



Chinese Horticulture and Vegetables Cold Chain Models :

Geographical and Logistical Considerations and Transportation Methods

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2018. 3. 8

Outline

1. Horticulture and Vegetable Industry Cold Chain Development Status and Comparison with Developed and Developing Countries
2. New Policies and Strategies for Cold Chain Distribution among Different Geographic Regions in China
3. New Trend and Latest Technology Used for Cold Chain Development in Horticulture and Vegetables Products
4. Cold Chain Application Models in Transportation in Trade Corridors
5. Conclusion and Suggestions



Objectives



- 1. To Understand the Chinese Horticulture and Vegetables Cold Chain Evolution Process and Policy Shift**
- 2. Learn the Case Examples of Latest Technologies Applied for Cold Chain Development**
- 3. Options for Cold Chain Models Application for Transportation To Promote Trade**
- 4. Discuss About the Advice for Future Joint Cooperation Among Central Asian Countries in HV**

I. Horticulture and Vegetable Industry Cold Chain Development Status and Comparison with Developed and Developing Countries

Freshness and high quality are key to the horticulture and vegetable industry development

- **China is number one producer and consumer of horticulture and vegetable products, there five negative impacts if cold chain logistics and relevant technologies lag behind:**

- ① **Heavy loss of production and quality and waste of diversified resources:** In case of China, Vegetable and Fruits loss from farm gate to consumer dinner table around 20-30%, valued about 20billion USD, equals to waste of 2million ha of farmland and 10million tons of food grains. **While the loss rate in the developed countries is only about 5%, five time lower.**
- ② **Food safety degradation:** Degradation of the products definitely affects marketability and processing products development and cause disastrous impact to the industry.
- ③ **Negative impact on farmer' s income** Reduced shelf life can not meet the seasonality of supply during the off season with higher price.



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- ④ **Impact on price stability:** In case of the disasters, prices of horticulture and vegetable products will be volatile lacking of cold storage capacities as **cushion**.
- ⑤ **Impact on nutritional value and color and taste of the products:** Theses factors will directly affect the consumer perceptions and competitiveness of products price and trade in practice.



I. Horticulture and Vegetable Industry Cold Chain Development Status and Comparison with Developed and Developing Countries

Cold Chain Development is vital to adding value the horticulture and vegetable industry

- China is number one producer and consumer of horticulture and vegetable products, there five negative impacts if cold chain logistics and relevant technologies lag behind:

Concept of Cold Chain: *The **cold chain** involves the transportation of temperature sensitive products along a supply chain through thermal and refrigerated packaging methods and the **Logistical planning** to protect the **Integrity** of these shipments. There are several means in which cold chain products can be transported, including refrigerated trucks and railcars, refrigerated cargo ships as well as by air cargo.*



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Cold Chain Development is vital to adding value the horticulture and vegetable industry

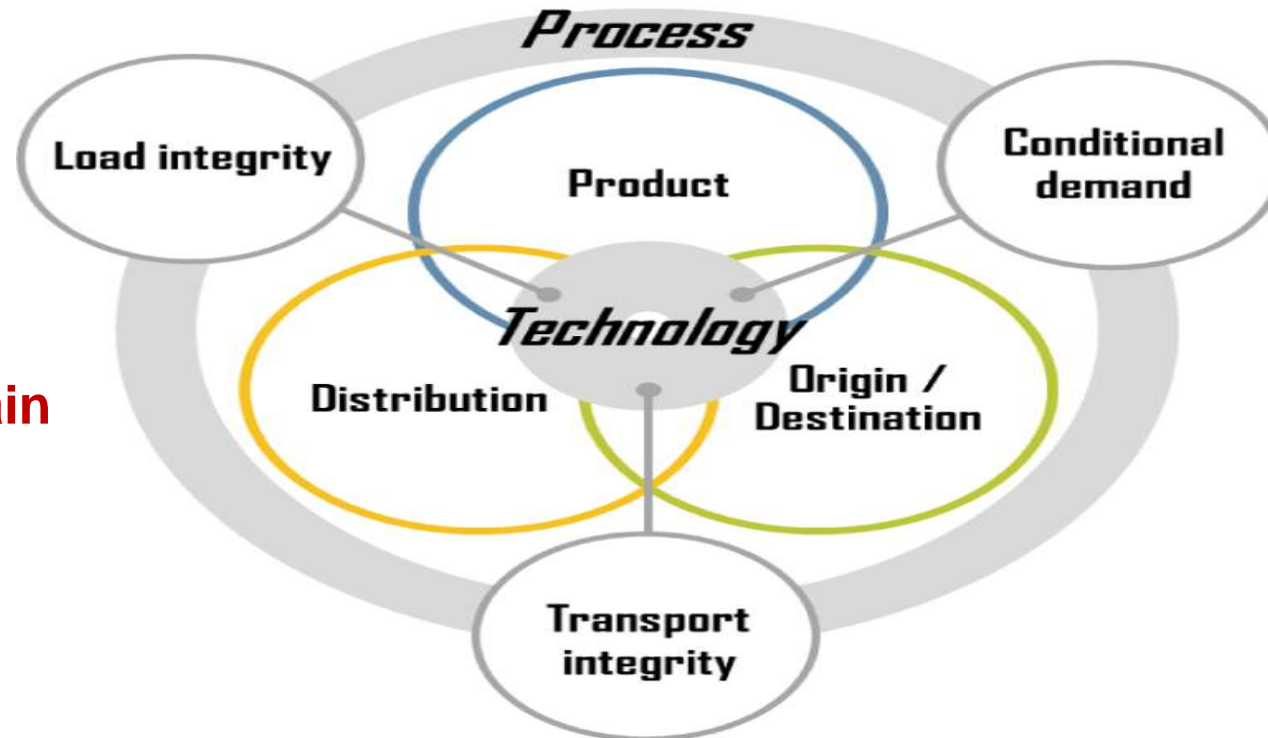
- **China is number one producer and consumer of horticulture and vegetable products, there five negative impacts if cold chain logistics and relevant technologies lag behind:**

The cold chain is thus a science, a technology and a process. It is a **science** since it requires the understanding of the chemical and biological processes linked with perishability. It is a **technology** since it relies on physical means to insure appropriate temperature conditions along the supply chain. It is a **process** since a series of tasks must be performed to prepare, store, transport and monitor temperature sensitive products.(Dr.Jean-Paul Rodrigue etc.)



I. Horticulture and Vegetable Industry Cold Chain Development Status and Comparison with Developed and Developing Countries

Cold Chain Development is vital to adding value the horticulture and vegetable industry



Elements of the Cold Chain



I. Horticulture and Vegetable Industry Cold Chain Development Status and Comparison with Developed and Developing Countries

Cold Chain Development is vital to adding value the horticulture and vegetable industry

From an economic development perspective, the cold chain enables many developing countries to take part in the global perishable products market either as producers or as consumers. The growth income is associated with a higher propensity to consume fruits, vegetables products. **Persons with higher socioeconomic status are more likely to consume vegetables and fruit, particularly fresh, not only in higher quantities but also in greater variety. Consumers with increasing purchase power have become preoccupied with healthy eating, therefore producers and retailers have responded with an array of exotic fresh fruits originating from around the world.**



I. Horticulture and Vegetable Industry Cold Chain Development Status and Comparison with Developed and Developing Countries

2017 Chinese cold chain logistics status for horticulture and vegetable industry development

■ China is number one producer and consumer of horticulture and vegetable products, there six characteristics:

- ① **Cold chain demands and consumption reached record high**, Vegetables reached 800million tons, Fruits reached 283 million tons, trade volume amounts to 40 billion USD;
- ② **Cold chain capacity and quality sharply improved**, in 2016, global capacity for cold storage is 600 million cubic meters while China herself reached 115million cubic meters about 17.5% of the global capacity, cold chain cargo reached 115,000 units with increase rate of 25%.
- ③ **Cold Chain infrastructure Distribution more rational**, selected 10 provinces including Shandong, Xinjiang Guangdong, Sichuan Henan, Zhejiang for Standard Base development.



I. Horticulture and Vegetable Industry Cold Chain Development Status and Comparison with Developed and Developing Countries

2017 Chinese cold chain logistics status for horticulture and vegetable industry development

■ **China is number one producer and consumer of horticulture and vegetable products, there six characteristics:**

- ④ **Cold chain standard development policy continue to improve**, with "One Belt and One Road initiative" into implementation, 285 firms selected for model development for extension and 31 cities selected for demonstration;
- ⑤ **Cold chain third party business firms capacity remarkably improved**, new business industry leaders in cold chain logistics like XijieRongqing Firm, Shanghai Liangxian Firm, Haihang Cold Chain, XianYi Supply Chain etc,
- ⑥ **Internet of things to apply cold chain distribution and management**, electronic business firms like Anxianda, Shunfeng etc.



I. Horticulture and Vegetable Industry Cold Chain Development Status and Comparison with Developed and Developing Countries

Problems for the cold chain industry for horticulture and vegetable in China

- **China is number one producer and consumer of horticulture and vegetable products, there five challenge problems for the development of the cold chain logistics :**
 - ① **Current market scale is limited and industry concentration is not ideal**, 2016, the market scale is about 40 billion USD, top 100 firms occupied only 10%, quite decentralized and lack of leading firms.
 - ② **Cold Chain Infrastructure unevenly distributed**, concentrated in the east part of China and the big cities, while there is less number facilities in production areas. Pre-cooling , processing centers and wholesaler centers in production areas are short and cause initial loss of production and quality.



I. Horticulture and Vegetable Industry Cold Chain Development Status and Comparison with Developed and Developing Countries

Problems for the cold chain industry for horticulture and vegetable in China

- **China is number one producer and consumer of horticulture and vegetable products, there five challenge problems for the development of the cold chain logistics :**
 - ③ **Lack of Consistent Standards for the cold chain industry for HV market**, most standards are developed specifically for the point in the chain, no systematic standards targeted for the whole chain operation.
 - ④ **Strong competition the traditional Cold Chain business sector without enough new market development**, concentrated cold storage rather than Pre-cooling , processing centers and wholesaler centers.
 - ⑤ **Rising cost of operation**, labor, transportation, gasoline etc accounting for 80% of the operation cost, less investment in information and new technology application.



I. Horticulture and Vegetable Industry Cold Chain Development Status and Comparison with Developed and Developing Countries

Comparison with developed and developing countries in the horticulture and vegetable cold chain industry

Country Indicators	China	Developed countries (US, Germany, Japan)	Developing countrie s (India and Indonesia)
HV Loss after harvest	25-30%	3-5%	30-40%
Refrigerating capacity	8 million tons	80 million tons	n. a
Refrigerated rate	20%	80-98%	less than 10%
Cold chain logistics	Cold chain logistics not fully formed, efficiency is low and cold technology is not widely used	Highly efficient and with good regulatory Standards as well as automated network information	Similar to China or even less developed



II. New Policies Strategies for Cold Chain Distribution among Different Geographic Region in China

New policies for cold chain industry for horticulture and vegetable in China

- April 2017, State Council released official policy document “Accelerate Cold Chain Development to Ensure Food Quality and Safety” Ten initiatives to support Cold Chain development in China regarding strengthening industry standards and inspection and transportation.
- Expanding cold chain infrastructure, particularly grading, precooling, packaging, fresh keeping storage facilities and processing oriented cold chain.
- Expanding “one belt one road” cold chain transportation with opening of the China to Russia and Germany railway cold chain transportation to expand network with central asian countries to promote agricultural trade.
- Third Party firms encouraged for professional and efficient cold chain industry development, Major players like Jingdong, Guangming dairy, Anxianda etc. New competitive firms will be come out with the new policy.



II. New Policies Strategies for Cold Chain Distribution among Different Geographic Region in China

New policies for cold chain industry for horticulture and vegetable in China

- Retailers are encouraged to use internet based whole chain targeted cold chain delivery system and changed the models of distribution.
- Encourage trans-boundary business transaction through e-business forms, 2016, central government approved 12 mega cities like Tianjin, Shanghai, Chongqing, Zhengzhou to setup trans boundary e-business operation centers.
- Community based automated instant cold chain service encouraged
- Smart cold chain developed based on big data and migration cold chain storage service
- Investment in capacity building for the cold chain professional work force



II. New Policies Strategies for Cold Chain Distribution among Different Geographic Region in China

New policies for cold chain industry for horticulture base distribution



II. New Policies Strategies for Cold Chain Distribution among Different Geographic Region in China

Cold chain logistics facilities from precooling to cold storage for horticulture and vegetable in China



II. New Policies Strategies for Cold Chain Distribution among Different Geographic Region in China

Cold chain logistics distribution for horticulture and vegetable in China



现象一：2017年全国冷库容量增速提升3.3%，冷库建设出现上升反弹。
现象二：2017年冷藏车总量下降2.5%，相比2016年下降23.2%，
同比回升21个百分点。
现象三：2017年自有冷藏车数量减少16.3%，社会冷藏车增加11.6%。



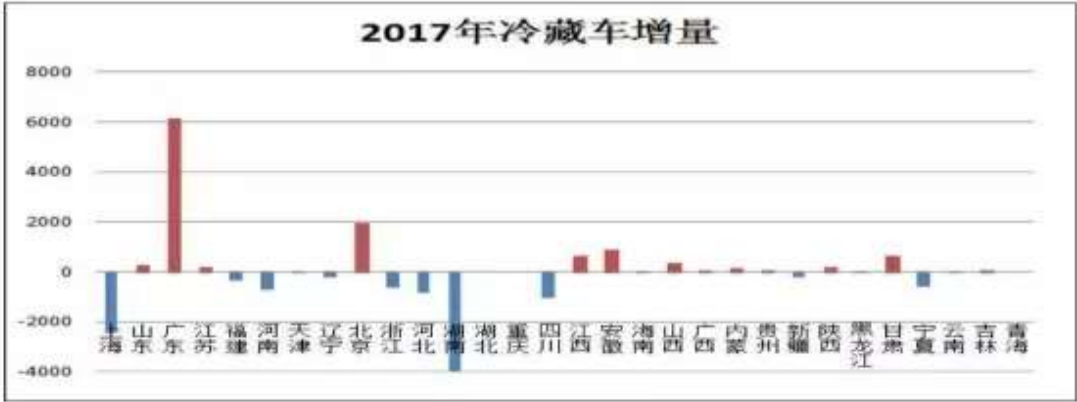
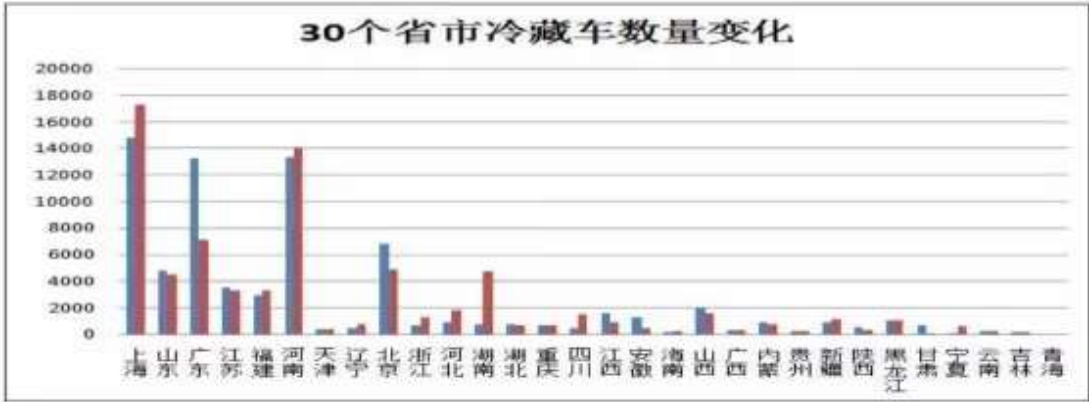
Rapid increase in cold chain storage facilities in China in the last ten years



II. New Policies Strategies for Cold Chain Distribution among Different Geographic Region in China

Cold chain logistics distribution for horticulture and vegetable in China

2017-2016年30个省市冷藏车总量排名及增长情况（单位：辆）



Changes in cold chain transportation facilities in different geographical areas China in 2016-2017



II. New Policies Strategies for Cold Chain Distribution among Different Geographic Region in China

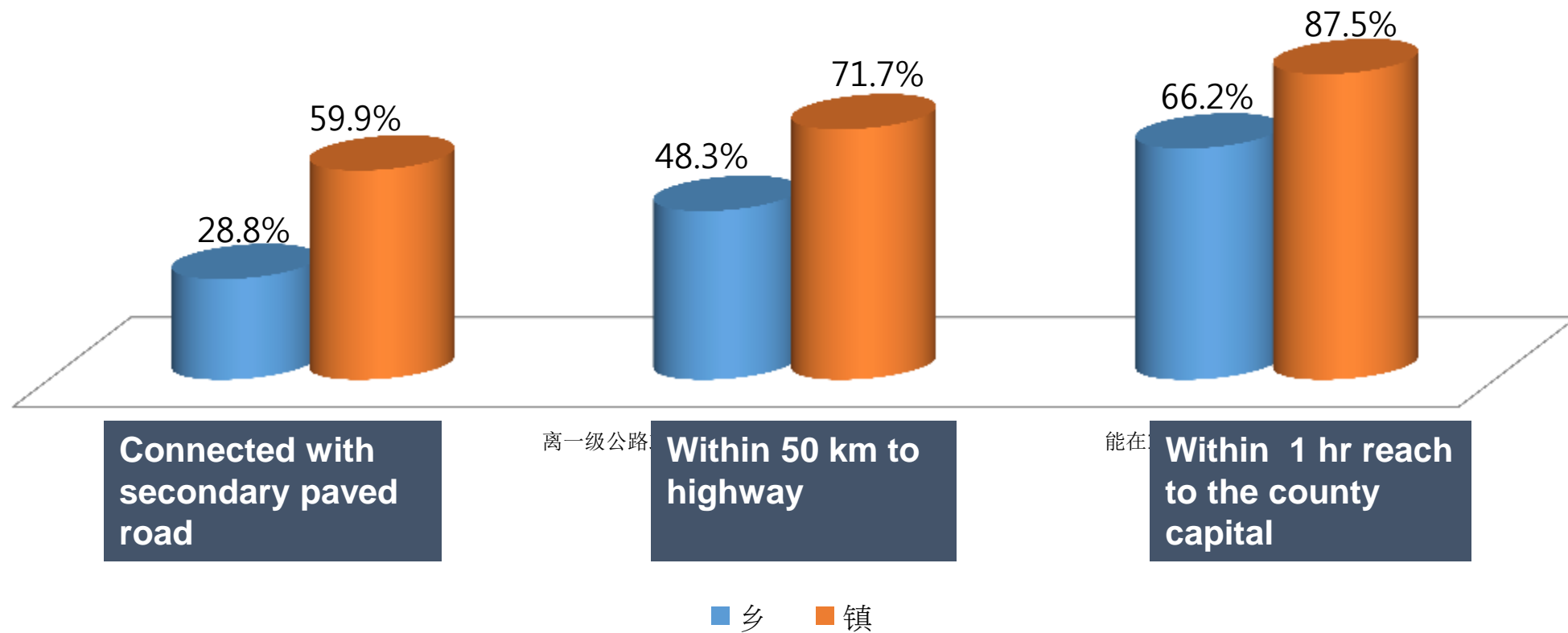
New policies for cold chain industry for horticulture and vegetable in China

E-agriculture

- Definition and areas of development
- 3-G based information system
- Development of market information and distribution systems



Status of Rural Transportation



II. New Policies Strategies for Cold Chain Distribution among Different Geographic Region in China

Index System	First Index	Second Index	Third Index
	Distribution environment	Institutional And environment Technical environment	Policy and law environment Logistic standards IT penetration Retrospective technology
	Distribution facilities	Hardware facilities Software facilities	Refrigerated truck scale Cold storage ration Information system application ratio
	Distribution operation	Operation efficiency Operation effect	Vehicle load rate On time delivery Loss rate, etc.



II. New Policies Strategies for Cold Chain Distribution among Different Geographic Region in China

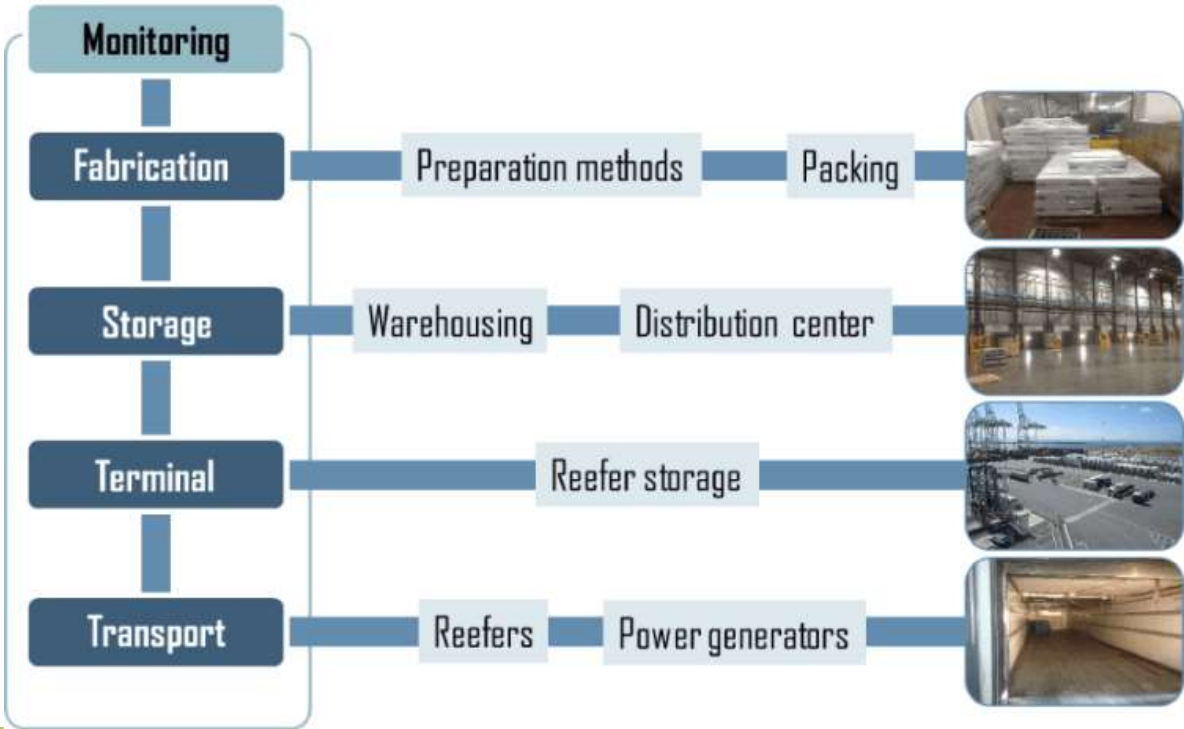
New criteria to select these areas for expansion for HV cold chain base in China

- ① Major HV production area
- ② Adjacent to road and railway transportation
- ③ Close to Seaport and Airport
- ④ Close to Boarder areas to promote international trade



III. New Trends and Latest Technology Used for Cold Chain Development in Horticulture and Vegetable Products

New trends and technology for cold chain industry for horticulture and vegetable in China



Cold chain technologies in different process.



III. New Trends and Latest Technology Used for Cold Chain Development in Horticulture and Vegetable Products

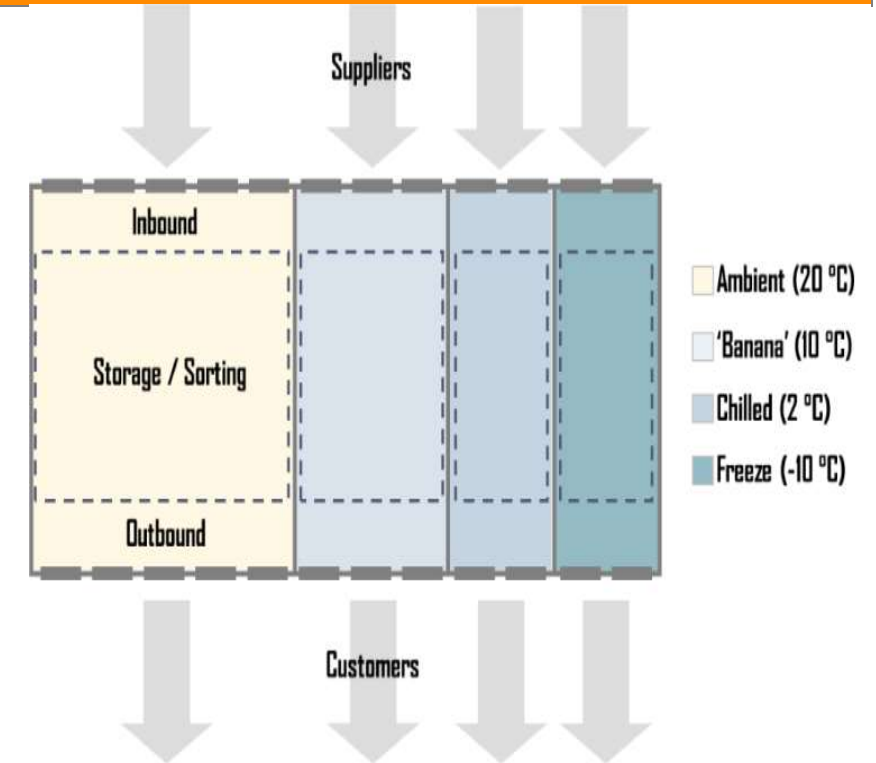
New trends and technology for cold chain industry for horticulture and vegetable in China

① Pre-cooling technology at production site:

Including movable Vacuum pre-cooling technology development and application, Case example like Date in vacuum pre-cooling in 20 minutes the temperature can reach zero degree with good effects.

Developing software of warning system for pre-cooling control and application and can monitoring the temperature changes

Use of cold storage room for pre-cooling

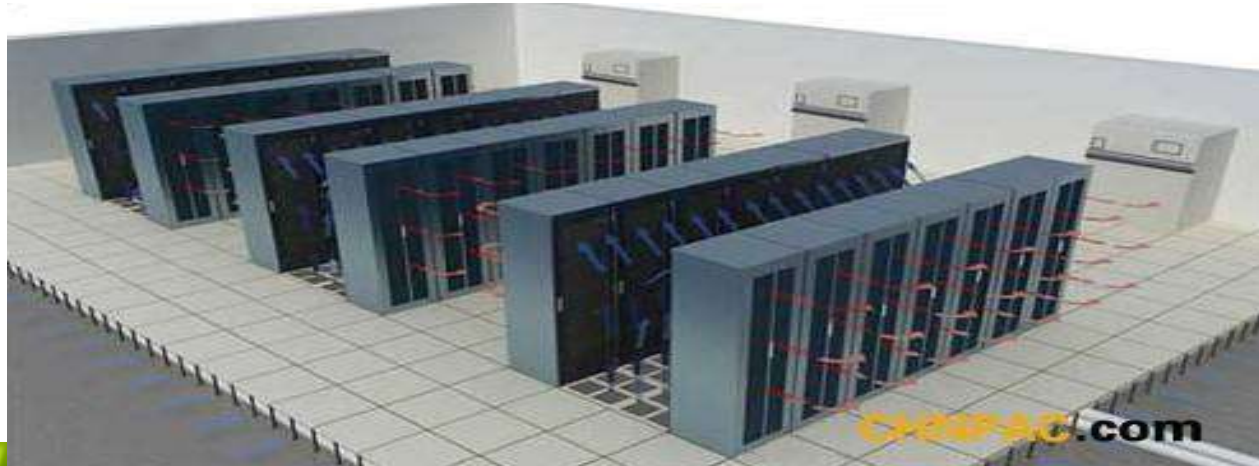


III. New Trends and Latest Technology Used for Cold Chain Development in Horticulture and Vegetable Products

New trends and technology for cold chain industry for horticulture and vegetable in China

② Pre-cooling technology at production site:

Ethylene glycol frequency conversion refrigeration, improving efficiency and saving energy



III. New Trends and Latest Technology Used for Cold Chain Development in Horticulture and Vegetable Products

New trends and technology for cold chain industry for horticulture and vegetable in China

③ Pre-cooling technology at production site:

Heat shock treatment which is effective for orange and pears and by using temperature higher 8-12 degree than its normal growth environment

Treatment of calcium dipping combined with electric field: which is very effective for berries and orange and apple retarding the respiration of HV products

UV-C treatment plus Vacuum approach is very good for the blue berries and pears



UVC equipment



III. New Trends and Latest Technology Used for Cold Chain Development in Horticulture and Vegetable Products

New trends and technology for cold chain industry for horticulture and vegetable in China

④ Pre-cooling technology at production site:

Newly developed fresh keeping packaging materials: including special preservative film, pressure cushion materials for mushroom using nano-scale packaging materials

- ⑤ **Fresh keeping agents** Like **Bacillus amyloliquefaciens HRH317** strains preventing HV product from decay, **Carvacrol**, for bacteria and decay prevention, **Chitosan - deacetyl chitin**, a natural product used for decay prevention and moisture keeping , **Tea saponin** used for cold resistance and decay prevention



III. New Trends and Latest Technology Used for Cold Chain Development in Horticulture and Vegetable Products

New trends and technology for cold chain industry for horticulture and vegetable in China

⑥ Fresh keeping technology:

Ice temperature preservation , moveable cold storage facilities, smart cold storage facilities with auto temperature control

- ⑦ **Advanced testing technology:** Near-infrared spectroscopy, Electronic nose for detection, Texture Analyzer, Solid phase micro-extraction coupled with gas chromatography and mass spectrometry, Remote monitoring software development and application



III. New Trends and Latest Technology Used for Cold Chain Development in Horticulture and Vegetable Products

New trends and technology for cold chain industry for horticulture and vegetable in China

Summary:

Fresh keeping technology: a number of examples in Chinese horticulture and vegetable production areas. A well developed set of technology after harvest for pre-cooling, packaging as well as cold storage and transport system can reduce the loss of horticulture and vegetable products below 10%.



III. New Trends and Latest Technology Used for Cold Chain Development in Horticulture and Vegetable Products

New trends and technology for cold chain industry for horticulture and vegetable in China

Processing Technology and Products:
Tomato

Apple

Grapes



Pomegranate

Avocado

Potato



IV. Cold Chain Application Models in Transportation in Horticulture and Vegetable Products in Trade Corridors

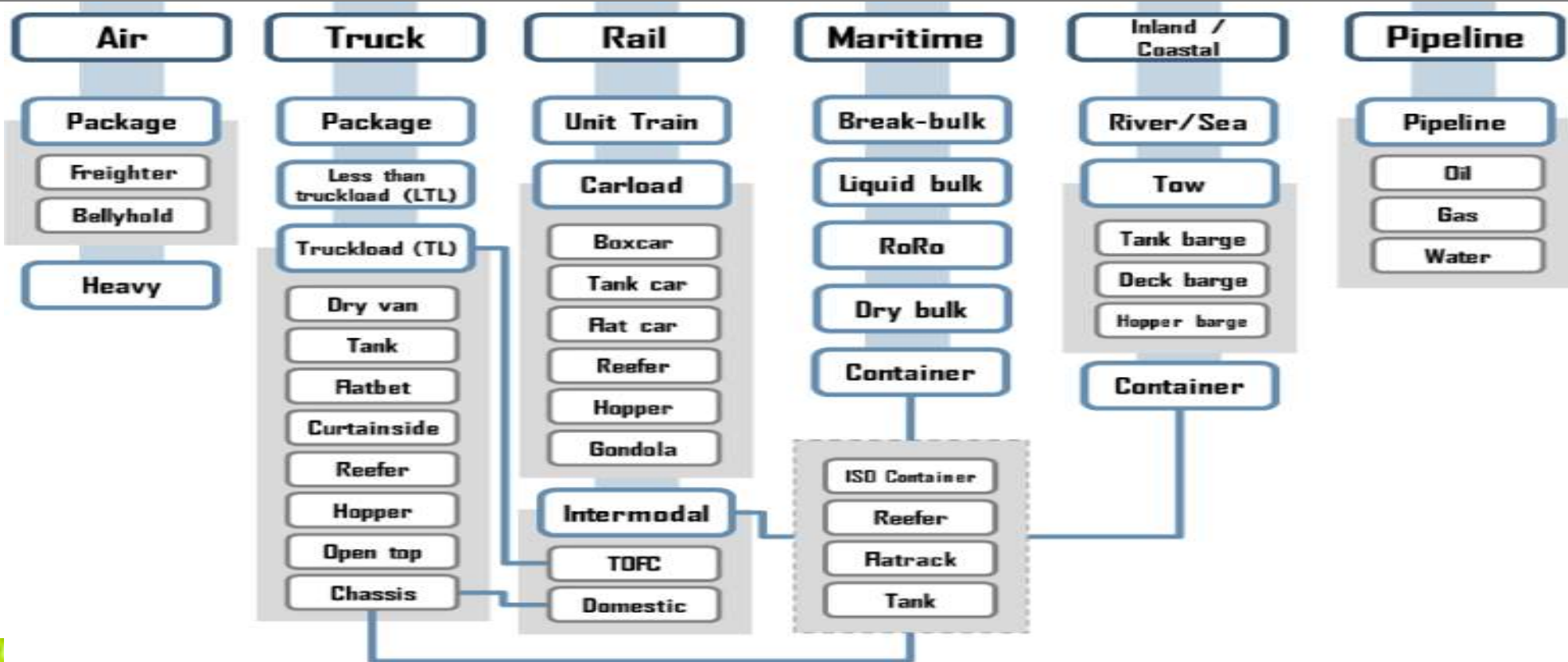
Cold chain logistics transportation models

Land, sea and air **modes** all have different operations for keeping food fresh throughout the transport chain. Depending on their speed, different modes will service different cold chain market with a clear segmentation between air and maritime services. Innovations in packaging, fruit and vegetable coatings, bioengineering (controlled ripening), and other techniques reducing the deterioration of food products have helped shippers extend the reach of perishable products. For food products such as fruits and vegetables, time has a direct impact on their shelf life and therefore on the potential revenue a consignment may generate.



IV. Cold Chain Application Models in Transportation in Horticulture and Vegetable Products in Trade Corridors

Cold chain logistics transportation models



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Cold chain logistics transportation models

Operational Conditions of Cold Chain Logistics



Conditional demand

- Each product has a specific perishability.
- Shelf life and revenue.
- Demand conditional to qualitative attributes.



Load integrity

- Reefers as the common load unit.
- Packing, packaging and preparation.
- Empty backhauls.



Transport integrity

- Uninterrupted integrity of the transport chain (modes, terminals and DC).
- Specialized modes (speed) and terminals.



IV. Cold Chain Application Models in Transportation in Horticulture and Vegetable Products in Trade Corridors

Cold chain logistics transportation models

In the case of China, most horticulture and vegetable products cold chain transportation are in the form of railway and road transportation, but some cases for international trade like cherry imported from Chile and Australia are through the maritime ship cargo by controlling the temperature, packaging and storage cabin air and CO₂ concentration it can keep freshness for 40 days to be marketed in Chinese market. For selection of transportation models, several factors has to keep in mind:

- ① **Several key factors play into how the shipment will be moved.** Distance between the origin and the final destination (which often includes a set of intermediary locations), the size and weight of the shipment, the required exterior temperature environment and any time restrictions (perishability) of the product all effect the available transportation options. Short distances can be handled with a van or a truck, while a longer trip may require an airplane or a container ship. In this case, the cost / perishability ratio becomes a factor in modal choice.



IV. Cold Chain Application Models in Transportation in Horticulture and Vegetable Products in Trade Corridors

Cold chain logistics transportation models

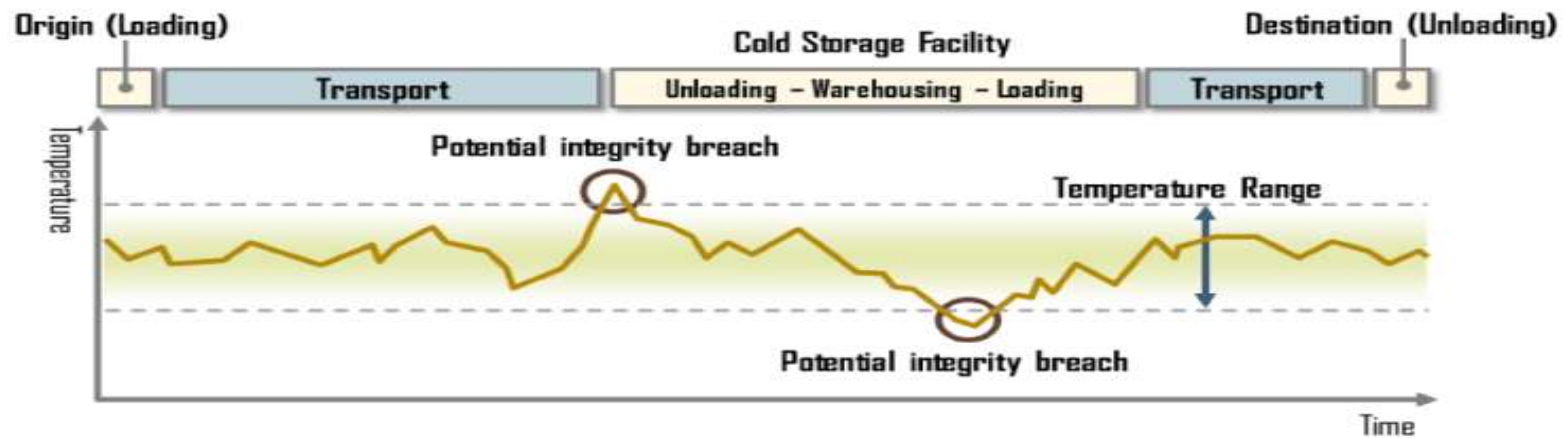
- ② **Temperature control:** Cold chain devices are commonly designed to keep a temperature constant, but not to bring a shipment to this temperature, so they would be unable to perform adequately if a shipment is not prepared and conditioned. Other concerns include the destination of the shipment and the weather conditions for those regions, such as if the shipment will be exposed to extreme cold or heat along the transport route. Using a reefer with its own power unit usually mitigates such concerns. The load unit carrying the temperature sensitive cargo must also be prepared. For instance, a refrigerated container must be steam cleaned to remove the risk of bacterial contamination and brought to the specified conditions of the shipper, namely temperature and humidity.
- ③ **The “Last Mile”.** The last stage is the actual delivery of the shipment to its destination, which in logistics is often known as the “last mile”. Key considerations when arranging a final delivery concern not only the destination, but the timing of the delivery so the critical labor and warehousing space is available. Trucks and vans, the primary modes of transportation for this stage, must meet the specifications necessary to transfer the cold chain shipment.



IV. Cold Chain Application Models in Transportation in Horticulture and Vegetable Products in Trade Corridors



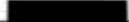





Cold chain logistics transportation models

- ④ **Integrity and quality assurance.** After the shipment has been delivered, any temperature recording devices or known temperature anomalies must be recorded and made known. This is the step of the logistical process that creates trust and accountability, particularly if liability for a damaged shipment is incurred. If problems or anomalies that compromise a shipment do occur, an effort must be made to identify the source and find corrective actions.



IV. Cold Chain Application Models in Transportation in Horticulture and Vegetable Products in Trade Corridors

Cold chain logistics transportation models: Performance Comparison for Selected Freight Modes

Vehicle	Capacity	Truck Equivalency
 Barge	1500 Tons / 50-100 TEU 52,500 Bushels 453,600 Gallons	57.7 (865 for 15 barges in tow) 18 to 40 (intermodal)
  Hopper car Doublestack rail car	100 Tons / 4 to 5.3 TEU 3,500 Bushels 30,240 Gallons	2.0 (intermodal) to 3.8
 100 car train unit 100 car intermodal train	10,000 Tons / 400 to 530 TEU 350,000 Bushels 3,024,000 Gallons	385
 Semi-trailer truck	26 Tons / 2.65 TEU 910 Bushels 7,865 Gallons 9,000 for a tanker truck	1
 Panamax containership	5,000 TEU	2,116
 VLCC	300,000 tons 2 million barrels of oil	9,330
 747-400F	100-125 tons (Depending on freight density and range)	5



IV. Cold Chain Application Models in Transportation in Horticulture and Vegetable Products in Trade Corridors

Cold chain logistics transportation models: Performance Comparison for Selected Freight Modes

Model of transportation	Quantity of transportation	Cost	Speed	Flexibility	Continuity
Road	4	4	2	1	2
Railway	2	2	3	3	1
River	3	3	5	4	5
Maritime	1	1	4	5	4
Air flight	5	5	1	2	3

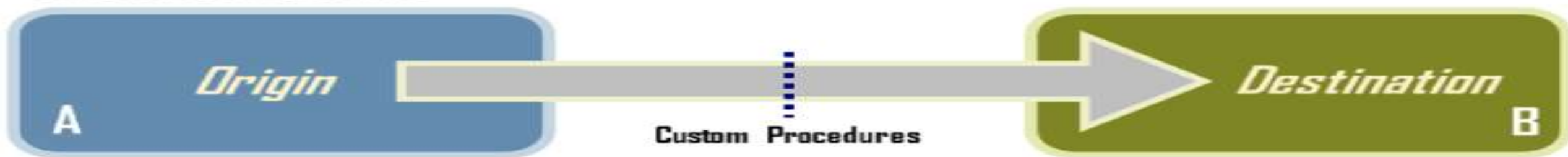
Note: “1” is the best, “5” is the worst



IV. Cold Chain Application Models in Transportation in Horticulture and Vegetable Products in Trade Corridors

Cold chain logistics transportation models for Trade

International Trade



Transport Chain



Physical Flows



IV. Cold Chain Application Models in Transportation in Horticulture and Vegetable Products in Trade Corridors

Cold chain logistics transportation models: New Technology used

- ① More professional and smart by application of RFID, GPS technology to instant monitoring the whole process of logistics
- ② Standardization of transportation facilities and management
- ③ Low carbonization, advanced big data based computerized capability and rational and optimum schedule with minimum cost will be realized



IV. Cold Chain Application Models in Transportation in Horticulture and Vegetable Products in Trade Corridors

Cold chain logistics transportation models: Cold Chain System Parameter Analysis

Case examples from China and Bali, Indonesia based on survey data of the HV production sites, distribution centers distribution mapping developed and created optimization models by using liner program:

Cold Chain Models developed by using variables like refrigeration components including pre-cooling chiller, cold rooms, and transportation refrigeration, retail market, cabinet display etc.(by INGS Waisnawa etc)

Cost analysis between conventional and cold chain system was analyzed by LCC methods. The modeling or simulation provide optimization on cold chain system with parameters analysis for : 1) type of product, 2) type of technology in cooling system, 3) energy requirement per product weight, 4) operating time 5) costing

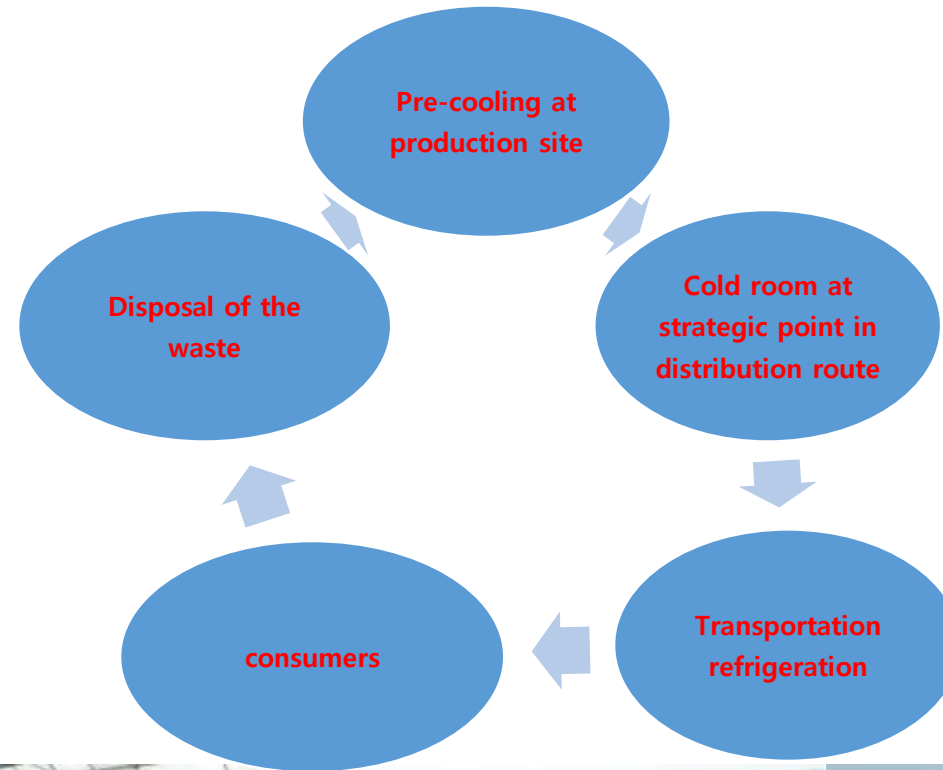
The analysis will be conducted by using computer programs.



IV. Cold Chain Application Models in Transportation in Horticulture and Vegetable Products in Trade Corridors

Cold chain logistics transportation models: Cold Chain System Parameter Analysis

Distribution route and cold chain model: Minimum storage temperature is 5 °C--16°C with relative humidity from 65% to 100% most vegetables storage life for Asparagus, tomato etc 2-3 weeks, while with CA cold storage can extend to 2 months



V. Conclusions and recommendation

Cold chain logistics transportation models: Recommendations

- ❑ Chinese Agriculture Development enters into a new era, science based agriculture will be full developed and expanding her collaboration with global partners;
- ❑ Cold Chain development will be a promoter in Belt and Road Development Initiative to promote trade particularly in horticulture and vegetable industry.
- ❑ Country specific plan needed for cold chain development to select most suitable models for their country. CI should developed industry based data bases for guidance of trade among the region.



The background image shows a large, modern, multi-story building with a grid of windows. A tall antenna tower stands to the left of the building. In the foreground, there is a large, tiered flower bed filled with yellow and red flowers. The sky is clear blue.

Thank you