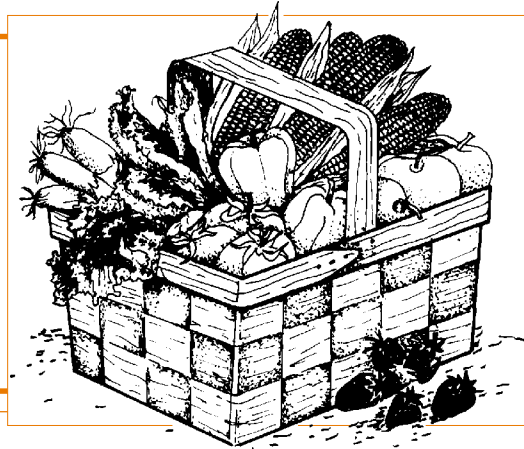


PACKING FACILITIES

FRUITS & VEGETABLES



By
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Once fruits and vegetables are harvested, they need to be packaged for sale—whether at a roadside farm stand, farmer's market stall, local retailers and restaurants, a Community Supported Agriculture (CSA) subscription service or a wholesale broker. For smaller retail operations, some postharvest handling practices can be done in the field. The facility used to handle harvested produce can be called a packhouse or packing shed. Within the packing shed, the physical arrangement of equipment and work stations that handle the produce is called the packing line. It is basically a factory assembly line and the packed produce is the finished product. Principles of designing a good factory layout can be applied to laying out the packing line and packing shed.

Step One

The first step in designing a packing shed is knowing what crops are to be grown and what the volume will be during the season. This will determine what equipment will be needed and how big the building and cold storage should be. An important consideration for the packing shed location is the nearness to the production field and roads. Since the packing shed is usually in operation during the hot summer months, a site with shade would be beneficial, although this may not be feasible for a large operation. To keep the building cool, good ventilation and fans will be needed. Insulation will also help keep the building cool, especially if it is air conditioned.

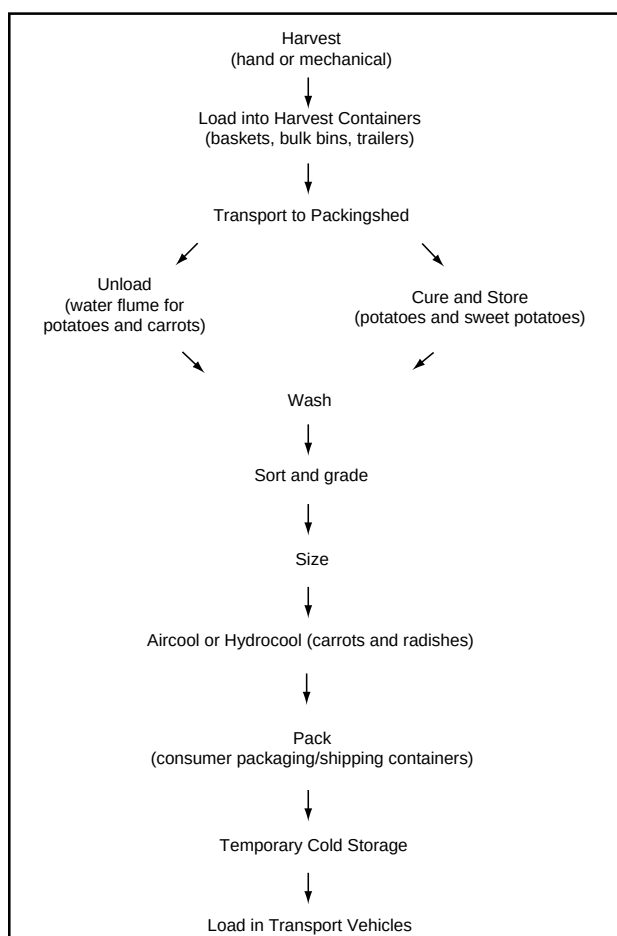


Figure 1. Postharvest Handling Flow Design for Root and Tuber Vegetables

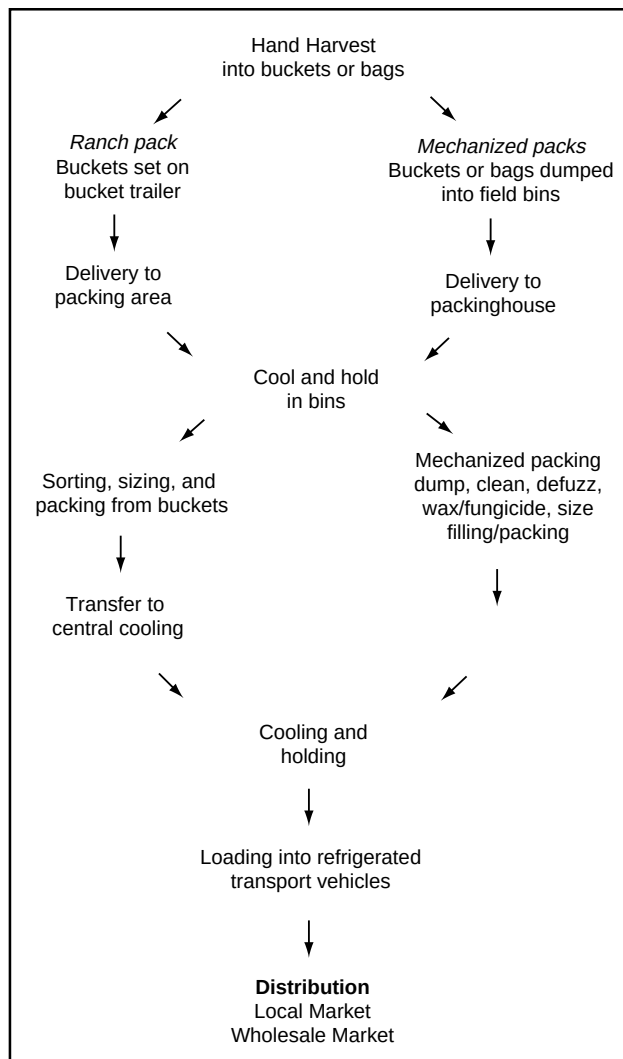


Figure 2. Postharvest Handling Flow Diagram for Stone Fruits

Step Two

Next, develop a flow diagram of all the post-harvest handling procedures which will be used with each crop. This diagram will help with the layout development of the packing shed (figures 1 and 2). The produce should always move in one direction, with no crossovers of the product from each step in the packing operation. This has become more important, as fresh produce handling methods must now include procedures and practices to prevent the spread of human pathogens. Since there are no steps, like heating, to eradicate pathogens, action must be taken to prevent contamination and recontamination. There should be one door for receiving produce from the field, and one door for shipping packed produce out.

Step Three

Arrangements must be made for a good water source and adequate utilities. Water used to wash the produce must be potable (safe to drink). A well supplying 100 gpm at 60 psi is adequate for most small sheds. An approximately 2-inch main water line with 1-inch laterals is recommended. The floors should be sloped to 6 inches wide drains that are 6- to 8-inches deep. Hot water is needed for clean-up and employee personal hygiene. The produce wash water should be chlorinated to 100 to 200 ppm. This recommended level kills pathogens that cause produce decay. However, it is not high enough to kill some food borne illness pathogens. The chlorine level should be checked throughout the day. As time passes, chlorine ions bind to organic matter and lose their effectiveness. Chlorination can be achieved by using household bleach, swimming pool chlorine or injection of compressed chlorine gas into the wash water. If a dump tank is used, the water should be changed frequently, especially if root crops or ones that have contact with the ground are being packed. Dirty water creates dirty produce.



Figure 3. Loading Dock



Figure 4a. Field Packing



Figure 4b. Small Scale Packing Line

Special attention needs to be given to the electrical requirements of the packing shed. It may be housing automated washing and sizing equipment, precooling facilities and cold storage units. The refrigeration equipment for the cold storage and chilling water for hydro-cooling often requires 3-Phase electrical power.

Step Four

The disposal of both liquid and solid waste is an important consideration in designing and setting up a packing shed. Maintaining and conserving water quality becomes an issue for produce operations—how to properly handle waste water from the packing line can also become a problem.

Waste water should never be dumped into the household septic system or the septic system for the toilets, showers and sinks in the packing facility. The volume of waste water will overwhelm these systems and reduce their effectiveness. Floor drains will be needed in the facility to carry waste water to a separate septic field. The solid waste (culled pro-



Figure 4c. Large Scale Packing Line

duce) may be composed, spread on fallow fields or sold as animal feed.

Step Five

Design a receiving area and packing line which fit your individual needs. The receiving area should be elevated so that produce can be easily unloaded off the trucks or wagons carrying it from the field. The height will depend on the vehicles used. Dollies, pallet jacks, and forklifts can then be used to load several harvest containers. The shipping area should also be elevated for easy loading to markets (figure 3).

The packing line is multifunctional, regardless of whether it is a sink and table or a high-speed automated conveyor line (figure 4a, b, and c). Listed below are the parts of an all purpose packing line:

1. A receiving area which can include a dump tank to initially clean and cool produce.
2. A washing area which can include the dump tank and a spray washer/brusher. This can be part of a conveyor belt system that automatically moves the produce, or simply a stock tank. The water used should be chlorinated at 100 to 200 ppm (figure 5a and b).
3. A drying area for the wet produce. Before being packed into containers, produce may be dried on sponges in a conveyor system or on screen tables.
4. An area for grading and sizing. Some culling can be done initially in the receiving area, especially if the produce is diseased, low grade or deformed. This can be a large table where produce can be spread out for inspection, a rotating table or conveyor belt with a sizer.



Figure 5a. Manual Washer

5. An area for packing produce into shipping, holding or marketing containers. This is often done in conjunction with grading and sizing.

There are specialized pieces of equipment for specific crops. Onions and garlic are not washed with water. Dry brushes are used to remove dirt and loose scales. If you pack cantaloupes, the sprayers may need to be elevated to accommodate the large produce. Apples require a heated dryer after being washed so they will not water spot. Apples, cucumbers, peppers and tomatoes are waxed to limit water loss for the wholesale market—therefore, these need a waxer. Peaches need a defuzzer. The defuzzer brushes the excess fuzz from the peaches.

All equipment in the packing shed should be OSHA approved for employee safety. It should be free of rust, chipping paint and grease, which could contaminate the produce. A routine maintenance schedule should be developed and adhered to faithfully.

Although wholesale containers are a prescribed size for each type of fruit or vegetable, most are either sold by weight or must be a minimum weight. A certified scale must be used. The Kansas State Department of Agriculture Division of Weights and Measurements is in charge of scale inspection and certification.

After produce has been packed into shipping containers, the container should be labeled with what it is; the size, count or net weight; grade; the grower's name and address; the date packed and a tracking code that incorporates the harvest date, bin number, packing time, packer number, inspector number and gassing room number for tomatoes and honeydew melons.



Figure 5b. Automatic Washer

Lighting

There are two factors to consider when deciding on facility lighting: (1) safety, and (2) quality. For safety considerations, all lights must have nonbreakable safety bulbs and must have safety shields covering them. By following these recommendations, the grower can avoid having to discard marketable produce if a bulb shatters onto it. Although most of this section is devoted to the importance of lighting for the packing line, all areas of the facility should be well lit to provide a safe working environment (figure 6).

Light quality for the packing line includes the type of light, placement of light, intensity of light and related environmental factors. Most people think that the lighting brings out the best and hides the worst in objects. This is not the case with grading and sorting produce. It is desirable to have lighting which shows every bruise, blemish and mark on the produce. Most facilities have used cool white (CW) fluorescent lighting because the bulbs were readily available and inexpensive. However, CW



Figure 6. Good Lighting Constitutes Good Produce

Table 1. Lighting Choices

Good		Bad
SP-30 Fluorescent	CW Deluxe	Daylight
Tungsten halogen quartz	Warm White	Natural
	Warm White Deluxe	Optima 32 and 50
	C-50	C-75

light is a poor choice for the packing line because it makes everything “look too good.” CW lighting, along with light colored clothing and conveyor belts, and stainless steel tables, causes eyestrain for graders and reduces their productivity. Luckily, CW 4- and 8-foot tubes are no longer manufactured. SP-30 fluorescent and tungsten halogen quartz are better choices, although they are more expensive (Table 1).

Lights should not be in the worker’s way or in their eyes. SP-30 lights should be 32 inches from the conveyor belt surface. The intensity should be between 250- to 500-foot candles at the conveyor belt surface. Light-colored produce can be graded with 250-foot candles, and dark colored produce is best graded at 500-foot candles. An easy way to regulate the light intensity is to install four bulb fixtures that can turn four bulbs on, or turn two bulbs on and two bulbs off. As for related environmental factors, the conveyor belt should have a non-glossy, dark surface. Workers’ clothing and surrounding equipment should also be dark and non-reflective.

Precooling and Cold Storage Area

Precooling equipment and procedures need to be incorporated into the packing shed design. Packed produce should pass quickly and efficiently from the packing line to the precooling area. Removal of field heat from the produce is important to prolong and maintain its postharvest life. K-State Research and Extension bulletin MF-1002, *Postharvest Management of Commercial Horticultural Crops: Precooling Produce, Fruits and Vegetables* covers methods of precooling more in-depth. If hydro-cooling is used, special attention must be made to how the cooling water is managed. If the water source can supply both the packing line and the hydrocooling, then where and how the waste water will be disposed needs to be addressed and dealt with. If air cooling is used, extra cold storage units and high-capacity refrigeration units will be needed.

Cold storage is the last stop before the produce is shipped to market. For a small grower who markets what they pack daily, this may be just a cool corner by the door before it is loaded for market. Refrigerated cold storage is recommended if the produce is not marketed every day. It should be close to the shipping area. K-State Research and Extension bulletins MF-1030, *Postharvest Management of Commercial Horticultural Crops: Storage Options, Fruits and Vegetables*; MF-1033, *Postharvest Management of Commercial Horticultural Crops: Storage Operations, Fruits and Vegetables*; MF-1039, *Postharvest Management of Commercial Horticultural Crops: Storage Construction, Fruits and Vegetables* all provide more in-depth information on how to select, construct and maintain a refrigerated cold storage.

There are other areas of the packing shed that are not directly involved with the handling of the produce, but are very important to the packing shed operation. This includes the container assembly area, restrooms, personal washing facilities, office, workshop and laboratory.

Container Assembly Area

An often forgotten activity for produce operations is the construction and storage of packing containers. In large packing facilities, space for these activities may occupy at least one-third of the operations space. Having these operations well placed and integrated into the plan of the packing facility will save time and labor costs. The assembly operation should be close to where the produce is actually packed into the containers. There should be a dry storage area near the assembly area for enough “unmade” containers to supply the day’s harvest, and enough “made” containers to keep up with the packing line flow. This area does not have to be the major storage area for the unmade containers. If a remote site is used for container storage, it should protect them from any moisture since most containers are made of unwaxed, corrugated cardboard.

Restrooms and Washing Facilities

Until a few years ago, bathrooms and wash areas were only considered employee amenities. Today, they are an integral part of any operation, because good personal hygiene is the cornerstone of a maintaining safe food handling procedures in a produce packing facility. Since the produce is never processed to eradicate harmful pathogens, special care must be taken to prevent the produce from being contaminated. Workers should always wash their hands before handling produce. Chlorine hand dips ($\frac{1}{4}$ cup bleach to 1 gallon water) are recommended. Workers need sanitary restrooms (one for each sex) and places to wash their hands with hot water and soap before handling produce again after using the restroom, eating or doing any activity that could potentially spread food borne illness pathogens.

Office, Workshop and Laboratory

The packing shed should include an office space for record keeping, a time clock for employees, a telephone, a fax machine, a computer and other management activities. A workshop is needed to house tools for repair and maintenance of the packing line equipment and packing shed facilities. If the operation has a HACCP, Hazardous Analysis of Critical Control Point Plan, a laboratory for microbial sampling and evaluation for the validation and verification steps of the plan is needed.

Operating the Packing Shed

Once the packing shed is operational, produce can begin to be processed or packed. Related activities such as container assembly, record keeping, and cleaning the facility after each use must also begin. When handling produce, several things need to be kept in mind. Even though you may have the best, state-of-the-art handling system, not training your employees about good handling techniques, not operating your equipment correctly, and not cleaning your equipment will damage your crop and reduce your returns. Listed below are recommendations for good handling practices:

- Train your graders to handle produce gently and a minimal number of times. Repeat the training often and supervise their work.

- Harvest only at the proper stage of maturity, and only when the produce is dry.
- Have graders wear cotton gloves, or ask them to trim their fingernails short.
- Use padding in the bottoms of harvest containers (baskets, boxes, bins).
- Use padding on the side and bottom of bulk bins.
- Do not over fill bulk bins or harvest containers.
- Reduce drop heights when moving produce from one container to another.

For the packing line:

- Use a water dump system to minimize the impact of emptying harvested produce onto the packing line.
- Produce should only be one layer deep on the grading surface.
- Graders should be taught to roll the produce to expose all sides for inspection.
- Keep the packing line level.
- Minimize drop heights between pieces of equipment.
- Use decelerator strips to slow produce down.
- Pad all surfaces that touch the produce.
- Synchronize the pieces of equipment.



Figure 7. Cleaning and Sanitizing Packing Line

- Place experienced graders at the end of the line to catch culls that less experienced graders miss.

The packing line and areas should be cleaned and sanitized daily at the end of the day's run. (figure 7) Continuous cleaning of floors and work areas will minimize the build-up of trash and culls that attracts flies and other insects. Listed are steps to follow:

1. Sweep or shovel as much debris and solid waste out of the way before washing down the equipment, working areas and floors.
2. Clean drains of debris.
3. Remove containers and other loose items from area.
4. Open equipment so that rinse water can reach interior spaces.
5. Rinse all surfaces with water—working from top to bottom.
6. Don't wash dirt and debris onto other pieces of equipment.
7. Scrub equipment and working area with water and detergent.
8. Rinse all surfaces with hot water.
9. Run the conveyor belts and other movable parts to make sure that all surfaces are cleaned.
10. Empty and clean all trash containers and drains. Make sure that no debris or trash is left in the area.
11. All equipment should be designed so that all parts can be taken apart for thorough cleaning and sanitizing.

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