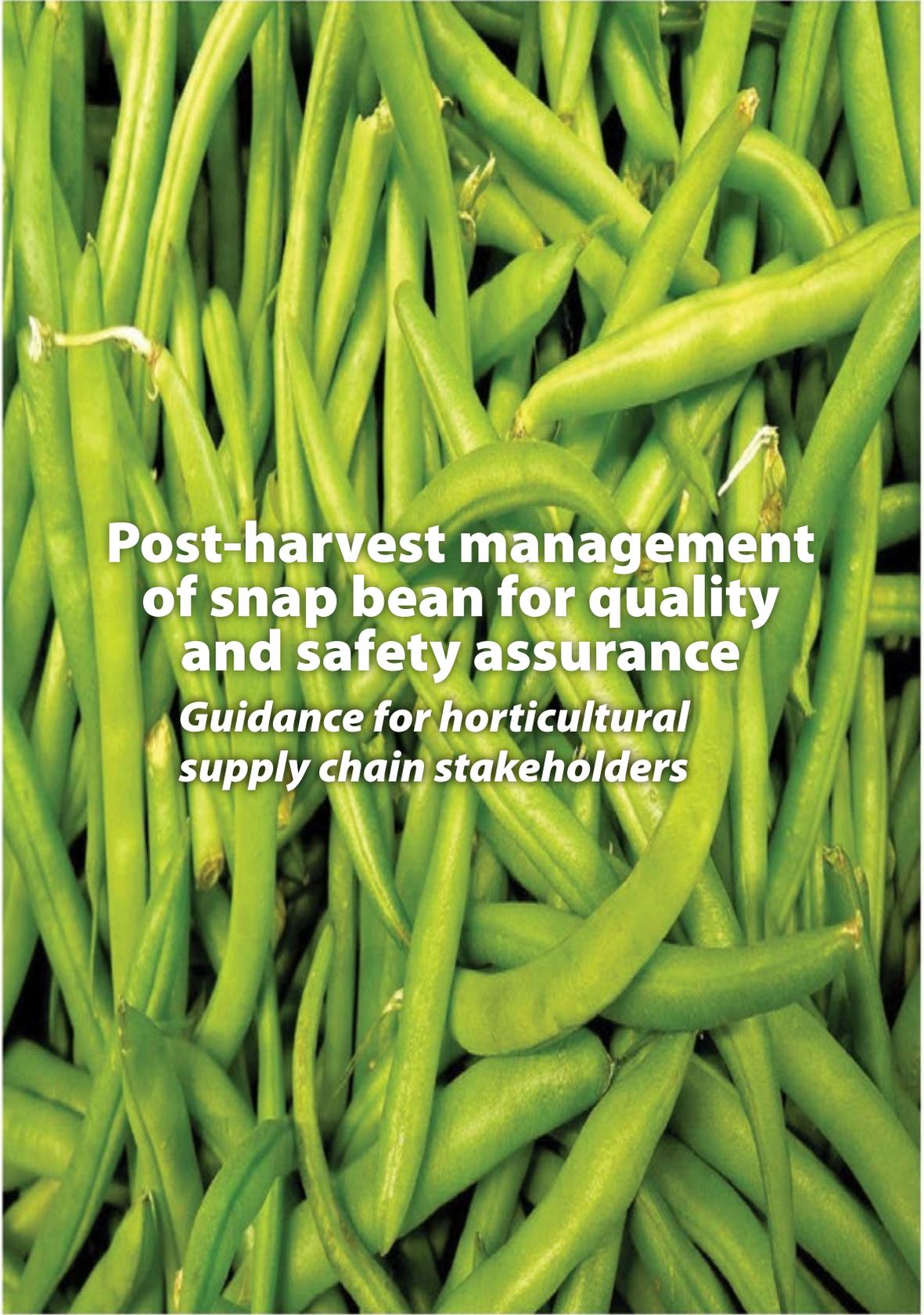




Food and Agriculture
Organization of the
United Nations

A close-up photograph of a large quantity of fresh, vibrant green snap beans, filling the central portion of the page. The beans are piled together, showing their characteristic curved shape and bright green color.

**Post-harvest management
of snap bean for quality
and safety assurance**

*Guidance for horticultural
supply chain stakeholders*

**Post-harvest management
of snap bean for quality
and safety assurance**
***Guidance for horticultural
supply chain stakeholders***

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INTRODUCTION

Snap bean (*Phaseolus vulgaris L.*) ranks 6th as the most demanded vegetable in Sri Lanka. It is produced mostly on small farms. The peak harvest seasons for snap beans are March – April and September – December.

As a vegetable, snap bean is high in protein and soluble fiber and low in calories. Snap beans are an excellent source of vitamin K and are a very good source of manganese, vitamin C, dietary fiber, folate, and vitamin B2, copper, vitamin B1, chromium, magnesium, calcium, potassium, phosphorus, choline, vitamin A (in the form of carotenoids), niacin, protein, omega-3 fatty acids, iron, vitamin B6, vitamin E, and contains valuable quantities in absorbable form, of the mineral silicon.



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A good quality snap bean pod is fleshy, young and tender, snaps easily, and is free of physical injury and damage caused by diseases and pests.

IMPORTANCE OF POST-HARVEST HANDLING

Post-harvest handling includes all the primary processes/steps that a harvested crop has to go through to get from the producer to the end consumer. Such processes which include raw material handling, storage, transport, distribution, and marketing, add value to the harvested produce. Post-harvest handling is an element of post-harvest science and technology, the goals of which are to maintain the fresh quality, as well as, assure the safety of crop commodities used as food and to meet buyers' specifications and trade requirements, while in the process, reducing losses.

Post-harvest handling is the weakest link in the supply chain from the producer to the market. Much is lost, both in terms of quantity and quality (including nutritional quality) during post-harvest handling, with fruits and vegetables incurring high losses due to their perishable nature. Post-harvest losses in the snap bean industry in Sri Lanka were reported at over 40 percent, with the marketing sub-sector incurring higher wastage and transaction costs (Haridas, 2015).

Losses in snap bean are the result of the following: poor knowledge about the right harvesting index, thus, a large proportion of the harvested beans are usually over-mature; poor handling practices – such as the use of plastic sacks for bulk packaging and transportation which results in mechanical damage that serves as entry points for disease-causing organisms leading to rotting of the pods; poor transport practices such as the use of trucks that have no cover thus exposing the produce to direct sunlight and high temperature; absence of low temperature storage facilities and transport systems; and, rough handling practices during distribution in retail

markets (IPHT Report, 2015). Maintaining snap bean quality and reducing quantitative losses is best done through the application of good post-harvest management practices, supported by good post-harvest technologies and through improvement of the post-harvest system.

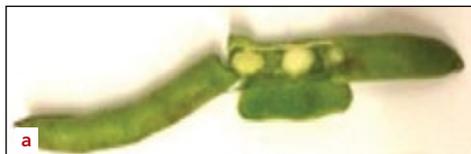
Characteristics of the snap bean

The snap bean, is an immature legume fruit or pod with underdeveloped seeds. Thus it is tender and crisp and snaps easily when hand-broken. If the pod is allowed to mature on the vine, the seeds will develop fully causing the pod to bulge. The mature pod becomes stringy and fibrous indicating poor eating quality, hence, low marketability (Photo a and b).

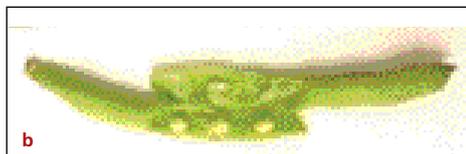
As an immature pod, the skin of the snap bean is thin and is very sensitive to even a slight applied physical force resulting in mechanical damage such as bruising and cuts. The damaged portion serves as an entry point for microorganisms that cause rots (Photo c, d and e).

The snap bean contains almost 85 percent water and because of its thin skin, it has the tendency to lose moisture (moisture loss) very quickly. The rate of water loss is highest when the temperature of the outside environment is high, and when the amount of moisture in the air (relative humidity) is low – for example on a hot, dry day- , resulting in loss of crispiness/freshness, softening and consequently yellowing and toughening of the beans.

Due to their high respiration rates and sensitivity to ethylene, snap beans have a short shelf-life and deteriorate rapidly after harvest (Photo f).



Mature pod with well-developed seeds



Immature pod with underdeveloped seeds



Bruising



Compression/abrasion damage



Fungal infection

Snap bean pods showing symptoms of water loss (loss of green color/yellowing)

HARVEST MANAGEMENT PRACTICES

Harvesting is the process of cutting/removing the pod from the mother plant. There are three important considerations to bear in mind during harvesting:

Harvesting index

Signs or indications that the snap bean pod has the desirable characteristics intended for its use

The snap bean pod must be harvested when it reaches the desired marketable size and before it becomes too large. In order to ensure that the bean meets consumer demand for quality at harvest, the pod should be green, fleshy, tender, and should easily break or snap when broken apart by the hand. The pod is considered over-mature and of poor quality when the seeds within the pod are fully enlarged and the pod bulges.

Time of harvest

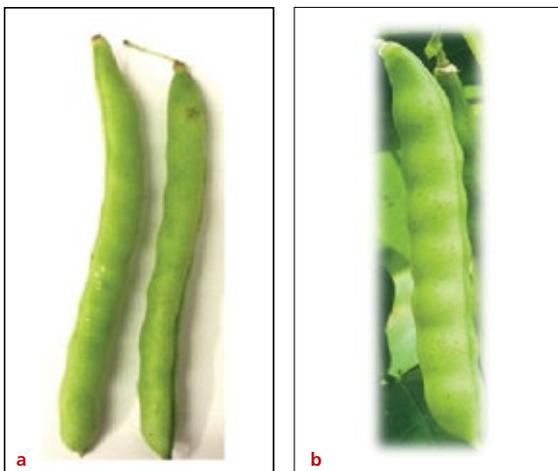
Time of day appropriate to harvest the pod

Many crops are harvested very early in the morning to take advantage of the cool temperature. For snap beans, the appropriate time to harvest is when the morning dew is off and the plants is thoroughly dry.

Harvesting procedure

Method of harvesting, use of harvesting tool and harvest container – the manner of detachment of the pods and collection of harvested pods

The pods are best harvested manually using a cutting tool (such a pair of scissors or shears). The pod must be held by hand and cut off from the plant. Harvested pods must be directly placed in a field collection container for transporting to a collection point. Plastic crates are one example of a good field collection container.



Snap bean harvested at the right stage of maturity (a) harvested over-mature (b).

POST-HARVEST HANDLING OPERATIONS

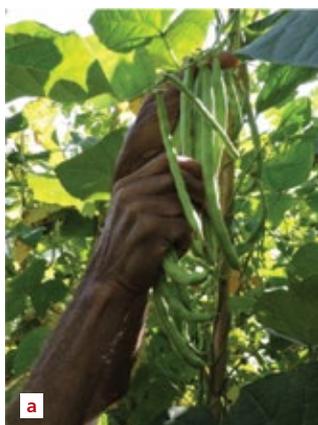
Post-harvest handling operations prepare harvested produce for marketing. Post-harvest handling operations can be done in the field, in collection centres or in a pack-house. It must be well-protected from the sun and rain and kept clean at all times. Animals and pets must be kept away from the harvested beans as they could contaminate the pods with their urine and fecal matter. Similarly, workers who handle the beans must observe good hygiene.

Field sorting

Culling out produce that is unmarketable in the field to lower the cost of hauling and to minimize disease contamination

It is recommended that where possible, snap beans are sorted at the farm in order to remove low quality (diseased) or damaged (insect or rat-damaged beans). Sorting in the field would also reduce the cost of hauling the beans to the collection centre.

Sorting must be done in a shaded area away from the sun. A temporary shed/shelter or the shade of a tree near the harvest area can serve the purpose of providing shade.



Snap bean pods are harvested manually (a) using a pair of shears (b) to cut the pods from the mother plant.



A plastic crate is the best harvest container for collection of the pods.

Plastic crates as harvest containers are stackable and can be easily hauled to the packing house with minimal damage to the pods.

Sorting/grading

At the packing area, snap beans may be sorted to remove beans with harvest-related defects such as cuts, severe abrasions, etc. before grading. In Sri Lanka, grading of snap beans is done on the basis of pod size (12 –15 cm in length) or maturity.

Sorting and grading can be done at a collection centre or in a packing area equipped with sorting tables and weighing scales. The area in which these operations are done must be clean and well lit. Workers must observe good hygiene and must be able to sit comfortably in order to engage in sorting operations.



Examples of pre-harvest defects to be removed during field sorting: Beans that are diseased with anthracnose (a), insect damaged (b), diseased with rust (c)



A temporary shelter is necessary during field sorting to prevent direct exposure to sunlight.

PACKAGING

Bulk packaging of snap beans for transportation to markets is considered the weakest link in the supply chain. Poor bulk packaging of snap beans results in quality defects due to bruising, wounding (cut, puncture, crack, split, breakage), change of shape, compression damage and abrasion. This damage is greater when the packages are either under-filled, over-filled or if the packaging material has rough surfaces, is not rigid, and when the packages are dropped during handling.



Some harvest-related defects that are sorted out prior to grading: nail cut (a), cut due to excessive hand-pulling (b), abrasion damage (c).



A sorting table used to sort commodities.



Packaging materials

Several types, of packaging materials are commercially available in Sri Lanka for use in handling and transporting fresh produce such as the snap bean. These include wooden crates, stackable plastic crates, polyethylene or polypropylene plastic bags, sacks made from plastic twine, and cardboard box/cartons. With the exception of plastic crates and mesh bags, these packaging materials do not allow for good ventilation, resulting in moisture condensation inside the bag, causing the pods to rot. Nevertheless, these packaging materials are commonly used because of their low cost and ready availability. In most cases, they are not properly used; often, they are overfilled, or are either too large or too small.



Bulk packaging of snap beans in Sri Lanka makes use of 50-kg mesh bags (a), or plastic twine sacks (b).



Mesh sacks (a), polyethylene plastic bags (b) and plastic sacks (c) are POOR packaging materials for snap beans as they do not provide protection against compression damage to the pods. Plastic-based bags do not allow for good ventilation so that condensation occurs inside the bag, causing the pods to rot.

While the cost of plastic crates is high, they can be repeatedly used over 6 to 10 years. Plastic crates are the best bulk packaging containers for snap beans because of their smooth inside finish, good ventilation that prevents the build up of heat produced during respiration of the bean pods; and because of the ease with which they can be cleaned. Due to the uniformity of their shape, plastic crates can be stacked securely inside transport vehicles. For best results, beans must be loosely packed in plastic crates in order to allow air flow through the beans inside the package.

When using plastic crates as bulk packaging containers, the following considerations should be borne in mind:

- ◆ **Hygiene** – Plastic crates must be thoroughly cleaned with soap/detergent, rinsed in a sanitizer and dried prior to use.
- ◆ **Handling** – Crates must be handled with care during loading, stacking and unloading; Crates must not be dropped or used as seat during sorting operations.
- ◆ Crates must not be used as storage containers for chemicals (fertilizers and pesticides) if used for fresh produce.
- ◆ **Storage** – Crates must be stored in a clean area that will prevent their contamination by insects and rodents. Crates must be stored separately from chemicals and from farm machinery to prevent contamination. Crates should not be left exposed to the external environment since they will readily wear out.



Snap beans are BEST packed in clean and undamaged plastic crates for transportation.

STORAGE OF SNAP BEANS

Snap beans are sensitive at temperature range of 5–10°C, hence, they have to be stored at the optimum low temperature condition which is 10–15°C. At this temperature range, the beans will stay fresh and in good condition for about 2–4 weeks.

In the absence of a refrigerated storage system, a simple, low cost evaporative cooler that allows lowering of temperature of the surrounding air by 3–5 degrees, can be used to maintain the freshness of the snap beans for about a week or so. An evaporative cooler works well in hot tropical conditions like that in Sri Lanka. Three models of evaporative coolers are presented below.



Snap beans in plastic crates inside a refrigerated storage system set at 10–15°C.



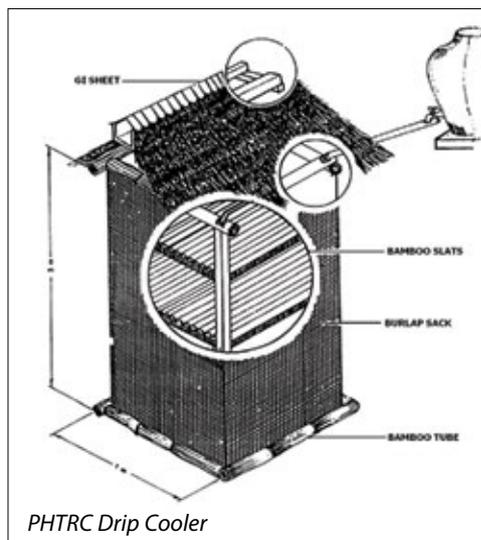
The PHTRC Storage/cooling chamber equipped with an evaporative cooling pad with charcoal as the wetted media. A submersible pump is used to move water from a sump tank to a water distributor at the top of the cooling pad.

TRANSPORT

Transport is key in the distribution of fruits and vegetables. Because of their inherent perishable nature, fruits and vegetables must reach destination markets within a short period of time, necessitating rapid and reliable transport systems.

Field-level transportation of snap beans would include the hauling from the farm to the collection center. This is done using a hauling vehicle if the collection centre is far from the farm, otherwise, manual hauling is practiced. Snap beans must subsequently transported from the collection centre to wholesale and to retail markets normally by a three-wheeled cab.

The level of losses that takes place during transport is influenced by the distance between the farm and the market, the number of loading and unloading points, the quality of the road, temperature of the environment, and availability of handling aids.



In Sri Lanka, the three-wheeled taxicab is commonly used to haul harvested commodities from the farm to the collection centre or from the wholesale market to retail markets. Overloading of the vehicle with bulk-packaged commodities can result in physical damage to the produce.

In order for the snap beans to arrive at their destination in good condition, good transport practices must be observed:

- ◆ During loading and unloading, the containers (plastic crates) must be handled gently; they should not be dropped or thrown on to each other.
- ◆ Passengers must not stand and/or sit on top of packages during transportation.
- ◆ Containers at the bottom of the stack of packages should not be used as steps to allow stacking to a greater height especially if semi-rigid containers like cartons are used.
- ◆ Packages of beans must not be exposed to the sun during transport.
- ◆ Allow air to circulate in the stacks or piles of bean by loosely packing the crates, and providing space between the stacked crates. If canvass is used as a cover, place the crates on top of a pallet in the vehicle in order to allow for air circulation around the produce. Use light colored material as cover as this will reflect heat.
- ◆ Minimize delays or facilitate the transfer of packages from one part of the market to another; four-wheeled hand trolleys will minimize damage during unloading and transfer of produce packed in plastic crates.
- ◆ Ensure that the transport vehicle is clean. A clean transport vehicle must:
 - Not contain decaying remains of produce from the previous shipment.
 - Not be infested with Insects and rodents nesting in the vehicles.
 - Not be used as a storage area for farm implements and chemicals.
 - Not be used to transport organic fertilizers.





Transport vehicle with light-colored cover absorbs less heat.



Plastic crates are the best transport containers for snap beans.



A two-wheeled hand trolley

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HANDLING AT WHOLESALE MARKETS

Snap beans are usually marketed by traders in wholesale and retail markets. Upon arrival at these distribution channels, certain basic rules should be followed to maintain the freshness and quality of the pods:

- ◆ Carefully unload containers from the transport vehicle to the marketing area or under a shaded area.
- ◆ Depending on the target market or buyer, re-sort or re-grade the pods and discard any damaged or rotten pods.
- ◆ Do not place the packages of beans in dirty areas in the wholesale market to minimize microbial contamination.

HANDLING IN RETAIL MARKETS

In the retail market, snap beans are best sold in plastic bags. Packaging in plastic bags prevents moisture loss from the pods as well as damage due to frequent handling by customers when they select the beans. A few pinpricks or small holes on the bags will help prevent the accumulation of moisture in the bags, and will allow the beans to remain fresh for longer periods. Plastic bags must not be over-filled in order to prevent breakage of the pods.



Snap beans in retail plastic packs with small holes – note the absence of moisture condensation in the bags provided with diffusion holes.

Over-packing snap beans in plastic bags results in pod breakage.

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Reduction of post-harvest losses
in horticultural chains in SAARC countries
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