Good Handling Practices in **Packing House for Vegetables**

AVA
Agri-Food & Veterinary Authority of Singapore

Acknowledgements

This publication of the Good Handling Practices (GHPs) in Packing House for Vegetables is a set of guidelines for packing house's operators to adopt and to train their workers to ensure and maintain the safety, quality and wholesomeness of vegetables at their packing house.

We would like to express our sincere thanks to the various local farms, distribution centres, importers, wholesalers and retailers, which have generously allowed us to view their packing house and observe their handling practices for the development of relevant GHPs as well as their invaluable support for the successful completion of this publication.

Publisher:
Post-Harvest Technology Department
Technology & Industry Development Group
Agri-Food & Veterinary Authority of Singapore
2 Perahu Road
Singapore 718915

ISBN: 978-981-09-2559-8

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1. Introduction

As at Financial Year 2013, there are 60 vegetable farms occupying about 128 hectares of land in Singapore. Such local vegetable farms produced 21,785 tonnes of vegetables, which constitute about 4% of the total vegetable consumption in Singapore. The other 96% of vegetables in Singapore were imported mainly from Malaysia, China and Thailand. Imported vegetables from Thailand and Malaysia may be delivered by open or cold trucks to Pasir Panjang Wholesale Centre or packing house belonging to local farms, fresh food distribution centres or importers where vegetables are trimmed, sorted, packed or re-packed (bulk break). Since considerable volume of vegetables are trimmed and repacked in Singapore, a set of guidelines is necessary for training workers to conduct good handling practices in the packing house, so as to maintain the safety and quality standard as well as to ensure wholesomeness of vegetables.

Good postharvest handling should be accompanied with good cold chain management for keeping vegetables fresh and wholesome. Temperature control is particularly important in governing the postharvest quality of fresh produce as it directly affects the microbiological, biochemical and physiological reaction pathways responsible for postharvest deterioration. Temperature abuse, poor handling and improper packaging often generates up to 30 % wastage in the vegetable supply chain, which constitutes to a substantial loss of valuable food resources and can be a threat to Singapore's food security.

Currently, Singapore Standard SS 585:2013 Cold Chain Management of Vegetables covers good practices for cold chain management along the entire supply chain for leafy vegetables, including the packing house. This handbook aims to support the Singapore Standard as a guideline for our local vegetable industry and stakeholders, including workers in the farm and distribution centres, importers, wholesalers and retailers, to implement best practices in the packing house and to contribute to the overall effort of cold chain management in ensuring produce safety and quality assurance.

This handbook will focus on 3 key areas as follows:

1. General design and facilities of packing house (e.g. ante area, pre-cooling facility, chiller and packing room)
2. Good handling practices in the packing house
3. Establishing internal control systems (hygiene, sanitation, maintenance and monitoring)

2.
Process Flow in Packing House

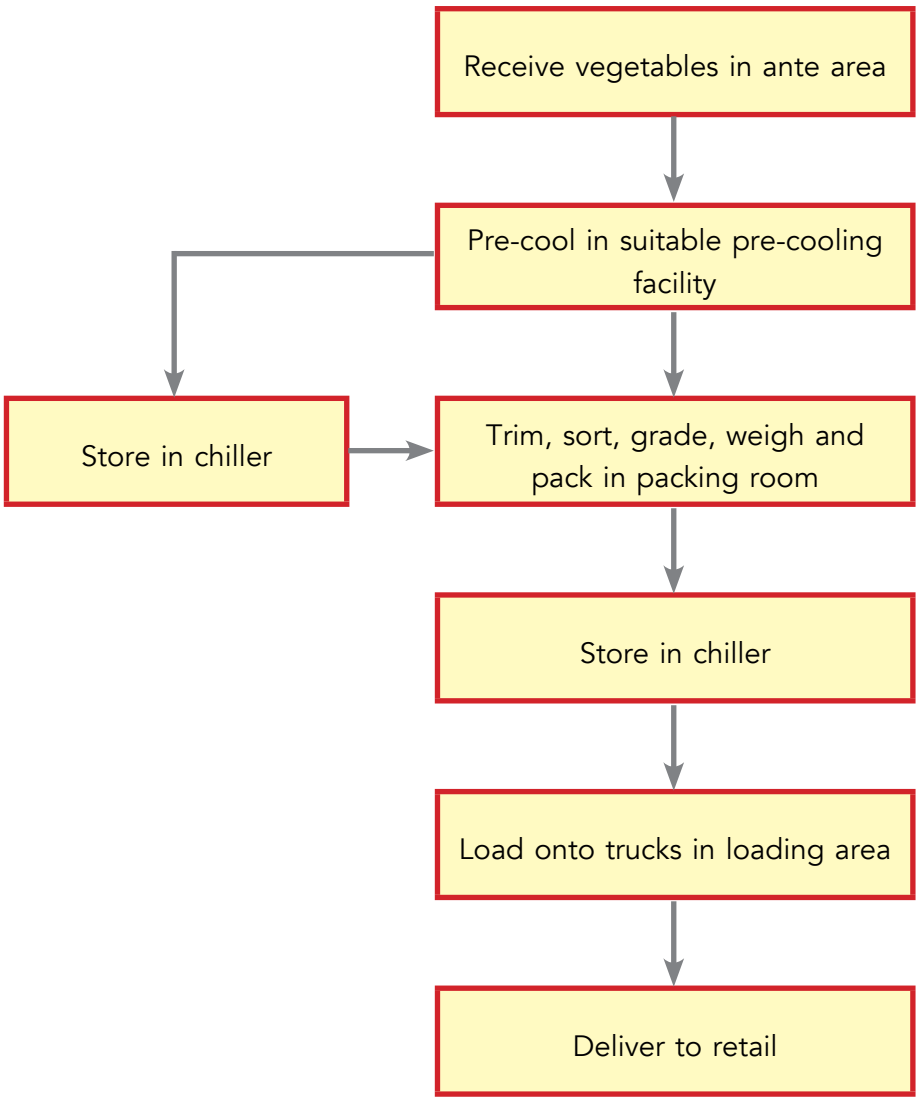

Figure 1: General process flow in packing house for vegetables

3. General Design and Facilities of Packing House

A packing house typically holds the ante area, pre-cooling facility, packing room, chiller and loading area in an enclosed premise to facilitate integrated cold chain management of vegetables. It is where vegetables are pre-cooled, trimmed, sorted, weighed, packed and stored before delivery to retail.

The packing house is an important component in the supply chain where majority of the handling and preparation of produce takes place prior to distribution to the market. The design of the packing house should be well planned to ensure smooth workflow and operations from receipt of vegetables to loading for delivery. Smooth handling operations within the premise would facilitate logistics movement and shorten the duration for transferring vegetables considerably.

Recommendations

I. Depending on the available capital, space constraint, type of produce and expected turnover rates, the packing house design could be modified to cater to these factors. A proposed general design of a small to medium-sized packing house for vegetables is depicted in Figure 2 below.

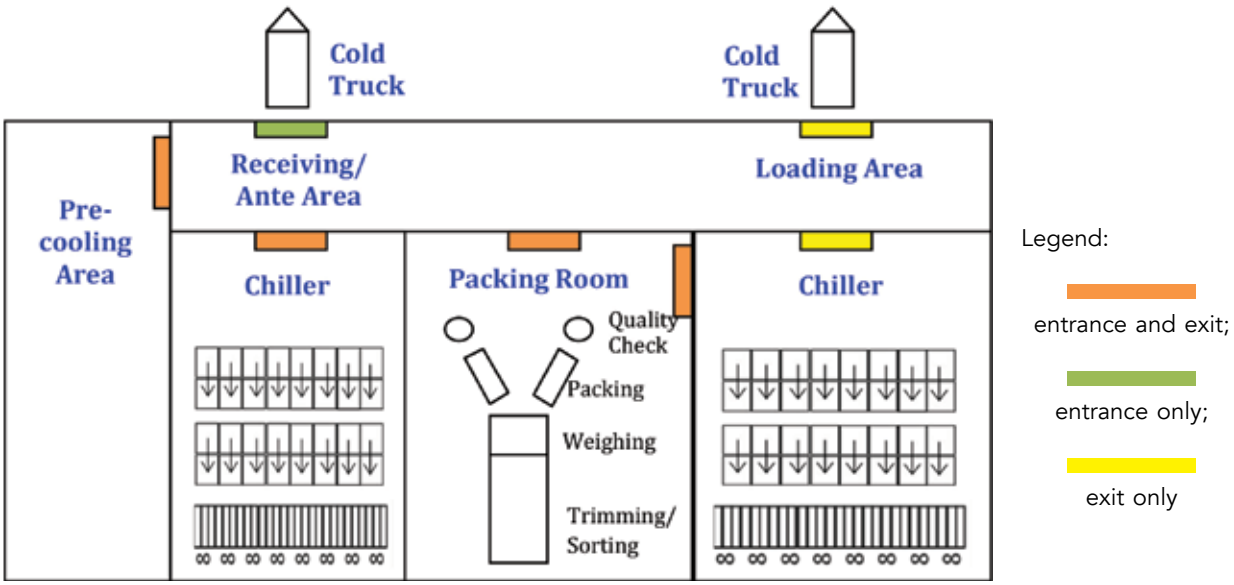

Figure 2: General layout of packing house for vegetables which allows continuous and smooth workflow.

II. The flow of produce should not criss-cross within the packing house. Fresh and finished packed produce should be kept separately to avoid cross-contamination.

III. The building should be completely sheltered and constructed with well-insulated (e.g. polyurethane) walls and floors.

IV. The floors should be sturdy and made of materials which allow effective cleaning.

V. The packing house should be maintained in clean and tidy condition. Proper cleaning and disinfection schedule should be carried out regularly to ensure cleanliness and hygiene.

VI. All lightings should be covered to prevent contamination of produce and protect workers from any shatter.

VII. There should be sufficient doors that are well-positioned for loading and unloading.

VIII. Devices such as plastic strip curtains or sensor-operated canvas curtains should be installed at the doors.

IX. Temperature monitoring devices should be properly located, preferably also at the far corners of the room, to reflect the true average temperature within premises.

4.
Good Handling Practices in Packing House

4.1 Ante Area

Ante area is also known as the receiving area where vegetables are unloaded from chilled or ambient trucks before being transferred to the pre-cooling facility. The ante area may open into the packing room if the processor chooses to pack the vegetables before pre-cooling.

It is necessary to unload vegetables from the truck into a clean and temperature-controlled area before pre-cooling, packing or storage to prevent contamination and further quality deterioration from the high temperature outside the packing house.

Recommendations

I. During operating hours, the temperature of ante area should be maintained between 18 to 23 °C.

II. Vegetables should not be kept in the ante area permanently but should be transferred to the pre-cooler or chiller as soon as possible.

III. The source, type, quantity and surface temperature of vegetables should be verified, assessed and documented by designated operator.

IV. The cleanliness and temperature of truck, as well as the condition of door seals and insulation of trucks upon arrival should be evaluated and documented by designated operator.

V. Condition of the produce should be evaluated for any quality defects such as mechanical injury, disorders and decay. Information about the vegetables should also be properly recorded and kept for the purpose of traceability.

VI. Once verified, the cartons/ baskets of vegetables should be tagged with tracking information before entering the pre-cooling or packing area.

4.2 Pre-cooling

After harvest or upon arrival at the packing house, the vegetables need to be cooled rapidly and this cooling process is known as pre-cooling. It is recommended to cool to their optimum storage temperature of approximately 2 to 6 °C. The pre-cooling area could be a chilled room where the vegetables are cooled, or an air-conditioned/ sheltered area where the pre-cooling facility (e.g. forced-air cooler and vacuum cooler) is placed.

Pre-cooling is an essential step for good cold chain management and is a process to remove field heat from freshly harvested crops by a cooling treatment. Reducing the temperature of vegetables rapidly after harvest is important in maintaining the vegetable freshness and quality. Pre-cooling reduces the vegetable enzymatic reactions, respiration rate, ethylene production rate, water loss and growth of spoilage microorganisms, and thus minimising quality deterioration of the highly perishable vegetables.

Recommendations

I. In general, vacuum cooling is preferred for pre-cooling leafy vegetables while forced-air cooling is more suitable for fruited vegetables. Vegetables should be sprayed with small amounts of water or covered with clean moist paper before vacuum cooling to prevent dehydration during pre-cooling.

II. Alternative methods such as hydro-cooling and ice cooling are more suitable for pre-cooling certain headed and fruited vegetables. (Details about the various pre-cooling methods may be found in Table 1 and 2)

III. If forced-air or room cooling is adopted, the room cooling unit should be switched on prior to the arrival of vegetables to ensure that the temperature and relative humidity are maintained at the pre-set conditions that are suitable for the vegetables to be pre-cooled.

IV. The pre-cooling facility should not be overloaded beyond its optimum capacity.

V. The stacking of produce should allow for adequate air-circulation in order to ensure even cooling of produce.

VI. Proper receptacles (such as vented boxes and baskets for forced-air cooling, and waxed cartons or Styrofoam boxes for hydro-cooling) should be used.

VII. The vegetables should be transferred out from the pre-cooling facility immediately after pre-cooling to avoid over-cooling or dehydration of the vegetables.

VIII. The source of water used for pre-coolers should be potable to minimize any food safety concerns.

IX. Ethylene-sensitive vegetables should be separated from ethylene-producing vegetables.

X. If a chiller is used for pre-cooling, it should be kept closed at all times to minimize temperature and relative humidity fluctuations during the pre-cooling process.

Table 1: Types of pre-cooling methods – definition and operation

Room Cooling

DEFINITION
Produce is pre-cooled in an insulated and refrigerated room.

OPERATION
Cool air is circulated by convection throughout the room until vegetables reach desired temperature.

Vacuum Cooling

DEFINITION
Produce is pre-cooled in a chamber under reduced atmospheric pressure.

OPERATION
At reduced atmospheric pressure within the vacuum chamber, rapid evaporation of water from the produce's surface occurs, removing heat along with it.

Forced Air Cooling

DEFINITION
Produce is pre-cooled in a refrigerated room equipped with cooling fans.

OPERATION
Cold air is drawn and forced through crates of vegetables covered by a canvas sheet which creates the air-channeling effects that help to reduce the temperature quickly to the desired temperature.

Hydro Cooling

DEFINITION
Produce is pre-cooled via cold running water in a continuous or batch process.

OPERATION
Vegetables are showered with or submerged in cold water that is circulated through the heat exchanger. High energy transfer from the warmer vegetables to the cooler cold water cools the vegetables until the desired temperature is achieved.

Ice Cooling

DEFINITION
Produce is pre-cooled through direct contact of vegetables with ice in water-proof packages, usually polystyrene cartons, to remove heat.

OPERATION
Layers of crushed ice are added on top of the vegetables manually or through mechanical means to increase the cooling and heat removal rate until the desired temperature is achieved.

Table 2: Types of pre-cooling methods and their features

Suitable Commodities	Pre-Cooling Duration	Advantages	Disadvantages
ROOM COOLING			
• Preferably commodities with similar optimum storage temperature • All fruited vegetables and fruits *E.g. tomato, capsicum*	• Between 4 to 20 hours, depending on the type of produce and heat load	• Clean and simple operation • Relatively low installation and maintenance cost • Provide temporary storage for the commodities after pre-cooling	• Relatively slow in cooling • Uneven cooling at the beginning hours • Not suitable for leafy vegetables due to prolonged cooling hours, resulting in dehydration
VACUUM COOLING			
• Leafy vegetables and mushroom due to greatest surface-to-volume ratio *E.g. caixin, kailan, lettuce, cabbage, spinach*	• Between 30 to 40 minutes to reduce temperature to near 0 - 4°C	• Rapid cooling method which enables high throughput volume • Even and uniform cooling for vegetables placed at every position • High energy efficiency	• Risk of wilting due to moisture loss • Relatively high capital cost • Requires packaging with holes for water evaporation • Cannot be used to store the commodities after pre-cooling
FORCED AIR COOLING			
• All leafy, fruited and rooted vegetables *E.g. caixin, kailan, xiaobaicai, tomato*	• Between 1 to 10 hours, depending on power, heat load, produce type and volume	• Clean and simple operation • Rapid cooling method which enables a relatively high throughput volume • High heat transfer performance • Relatively low installation and maintenance cost	• Limited room capacity to accommodate large quantities of harvested crops • Relatively slower process as compared to vacuum cooling
HYDRO-COOLING			
• Fruited vegetables and fresh-cut fruits tolerant of prolonged exposure to wet conditions *E.g. tomato, artichoke, leaf lettuce, sweet corn, radish, asparagus, carrot*	• Between 5 minutes to 1 hour	• Rapid cooling method which enables a high throughput volume • High energy efficiency • Provide means to clean up the vegetables (E.g. chlorinated water) used to avoid spoilage of vegetables	• Limited usage for leafy vegetables as additional step of drying required • Additional effort required to monitor water quality and cleanliness of cooler daily
ICE COOLING			
• Headed vegetables and high-respiration vegetables tolerant of prolonged exposure to wet conditions *E.g. broccoli, spinach, parsley, green onions, brussels sprouts*	• Between 5 to 20 minutes	• Rapid cooling method • High heat transfer performance • Prevent any moisture loss from the vegetables	• Additional weight from the crushed ice and high water content from melting ice could increase the risk of physical injury and rotting of the vegetables • Risk of suffering chilling injury if the period of icing is prolonged

4.3 Packing Room

The packing process commonly involves trimming, sorting, grading, weighing and packing of vegetables. The packing room should be temperature-controlled and easily accessed between the pre-cooling room and the chiller.

The general packing process in a packing room is depicted below:

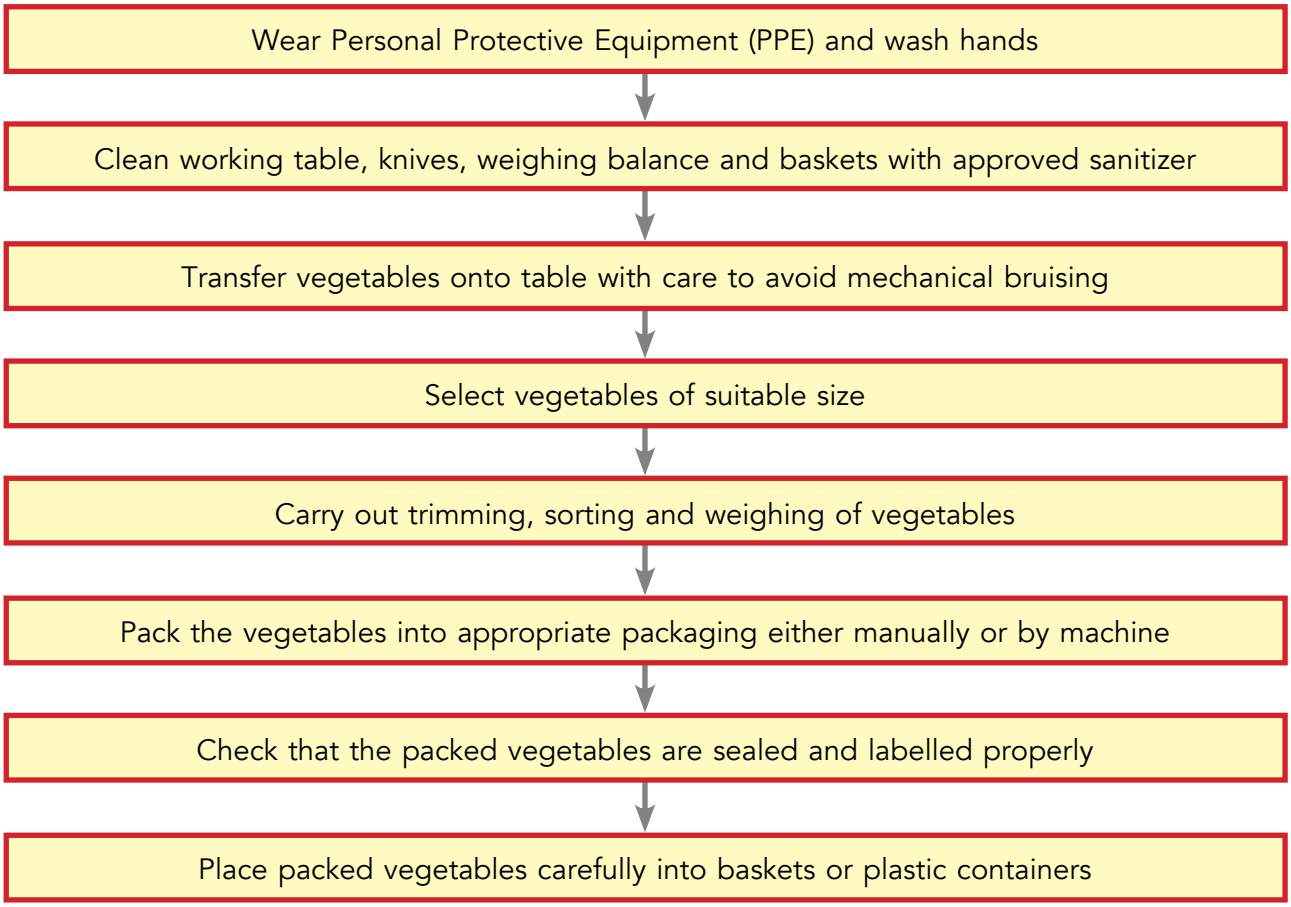

Figure 3: General packing process in packing room

The trimming and sorting process is essential for selecting good quality produce which are marketable and removing undesirable produce or parts of the produce that would cause rapid quality deterioration of other vegetables that are packed together with it.

Using suitable packaging can help to protect the produce from undesirable environmental factors (such as dehydration, heat accumulation, physical damage, stack stress as well as pest and diseases) and minimize contamination and damage during handling operations along the supply chain. In addition, packaging facilitates transportation, distribution and marketing.

Recommendations

4.3.1 Packing line

I. The temperature and relative humidity of the packing room should be maintained between 15 to 20 °C and 80 to 95 % respectively, to ensure that the benefit from pre-cooling is conserved.

II. Vegetables should be taken out from the chiller in batches and just before packing to reduce the time of exposure to packing room's temperature

III. Stainless steel tables should be used in the packing area to avoid rust contamination, and to allow for easy cleaning.

IV. Sharp and smooth knives should be used for trimming, and clean cuts should be made to prevent bruising of the produce.

V. Leafy vegetables should be trimmed by trained operators to remove the outer leaves or any leaves with signs of disease, yellowing and obvious defects.

VI. Dirty cloth and knives should be washed and cleaned in food-grade sanitizing solution regularly.

VII. Grading should be done to classify produce based on parameters such as size, shape, weight, colour and maturity stage.

VIII. If vegetables have to be washed to remove soil, care should be taken to air-dry the vegetables sufficiently before packing.

IX. Only new and clean packaging bags should be used.

X. When packing leafy vegetables into retail packaging bags, vegetables could be slipped into the bags with the help of clean plastic sheets to avoid damage to the edge of the leaves.

XI. Trained operators should be assigned at the end of the packing line to conduct quality checks (weight, quantity and quality) on the packed produce before placing into baskets for storage/ delivery.

XII. Proper labels should be established on the cartons or containers, indicating necessary information such as type and source of vegetable, harvest date, packing date, weight, grade and size, etc.

4.3.2 Packaging

The following properties should be considered when selecting a suitable packaging for your produce:

I. For food safety, the packaging should act as a functional barrier against external contaminants.

II. The packaging should be able to withstand physical stress (example, weight from additional package during stacking) to protect the produce from impact, compression, vibration and abrasion injuries; as well as designed to allow for proper stacking and prevent blockage of vents.

III. The packaging should be equipped with appropriate heat-transfer characteristics such as presence of vents or holes to allow for the circulation of cool air.

IV. Soft commodities should be cushioned within the packaging to protect from impact or vibration injury.

V. The packaging should allow for good heat-seal to ensure package integrity.

VI. The packaging should be of printable functionality to facilitate labelling and marketing.

VII. The packaging of produce should be transparent or opaque depending on consumers' preference for the ability to see and assess the produce.

VIII. Other types of packaging technologies could be considered:

a) Modified Atmosphere Packaging with barrier properties which suits the respiration rate of produce

b) Active Packaging with antimicrobial or ethylene-scavenging effects

c) Biodegradable or Green Packaging

4.4 Chiller

The chiller may be located between the packing room and the loading area, and is where vegetables are stored prior to delivery from the packing house to the retail market. Sometimes, a holding chiller may be located near the receiving area to store vegetables temporarily while waiting for pre-cooling or packing.

The chiller should have a precise temperature control system, adequate refrigeration capacity and uniform air distribution to facilitate efficient cooling. Uniform and low temperature condition would help to inhibit undesirable metabolic and microbiological activities, respiratory heat productions, as well as reduce moisture loss that could result in wilting.

Recommendations

I. The design and layout of a chiller should be built based on individual's operations in accommodating different types of produce and storage capacity. A simplified version of a typical chiller is depicted in Figure 4 below.

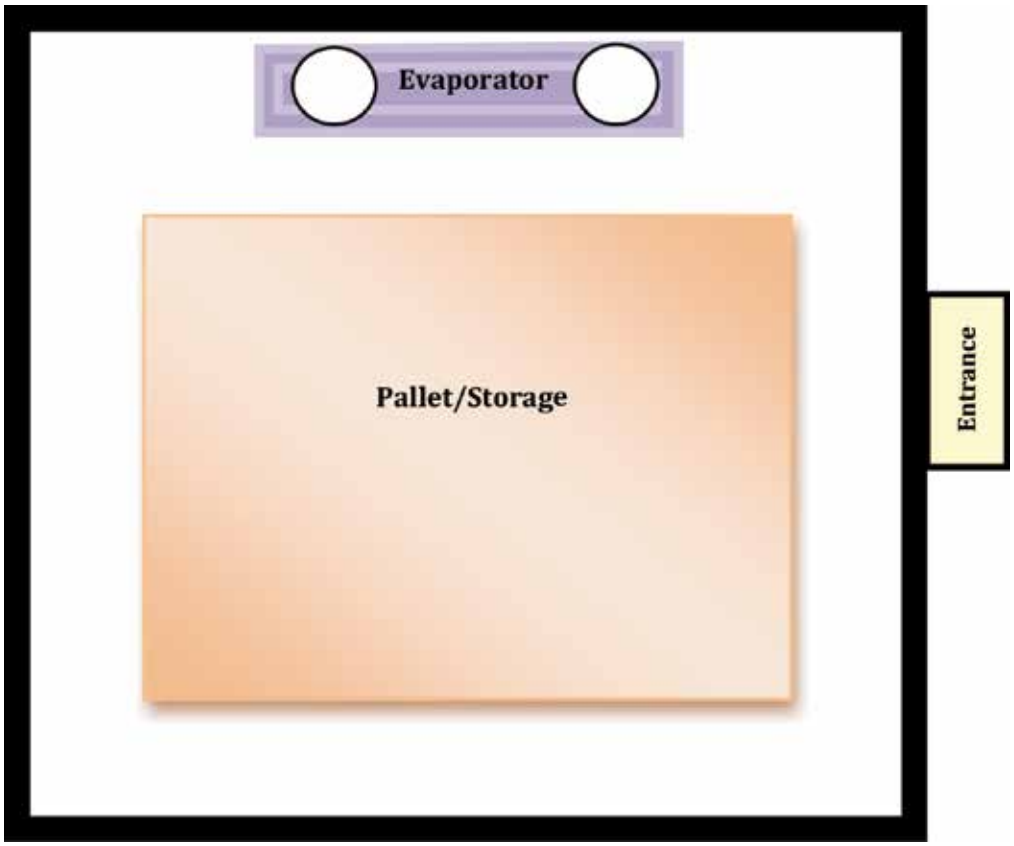

Figure 4: Layout of a typical chiller.

Various recommended layouts of chiller are depicted below:

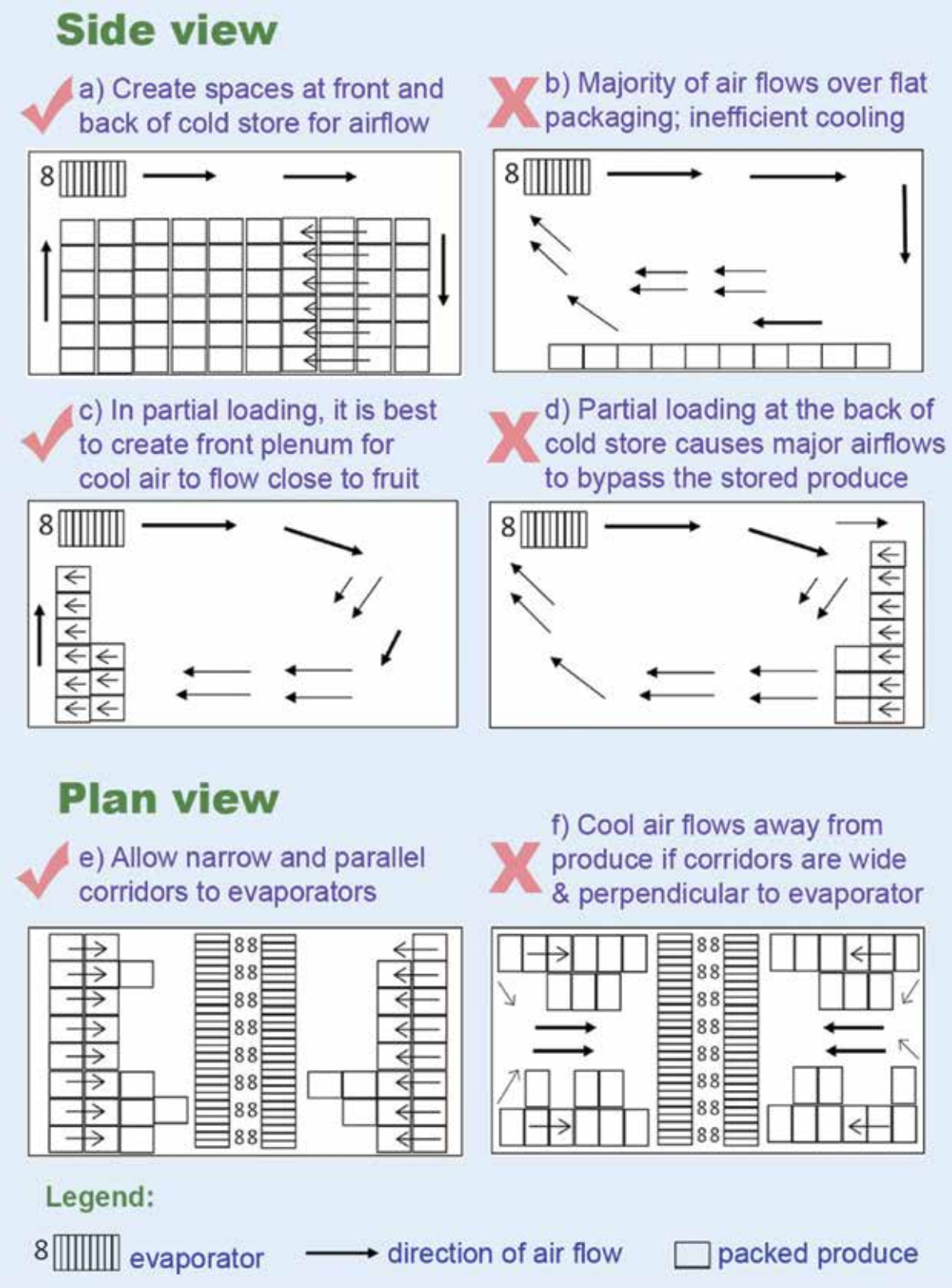

Figure 5: Schematic diagram showing the examples of good and bad arrangements of packed produce crates in chiller

II. The width of the entrance should ideally be at least 3 m wide in order to ensure smooth product movement in and out of the chiller, as well as to allow sufficient space for pallet's movement with the use of hand-jack or forklift.

III. The chiller should be switched on prior to the arrival of vegetables, and maintained at the vegetable's optimum storage temperature of 2 to 6 °C and relative humidity of 80 to 95 % to keep vegetables fresh and reduce product moisture loss.

Table 3: Recommended storage temperature for varied vegetable category

Vegetable category	Recommended storage temperature* (°C)
Leafy (e.g. Xiao Bai Cai, Cai Xin, Gai Lan, Lettuce)	2-5
Leafy (e.g. Bayam, Kang Kong)	10-12
Headed (e.g. Broccoli, Cauliflower)	0-2
Headed (e.g. Round cabbage)	5-7
Fruited (e.g. Bell pepper, Chilli, Long bean)	5-7
Fruited (e.g. Chayote, Okra, Red tomato)	7-10
Fruited (e.g. Bitter melon, Cucumber, Brinjal, Green tomato)	10-13

** The listed recommended storage temperature only serves as reference, and is subjected to variation under different operating conditions.*

IV. Temperature of both the chiller and produce should be monitored and maintained to minimise any exposure to alternating cold and warm temperatures that could result in moisture accumulation on the surface of produce.

V. The produce stored in the chiller should not exceed its storage capacity.

VI. The chiller cooling efficiency could be improved by installing more evaporators along the width of the chiller and positioning condensers on rooftop or away from narrow corridor walls. Inflatable air cushions or rubber pads at docking doors could help to prevent warm air infiltration into the chiller.

VII. Pallets or boxes used should have holes for good air ventilation.

VIII. The containers of vegetables should be stacked on pallets with adequate space in between pallets (about 15 to 18 cm apart), and between the room walls (about 8 cm) and ceiling (about 30 to 45 cm) so as to ensure efficient air circulation.

IX. The containers of vegetables should be stacked in a manner which allows for efficient cooling, as described in Figure 5.

X. Doors of chillers should be kept closed at all times to prevent heat infiltration and condensation on walls.

XI. Plastic strips should be hung on the inside of doorway to minimise possible influx of warm air from the external environment into the chiller.

XII. Ethylene-sensitive produce should be stored separately from ethylene-producing produce.

XIII. Strong odour-producing vegetables like garlic and onions should not be stored in the same chiller as other non-odour-producing vegetables like leafy vegetables.

XIV. Vegetables should be transferred out of the chiller to retail following "first-in-first-out" (FIFO) good storage practice.

4.5 Loading Area and Transport

The loading area is where the vegetables are transferred out from chiller and held while they are being loaded onto refrigerated trucks for distribution.

The loading area forms part of the integrated cold chain management system as it allows vegetables to be held in a clean, cool and enclosed/ sheltered area while waiting to be loaded onto trucks for delivery. It helps to reduce the risk of contamination and quality deterioration.

Recommendations

I. The loading area should be sheltered and not exposed to direct sunlight.

II. The temperature of loading area should be maintained between 18 to 23 °C.

III. The cleanliness and temperature of truck, as well as the condition of door seals, plastic strip curtains and insulation of trucks should be evaluated and documented by designated operator prior to loading.

IV. Refrigerated trucks with good cooling and insulation properties should be used for the transport of vegetables at the desired temperature.

V. The desired holding temperature of the truck should be reached before vegetables are loaded.

VI. Vegetables should be palletized for loading.

VII. Vegetables should be loaded onto trucks within 30 minutes to reduce exposure to elevated temperatures in the loading area.

VIII. Containers should neither be stacked too high nor against side walls and rear doors of the truck, as this would hinder efficient cooling.

5.
Monitoring and Maintenance

Recommendations

I. All work instructions, schedules and procedures should be clearly documented and operators should be trained to perform and document the adopted procedures for traceability.

II. Temperature and humidity of the various operation facilities in the packing house should be monitored and recorded regularly.

III. Records of produce temperature and quality at various stages in the packing house (e.g. upon receipt at packing house, before and after pre-cooling and packing, during storage and loading) should preferably be established and maintained.

IV. All equipment such as pre-cooling facility, refrigeration units, temperature and humidity monitoring devices, and weighing devices should be maintained and calibrated regularly, preferably by accredited suppliers.

V. Incoming produce and finished products should be adequately and effectively documented to ensure product traceability.

6.
Sanitation and Personal Hygiene

Recommendations

I. Workers should wear Personal Protective Equipment (PPE) such as hair net, face mask and gloves in the packing area at all times.

II. All operators and workers should wash their hands:
   a. Before vegetable handling
   b. After going to the toilet
   c. After handling any garbage or garbage bins
   d. After coughing or sneezing
   e. After touching nose, mouth or hair
   f. After smoking
   g. After handling money
   h. Before and after meal breaks

III. All equipment, tools, tables and containers used should be cleaned with food-grade sanitizers at the start and end of the day. Plastic strip curtains should also be cleaned regularly to avoid mould growth.

IV. Cleaning schedule, records, work instructions and supervising officer's inspection records should be well established and documented.

V. All staff should be trained on good hygiene and sanitation practices. Staff training records should be well established and documented.

VI. Elimination of harbourage and pest attractant areas, as well as rapid removal of waste should be done to avoid creating conducive environment for pests.

VII. Destruction and eradication of pest should be done periodically by pest control specialist, and records should be maintained.

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GOOD HANDLING PRACTICES IN VEGETABLE PACKING HOUSE

GENERAL REQUIREMENTS

Good Hygiene & Cleanliness

- Always clean and sanitize hands before and after handling produce, and wear clean gloves, masks, hairnets and apron during packing.

- Keep all facilities (i.e. ante area, pre-cooling, packing room and cold room) clean and dry.

Good Manufacturing Practices (GMP)

- Maintain the packing room and chiller at their optimum temperature and humidity.

- The tables used should be made of materials such as stainless steel, which can allow effective cleaning.

- Regular pest control monitoring should be in place to prevent and eliminate pests.

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GOOD HANDLING PRACTICES IN VEGETABLE PACKING HOUSE

PACKING AREA

Good Hygiene & Cleanliness

- Sanitize the packing table, knives and weighing scale before and after packing, with food-grade sanitizers.

- Use only clean and sharp knives for trimming vegetables.

Good Labelling Practices

- Each packaging should be clearly labeled with relevant information such as
  - Type of variety/ common name of fresh produce
  - Origin of fresh produce (address of farm)
  - Name and address of local importer/ exporter
  - Net weight per package
  - Country of origin of produce

Produce Quality Assurance

- Take a suitable volume of vegetable out from the chiller just before packing to reduce the time of exposure to Packing Room's temperature.

- The produce should be dry, cool and appropriately trimmed prior to packing.
- Use new and clean packaging for vegetables. Ensure that the vegetables are placed neatly into packaging.

- Choose the correct packaging for vegetables. For example, leafy vegetables can be packed in PE bags with holes to avoid accumulation of field heat.

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GOOD HANDLING PRACTICES IN VEGETABLE PACKING HOUSE

CHILLER

Good Cold Chain Management

- Install and maintain plastic strip curtains/ automated vertical canvas curtains on the inside of doorway.

- Keep the door to the chiller close at all times except for the need of consignment transfer.
- Entrance to chiller should only be accessible to authorized personnel.

- The containers of produce should be stacked on pallets with adequate spacing in between pallets, room walls and ceiling, to improve cooling efficiency of fresh produce.
- Produce should be arranged parallel to evaporator to maximise the efficiency of evaporator.
- Produce stored in chiller should not exceed its storage capacity.

Good Manufacturing Practices (GMP)

- Use clean, strong and durable baskets or cartons that are stackable.

Produce Quality Assurance

- Store vegetables which are compatible in terms of ethylene production/ sensitivity and storage temperature in the same room.

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GOOD HANDLING PRACTICES IN VEGETABLE PACKING HOUSE

RECEIVING/ LOADING AREA & TRANSPORT

Good Manufacturing Practices (GMP)

- Handle the produce with care and use pallets of good condition.

Good Hygiene & Cleanliness

- Ensure regular cleaning and maintenance of the refrigerated truck.

Good Cold Chain Management

- Receive the produce at a sheltered or refrigerated area and transfer to cold room within 30 minutes.

- Stack the pallets to an appropriate capacity and height to allow good air circulation in the refrigerated truck.

- Use refrigerated truck for loading and transport and set the truck to the desired temperature before loading the produce.

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