Packaging Requirements for Fresh Fruits and Vegetables

NC STATE EXTENSION

Postharvest Technology Series

Introduction

Packaging fresh fruits and vegetables is one of the more important steps in the long and complicated journey from grower to consumer. Bags, crates, hampers, baskets, cartons, bulk bins, and palletized containers are convenient containers for handling, transporting, and marketing fresh produce. More than 1,500 different types of packages are used for produce in the United States and the number continues to increase as the industry introduces new packaging materials and concepts. Although the industry generally agrees that container standardization is one way to reduce cost, the trend in recent years has moved toward a wider range of package sizes to accommodate the diverse needs of wholesalers, consumers, food service buyers, and processing operations.

Packing and packaging materials contribute a significant cost to the produce industry; therefore it is important that packers, shippers, buyers, and consumers have a clear understanding of the wide range of packaging options available. This factsheet describes some of the many types of packaging, including their functions, uses, and limitations. Also included is a listing, by commodity, of the common produce containers standard to the industry.

The Function of Packaging or Why Package Produce?

A significant percentage of produce buyer and consumer complaints may be traced to container failure because of poor design or inappropriate selection and use. A properly designed produce container should contain, protect, and identify the produce, satisfying everyone from grower to consumer.

PACKAGING POINTS

Recyclability/Biodegradability.
A growing number of US markets and many export markets have waste disposal restrictions for packaging materials. In the near future, almost all produce packaging will be recyclable or biodegradable, or both. Many of the largest buyers of fresh produce are also those most concerned about environmental issues.

Variety.
The trend is toward greater use of bulk packages for processors and wholesale buyers and smaller packages for consumers. There are now more than 1,500 different sizes and styles of produce packages.

Sales Appeal.
High quality graphics are increasingly being used to boost sales appeal. Multi-color printing, distinctive lettering, and logos are now common.

Shelf Life.
Modern produce packaging can be custom engineered for each commodity to extend shelf life and reduce waste.

Containment

The container must enclose the produce in convenient units for handling and distribution. The produce should fit well inside the container, with little wasted space. Small produce items that are spherical or oblong (such as potatoes, onions, and apples) may be packaged efficiently utilizing a variety of different package shapes and sizes. However, many produce items such as asparagus, berries, or soft fruit may require containers specially designed for that item. Packages of produce commonly handled by hand are usually limited to 50 pounds. Bulk packages moved by forklifts may weigh as much as 1,200 pounds.

Protection

The package must protect the produce from mechanical damage and poor environmental conditions during handling and distribution. To produce buyers, torn, dented, or collapsed produce packages usually indicate lack of care in handling the contents. Produce containers must be sturdy enough to resist damage during packaging, storage, and transportation to market.

Because almost all produce packages are palletized, produce containers should have sufficient stacking strength to resist crushing in a low temperature, high humidity environment. Although the cost of packaging materials has escalated sharply in recent years, poor quality, lightweight containers that are easily damaged by handling or moisture are no longer tolerated by packers or buyers.

Produce destined for export markets requires containers to be extra sturdy. Air-freighted produce may require special packing, package sizes, and insulation. Marketers who export fresh produce should consult with freight companies about any special packaging requirements. Additionally, the USDA and various state export agencies may be able to provide specific packaging information.

Damage resulting from poor environmental control during handling and transit is one of the leading causes of rejected produce and low buyer and consumer satisfaction. Each fresh fruit and vegetable commodity has its own requirements for temperature, humidity, and environmental gas composition. Produce containers should be *produce friendly* - helping to maintain an optimum environment for the longest shelf life. This may include special materials to slow the loss of water from the produce, insulation materials to keep out the heat, or engineered plastic liners that maintain a favorable mix of oxygen and carbon dioxide.

Identification

The package must identify and provide useful information about the produce. It is customary (and may be required in some cases) to provide information such as the produce name, brand, size, grade, variety, net weight, count, grower, shipper, and country of origin. It is also becoming more common to find included on the package nutritional information, recipes, and other useful information directed specifically at the consumer. In consumer marketing, package appearance has also become an important part of point of sale displays.

Universal Product Codes (UPC or bar codes) may be included as part of the labeling. The UPCs used in the food industry consist of a ten-digit machine readable code. The first five digits are a number assigned to the specific producer (packer or shipper) and the second five digits represent specific product information such as type of produce and size of package. Although no price information is included, UPCs are used more and more by packers, shippers, buyers, and retailers as a fast and convenient method of inventory control and cost accounting. Efficient use of UPCs requires coordination with everyone who handles the package.

Types of Packaging Materials

Wood

Pallets literally form the base on which most fresh produce is delivered to the consumer. Pallets were first used during World War II as an efficient way to move goods. The produce industry uses approximately 190 of the 700 million pallets produced per year in the United States. About 40 percent of these are single-use pallets. Because many are of a non-standard size, the pallets are built as inexpensively as possible and discarded after a single use. Although standardization efforts have been slowly under way for many years, the efforts have been accelerated by pressure from environmental groups, in addition to the rising cost of pallets and landfill tipping fees.

Over the years, the 40-inch wide, by 48-inch long pallet has evolved as the unofficial standard size. Standardization encourages re-use, which has many benefits. Besides reducing cost because they may be used many times, most pallet racks and automated pallet handling equipment are designed for standard-size pallets. Standard size pallets make efficient use of truck and van space and can accommodate heavier loads and more stress than lighter single-use pallets. Additionally, the use of a single pallet size could substantially reduce pallet inventory and warehousing costs along with pallet repair and disposal costs. The adoption of a pallet standard throughout the produce industry would also aid efforts toward standardization of produce containers.

In the early 1950s, an alternative to the pallet was introduced. It is a pallet-size sheet (slipsheet) of corrugated fiberboard or plastic (or a combination of these materials) with a narrow lip along one or more sides. packages of produce are stacked directly on this sheet as if it were a pallet. Once the packages are in place, they are moved by a specially equipped forklift equipped with a thin metal sheet instead of forks.

Slipsheets are considerably less expensive than pallets to buy, store, and maintain; they may be re-used many times; and they reduce the tare weight of the load. However, they require the use of a special forklift attachment at each handling point from packer to retailer.

Depending on the size of produce package, a single pallet may carry from 20 to over 100 individual packages. Because these packages are often loosely stacked to allow for air circulation, or are bulging and difficult to stack evenly, they must be secured (unitized) to prevent shifting during handling and transit. Although widely used, plastic straps and tapes may not have completely satisfactory results. Plastic or paper corner tabs should always be used to prevent the straps from crushing the corners of packages.

Plastic stretch film is also widely used to secure produce packages. A good film must stretch, retain its elasticity, and cling to the packages. Plastic film may conform easily to various size loads. It helps protect the packages from loss of moisture, makes the pallet more secure against pilferage, and can be applied using partial automation. However, plastic film severely restricts proper ventilation. A common alternative to stretch film is plastic netting, which is much better for stabilizing some pallet loads, such as those that require forced-air cooling. Used stretch film and plastic netting may be difficult to properly handle and recycle.

A very low-cost and almost fully automated method of pallet stabilization is the application of a small amount of special glue to the top of each package. As the packages are stacked, the glue secures all cartons together. This glue has a low tensile strength so cartons may be easily separated or repositioned, but a high shear strength so they will not slide. The glue does not present disposal or recycling problems.

Pallet Bins. Substantial wooden pallet bins of milled lumber or plywood are primarily used to move produce from the field or orchard to the packing house. Depending on the application, capacities may range from 12 to more than 50 bushels. Although the height may vary, the length and width is generally the same as a standard pallet (48 inches by 40 inches). More efficient double-wide pallet bins (48 inches by 80 inches) are becoming more common in some produce operations.

Most pallet bins are locally made; therefore it is very important that they be consistent from lot to lot in materials, construction, and especially size. For example, small differences in overall dimensions can add up to big problems when several hundred are stacked together for cooling, ventilation, or storage. It is also important that stress points be adequately reinforced. The average life of a hardwood pallet bin that is stored outside is approximately five years. When properly protected from the weather, pallets bins may have a useful life of 10 years or more.

Uniform voluntary standards for wood pallets and other wood containers are administered by the National Wooden Pallet and Container Association, Washington, DC. Additionally, the American Society of Agricultural Engineers, St. Joseph, Michigan, publishes standards for agricultural pallet bins (ASAE S337.1).

Wire-Bound Crates. Although alternatives are available, wooden wire-bound crates are used extensively for snap beans, sweet corn and several other commodities that require hydrocooling. Wire-bound crates are sturdy, rigid and have very high stacking strength that is essentially unaffected by water. Wire-bound crates come in many different sizes from half-bushel to pallet-bin size and have a great deal of open space to facilitate cooling and ventilation. Although few are re-used, wire-bound crates may be dissembled after use and shipped back to the packer (flat). In some areas, used containers may pose a significant disposal problem. Wire-bound crates are not generally acceptable for consumer packaging because of the difficulty in affixing suitable labels.

Wooden Crates and Lugs. Wooden crates, once extensively used for apples, stone fruit, and potatoes have been almost totally replaced by other types of containers. The relative expense of the container, a greater concern for tare weight, and advances in material handling have reduced their use to a few specialty items, such as expensive tropical fruit. The 15-, 20-, and 25-pound wooden lugs still used for bunch grapes and some specialty crops are being gradually replaced with less costly alternatives.

Wooden Baskets and Hampers. Wire-reinforced wood veneer baskets and hampers of different sizes were once used for a wide variety of crops from strawberries to sweetpotatoes. They are durable and may be nested for efficient transport when empty. However, cost, disposal problems, and difficulty in efficient palletization have severely limited their use to mostly local grower markets where they may be re-used many times.

Corrugated Fiberboard

Corrugated fiberboard (often mistakenly called cardboard or pasteboard) is manufactured in many different styles and weights. Because of its relativity low cost and versatility, it is the dominant produce container material and will probably remain so in the near future. The strength and serviceability of corrugated fiberboard have been improving in recent years.

Most corrugated fiberboard is made from three or more layers of paperboard manufactured by the kraft process. To be considered paperboard, the paper must be thicker than 0.008 inches. The grades of paperboard are differentiated by their weight (in pounds per 1,000 square feet) and their thickness. Kraft paper made from unbleached pulp has a characteristic brown color and is exceptionally strong. In addition to virgin wood fibers, Kraft paper may have some portion of synthetic fibers for additional strength, sizing (starch), and other materials to give it wet strength and printability. Most fiberboard contains some recycled fibers. Minimum amounts of recycled materials may be specified by law and the percentage is expected to increase in the future. Tests have shown that cartons of fully recycled pulp have about 75 percent of the stacking strength of virgin fiber containers. The use of recycled fibers will inevitably lead to the use of thicker walled containers.

Double-faced corrugated fiberboard is the predominant form used for produce containers. It is produced by sandwiching a layer of corrugated paperboard between an inner and outer liner (facing) of paper-board. The inner and outer liner may be identical, or the outer layer may be preprinted or coated to better accept printing. The inner layer may be given a special coating to resist moisture. Heavy-duty shipping containers, such as corrugated bulk bins that are required to have high stacking strength, may have double- or even triple-wall construction. Corrugated fiberboard manufacturers print box certificates on the bottom of containers to certify certain strength characteristics and limitations. There are two types of certification. The first certifies the minimum combined weight of both the inner and outer facings and that the corrugated fiberboard material is of a minimum bursting strength. The second certifies minimum edge crush test (ETC) strength. Edge

crush strength is a much better predictor of stacking strength than is bursting strength. For this reason, users of corrugated fiberboard containers should insist on ECT certification to compare the stackability of various containers. Both certificates give a maximum size limit for the container (sum of length, width, and height) and the maximum gross weight of the contents.

Both cold temperatures and high humidities reduce the strength of fiberboard containers. Unless the container is specially treated, moisture absorbed from the surrounding air and the contents can reduce the strength of the container by as much as 75 percent. New anti-moisture coatings (both wax and plastic) are now available to substantially reduce the effects of moisture.

Waxed fiberboard cartons (the wax is about 20 percent of fiber weight) are used for many produce items that must be either hydrocooled or iced. The main objection to wax cartons is disposal after use— wax cartons cannot be recycled and are increasingly being refused at landfills. Several states and municipalities have recently taxed wax cartons or have instituted rigid back haul regulations. Industry sources suggest that wax cartons will eventually be replaced by plastic or, more likely, the use of ice and hydrocooling will be replaced by highly controlled forced-air cooling and rigid temperature and humidity maintenance on many commodities.

In many applications for corrugated fiberboard containers, the stacking strength of the container is a minor consideration. For example, canned goods carry the majority of their own weight when stacked. Fresh produce usually cannot carry much of the vertical load without some damage. Therefore, one of the primarily desired characteristics of corrugated fiberboard containers is stacking strength to protect the produce from crushing. Because of their geometry, most of the stacking strength of corrugated containers is carried by the corners. For this reason, hand holes and ventilation slots should never be positioned near the corners of produce containers and be limited to no more than 5 to 7 percent of the side area.

Interlocking the packages (cross stacking) is universally practiced to stabilize pallets. Cross stacking places the corner of one produce package at the middle of the one below it, thus reducing its stacking strength. To reduce the possibility of collapse, the first several layers of each pallet should be column stacked (one package directly above the other). The upper layers of packages may be cross stacked as usual with very little loss of pallet stability.

There are numerous styles of corrugated fiberboard containers. The two most used in the produce industry are the one piece, regular slotted container (RSC) and the two piece, full telescoping container (FTC). The RSC is the most popular because it is simple and economical. However, the RSC has relatively low stacking strength and therefore must be used with produce, such as potatoes, that can carry some of the stacking load. The FTC, actually one container inside another, is used when greater stacking strength and resistance to bulging is required. A third type of container is the Bliss box, which is constructed from three separate pieces of corrugated fiberboard. The Bliss box was developed to be used when maximum stacking strength is required. The bottoms and tops of all three types of containers may be closed by glue, staples, or interlocking slots.

Almost all corrugated fiberboard containers are shipped to the packer flat and assembled at the packing house. To conserve space, assembly is usually performed just before use. Assembly may be by hand, machine, or a combination of both. Ease of assembly should be carefully investigated when considering a particular style of package.

In recent years, large double-wall or even triple- wall corrugated fiberboard containers have increasingly been used as one-way pallet bins to ship bulk produce to processors and retailers. Cabbage, melons, potatoes, pumpkins, and citrus have all been shipped successfully in these

containers. The container cost per pound of produce is as little as one fourth of traditional size containers. Some bulk containers may be collapsed and re-used.

For many years, labels were printed on heavy paper and glued or stapled to the produce package. The high cost of materials and labor has all but eliminated this practice. The ability to print the brand, size, and grade information directly on the container is one of the greatest benefits of corrugated fiberboard containers. There are basically two methods used to print corrugated fiberboard containers:

- **Post Printed.** When the liner is printed after the corrugated fiberboard has been formed, the process is known as post printing. Post printing is the most widely used printing method for corrugated fiberboard containers because it is economical and may be used for small press runs. However, postprinting produces graphics with less detail and is usually limited to one or two colors.
- **Preprinted.** High quality, full-color graphics may be obtained by preprinting the linerboard before it is attached to the corrugated paperboard. Whereas the cost is about 15 percent more than standard two color containers, the eye catching quality of the graphics makes it very useful for many situations. The visual quality of the package influences the perception of the product because the buyer's first impression is of the outside of the package. Produce managers especially like high quality graphics that they can use in supermarket floor displays.

  Preprinted cartons are usually reserved for the introduction of new products or new brands. Market research has shown that exporters may benefit from sophisticated graphics. The increased cost usually does not justify use for mature products in a stable market, but this may change as the cost of these containers becomes more competitive.

Pulp Containers. Containers made from recycled paper pulp and a starch binder are mainly used for small consumer packages of fresh produce. Pulp containers are available in a large variety of shapes and sizes and are relatively inexpensive in standard sizes. Pulp containers can absorb surface moisture from the product, which is a benefit for small fruit and berries that are easily harmed by water. Pulp containers are also biodegradable, made from recycled materials, and recyclable.

Paper and Mesh Bags. Consumer packs of potatoes and onions are about the only produce items now packed in paper bags. The more sturdy mesh bag has much wider use. In addition to potatoes and onions, cabbage, turnips, citrus, and some specialty items are packed in mesh bags. Sweet corn may still be packaged in mesh bags in some markets. In addition to its low cost, mesh has the advantage of uninhibited air flow. Good ventilation is particularly beneficial to onions. Supermarket produce managers like small mesh bags because they make attractive displays that stimulate purchases.

However, bags of any type have several serious disadvantages. Large bags do not palletize well and small bags do not efficiently fill the space inside corrugated fiberboard containers. Bags do not offer protection from rough handling. Mesh bags provide little protection from light or contaminants. In addition, produce packed in bags is correctly perceived by the consumer to be less than the best grade. Few consumers are willing to pay premium price for bagged produce.

Plastic Bags. Plastic bags (polyethylene film) are the predominant material for fruit and vegetable consumer packaging. Besides the very low material costs, automated bagging machines further reduce packing costs. Film bags are clear, allowing for easy inspection of the contents, and readily accept high quality graphics. Plastic films are available in a wide range of thicknesses and grades and may be engineered to control the environmental gases inside the bag. The film material "breathes" at a rate necessary to maintain the correct mix of oxygen, carbon dioxide, and water vapor inside the bag. Since each produce item has its own unique requirement for environmental gases, modified atmosphere packaging material must be specially engineered for each item. Research has shown that the shelf life of fresh produce is extended considerably by this packaging. The explosive growth of precut produce is due in part to the availability of modified atmosphere packaging.

In addition to engineered plastic films, various patches and valves have been developed that affix to low-cost ordinary plastic film bags. These devices respond to temperature and control the mix of environmental gases.

Shrink Wrap. One of the newest trends in produce packaging is the shrink wrapping of individual produce items. Shrink wrapping has been used successfully to package potatoes, sweetpotatoes, apples, onions, sweet corn, cucumbers and a variety of tropical fruit. Shrink wrapping with an engineered plastic wrap can reduce shrinkage, protect the produce from disease, reduce mechanical damage and provide a good surface for stick-on labels.

Rigid Plastic Packages. Packages with a top and bottom that are heat formed from one or two pieces of plastic are known as clamshells. Clamshells are gaining in popularity because they are inexpensive, versatile, provide excellent protection to the produce, and present a very pleasing consumer package. Clamshells are most often used with consumer packs of high value produce items like small fruit, berries, mushrooms, etc., or items that are easily damaged by crushing. Clamshells are used extensively with precut produce and prepared salads. Molded polystyrene and corrugated polystyrene containers have been test marketed as a substitute for waxed corrugated fiberboard. At present they are not generally cost competitive, but as environmental pressures grow, they may be more common. Heavy-molded polystyrene pallet bins have been adopted by a number of growers as a substitute for wooden pallet bins. Although at present their cost is over double that of wooden bins, they have a longer service life, are easier to clean, are recyclable, do not decay when wet, do not harbor disease, and may be nested and made collapsible.

As environmental pressures continue to grow, the disposal and recyclability of packaging material of all kinds will become a very important issue. Common polyethylene may take from 200 to 400 years to breakdown in a landfill. The addition of 6 percent starch will reduce the time to 20 years or less. Packaging material companies are developing starch-based polyethylene substitutes that will break down in a landfill as fast as ordinary paper.

The move to biodegradable or recyclable plastic packaging materials may be driven by cost in the long term, but by legislation in the near term. Some authorities have proposed a total ban on plastics. In this case, the supermarket of the early 21st century may resemble the grocery markets of the early 20th century.

Standardization

Produce package standardization is interpreted differently by different groups. The wide variety of package sizes and material combinations is a result of the market responding to demands from many different segments of the produce industry. For example, many of the large-volume buyers of fresh produce are those most concerned with the environment. They demand less packaging and the use of more recyclable and biodegradable materials, yet would also like to have many different sizes of packages for convenience. Packers want to limit the variety of packages they must carry in stock, yet they have driven the trend toward preprinted, individualized containers. Shippers and trucking companies want to standardize sizes so the packages may be better palletized and handled.

Produce buyers are not a homogeneous group. Buyers for grocery chains have different needs than buyers for food service. For grocery items normally sold in bulk, processors want largest size packages that they can handle efficiently - to minimize unpacking time and reduce the cost of handling or disposing of the used containers. Produce managers, on the other hand, want individualized, high quality graphics to entice retail buyers with in-store displays.

Selecting the right container for fresh produce is seldom a matter of personal choice for the packer. For each commodity, the market has unofficial, but nevertheless rigid standards for packaging; therefore it is very risky to use a nonstandard package. Packaging technology, market acceptability, and disposal regulations are constantly changing. When choosing a package for fresh fruits and vegetables, packers must consult the market, and in some markets, standard packages may be required by law.

Table 1. Some common shipping containers by commodity.

Apples 45 lb 1⅛ bushel cartons, loose 40 to 45 lb cartons, tray-pack 40 lb bushel cartons, tray- or cell-pack 40 lb bushel cartons, loose 40 lb cartons, ten 4 lb bags 40 lb cartons, eight 5 lb bags 40 lb cartons, sixteen 8 count trays, over wrapped 38 to 42 lb cartons, loose 37 to 43 lb cartons, cell-pack 36 lb cartons, twelve 3 lb bags 20 lb half-bushel cartons, loose	**Blueberries** 11 lb flats, twelve 1 pint cups 9 lb flats, twelve 250 gram cups 5 lb flats, twelve 8 oz baskets
Asparagus 30 lb pyramid cartons/crates, bunched or loose 28 lb cartons/crates, bunched 25 lb lugs/cartons, loose 24 lb cartons, sixteen 1½ lb packages 21 lb lugs/cartons, loose 20 lb pyramid cartons/crates 20 lb cartons, bunched 15 to 17 lb pyramid cartons/crates, bunched or loose 14 lb cartons, loose 12 lb cartons, loose 12 to 13 lb cartons/crates, bunched 11 lb cartons/crates, loose	**Broccoli** *Bunched* 21 lb cartons/crates, 14s and 18s *Crown-Cut* 20 lb cartons, loose *Florets* 10 lb film bags 5 lb film bags
Beans *All Types* 26 to 31 lb bushel crates/hampers 25 to 30 lb cartons/crates, including semi-telescope types *Snap Beans* 20 to 22 lb cartons 15 lb cartons *Yellow wax beans* 30 lb bushel hampers/crates	**Brussels Sprouts** 25 lb cartons, loose 10 lb flats/cartons

Beets 50 lb mesh bags 45 lb wirebound crates/cartons, bunched in 12s 38 lb cartons/crates, bunched in 12s 35 lb half crates, loose 32 lb 4/5 bushel crate 25 lb bags, loose 20 lb cartons/crates, bunched in 12s	**Cabbage** *Green and Red* 2,000 lb bulk bins 1,000 lb bulk bins 50 to 60 lb flat crates 50 lb 1 3/4 bushel crates/cartons/bags 45 lb cartons 40 lb cartons/bags *Savoy* 40 lb 1 3/4 bushel crates *Chinese* 80 to 85 lb crates 45 to 54 lb crates 50 to 53 lb carton
Carrots *Topped* 50 lb cartons/bags, loose 50 lb cartons, ten 5 lb bags 48 lb master bags, containing forty eight 1 lb, twenty-four 2 lb or sixteen 3 lb bags 26 lb cartons, bunched 25 lb bags, loose 24 lb cartons, containing twenty four 1 lb bags 15 lb cartons, containing twenty 12 oz bags *Bunched* 26 lb cartons/crates, 24s *Baby whole* 24 lb cartons, containing twenty four 1 lb film bags 20 lb cartons, containing twenty 1 lb bags 15 lb cartons, containing twenty 12 oz bags	**Cantaloupe** 1,000 lb pallet bins 800 lb pallet bins 80 lb jumbo crates 60 lb 1 3/4 bushel cartons 54 lb cartons 45 to 50 lb wirebound crates 40 lb cartons/crates 40 lb 1 1/9 bushel cartons/crates

Cauliflower 60 lb wirebound crates 50 lb cartons/crates (Long Island Type) 25 to 30 lb cartons,12s and 16s film-wrapped and trimmed	**Eggplant** 33 lb bushels or 1 1/9 bushel cartons/crates/baskets 26 to 28 lb cartons/crates/lugs 25 lb cartons 22 lb lugs/cartons, 18s and 24s 17 lb ½ bushel lugs *Chinese* 26 lb lugs 25 lb cartons 15 lb ½ bushel cartons/crates *Italian* 26 lb lugs 15 lb ½ bushel cartons/crates *Japanese* 15 lb ½ bushel cartons/crates
Corn 50 lb cartons/crates/bags 42 lb cartons/crates/bags 37 lb mesh bags	**Grapes** Bunch 24 lb crates, eight 2-quart baskets 22 to 23 lb cartons/lugs 21 lb lugs 20 lb 12-quart baskets 16 lb lugs,16 lb bagged/wrapped *Muscadines* 12 lb flats, twelve 1 pint cups
Cucumbers *Pickling* 55 lb 1 1/9 bushel cartons/crates *Slicers* 50 lb bushel cartons/crates 30 lb cartons, 48s 28 lb 5/9 bushel cartons/crates 24 lb cartons, 36s and 42s 22 lb cartons, 24s *Greenhouse* 16 lb cartons, loose, film-wrapped 12 lb flats/cartons, loose, film-wrapped	**Greens** 30 to 35 lb 1 2/5 bushel and 1 3/5 bushel crates 20 to 25 lb bushel baskets/crates/cartons 20 to 25 lb 12-24 bunches per crates/cartons
Melons *Casaba and Crenshaw* 32 to 34 lb cartons, 4s, 5s & 6s 48 to 51 lb flat crate, 5s & 6s	**Honeydew** 35 lb flat crates 30 lb cartons

Okra 30 lb bushel baskets/crates/hampers 23 lb ¾ bushel hampers 15 lb ½ and ⅝ bushel baskets/crates/lugs/clamshells	**Lettuce** *Iceberg* 50 lb cartons, 30s, 24s, 18s 30 lb cartons 20 lb cartons *Boston* 22 lb 1⅛ bushel crates 20 lb cartons/crates, 24s 10 lb flat cartons/crates 5 lb 12-quart baskets/cartons *Bibb* 10 lb flat cartons/crates 5 lb 12-quart baskets/cartons 5 lb baskets, greenhouse *Looseleaf* 25 lb cartons/crates 20 lb ⅘ bushel crates 14 lb 1⅛ bushel crates 10 lb baskets/cartons *Romaine* 40 lb ⅔ cartons/crates 28 lb 1⅓ bushel cartons 22 lb 1⅛ bushel cartons/crates 22 lb carton, 24s
Onions, bulb 50 lb cartons/bags/crates, loose 50 lb cartons, containing ten 5 lb bags 48 lb cartons, containing sixteen 3 lb bags or 24 2 lb bags 45 lb cartons, containing fifteen 3 lb bags 40 lb cartons, containing twenty 2 lb bags 40 lb cartons, loose 36 lb cartons, containing twelve 3 lb bags 32 lb cartons, sixteen 2 lb bags 25 lb bags/cartons, loose 24 lb cartons, containing twelve 2 lb bags 10 lb bags, loose	**Peppers** *Bells* 35 lb 1¼ bushel cartons 30 lb cartons/crates 28 lb bushel and 1⅛ bushel cartons/crates 25 lb cartons 14 to 15 lb half-bushel cartons 11 lb flat cartons *Jalapenos and Chilies* 16 to 25 lb half- and ⅝ bushel cartons/crates, loose 20 lb cartons, loose 10 lb cartons, retail packs

Onions, green 28 lb cartons, bunched 12s, bulb-type 20 lb cartons/crates, bunched 24s, bulb-type 13 lb cartons, bunched 48s 11 lb cartons, bunched 36s	**Potatoes** 100 lb bags 50 lb cartons/bags 50 lb carton, containing five 10 lb or ten 5 lb bags
Peaches 38 lb ¾ bushel cartons/crates 35 lb cartons 26 lb cartons 25 lb ½ bushel cartons/crates 22 lb 2-layer carton 11 lb crates/flats,1-layer tray pack 10 lb cartons 9 lb cartons,1-layer	**Pumpkins** 1,000 lb bins 50 lb cartons/crates/bags 25 lb ½ bushel cartons/crates
Peas *Green* 30 lb bushel baskets/crates/hampers 30 lb 1⅑ bushel crates/cartons *Snow, China, Sugar, Sugar Snap* 10 lb cartons *Southern* 25 lb bushel hampers	**Radishes** *Topped* 40 lb bags, loose 25 lb bags, loose 14 lb cartons, containing fourteen 1 lb bags 12 lb baskets/cartons, containing thirty 6 oz bags *Bunched* 35 lb cartons/crates, 48s, 24s 30 lb ⅘ bushel cartons/lugs 20 lb cartons/crates, containing 24 bunches 15 lb cartons/crates, 24s
Squash *Summer* 42 lb bushel and 1⅑ bushel carton 35 lb cartons/crates 30 lb ¾ bushel cartons/crates 26 lb cartons/lugs 21 lb ½ or ⅝ bushel baskets/cartons/crates 10 lb 8-quart baskets/cartons *Winter* 50 lb 1⅑ bushel cartons/crates 40 lb cartons/crates 35 lb cartons/crates 12 lb flats, 6 quarts	**Spinach** 32 lb 1⅔ bushel cartons/crates 25 lb bushel carton/crates 20 lb cartons, 24s 12 lb bags 10 lb 24 quart baskets 8 lb cartons, twelve 10 oz bags

Sweetpotatoes 800 lb bulk bins 40 lb cartons/crates 40 lb cartons, containing eight 5 lb bags 20 lb boxes 10 lb boxes 5 lb cartons/bags	**Tomatoes** 28 lb ½ or 4/7 bushel cartons 25 lb cartons, loose 20 lb cartons/flats, loose or layered *Cherry* 15 lb flats, containing twelve 1-pint cups 5 lb cartons, containing nine 250-gram cups *Mature Green* 25 lb cartons, loose 20 lb cartons, loose or layered 10 lb cartons, loose *Greenhouse* 15 lb flats, 1-layer *Plum or Roma* 25 lb cartons, loose
Watermelon 1,000 lb pallet bins 100 lb cartons 85 lb cartons, various counts 40 lb cartons 35 lb cartons (Mickey Lee)	**Turnips** 50 lb bushel basket/bags 40 lb cartons, bunched 25 lb half-bushel baskets/cartons/crates/bags 24 lb cartons, twenty-four 1 lb bags 20 lb cartons, bunched 12s

Definitions

Back Haul. The return trip from delivering produce or any item to its destination. For efficiency, truckers try to limit empty unproductive (known as dead-heads) back hauls.

Bulk Container. A container designed to contain a relatively large quantity of produce. Bulk containers are used in conjunction with a shipping pallet but are normally separate from the pallet. Bulk containers may carry up to 2,000 lb of produce. Compare to pallet bin.

Bulk Produce. Produce handled in generally truckload lots but not in small containers such as cartons, bags, etc. Bulk produce may be transported in gondolas, dump trucks, or refrigerated vans. Bulk produce is mostly used for processing.

Container. Any type of box, carton, bag, or bin used to form a package of produce. See package.

Corrugated Fiberboard. Common packaging material made from a layer of corrugated fiberboard sandwiched between two additional layers of fiberboard. Sometimes mistakenly called pasteboard or cardboard.

Carton. A container of various construction, but usually made from corrugated fiberboard or possibly plastic, that generally contains fifty pounds or less of fresh produce.

Cold Chain. Most types of produce require continuous postharvest refrigeration for maximum quality maintenance. On-farm refrigeration, refrigerated transport, the buyer's refrigerated receiving warehouse, and refrigerated retail displays all form the cold chain.

Controlled Atmosphere Package. An engineered package where the interaction between the produce and the packing material actively regulates a beneficial mix of environmental gases. See Modified Atmosphere package.

Count Packing. Packing method in which a certain specified number of sized and graded items are placed in the carton.

Fiberboard. A paper material usually made by the kraft process having a thickness greater than .008 inches. Fiberboard may contain additional materials for strength and resistance to water.

Field Packing. A packing method in which all harvesting, grading, and packing functions are performed at the same time in the field or orchard.

Food Service. An enterprise whose function is to supply food items, including fresh produce, to institutions, restaurants, and increasingly, grocery outlets.

Forced-Air Cooling. Forced-air cooling is a commonly used cooling method that utilizes specially constructed portable fans or rooms to draw chilled air horizontally through pallets or stacks of packaged produce. A properly designed forced-air cooling system is fast, energy efficient and relatively inexpensive. It may be utilized on most types of produce.

Fresh-Cut. A value adding process where fresh produce is shredded, trimmed, sliced, or otherwise prepared for consumer use. Fresh-cut produce is generally prepared by a processor or retailer and requires increased attention to sanitation, packaging, handling, the storage environment and labeling. Also called pre-cut or ready-cut.

Hundredweight. A unit of one hundred pounds. Abbreviated Cwt.

Hydrocooling. Cooling freshly harvested produce by flooding, immersing, or spraying with large quantities of cold water. Compared to other cooling methods, hydrocooling is fast and generally thorough. Hydrocooling is limited to those produce items that will tolerate liquid water.

Icing. Cooling fresh produce by the addition of crushed ice or a slurry of crushed ice and water over the top of a load or to each individual package. This method is limited to those produce items that are not harmed by contact with ice.

Layer Packing. Packing method where the entire package of produce is packed in orderly layers.

Lug. A sturdy container, often wholly or partially of wood, designed to have high stacking strength. Lugs are often used for soft fruit such as grapes, berries or tomatoes that are easily damaged by crushing.

Face Packing. A packing method where most of the container is loose or volume filled except for top layer. Items in the top layer are arranged in an orderly pattern for appearance.

Master (flat). A type of carton designed to contain smaller, usually consumer size, units of produce. Masters designed to contain 8 quarts or 12 pints or half pints are commonly used with strawberries and other small fruit.

Mixed Load. A single truck load of fresh produce consisting of two or more products shipped together. The use of mixed loads reduce transportation costs but care must be exercised to prevent ethylene or odor contamination.

Modified Atmosphere Packaging. A method of packaging in which the produce is packed in a sealed container into which a specific mix of gases are introduced. The container only prevents the gases from escaping and does not regulate the mix.

Pallet Bin. A bulk bin made integral to a pallet for the transport of bulk produce. Pallet bins may be made of wood, plastic or some other sturdy material and are primarily intended to be used between the field/orchard and packing house.

Packout Rate. The portion, often expressed as a percentage, of harvested produce actually packed for shipment. That portion not packed is referred to as culls.

Package. Any type of filled box, carton, bag, or bin of product. See container.

Packing House. A facility designed to wash, grade, or trim harvested produce but primarily to place the produce into containers suitable for sale.

Postharvest Handling. Any operation performed after harvest constitutes postharvest handling. Among these operations are washing, grading, packing, storing, cooling, transporting, and marketing.

Precooling. Precooling is the practice of cooling bulk produce prior to grading and packaging although the term has been used to describe cooling at any time before transport. The practice of true precooling is gradually fading since precooled product has an opportunity to warm during subsequent operations. The broader term "cooling" has now almost replaced "precooling."

Room Cooling. Room cooling is the practice of storing bulk or packaged produce in a refrigerated room for an indefinite period. By the processes of conduction and convection, the heat is gradually removed from the produce. Because the outside of the containers cool more rapidly than the inside, the cooling is uneven and slow. The cooling rate of room cooling may be sufficient for many not very perishable produce items such as potatoes, cabbage, or root crops, however, it has proven unsatisfactory for many very perishable items such as strawberries, blueberries, and snap beans.

Shipper. An individual or company that transports produce from the grower to the buyer. Growers, packers, or buyers often assume their own shipping function.

Slip Sheet. A sheet of material, roughly the size of a pallet, of corrugated fiberboard, plastic, or a combination of these materials designed as a replacement for a shipping pallet.

Stacking Strength. The ability of a container to resist a specified vertical load without significant deformation.

Weight Packing. Packing method where a specified minimum weight, but not necessarily number of produce items, are packed in a container.

Vacuum Cooling. When warm produce is placed inside a closed container and reduced to a partial vacuum, a small portion of the water in the produce evaporates, causing a cooling effect. Vacuum cooling is fast and may be utilized very effectively on packaged produce. It is generally more effective on those items with a large surface area to weight ratio such as lettuce and various greens.

Vibration Fill Packing. A packing method designed to reduce bruising and scuffing of the produce. After filling, the package is gently vibrated to maximize product density and stability.

Volume Fill Packing. Packing method where a specified volume of produce is packed in the container. Both the number of individual produce items and the weight may vary in volume fill packing.

References

Ashby, B.H., et al. 1987. Protecting perishable foods during transport by truck, Handbook no. 669. USDA, Office of Transportation. Washington, DC.

Erdei, William H. 1993. Bar codes: design, printing and quality control. McGraw-Hill, New York.

Hardenberg, R.E., A.E. Watada and C.Y. Wang. 1986. The commercial storage of fruits, vegetables and florist and nursery stocks. USDA Handbook 66 (revised). Washington, D.C. GPO.

McGregor, B.M. 1987. Tropical Products Transport Handbook, Handbook no. 668. USDA, Office of Transportation. Washington, DC.

Mitchell, F.G., R. Guillou and R.A. Parsons. 1972. Commercial cooling of fruits and vegetables, Manual 43. California Agricultural Experiment Station. Davis, CA.

Moline, H.E., ed. 1984. Postharvest pathology of fruits and vegetables: postharvest losses in perishable crops, publication NE-87. California Agricultural Experiment Station, Davis, CA.

Nicholas, C.J. 1985. Export handbook for U.S. Agricultural Products, Handbook no. 593. USDA, Office of Transportation. Washington, DC.

Nonneck, l .L. 1989. Vegetable Production. Van Nostrand Reinhold Company. New York.

O'Brien, M., L.L. Claypool, S.J. Leonard, G.K. York and J.H. McGillivray. 1963. Causes of fruit bruising on transport trucks. Hilgardia, vol. 35, no. 6. University of California. Davis, CA.

Paine, F.A., ed. 1987. Modern Processing, Packaging and Distribution Systems for Food. Van Nostrand Reinhold Company, New York.

Patchen, G.O. 1969. Effects of vent holes on strength of fiberboard boxes and fruit cooling rate, ARS 52-34. USDA-ARS. Washington, DC.

Parsons, R.A., F.G. Mitchell and G. Mayer. 1972. Forced-air cooling of palletized fresh fruit. Transactions of the ASAE. 15(4):729-731.

Pierce, L.C. 1987. Vegetables: Characteristics, Production and Marketing. John Wiley and Sons. New york.

Stephens, J.M. 1988. Manual of Minor Vegetables, Bulletin SP-40. University of Florida. Gainesville, FL.

Stokes, D.R. 1974. Standardization of shipping containers for fresh fruits and vegetables, Handbook no. 991. USDA-ARS. Washington, DC.

1993. Uniform voluntary standard for wooden pallets. National Wooden Pallet and Container Association. Washington, DC.

1982. Wirebound boxes and crates, Bulletin 419. Package Research Laboratory. Rockaway, NJ.

1992. Fibre Box Handbook, 20th ed. Fibre Box Association. Rolling Meadows, IL.

This publication was sponsored by the Energy Division, North Carolina Department of Commerce, with State Energy Conservation Program funds, in cooperation with North Carolina State University. The opinions, findings, conclusions, or recommendations expressed herein are those of the authors and do not reflect the views of the Energy Division, North Carolina Department of Commerce.

Authors

Mike Boyette
Philip Morris Professor Biological & Agricultural Engineering

D. C. Sanders
Extension Horticulture Specialist Horticulture

G. A. Rutledge
Senior Research Associate Food Science

Publication date: Sept. 1, 1996
AG-414-08