POST-HARVEST HANDLING

adapted from Knott's Handbook for Vegetable Growers

Fresh vegetables are extremely **perishable** and have relatively short shelf lives. They are living, respiring tissues that start senescing immediately at harvest. **Freshly harvested vegetables** are mostly comprised of water with most having 90 to 95% moisture content. Water loss after harvest is one of the most serious postharvest conditions. Consequently, special effort is required to reduce the effects of these naturally occurring processes if quality harvested in the field will be the same at the consumer level.

Variables consumers perceive as a reflection of produce quality are ranked in order of preference as follows: **crispness** and **freshness**, taste, **appearance** and condition, nutritive value, and price. Studies have shown that two factors normally enter into consumers purchase decisions: competition between like items on the **display shelf**, and, the acceptability of the item in reference to his or her standard for that item in reference to the above variables. Consequently, producer who are able to produce and package their produce in such a way to enhance these variables are the most successful in the market place.

Maintaining Quality

Because of the perishable nature of vegetables, harvesting and handling speed is of utmost importance as soon as harvest maturity has occurred. Consequently, a grower must be prepared to operate in advance of the actual harvest operation. **Preharvest preparation** should include lining up sufficient labor, supplies (containers and packaging items), cleaning the **grading/ packing shed**, and determining if all equipment is operable.

Postharvest handling includes all steps involved in moving a **commodity** from the producer to the consumer including **harvesting, handling, cooling, curing, ripening, packing, packaging, storing**, **shipping, wholesaling, retailing**, and any other procedure that the product is subjected to. Because vegetables can change hands so many times in the Postharvest sector, a high level of management is necessary to ensure that quality is maintained.

Maintaining produce quality from the farm to the buyer is a major prerequisite of successful marketing. The initial step required to insure successful marketing is to **harvest the crop** at the optimum stage of maturity. Full red, vine-ripened tomatoes may be ideal to meet the needs of a **roadside stand**, but totally wrong if the fruit is destined for long distance shipment. Factors such as **size, color, content of sugar, starch, acid, juice or oil, firmness, tenderness, heat unit accumulation, days from bloom, and specific gravity** can be used to schedule harvest.

Reducing Damage

With all vegetables, care should be taken to prevent **injury** due to harvesting and handling errors. A crucial time to be aware of this is during the harvesting operation. **Broken skin** and **bruises** reduce **eye appeal** and provide a ready access to decay organisms and enhance physiological breakdown.

Bruise damage will cause respiration rates and ethylene production to increase dramatically. This shortens the shelf life. There are several management practices that can reduce or eliminate **harvest injury**.

- Remove protruding nails or staples and smooth the rough edges on field containers.
- Harvest workers should not have long, sharp fingernails.
- Use care in **dumping** products from one container to another. This is one of the most common trouble spots.

- Use **padding** on all impact areas when possible.
- Clean sand and all debris out of all containers.
- Don't **overfill** containers! Severe damage can result when stacked.
- Consider the time of day of harvest. Many products are more turgid in the early morning and bruise more easily.

Transport from field to **packinghouse** can be a source of injury.
Dumping or unloading at the **packing shed** is also a trouble spot.

Precooling

Rapid cooling as soon as possible after harvest is essential to the maintenance of optimum quality. The first consideration at harvest is removal of the produce from **direct sunlight**, and secondly, to precool as quickly as possible.

Precooling Methods

Room Cooling

Exposure of produce to cold air in an **enclosed space** is the simplest and most common cooling method. Cold air normally is discharged horizontally near the ceiling so as to enable it to return through **produce stacked on the floor**.

Forced-Air Cooling

Forced-air cooling or pressure cooling is accomplished through the use of **fans** and strategically placed barriers so that cold air is forced to pass through the containers of produce. This method usually takes from 1/4th to 1/10th the time required to cool produce by passive room cooling, but takes two or three times longer than hydro or vacuum cooling.

Icing

The use of ice for cooling, either by package icing or by bulk application to the top of a load, is one of the oldest cooling methods. The use of slurries and mechanization of the process have made this a popular method for some commodities like broccoli. Cartons must be able to **withstand** free water. Once iced, they should be placed in a refrigerated storage unit or transit vehicle.

Hydrocooling

Hydrocooling is one of the most efficient of all methods for precooking. Produce is drenched with cold water, either on a **moving conveyor** or in a stationary setting. In some cases, commodities may be forced through a tank of cold water. Hydrocooling is an excellent method for **bulky items** such as sweet corn, peaches, or cantaloupes. Good water **sanitation practices** must be observed and once cooled, the produce should be kept cold.

Vacuum Cooling

Commodities may be enclosed in a sealed container from which air and water vapor are rapidly pumped out. As the air pressure is reduced, the boiling point of water is lowered, so the product is cooled by surface water evaporation. Vacuum cooling works best with products that have a high surface to volume ratio, such as **lettuce** or **leafy greens**. The method is effective on produce that is already packaged providing there is a means for water vapor to escape.

Food Safety

Another important **facet** of market quality demands is clean fruit. Most vegetables should be washed after harvest to remove dirt, pesticide residue and **to freshen up wilted items**. With the proper design of a produce shed, the washing and cooling processes can be combined into one continuous operation. Proper design and maintenance of packing sheds can go a long way in reducing the incidence of contaminated produce being shipped to supermarkets.

Sanitary Facilities: Producers should describe the appropriate number of toilets to the number of workers, proper hand washing facilities, maximum worker to restroom distance, how often such a facility should be cleaned, and how the waste is to be disposed to avoid contamination of worker and produce.
Field Stations: Attempts should be made to prevent **cross-contamination** of fresh produce during preharvest and harvest activities that may result from contact with soils, fertilizers, water, workers, and harvesting equipment. Clean harvest containers and **storage facilities** prior to use, discard broken or damaged **bins**, field containers and bulk load equipment periodically, remove as much dirt as possible in the field, and maintain harvest equipment.
Packing Sheds: Maintain buildings, fixtures, and other physical facilities, and their grounds. Practice good sanitation within the packing shed. Clean pallets, rest rooms, containers, **grading and packing lines** daily. Develop a vigorous **pest control** program.
Sanitation within the Shed: Problems of rough handling and poor temperature management are compounded when poor sanitation practices exist in the postharvest environment. Packing sheds and storerooms should always be clean and neat. Products left on the floor under machinery will **rot** and contaminate the air with spores of decay causing organisms that may then infect other commodities. The packing line itself should be left free of produce each day and cleaned regularly. Bulk bins, storage buckets, and other containers should be cleaned and disinfected regularly.
The risk of decay always increases with the exposure of commodities to water. **Dump tanks**, which are used to minimize bruising during dumping of fruits and vegetables, can be a particular problem if not managed properly.

Packing

Appearance plays a major role in vegetable sales success. Therefore, a grower should pay special attention to **maturity**, size, color, shape, and **freedom from blemishes** and dirt when grading and sorting produce. Each package or display bin should contain fruit having similar qualities. If vegetables are to be shipped, container size is an important consideration.

A good package should protect the product during storage and transit, facilitate temperature management, protect from water loss, be compatible with any special treatments required by the product, and be compatible to existing handling systems.

One of the newest developments in packaging has been the use of materials that allow for modification of the atmosphere within the package, thus the term **modified-atmosphere (MA) packaging**. This involves the use of plastic films that allow depletion of oxygen and accumulation of carbon dioxide within the container, which will increase the shelf life of some commodities. However, some products develop **off-odors** or have increased bacterial growth under MA, and much research is ongoing to define which products respond best to MA.

Storage

Proper storage and/or transit conditions should be used if vegetables are to be held prior to sale or if they are to be transported over a great distance.
One of the major problems encountered during storage of certain vegetables is chilling injury.

Table X-3. Chilling Injury Symptoms[1]

Product	Lowest Safe Temperature (°F)	Symptoms
Asparagus	32/36	Dull, gray green, limp tips
Bean, lima	34/40	Rusty brown specks, spots
Bean, snap	45	Pitting and russeting
Cucumber	45	Pitting, water soaked spots
Eggplant	45	Surface scald, Alternaria rot, blackening of seeds

Muskmelon	36/41	Pitting, surface decay
Honeydew	45/50	Reddish tan discoloration, pitting, surface decay
Watermelon	40	Pitting, objectionable flavor
Pepper, Sweet	45	Sheet pitting, Alternaria rot on pods
Potato	38	Browning, sweetening
Pumpkin and Winter Squash	50	Decay, especially Alternaria rot
Sweetpotato	55	Decay, pitting, internal discoloration,
Tomato, mature green	55	Poor color when ripe, Alternaria rot
Tomato, ripe	45/50	Water soaking and softening, decay

Sweating

When fruits or vegetables are removed from a low temperature to a higher one, moisture often condenses from the air on the cool surface of the commodity. This is known as sweating; the higher the relative humidity of the outside air, the more marked it becomes. This is because the dew point of the air is at or above the temperature of the commodity. Sweating should be prevented or minimized whenever possible, particularly with onions and the more tender fruits, because it may favor decay.