

Establishing and managing  
**SMALLHOLDER  
VEGETABLE PACKHOUSES**  
to link farms and markets

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SMALLHOLDER VEGETABLE PACKHOUSES  
to link farms and markets

A training manual

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March 2016

AVRDC/USAID Postharvest Program – Asia



Published by



**AVRDC–The World Vegetable Center** is the leading international nonprofit organization committed to alleviating poverty and malnutrition in the developing world through the increased production and consumption of safe vegetables.

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*Cover photo: Simple packhouse facility of the Khum Khnart Samakey ROUNG ROUERNg Agricultural Cooperative (KKSRRAC), Siem Reap, Cambodia; Nepali tomato farmers harvesting fruit; KKSRRAC women–farmers cleaning and sorting leafy vegetables; and Coolbot cold storage of vegetables (photos courtesy of B Buntong and DM Gautam)*

**Suggested citation:**

Acedo AL Jr, Rahman MA, Buntong B, Gautam DM. 2016. Establishing and managing smallholder vegetable packhouses to link farms and markets. Publication No. 16–801. AVRDC – The World Vegetable Center, Taiwan. 46 p.

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## Acknowledgement

This training manual was produced under the AVRDC/USAID Postharvest Program with support provided by the Bureau for Food Security, U.S. Agency for International Development (USAID) under the terms of Award No. AID-BFS-IO-12-00004. All opinions expressed in this manual are those of the authors and do not necessarily reflect the views of USAID.

# 1 PACKHOUSE

- A packhouse is a physical structure where harvested produce is consolidated and prepared for transport and distribution to markets.
- Packing is the main activity from which the name ‘packhouse’ is derived. But there are activities before and after packing— together they are called *packhouse operations*.
- Packhouse operations include cleaning, sorting/grading, pre-treatments, packing, cooling, storage and dispatch to market.
- A packhouse is also called a consolidation center or collection center.
- Many consolidation or collection centers in developing countries have no packhouse operations. They serve only as collection points, where farmers bring their produce for traders to collect (Figure 1).
- A packhouse may be simple or modern. This manual focuses on simple packhouses for smallholder farmers’ groups or cooperatives. An individual farmer can also develop a simple packhouse. As business expands and cooperatives or individual farmers gain skill and knowledge, they can establish a modern packhouse (Figure 2).



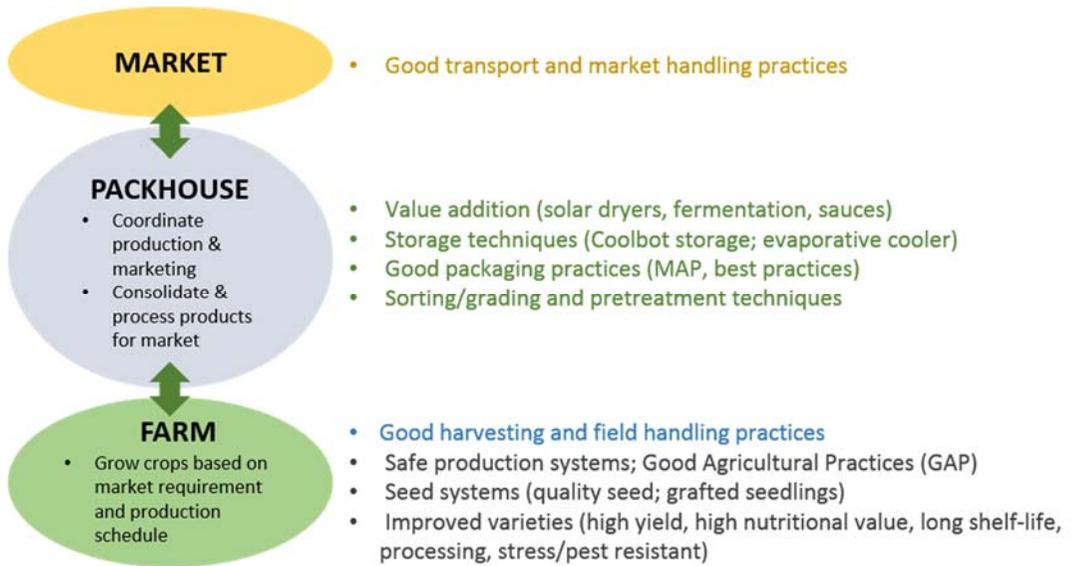
**Figure 1** Collection center in Banke, Nepal



**Figure 2** Modern packhouses supply supermarkets and exporting

## 2 IMPORTANCE OF A PACKHOUSE

- A packhouse enables quality assurance activities that ensure product quality and quantity meet market requirements and losses are minimized during transport and distribution to markets. Developing countries incur serious postharvest losses of vegetables, usually ranging from 20–40% of production.
- A packhouse can serve as a hub for coordination and governance of a farm–packhouse–market organization in which market demand dictates production and packhouse activities (Figure 3).

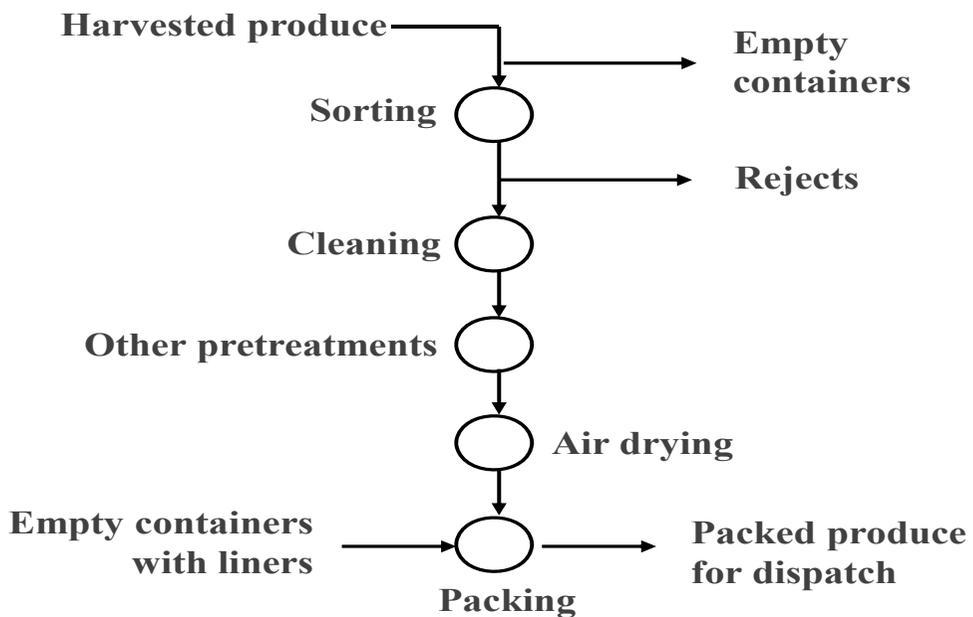


**Figure 3** Farm–packhouse–market value chain and best practices along the chain.

- A farm–packhouse–market organization maximizes economy of scale, improves market access, and facilitates technical and business development interventions. Figure 3 shows the possible technical improvements along the value chain.
- The farm–packhouse–market organization can be managed by three teams: **management team** (overall leadership; selected officers and members of the cooperative/group); **production team** (production and harvest scheduling); and **marketing team** (packhouse and market operations; market linking). The production and marketing teams should work closely to meet market demand.
- Overall, the packhouse is the focal point of a farm business. Proper management ensures the business will prosper in a sustainable manner.

### 3 ESTABLISHING A PACKHOUSE

- A packhouse should be designed to enable different operations for handling vegetables. It should:
  - be located as close to farms as possible.
  - provide service to the greatest number of farmers.
  - facilitate drop-off and pick-up of produce and containers.
  - be easily accessible to markets or transport terminals.
- The site and premises of the packhouse should have:
  - good roads
  - minimal risk of contamination
  - protection from sun and rain
  - dependable water and electricity supplies
  - adequate drainage
  - provision for comfort and safety of workers
- Information on production area, volume and quality of produce, and target market and quality requirements should be properly recorded and known by all involved in production and marketing.
- Identify the packhouse operations to be conducted for the produce and assemble the operations into a flow chart (e.g. Figure 4).



**Figure 4** Flow chart of packhouse operations for most vegetables.

- Identify materials, tools, and apparatus or equipment needed (these are given under each of the packhouse operations below).
- Determine the area requirement. As a general rule, the minimum is 20 m<sup>2</sup> floor area per ton (1,000 kg) of produce. Additional space is needed for equipment, containers, storage, washing station, passageways, waste disposal, lavatories, and vehicle parking.
- When setting up the facilities and flow of operations, consider movement of personnel and contamination of produce. The receiving area should be separated from the dispatch area (Figure 5).

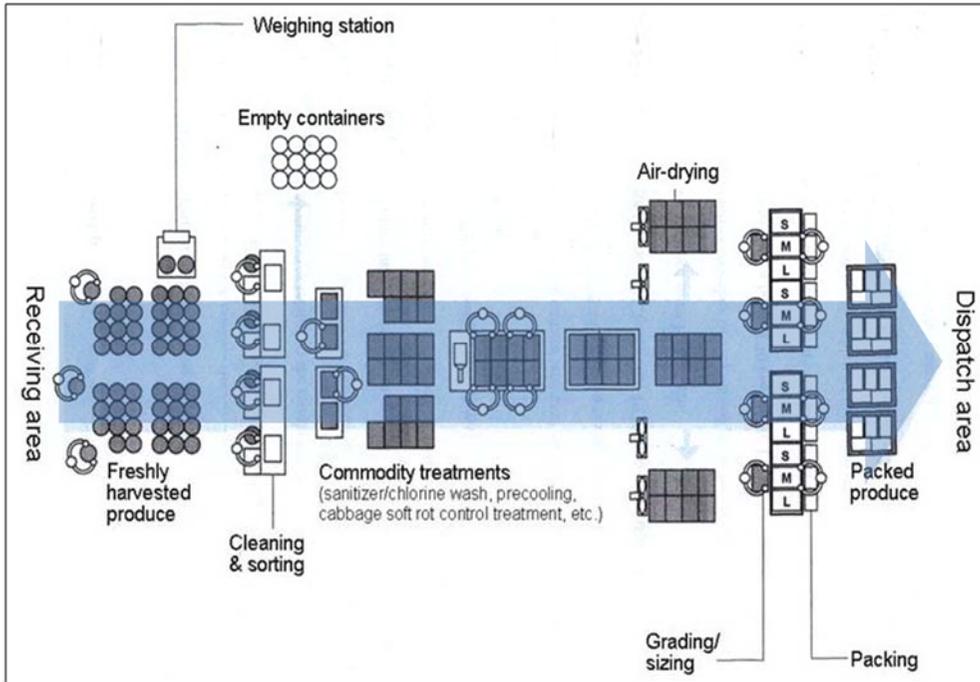
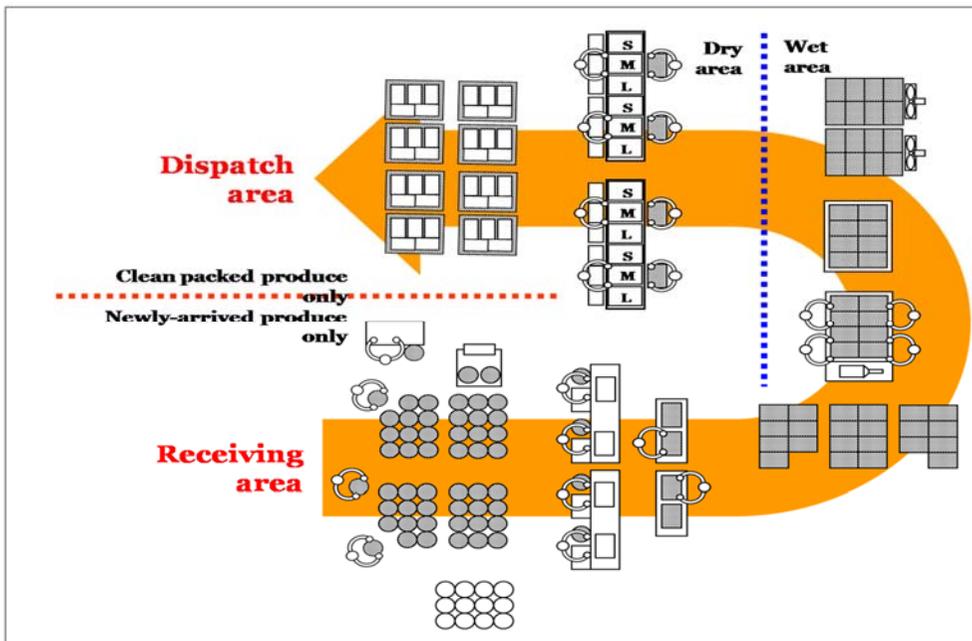
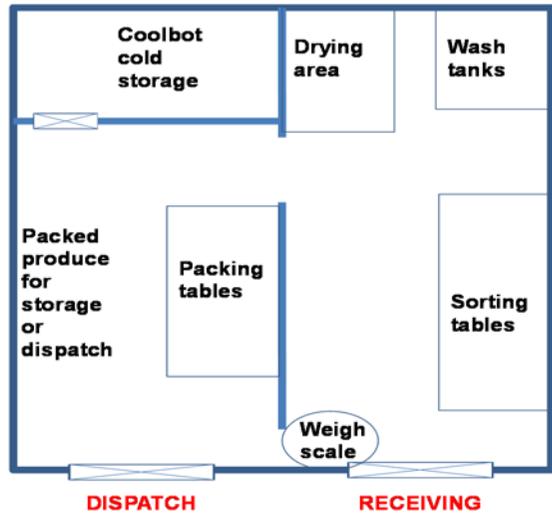


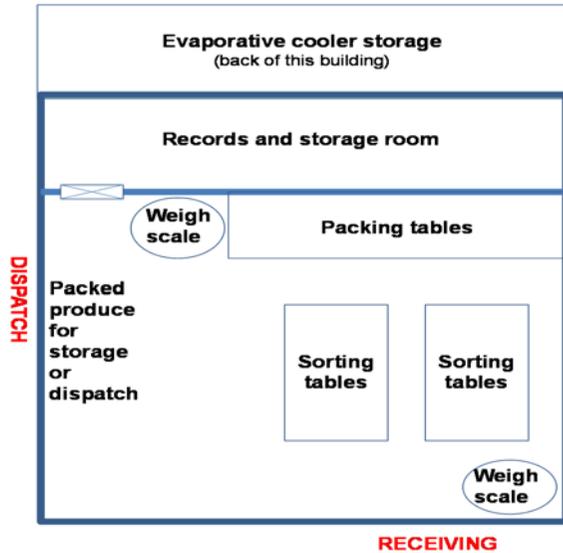
Figure 5 Straight-line (*above*) and U-shaped (*below*) flow of produce and operations in a packhouse



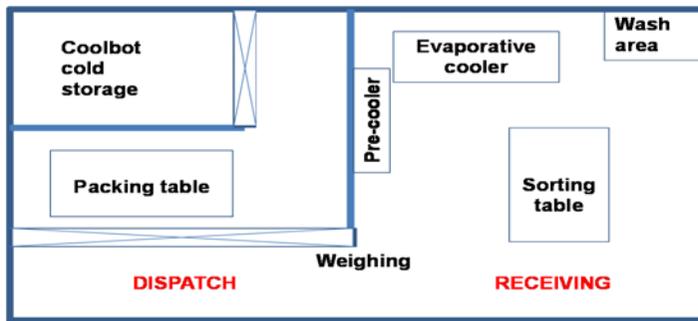
- A U-shaped flow of operations is adapted in the collection center with packhouse facilities in Jessore, Bangladesh (Figure 6). The facility is managed by a Farmers' Marketing Association representing 38 farmers' groups.
- In Nepal, the collection center of a farmers' cooperative is an open roofed structure with an L-shaped layout of packhouse operations (Figure 7).
- In Cambodia, the simple packhouse of a farmers' cooperative has essentially a straight-line layout of operations from receiving and sorting to packing before Coolbot cold storage or dispatch (Figure 8). For produce that needs washing, a wash area is provided after the sorting area. An evaporative cooler also serves as an alternative storage facility while a pre-cooler is used before storage or transport in iced foam boxes using the cooperative's vehicle (Figure 8).
- An open ground floor of a house, which is typical in rural areas in Southeast Asia, can be converted into a packhouse where sorting, cleaning and packing can be done (Figure 9).



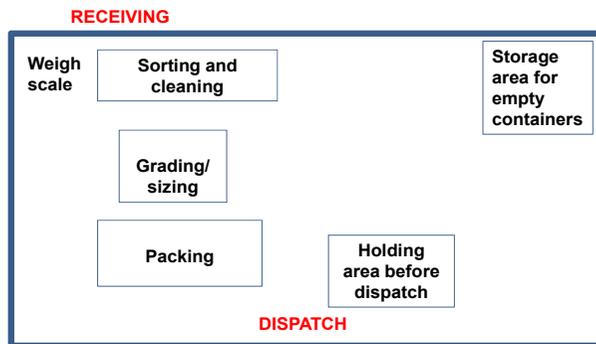
**Figure 6** Collection center of a farmers' marketing association in Jessore, Bangladesh, with U-shaped floor layout of packhouse operations.



**Figure 7** Collection center of a farmers' cooperative in Banke, Nepal, with packhouse floor layout.



**Figure 8** Simple packhouse of a farmers' cooperative in Siem Reap, Cambodia, with floor layout of packhouse operations and the vehicle for direct marketing of produce.



**Figure 9** Open ground floor of a rural house in Southeast Asia converted into a packhouse.

- Establishing a simple packhouse offers many benefits. A facility for sorting and packing could lead to significant gains in income. With proper sorting, more value is added to the produce; with proper sorting and packing, at least 25% less losses are incurred during handling because off-type and diseased produce is discarded and physical injuries are minimized.

## 4 PACKHOUSE OPERATIONS

- Packhouse operations add value to the produce.
- The activities depend on the type of produce and market. Fruit-vegetables may require certain operations not applied to leafy vegetables. Nearby markets may need only sorting and packing, while for distant markets, additional operations are needed. When immediate transport is available, storage may not be necessary.
  - *Tomato, eggplant, chili, cucumber, bitter melon and yard-long bean:* receiving ► sorting ► cleaning/sanitizing ► air-drying ► grading ► packing ► storage ► dispatch
  - *Cauliflower:* receiving ► sorting ► trimming ► packing ► storage ► dispatch
  - *Leaf mustard:* receiving ► sorting/grading ► trimming/cleaning ► air-drying ► packing ► storage ► dispatch
  - *Cabbages and Chinese kale:* receiving ► sorting ► trimming ► bacterial soft rot control ► air-drying ► sizing ► packing ► storage ► dispatch

## Receiving

- The farm source and weight of produce are recorded upon arrival for accounting purposes. Recordkeeping introduces the group to ways of doing business when it expands to quality markets that may require a traceability system (Figure 10).
- Samples of produce can be collected and analyzed for pesticide residues using test kits if available. This can be used for product labeling for market credence.
- While waiting for the different operations, the produce should be protected from the heat of the sun and from sources of physical damage (e.g. heavy weights) and contamination (e.g. ground soil, stray animals).
- The produce can be inspected for the extent of damage (insect, disease, and physical injury) and foreign matter to facilitate sorting and cleaning.



**Figure 10** Packhouse activities for cabbages for supermarkets: receiving and recording, wrapper leaf removal, butt trimming and lime application for soft rot control, plastic film packing, crating and storage.

## Sorting and Grading

- Sorting and grading can add 40–60% more value to the produce.
- Sorting and grading can reduce postharvest losses by:

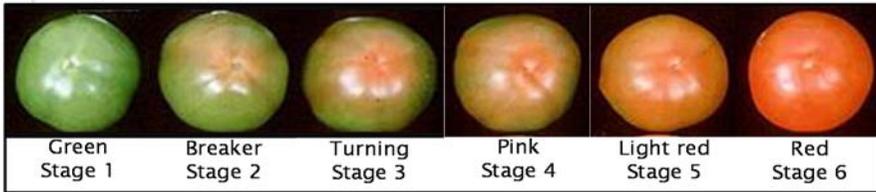
- Preventing disease contamination of sound produce which otherwise occurs when sound and diseased produce are mixed.
  - Minimizing ethylene damage (e.g. premature senescence or ripening) which otherwise occurs when injured produce or ripe fruit (high ethylene producers) is mixed with undamaged produce or unripe fruit.
- Sorting and grading facilitates production, packhouse operations and marketing when the quality grades used are recognized in a value chain or entire industry.
  - Quality grades (or grade standards) serve as a universal language of trade and driver of technology adoption. Markets can place orders based on quality grades, which will then be used to guide operations in the packhouse and farms.
  - Sorting is done to remove damaged or diseased produce or those not meeting quality requirements. It is usually the first packhouse operation.
  - Grading is done when the sorted defect-free produce is classified into grades or classes of specific weights or sizes (sizing) and maturity stage. It can be done after sorting or just before packing.
  - Sorters/graders must be skillful and provided with adequate lighting and work breaks. Sorting aids should be used such as sorting tables (Figure 11) and color pictures of quality grading and defects (e.g. Figure 12).



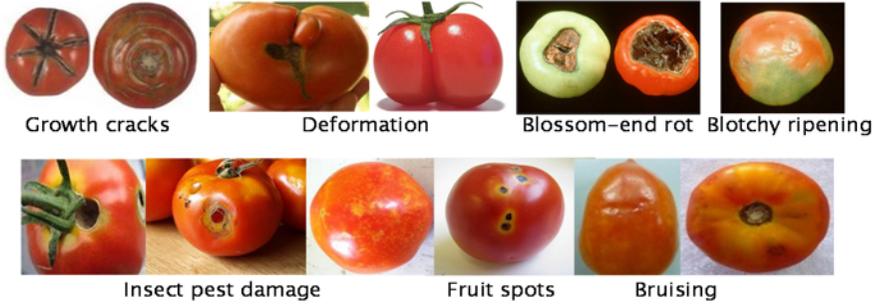
**Figure 11** Some simple sorting tables for vegetables used in a packhouse or farmhouse.

## Tomato quality grading

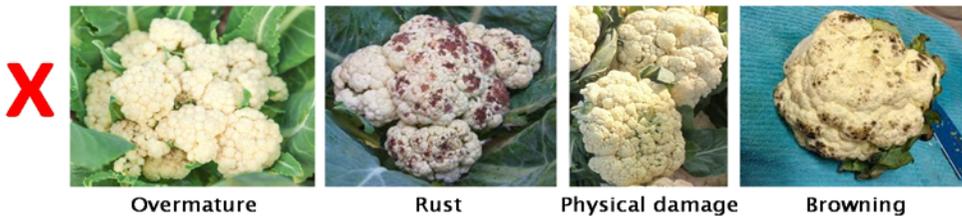
### ✓ Fruit ripening stages



### ✗ Fruit defects



## Cauliflower quality grading



## Brinjal (eggplant) quality grading

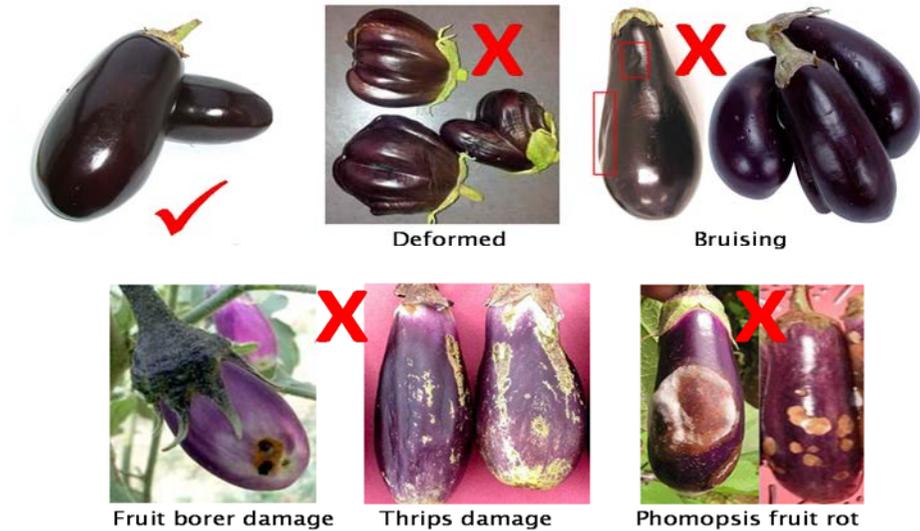


Figure 12 Photos of quality defects of vegetables to guide sorting.

## Cleaning

- Clean vegetables have higher market appeal and prices than dirty vegetables.
- Cleaning reduces microbial contamination, physical damage and transport cost.
- Produce can be cleaned by:
  - trimming fruit stems of tomato or eggplant, roots of leaf mustard, leaves and butt end of cauliflower (Figure 12), cabbage or Chinese kale. In cabbage, retain 3–4 wrapper leaves for protection.
  - wiping tomato, eggplant or cucumber with a clean soft cloth.

- washing using clean water to remove adhering soil and other debris. After washing, the produce should be air-dried before packing.
- While cleaning, sorting can also be done. Avoid contact of produce with the soil, which is a rich source of spoilage and human pathogens (Figure 13).



**Figure 13** Use of ground cover or raised floor to avoid contact of produce with the soil.

## Treatments before Packing

- Sanitizers:
  - Washing in 100–200 ppm chlorine (mixing 4–8 tablespoons of commercial bleach, which has 5.25% sodium hypochlorite or NaOCl, per gallon of water) for 1–3 minutes can reduce microbial load and decay in tomatoes (Figure 14). The produce should be air-dried before packing.
  - Calcinated calcium from scallop powder applied as 0.01% solution (0.1 gram scallop powder per liter of water) as a

3–5 minute dip enhanced food safety (Table 1). It was developed as a non-chlorine sanitizer because of health concerns about chlorine, which reacts with organic matter in the produce to form trihalomethanes, a highly carcinogenic compound.



**Figure 14** Reduction of Phomopsis rot in eggplant by chlorine wash.

Table 1 Aerobic plate count (APC)\* in log CFU/g on tomato and eggplant.

Sanitizer	Tomato			Eggplant
	Bangladesh	Cambodia	Nepal	Bangladesh
Calcinated calcium, 0.01%	3.2	6.1	3.7	3.7
Chlorine, 150 ppm	3.2	6.3	3.3	3.2
Water (control)	5.4	6.7	8.3	5.2

*APC of 5 log CFU/g is generally considered as the microbiological food safety limit.*

- Soft rot control – Bacterial soft rot is the most serious problem in cabbages in the humid tropics (Figure 15). Applying 10% alum (10 g alum/100 ml water), lime paste (mix lime powder and water at 1:1) or guava leaf extract (mix pure extract and water at 1:1) on the butt end of cabbage reduced trimming loss due to soft rot to 0–20% from 20–44% without treatment, resulting in net return of 0.09–0.16 USD/kg produce based on studies in Cambodia, Laos and Vietnam.



**Figure 15** Controlling cabbage soft rot with alum, lime or guava leaf extract.

- Chitosan – Extracted from local shrimp waste in Cambodia, chitosan at 1% (10 g/liter water) as 5-minute dip delayed ripening and increased shelf life of tomato by 6 days, and reduced weight loss by 50% than that of untreated fruit, giving a net return of 0.20 USD/kg produce.

## Packaging

- Packaging is the main packhouse operation. It must provide protection of produce from damage but existing practices remain wanting; in Figure 16, for example, most produce was

damaged or bruised on arrival at market destinations. Poor packaging is a major cause of postharvest losses.



*(above) 400-kg extended jute-basket for eggplant in Bangladesh, requiring many people to carry (below)*



*(above) >100-kg sacks for eggplant in Bangladesh and cauliflower in Nepal; (below) 200-kg basket in Cambodia*



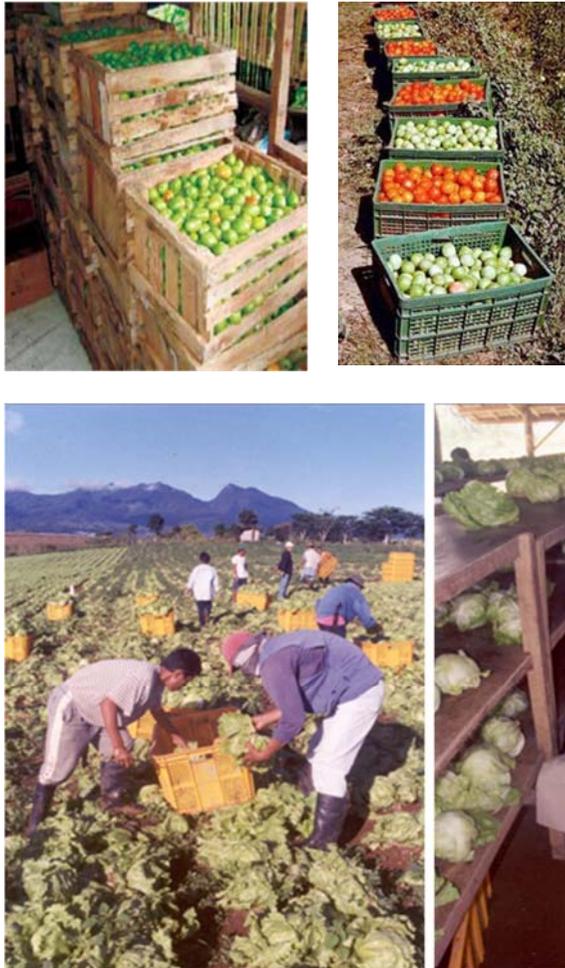
**Figure 16** Some existing packaging practices in Bangladesh, Cambodia and Nepal

- Several packaging materials are available (Figure 17). Package selection depends on the type of produce, distance and mode of transport, and market.



**Figure 17** Containers that can be used for vegetables: bamboo and plastic baskets; plastic crates; wooden crates with inner cardboard sides and collapsible type; carton and foam boxes.

- Rigid containers, such as wooden or plastic crates (Figure 18), are more advisable but for wooden crates and other containers with rough surfaces, liners such as used newsprint, should be used.



**Figure 18** Wooden and plastic crates used as harvesting and transport containers.

- Protective packaging measures (Figure 19):
  - Use clean containers
  - If manual handling, use containers with capacity (e.g. <40 kg) that can be easily handled by an average person.
  - Fill package to capacity. Do not underpack (more vibration damage) or overpack (more compression damage).
  - Pack fruit of only one maturity per container.

- Immobilize produce in the container. Gently shake the container now and then to permit filling up of spaces.
- Secure the package by proper binding or strapping.
- Pack and stack in a cool place.
- Observe care during packing and handling of packages of produce.



Container liners-fresh banana leaves, newsprint



Individual wraps-newsprint, paper, stretchable foam cup

**Figure 19** Protective packaging: use of liners and cushion (newsprint), individual wraps, vents in carton box to minimize heat buildup, and proper strapping.

## Modified Atmosphere Packaging (MAP)

- MAP is the sealing of produce in plastic bags to establish an atmosphere of lower oxygen and higher carbon dioxide levels than that at ambient (21% O<sub>2</sub> and 0.03% CO<sub>2</sub>). It creates a humid condition that slows metabolic processes and water loss (Figure 20).



Figure 20 MAP practices for vegetables.

- Commercial plastic bags are used: 25 micron-thick (with market label as 001 film) low-density polyethylene (LDPE), high-density PE (HDPE) or polypropylene (PP) films. Thicker films (002–004) are not advisable due to rotting. Place produce inside the bag, seal, and keep for 3–10 days (usual duration of transport or storage/ temporary holding period), then in the open.
- MAP can be used in box packaging and storage; benefits are high (Table 2).

Table 2 Technical and economic benefits of MAP for vegetables.

Vegetable	Weight loss, %	Shelf life, days	Net return, USD/kg (partial budget)
Tomato	1–8 (6–20)	15–19 (9)	0.13–0.36
Chili	0–1 (9–12)	6–9 (3–6)	0.40–0.65
Eggplant	0–4 (6–22)	4–14 (2–5)	0.20–0.80
Leaf mustard	1–5 (11–28)	3–4 (1)	0.10–0.35
Cauliflower	25 (31)	9 (7)	0.10
Bitter gourd	1 (6)	4 (2)	0.30
Cabbage	1–5 (19–22)	12–24 (8–14)	0.21–0.48
Chinese kale	1 (37)	3 (1)	0.32
Cucumber	0 (10)	4 (2)	0.25
Kangkong	2 (22)	3 (1)	0.09
Long bean	0 (12)	3 (1)	0.15
Mustard, aromatic	4 (14)	3 (1)	0.58

*Values in parentheses are responses of produce with no MAP (control); storage was at ambient, crop varieties were the commercial ones, and samples were at commercial harvest maturity. Results were from AVRDC projects in Cambodia, Nepal, Laos and Vietnam; MAP was ineffective in Bangladesh for tomato and eggplant except during Coolbot storage (13°C).*

## Cooling and Storage

- Cooling is the foundation of produce quality protection. It slows metabolic processes and microbial growth.
- Every degree of reduction from ambient temperature increases storage life. Every form of cooling is beneficial even if not optimum (e.g. avoiding exposure to the sun, harvesting at cooler times of the day or evaporative cooling storage).
- Desired temperature and relative humidity (RH) for vegetable storage (Table 3) are usually achieved by a mechanical refrigeration system, which is expensive. Low-cost alternatives are described here.

Table 3 Recommended temperature and RH for vegetable storage and handling.

Commodity	Temperature (°C)	RH (%)	Storage life
Amaranth	0-2	95-100	10-14 d
Asparagus	0-2	95-98	2-3 wk
Bean, snap	4-7	95-98	7-10 d
Bean, lima (in pod)	5-6	95	5 d
Beet, topped	0	98-100	4-6 mo
Bittermelon	12-13	85-90	2 wk
Broccoli	0	95-98	10-14 d
Cabbage	0	98-100	3-6 wk
Carrot	0	95-100	4 wk
Cauliflower	0	95-98	2-4 wk
Celery	0	95-98	2-4 wk
Chayote	7	85-90	1-2 wk
Chinese cabbage	0	95-100	2-3 mo
Corn, sweet	0	95-98	4-8 d
Cucumber	10-13	90-95	10-14 d
Eggplant	12-15	90-95	7 d
Garlic	0	60-70	6-7 mo
Ginger	13	65-75	4-6 mo
Jicama	13-18	65-70	1-2 mo
Leek	0	95-100	3 mo
Lettuce	0-1	95-100	2-3 wk
Melon, honeydew	7-10	90-95	2-3 wk
Okra	7-10	90-95	2-3 wk
Onion, green	0	95-100	4 wk
Onion, bulb	0	65-70	6-8 mo
Parsley	0	95	2-3 wk
Peas	0-1	95	1-2 wk
Pepper, sweet	7-10	90-95	2 wk
Potato	4	95	3-5 mo
Radish	0	95	3-4 wk
Squash	5-10	95	1-2 wk
Taro	7-10	85-90	3-5 mo
Tomato	10-13	85-90	7-10 d
Watermelon	10-15	90	2-3 wk
Winged bean	10	90	2-3 wk
Yam	16	70-80	3-6 mo

Source: FAO 2012

- General guidelines in vegetable storage:
  - Only good quality produce should be stored; sort and clean the produce.
  - Use packaging containers that can be easily moved in and moved out of the storage chamber and that can be stacked without causing damage.
  - In prolonged storage, the produce should be checked periodically to cull out diseased or deteriorated produce and prevent disease spread.
  - Before placing the produce in the storage chamber, the desired temperature and RH should have been established. If cold storage is used, it is advisable to precool the produce.

### Low-cost cold storage

- The Coolbot was developed in the USA. This device overrides the air conditioner's temperature gauge to lower the temperature from 16°C (lowest in an air-conditioned room) to 4°C, thereby converting an insulated room and air conditioner into a cool room, substantially reducing the cost of a cool storage environment (Figure 21).
- Temperatures are maintained at 11–13°C for tropical vegetables and 5–7°C for subtropical produce; shelf life markedly increased (Table 4). Do not mix these two types of vegetables: if tropical produce is stored at 5–7°C, it will develop chilling injuries; if subtropical produce is stored at 11–13°C, the shelf-life will be shortened.



**Figure 21** Coolbot cold storage with the Coolbot device connected to the air conditioner.

Table 4 Shelf life and weight loss of vegetables stored in the Coolbot or at ambient (control).

Vegetable	Weight loss, %		Shelf life, days	
	Coolbot	Ambient	Coolbot	Ambient
Tomato	5	10–12	18–24	9–12
Eggplant	2	7	14	4
Leaf mustard	5	13	6	0.5

*Results were from AVRDC projects in Bangladesh and Cambodia; Coolbot temperature was maintained at 12–13°C while ambient temperature varied from 22–35°C. Crop varieties were the commercial ones and samples were at commercial harvest maturity.*

- The Coolbot chamber maintains lower RH than the recommended level often below 50%, rapidly desiccating vegetables. Providing wet cloth or pan of water, misting with water or keeping produce in MAP can maintain high RH.

## Low-cost hydrocooling

- This precooling method rapidly removes product heat before cold storage to slow metabolic processes and reduce heat load in the cool chamber. There are two simple designs: knockdown hydrocooler and overhead hydrocooler (Figure 22).



**Figure 22** Simple knockdown hydrocooler (leftmost) and overhead hydrocooler applying cold water with water pump on the produce (middle and rightmost).

- The knockdown hydrocooler uses iced water (5°C) for 10–15 minutes dipping while the overhead hydrocooler applies 5°C water with a water pump for 15–30 minutes to bring down the product temperature to 10°C. The produce is then drained of excess water before placing in the storage chamber.

## Ice cooling

- Crushed ice is commonly used in packages to cool the produce during transport to markets (Figure 23). Direct contact of ice can injure the produce.
- The ice bottle technique is an innovative way to avoid direct contact of ice with the produce. The ice bottles (2 pieces per 25 kg pack of vegetables) are wrapped with newsprint and placed in the package. Temperatures are reduced to 20–25°C from 35–40°C in packs of produce sealed in the afternoon and transported the following morning.



*Ice packing*



Ice bottle making

Ice bottles



ice bottles in use

*Ice bottle cooling*

**Figure 23** Ice cooling methods in packages of produce for transport to markets.

## Evaporative cooling

- Low-cost cooling by evaporation of water provided in the vicinity of produce. The decrease in temperature is small, 1–6°C lower than ambient, but RH increases to more than 90%. It is effective in reducing weight loss.
- Simple evaporative cooler (EC) structures (also called zero-energy cool chamber as it does not use electricity) are shown in Figure 24.



*Brick-walled EC 4.5x2.5x0.6 m in length, width & height, 15–20 cm double wall with moist sand insulation*

*Box-type EC 1.3x0.9x2.0 m in L, W, H, with moist jute sack*



**Figure 24** Brick-walled and box-type evaporative coolers (EC).

- The EC markedly reduced weight loss and improved shelf life of vegetables, resulting in high net returns (Table 5).

Table 5 Technical and economic benefits of storage of vegetables in evaporative coolers.

Vegetable	Weight loss, %	Shelf life, days	Net return, USD/kg (partial budget)
Tomato	1–7 (5–23)	12–15 (7–9)	0.24–0.34
Chili	4–6 (12)	6–8 (3–4)	0.28–0.33
Eggplant	1 (6)	4 (2)	0.20
Leaf mustard	3–15 (15–28)	3 (1)	0.14–0.26
Cauliflower	18 (44)	9 (7)	0.50
Bitter gourd	2 (6)	5 (2)	0.25
Cabbage	6–11 (19–22)	14–22 (8–16)	0.19–0.24
Chinese kale	4 (23)	4 (2)	0.22
Cucumber	3 (10)	4 (2)	0.18
Long bean	4 (12)	3 (1)	0.30
Mustard, aromatic	7 (14)	3 (1)	0.52

*Values in parentheses are responses of produce stored at ambient. Commercial crop varieties were used and samples were at commercial harvest maturity. Results were from AVRDC projects in Bangladesh, Cambodia, Nepal and Laos.*

## Dispatch to Market

- During loading to the transport vehicle at the dispatch area of the packhouse, care should be observed in handling the packages of produce to avoid physical damage and package failure. Protection from sun or rain should be provided.

- To facilitate loading, some equipment can be used (Figure 25). Proper records of dispatched produce should be kept for financial accounting.



*Weighing scale*



*Hand jack*



*Conveyors used in handling packages of produce*



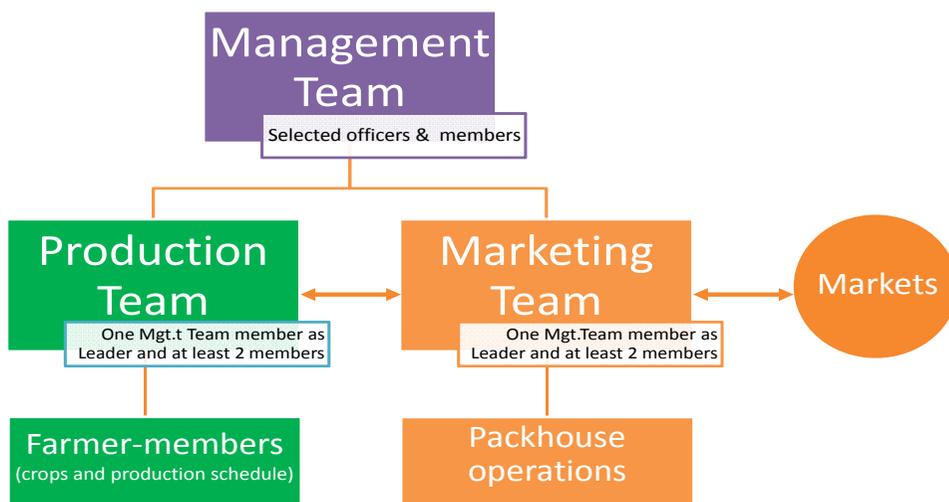
**Figure 25** Some packhouse equipment including that used during loading to transport vehicle.

## 5 MANAGING A PACKHOUSE

- Managing a smallholder farmers' cooperative or farmers' group packhouse is challenging as the cooperative/group has limited capability and resources and its members have varying interests and priorities.
- Managing the packhouse is a business venture and much more complex and risky compared to operating a collection center, where farmers bring their produce for traders to collect. Many collection centers established for smallholders in developing countries have not been successful.

### Management Requisites

- Strong and resourceful leadership and management are critical.
- The cooperative/group leaders and members should embody and live the vision and have a strong commitment to shift from traditional farming to a farming business by following the farm–packhouse–market system.
- The packhouse is the heart of the farm–packhouse–market system. Good packhouse management will ensure sound technical operations inside the facility. Links will be made with markets to establish profitable and enduring supply arrangements and with farmer–members to produce the quality and volume of products for consolidation and preparation at the packhouse before dispatch to markets.
- Three management teams are therefore recommended: overall management, marketing, and production teams (Figure 26). More teams can be formed when the business expands.



**Figure 26** Management structure of the farm–packhouse–market system.

- The duties and responsibilities of the management teams should be fully understood and adhered to. Similarly, the policies, rules and regulations, including those for the operations of the packhouse, should be understood and followed by all members. Flexibility and openness should be exercised to accommodate and apply innovative ideas.
- Capacity–building activities, such as training for technical skills, entrepreneurship, record keeping and financial accounting, financing, marketing and market development, should be pursued to strengthen the operation and management efficiency of the packhouse.
- Meetings should be conducted regularly to evaluate progress, act on potential, discuss and solve existing and persistent problems, and prepare for future initiatives.

## Operational Management

- Managers and workers should be knowledgeable about the principles and practices of packhouse operations.

- Monitor process flow and operations and apply process control requirements.
- Maintain good hygiene in the packhouse:
  - The packhouse line should be left free of produce every day.
  - Routinely clean and sanitize pack line and all surfaces in contact with produce using approved sanitizers.
  - Remove any debris using a top-to-bottom approach (clean first the top parts before the bottom) to avoid re-soiling cleaned surfaces.
  - Seal and store chemicals in a locked area with a hazard sign.
  - Close doors in handling areas to limit contamination by animals/birds.
  - Properly dispose waste product and spent chemicals.
  - Provide hygiene facilities, such as hand washing stations, toilets, and a potable water supply
  - Workers should practice general and personal cleanliness
- Introduce Good Manufacturing Practices (GMP) for future application:
  - GMP is a set of manufacturing procedures to ensure produce is able to consistently meet specifications and customer expectations (de Silva 2007).
  - GMP reduces the risk of contamination of fresh produce during handling, packing, storage and transportation.
  - Adoption of GMP increases market competitiveness and access to lucrative high-end markets, exports and global food chains.

- GMP comprises of three programs: (1) manufacturing operations, (2) food control operations and (3) management.
  - Manufacturing operations include all aspects of produce handling to achieve high-quality and safe produce.
  - Food control operations cover the infrastructure and personnel needed to evaluate samples, monitor conditions during handling, and transmit feedback to the proper personnel to adjust for problems discovered.
  - Management involves managers responsible for achieving GMP objectives with personnel and input suppliers.
- Maintain proper records of operations and transactions.

# 6 PRACTICAL EXERCISES

## Familiarization of the Packhouse

- Purpose:
  - To observe and understand the different elements of the packhouse.
  - To formulate individual/group ideas and contributions for the successful operation of the packhouse.
  
- Activities:
  - The different components of the packhouse will be shown and described by the trainer and the activities in each component will be demonstrated.
  - Groups will be formed and each group will deliberate and formulate:
    1. The packhouse operations and specific activities for the assigned commodity. Draw a product flow in the packhouse and describe the activities under each stage in the product flow.
    2. Your opinions on how the packhouse can benefit farmers.
    3. What can you contribute to the successful operation of the packhouse and the farm–packhouse–market model?
  - Present your propositions 1–3 to the whole group for discussion.

## Sorting/Grading and Cleaning

- Purpose:
  - To acquire skills in quality grading and in developing quality grades.
  - To acquire skills in washing and sanitizing produce in the packhouse.
  
- Activities:
  - Each group will be given a lot of vegetables.
  - Perform sorting, and weigh the selected and discarded produce.
  - For the selected produce, observe overall quality and formulate your own quality grades with specifications of quality per grade (e.g. Grade 1 –best quality; Grade 2...)
  - Classify the produce based on the proposed grades and take the weight for each grade.
  - For another set of vegetables of 3 groups (1 –sorted produce of the same ripeness; 2 –sorted produce of different ripeness; and 3 –unsorted produce), you will be asked whether you are willing to pay a higher price for the sorted produce and by how much higher compared to that of unsorted produce. The results will be averaged and discussed.

## Packaging Techniques

- Purpose:
  - To acquire skills in protective packaging using liners.
  - To acquire skills in the MAP of vegetables.
  
- Activities:
  - The use of liners (newspaper, banana leaves) in bamboo baskets, wooden boxes or plastic crates will be demonstrated. The benefits of using liners will be discussed.
  - Using samples of priority vegetables, each group will be given different kinds of MAP bags, and will then pack the samples in the bag.
  - In separate samples of MAP and open produce set up 2 days before the training, the group will take the weight and color of the samples (and other distinct quality differences) and calculate percentages and averages. The results will then be discussed with the whole group.

## Cooling and Storage

- Purpose:
  - To acquire skills in cooling produce by simple methods.
  - To acquire skills in storage techniques for vegetables.
- Activities:
  - Cooling with iced water will be demonstrated.
  - Observations on the storage of vegetables in evaporative cooler or Coolbot cold chamber set up 2 days before the training will be taken. Weight loss, color changes and decay data will be measured. The results will be discussed with the whole group.

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