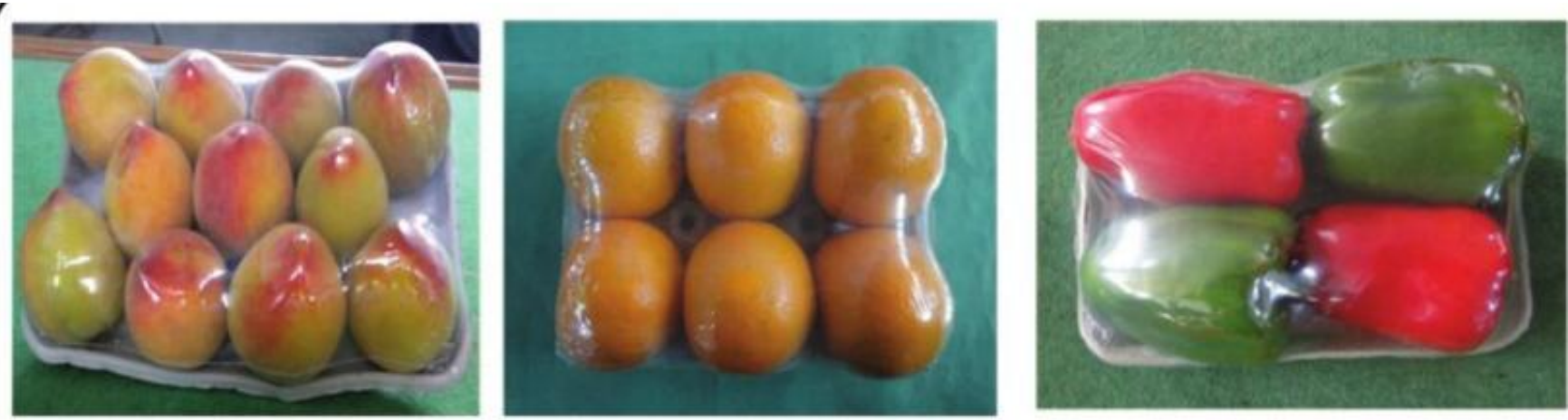


2.3.6 Package

- Packaging is an important consideration in vegetable and fruit market, which shelf life can be increased by 5-15 days.
- The use of properly designed containers for transporting and marketing of produce can significantly reduce their losses and maintain their freshness succulence and quality for longer period.
- Packaging also provides protection from mechanical damage and undesirable physiological changes and pathological deterioration during storage, transportation and marketing.
- Packaging can be classified in two groups: containers for shipment or for the consumer.

Modified atmosphere packaging(MAP)

- MAP may be described as the use of an atmosphere composition surrounding the product.
- O_2 ↓, CO_2 ↑, T↓
- Two way to modify atmosphere:
  - ✓ Flushing the package with gases
  - ✓ Naturally occurring processes



Modified atmosphere packaging of peach, kinnow, and capsicum


95mm
95mm
纸板采用BC瓦楞，厚度约7mm
甘肃静宁金苹果致富有限公司
www.hc360.com
全景网 www.quanjing.com


开袋即食

2.4 Transportation

- Transportation of fresh product from the farm gate to the primary and secondary collection centers is primarily as shoulder loads or by means of farm animals, wheel barrows, carts, bicycles, motorcycles, and motor vehicles of all sorts in the developing country.

Long distance transportation

truck,
train,
ship,
Plane,
.....

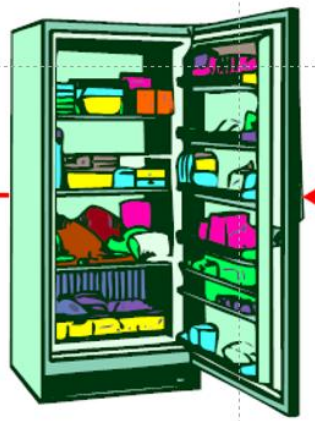
Modern transportation: Cold chain

- A cold chain or cool chain is a temperature-controlled supply chain. (air control)
- An unbroken cold chain is an uninterrupted series of refrigerated production, storage and distribution activities, along with associated equipment and logistics, which maintain a desired low-temperature range.
- It is used to preserve and to extend and ensure the shelf life of products, such as fresh agricultural produce, seafood, frozen food, photographic film, chemicals, and pharmaceutical drugs.

Cold chain




Cold chain is a complex and huge engineering system.



Optimum Transport Conditions and Predicted Storage Life for Some Vegetables

Vegetable	Transport Temperature[a] (℃)	Freezing Temperature[b] (℃)	Ventilation[c]	RH[d] (%)	Predicted storage life[e]
Artichoke (*Cynara scolymus L.*)	-0.5-4	-1	L	95-98	2-16 w
Asparagus (*Asparagus officinlils L.*)	0-4	-0.5	M	95-98	2-5 w
Beans (*Phaseolus vulgaris L.*)	0-8	-0.5	M/H	98	10-20 d
Beetroot (*Beta vulgaris L.*)	0	-0.5	L	92-95	2-12 w
Broccoli (*Brassica oleracea L., Italica group*)	0-5	-0.5	H	95-98	10-30 d
Brussels spouts (*Brassica oleracea L., Gemmifera group*)	-1-5	-0.5	H	95-100	1-4 m
Cabbage (*Brassica oleracea L., Capatita group*)	-2-0	-0.5	H	98-100	3 w-6 m
Carrots (*Daucus carota L.*)	0-1	-1.4	L	98-100	10 d-8 m
Cauliflower (*Brassica oleracea L., Botrytis group*)	0	-0.5	H	95-100	3-12 w
Celery (*Apium graveolens (Mill.) Pers.*)	0	-0.3	H	98-100	2-3 m
Chicory (*Chircorium intyvus L.*)	-1-0	-0.5	H	98-100	2-12 w
Cucumber (*Cucumis sativus, L.*)	7-13	-0.3	H	95	1-3 w
Eggplant (*Solanum melongena L.*)	7-12	-0.5	L	90-95	7-14 d
Garlic (*Allium sativum L.*)	-1-0	-0.5	L	65-70	3-7 m
Ginger (*Zingiber offcinale, Roscoe*)	12-13	----	L	65	3-6 m
Leek (*Allium ampeloprasum L., Porrum group*)	0	-0.5	M	=95	2-5 m
Lettuce (*Lactuca sativa L.*)	0-1	-0.2	H	98	2-6 w
Marrow *(Cucurbita spp.*)	7-12	-0.3	L/M	60-90	1-12 w
Onion (*Allium cepa L.*)	0	-0.5	M	65-95	0.5-8 m
Pea (*Pisum sativum L.*)	-1-0	-0.5	M	98	1-3 w
Pepper (sweet) (*Capsicum annuum L.*)	7-13	-0.5	M	90-95	2-5 w
Potato (*Solanum tuberosum L*)	4-10	-0.5	M	90-95	3 w -9 m
Pumpkin (*Cucurbita spp.*)	10-13	-0.5	L	50-70	2-3 m
Rhubarb (*Rheum rhaponticum L*)	0	-0.5	L	95-100	2-4 w

Commodity	Temperature (°C)	Relative Humidity (per cent)	Approx. Storage Life
a) Fruit Crops			
Apple	–1.0-4.0	90-95	1-12 months
Apricot	–0.5-0	90-95	1-3 weeks
Banana	13.0-14.0	85-90	1-4 weeks
Ber	7.5	90-95	2 weeks
Cherries	–1.0 to -0.5	90-95	2-3 weeks
Coconut	0-1.5	80-85	1-2 months
Fig	–0.5-0	85-90	7-10 days
Grapefruit	10-15	85-90	6-8 weeks
Grape	–1.0 to -0.5	90-95	1-6 months
Guava	5-10	90	2-3 weeks
Kiwifruit	–0.5-0	90-95	3-5 months
Lemon	10-13	85-90	1-6 months
Lime	9-10	85-90	6-8 weeks
Litchi	1.5	90-95	3-5 weeks
Mandarin, Kinnow	4-5	90-95	2 months
Mango	13	85-90	2-3 weeks
Papaya	7	85-90	1-3 weeks
Peach	–0.5-0	90-95	2-4 weeks
Pears	–1.5 to -0.5	90-95	2-7 months
Pineapple	7-13	85-90	2-4 weeks
Plum	–0.5-0	90-95	2-5 weeks
Pomegranate	5	90-95	2-3 months
b) Vegetable Crops			
Asparagus	0-2	95-100	2-3 weeks
Beans, green	4-7	95	7-10 days
Beet	0	98-100	10-14 days
Broccoli	0	95-100	10-14 days
Brussels sprout	0	95-100	3-5 weeks
Cabbage	0	98-100	3-6 weeks
Carrot	0	98-100	4-6 weeks
Cassava	0-5	85-90	1-2 months
Cauliflower	0	95-98	3-4 weeks
Celery	0	98-100	2-3 months
Cucumber	10-13	95	10-14 days
Eggplant	10-11	90-95	2-3 week
Garlic	0	65-70	6-7 months
Ginger	13	65	6 months
leafy Greens	0	95-100	10-14 days
Lettuce	0	98-100	2-3 weeks
Cantaloupe	0-2	95	5-14 days
Watermelon	10-15	90	2-3 weeks
Mushroom	0	95	3-4 days
Okra	7-10	90-95	7-10 days
Onion (green)	0	95-100	3-4 weeks
Onion (dry)	0	65-70	1-8 months
Peas (green)	0	95-98	1-2 weeks
Chilli (green)	0	95-98	40 days
Potato		90-95	5-10 months
Pumpkin	10-13	50-70	2-3 months
Radish	0	95-100	2-4 months
Spinach	0	95-100	10-14 days
Sweet potato	13-16	85-90	4-7 months
Tomato	8-10	90-95	4-7 days
Turnip	0	95	4-5 months
Yams	16	70-80	6-7 months
c) Flowers			
Alstroemeria	0-1	Sensitive*	1 week
Anthurium	12.5-20.0	Insensitive	1-2 weeks
Gypsophila	0-1	Sensitive	1- 3 weeks
Bird of Paradise	6-7	Insensitive	4 weeks
Carnation	0-1	Sensitive	2-4 weeks
Chrysanthemum	0-1	Insensitive	1-3 weeks
Freesia	0-1	Insensitive	–
Gerbera	0-1	Insensitive	1 week
Gladiolus	0-1	Insensitive	1 week
Iris	0	Insensitive	1 week
Lily (Asiatic)	0-1	Sensitive	Upto 4 weeks
Orchids	0-12.5	Sensitive	–
Rose	0-1	Sensitive	1-2 weeks
Snapdragon	0-1	Sensitive	7-10 days
Tuberose	0	Insensitive	1 week
Tulip	0-1	Insensitive	Upto 7 weeks

03

The Contract Farming Model

The contract farming model: enterprise + cooperative/ agro-dealer+ farmer: "unified technology, unified standard and unified acquisition"

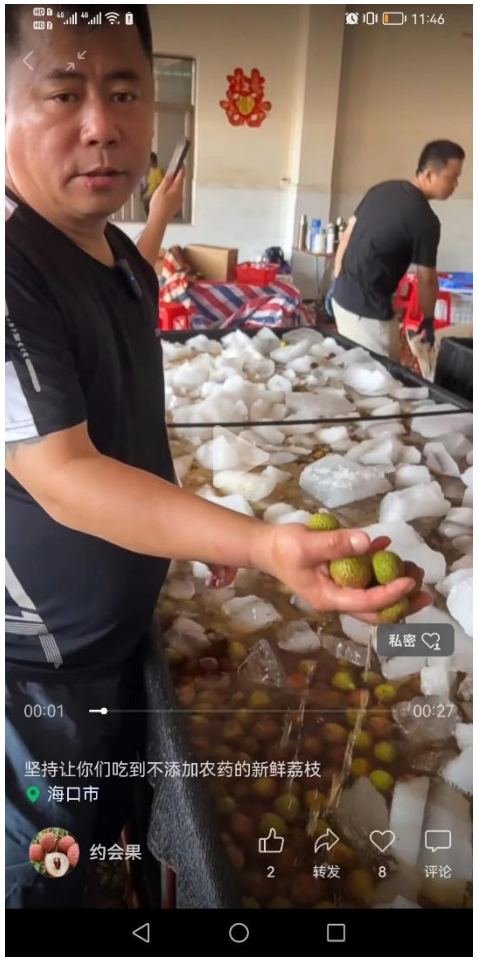
- The farmer cooperative plants certain types of agricultural products and the social enterprise, in turn, procures agricultural products from the farmer cooperative and then resells them to the final market.
- Since each farmer's planting scale is generally small, agro-dealers tend to sign contracts with many small farmers;
- Constrained by planting scale, technology and capital, farmers are usually in a weak position while negotiating with agro-dealers on the wholesale price of agricultural products.
- Many contract farmers choose to expand their planting scale because the contracts effectively solve the issues of

Example 1 : enterprise + farmer

Litchi in Hainan province

- **Farmer**:
  - ✓ Plant
  - ✓ Harvest
  - ✓ Transfer
- **Enterprise**:
  - ✓ **Collection**
  - ✓ **Processing:**
    - **Ice precooling**
    - **Grading**
    - **Package**
  - ✓ **Transportation**
  - ✓ **Market**

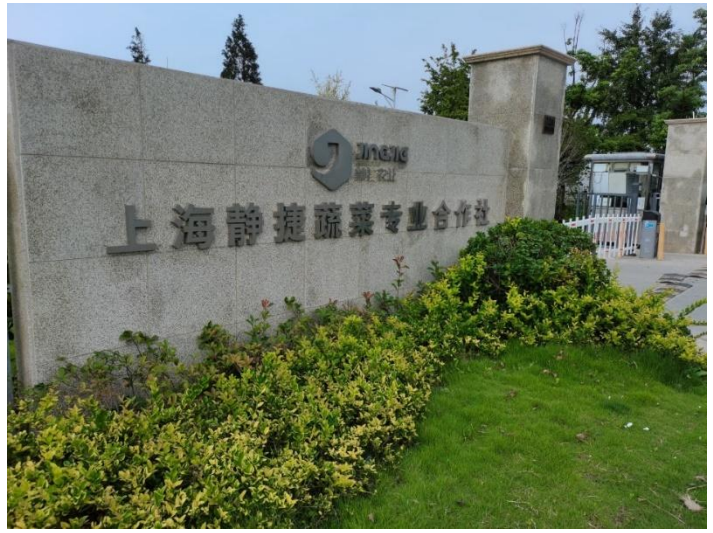
A Farmer



Exmple 2:

- Coucou Catering Management Co., Ltd Hotpot is its main dish.
- The fruits and vegetables of the big restaurant such as Coucou Catering Management Co., Ltd are partly from the own production base and partly from the market.
- Some production bases are large enterprises, some enterprises use farmers' cooperative mode, which is “enterprise + cooperative + farmer”.

Coucou Catering Management Co.,Ltd



Cooperative Warehouse

Pre-processing

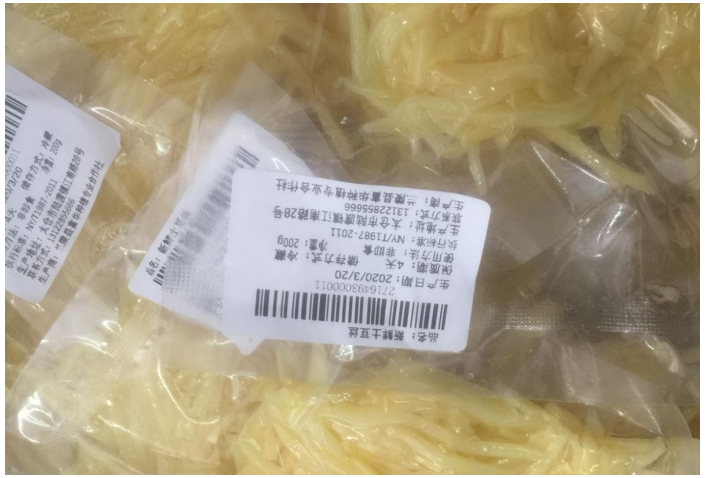
Customers/Company

Acceptance standards for vegetables, fruits and seafood

Version: 2021-05-12

name	Specification requirements	picture	name	Specification requirements	picture	name	Specification requirements	picture
Spinach	Overall height 25-30 cm. The diameter of the stem is 0.3-0.5cm. The roots of made.		chrysanthemum coronarium	10-18 cm height. The maximum diameter of the whole dish is 0.3-0.5 cm.		Chive	Variety: 200 beans, rice green onion, black green onion. 25 cm height or greater. Spring onion rod diameter 0.3-0.8 cm.	
Romaine lettuce (Wrinkled leaf)	Overall height 20-30cm. Root flattening.		Malabar spinach	The height of the whole plant is 8-20cm. Remove roots and leaves with vine.		Coriander	Variety: Large leaf. 20-40 cm height. Stem diameter ≤0.3 cm Root length ≤1.5cm.	
Artemisia stem	Height (measure the length of stem after root removal) 20-30cm. The diameter of the stem is 0.3-0.5cm, the root is removed and flattened; unwashed. From July to September, hollow, white core and diameter exceeding 0.5cm		Chinese Cabbage	Varieties: Liangqing, 70, 80, Qingbai, gold Single weight ≥ 1500g.		Chrysanthemum	Annual 10/1 to 4/30, height 20-30cm. Annual 5/1 to 9/30, height 17-25cm. Root removal	

Large wholesale market: collect, pre-process, turnover, customer



04

Summary

What should be considered for postharvest fruits and vegetables?

- All chain steps should be included from field to consumer for perishable fruits and vegetables!
- What happens at each point?
- What should be done at each point?
- Is it efficient?

Notes：

- A lot of post-harvest handling techniques could be applied to horticultural crops.
- When the techniques are used, it should be immediate after harvest and combined together and in a continuous way to meet the requirements of less processing operation and serving time.

Summary

- Postharvest loss is high for agricultural product, especially for perishable fruits and vegetables in developing countries, and it pays critical role in the food supply.
- Postharvest handling technology could reduce the loss effectively.
- The most effective and generally used techniques for fruits and vegetables are refrigerated and controlled atmosphere storage.
- The application of these techniques is based on a well understanding of product's characteristics and storage facilities.
- The appropriate and careful management is the key to reducing the postharvest loss of fruits and vegetables.

Thank You!

Contact info:

Food Sci. & Tech. Building, Nanjing Agricultural University

Email: xhm@njau.edu.cn

The SSTC project is funded by:
Ministry of Agriculture and Rural Affairs

P. R. China