Field packing and packinghouse operations

Introduction

All fruits and vegetables require a series of treatments between harvesting and final packaging. Packing operations can be categorized into fielding packing and packinghouse packing. Selection of a particular method to take the produce from farm to consumer depends on several factors like perishability and value of crop. Field packing can be as easy as harvest and pack it directly into containers directly by only pickers or as complex as using some designed packing machines. Packing in packing house usually more complex since huge machines are usually used.

The packing operations differ from crop to crop. The packinghouse operations usually include washing, pre-cooling, trimming, waxing, sorting/grading, vapor treatment, irradiation, chemical treatment etc. Not all crops require all stages of these packing operations, while some crops may need more operations to maintain good quality. Washing is always applied to root and tuber crops to remove soils. Waxing and grading of fruits are efficient marketing strategy. Packaging can reduce physical damages during fruits shipment.

In this report, field packing and packinghouse packing technologies will be introduced and further discussed using different examples.

FIELD PACKING

Due to their soft and tender texture, some fruits and vegetables are harvested and packed in the field to reduce the physical damages and storage rot. Field packing refers to pick, sort and pack fruits or vegetables directly into the shipping or commodity container by pickers in the field.

Field packing can be completed by picker only, picker and packer together, or picker with complex machine. Strawberry field-packing uses the simplest mode—picker only. In Hinton Farms, strawberry are harvested and packed in the field. Pickers pick strawberry according to their the degree of maturity and put them into clamshells directly in the field. When a flat, containing 8 clamshells, is filled, pickers carry it to loading truck. A supervisor visually inspects packed strawberries before loading and record the number of trays completed by each picker for payment. Usually, blueberry and blackberry are also packed in this way.

Figure 1. Strawberry field packing in Hinton Farms

"Avenue packing" is another field packing method. In this system, both pickers and packers are needed. Pickers pick and trim the fruit and put them into field lugs, which is transferred to the packer when it is filled. Packers work on a working table located in the avenue between blocks in the field. They are responsible to further inspect the fruit and pack them into certain packages. Table grapes are packed using this field packing method.

Figure 2. Table grape harvesting and packing.

(Cited from www.fao.org/inpho/content/compend/text/ch34/Ae615e03.htm)

Some vegetables are packed with designed field packing facility as showed in the following picture. The harvesting crew work behind the harvest aid or wrapping machine. Harvesters cut and trim the lettuce with a long knife. Packers package the lettuce in a cardboard carton or wrap the lettuce with cellophane or bagging when required.

Figure 3. Harvest crew cutting and packaging lettuce near Yuma, AZ

(Cited from http://ag.arizona.edu/crops/vegetables/cropmgt/az1099.html#harvest)

Discussion---Field Packing

Field packing system minimizes re-handling of fruits and vegetables. The time from picking to cooling can be as short as 1 hour. In addition, there is no need to have packinghouse for this system, which saves expense. However, it makes the quality control of the product more difficult than in the packinghouse since pickers may have different training experiences.

Cross-contamination is another consideration. No sanitation is applied during field packing process. Workers must be well trained for both how to identify mature crops and safety issues.

PACKINGHOUSE OPERATIONS

The common packinghouse operations are mainly dumping, washing, waxing, sorting, packaging.

Dumping

Dumping must be done gently, whether using water assisted methods or dry dumping. Wet dumping can decrease bruising and abrasions by using moving, chlorinated (100-150 ppm) water to carry delicate produce. When the product is dumped dry padded, sloped ramps or moving conveyor belts decrease injuries to the produce.

Truck dumping system

Figure 4. Truck dumping system

This type of system has lot of advantages like

- Less product damage, because it tilts at a smaller angle eliminating damage to the fruit and reduce labor costs.
- Metered discharge, Low maintenance
- Easy access

Citrus fruits are dumped in this fashion. Vegetables like beans, bell peppers and potatoes are also dumped in the same fashion.

Bin Dumping

The produce is brought in big bins and then is dumped into washing tank for further washing of vegetables. Tomatoes are generally brought in this fashion and dumped.

Washing

The fruits and vegetables should be cleaned before sorting to remove the foreign materials like dirt etc. Produce related concerns has increased in the recent years since most of the outbreaks have been related to leafy vegetables, tomatoes, melons, berries and unpasteurized juices. Some microorganisms associated with the outbreaks are *Escherichia coli* O157:H7, *Salmonella* species, *Listeria monocytogenes*, *Shigella*, Norwalk-like virus etc.

Washing can be done with just water or sanitizers may be added which have been proved to be antimicrobial. The various sanitizers used are hypochlorite, acidified sodium chlorite, chlorine dioxide, bromine, Iodine, trisodium phosphate, quaternary ammonium compounds, acids, hydrogen peroxide, Ozone, Irradiation (Parish et al., 2003). Chlorine is the most widely used sanitizing agent for fresh produce. There was 2log reduction of total microbial count when shredded carrots were prewashed with chlorinated water (Klaiber et al., 2004). Sequential washing of shredded lettuce and carrots with thyme oil and then with chlorine dioxide and ozonated water was found to be effective in killing *E. coli* O157:H7 (Singh and others 2002). Ozone and chlorine dioxide where found to be very effective in reducing the microbial load up to 5 log CFU/ml in apples, lettuce, strawberries and cantaloupes (Rodgers and others 2004).

Hypochlorite

This has a long history of usage on many produce commodities. This is commonly used in the range of 50-200 ppm for 1-2 min. There are some limitations like corrosion of epuipment, sensitive to light, air and temperature and pH dependent.

Acidified Sodium Chlorite

This has greater efficacy than hypochlorite due to its low pH and can be used in the range of 500 to 1200 ppm.

Chloride dioxide

Use depends on different food produce like 5 ppm on vegerables and whole fruits, 1 ppm on peeled potatoes. It has better anti microbial activity when compared to hypochlorite at neural pH. It is not permitted for cut produce.

Trisodium carbonate

This sanitizing agent is less corrosive to other sanitizing compounds and has a very high pH. It is used occasionally on fresh market citrus.

Acids

They are very economical and antimicrobial effect depends on the type of acid and strain of microorganism. Phosphoric acid is very commonly used on citrus at about 200 ppm.

Ozone

Ozone has broad spectrum, good penetration and effective at low concentration and applied only for a short period of time, but is corrosive to equipment, may have toxic effects on humans. Physiological damage to produce is also possible. This is effective on pathogens reported on fruits and vegetables.

Various types of washers are available for commodities such as apples and potatoes, leafy vegetables, broccoli, root vegetables, corn etc. These include brush rollers, pressure washers, hydro air agitation wash tanks and immersion pipeline washers.

Flume washing

Figure 5. Flume system of washing vegetables

The flume system type of washing contains tanks or long conveyors of water. Turbulence is created at the water injection to turn the produce and expose all of its surfaces to the water for effective cleaning. This type of washing can be used to wash all fruits and vegetables including leafy products. In the field trip, we saw this type of washing for beans and bell peppers. This system is easy to install and maintain. The agitation of the product gives an improved method of wash.

Immersion pipeline washers

Figure 6. Immersion pipeline washers

The action of this system thoroughly washes leafy greens, cut produce, and whole vegetables. The product is kept underwater with unobstructed movement. Perforated sand trap helps in trapping all the debris which can be flushed out through a clean-out port. It is easy to clean with complete access to piping through sanitary pipes and valves

Brush Rollers

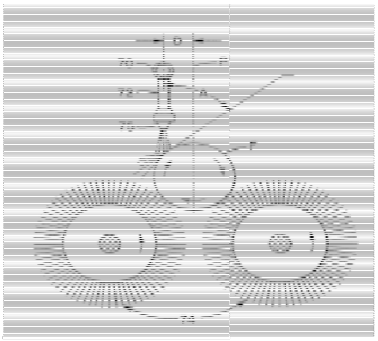

Figure 6. Mechanism of brush roller

Roller brushes are used in many industrial applications where continuous filament movement creates the proper brushing action. From cleaning conveyors to polishing fresh produce, roller brushes are effective in applying coatings or removing debris for varied surfaces and shapes. The water with or without sanitizing agents under high pressure is discharges into conduit which connect with cross tubes. These vertical tubes at the end are provided with an orifice which produces a fan-shaped spray pattern. The fruit or vegetable is supported on the brush rollers and are washed by the mechanical movement of the brush rollers.

Figure 6. Brush used in brush rollers

Discussion---Dumping and Washing

Dumping of product may cause injury to the fruit which is a serious concern and leads to spoilage. Harvesting should be done at cooler parts of the day and then the produce should be shifted to the packinghouse as soon as possible. Harvesting during or after rain causes increase in microbial activity when brought to the packinghouse. Washing of fruits and vegetables is done to reduce microbial load and remove any debris present on the produce. However, there are concerns that use of brush for washing can increase water loss from fruits like citrus.

Waxing

Quality retention of horticultural crops is a major topic in postharvest researches. Various techniques are applied to preserve quality of fresh fruit and vegetables, including controlled atmosphere (CA), refrigerated shipment and storage. Waxing is also used to preserve

quality of harvested horticultural crops, such as citrus, apple and tomato. Waxing can not only improve cosmetic appearance of fruits and vegetables, but also can slow down senescence and increase shelf life by reducing water loss, covering injuries, and decreasing respiration and transpiration rates (Verma, 2000)

Waxing refers to the application of waxes on the surface of fruits and vegetables (Verma, 2000). Waxes are natural or synthetic organic compounds, which are insoluble in water but soluble in petroleum based solvent. Natural waxes are typically esters of fatty acids and monohydric alcohols. Synthetic waxes are hydrocarbons without functional groups. Waxes act as a protective layer for fruits and vegetables.

Types of wax

- A desirable wax for horticultural crops should have following characteristics (Kader et al., 2002; Sudheer et al., 2007)
- It must be approved as "food grade" materials.
- It should not induce off-flavor problem of produce.
- It should reduce at least 30% weight loss of commodity.
- Waxed produce can be dried rapidly and waxes can be cleaned up easily.
- In addition, low price is also a desirable factor of good waxes. There are different ways to sort waxes. According to their usage, waxes are classified as storage wax, pack-out wax and high-shine wax. Storage wax is used when produce are not to be marketed immediately, while pack-out wax is used in the opposite case. High-shine wax is specific to produce with high grace demand in market.

Waxes are categorized into solvent waxes, water waxes and paste or oil waxes according to their components. Solvent waxes are composed of 70-80% aliphatic hydrocarbon and aromatic hydrocarbons and solvents. They are used most widely in produce, especially citrus. Resin solution and emulsion waxed are most commonly used water waxes. Emulsion waxes are natural waxes such as carnauba or paraffin or synthetic wax, for example, polyethylene emulsion. Paste or oil waxes, composed of paraffins, are always used on vegetables.

The commonly used commercial waxes include paraffin wax, carnauba wax, bee wax, shellac, wood resins, polyethylene, and their mixture (Verma, 2000). Recent researches indicated that sheabutter is another potential food grade wax for oranges and plantain because it more efficiently reduces postharvest loss and extend pre-climacteric and shelf life. Furthermore, it has no safety or residue concern, which meets the increasing demand of no post-harvest chemicals in fruit treatments (Sugri et al., 2010; Adetuyi et al., 2010).

Wax application and methods

Waxing uniformity is a major consideration during wax application. To guarantee the uniformity, was should be applied at the rate of 1.5 litres/tone of fruit. It cannot be diluted by water and should be sprayed or dripped on to produce evenly by using brushes. There are five wax application methods. Low pressure spraying such as spinning head, is the most popular one. This method better controls quantity of wax used and evenly distribute wax by brushes. High pressure atomizing is another application method, in which volatile constituent of wax is passed on to produce when it comes from nozzle of atomizer, and then becomes chalking during drying. Dipping and flooding are two convenient wax application methods. However, the wax uniformity and wax performance are poorer due to the dilution of wax. Foaming is also used for waxing application (Sudheer et al., 2007).

Figure 7. Low Pressure Spray

Figure 8. Dipping

(Cited from http://www.useful-cn.com/en/exhview.asp?id=66)

A typical wax applicator is illustrated in Figure 9. The wool felt is used to distribute the liquid wax to the fruits or vegetables from a trough made to the same width as the belt. To reduce evaporation of wax from the felt, the felt is covered with a layer of heavy polyethylene sheeting. Brushes roll the fruits and evenly distribute wax on them.

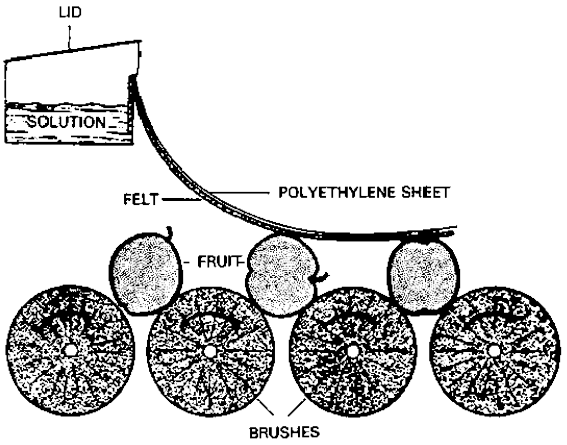

Figure 9. A Typical Wax Applicator

(Cited from http://www.fao.org/Wairdocs/X5403E/x5403e05.htm#waxing)

Citrus waxing was observed in Sun Harvest. The following picture shows the waxing device (Fig.10). Spraying method was used for the waxing application. Brushes help to pass wax on fruits evenly.

Figure 10. Waxing Machine in Sun Harvest

Discussion and analysis---Waxing

Waxing can replace natural waxes removed during postharvest treatments. It improves appearance of fruits and vegetables. It acts as a protective film, which reduces water loss, metabolism rate by decrease the availability of oxygen to tissues, and spoilage induced by chilling injury and browning of harvested crops. In addition, it protects produce from microbiological infection (Verma, 2000). Waxing has different effects on different kinds of

produce. Waxing was indicated to delay fruit softening and color development during ripening in mangoes (Baldwin et al., 1999). Maftoonazad et al. reported that waxed peaches have low respiration rate, moisture loss and other quality parameters such as firmness, acidity, pH (Maftoonazad et al., 2006). Protective carnauba wax application significantly reduces incidences of both brown rot and Rhizopus rot in nectarines and plums (Goncalves et al., 2010). For tomatoes, Waxing not only delays fruits postharvest loss, color development and ripening, also reduce the sensitivity of tomato fruit to chilling injury (Mejía-Torres et al.,2009).

However, the major disadvantage of waxing is the possibility of developing off-flavor of produce. This is caused by the restriction of O_2 and CO_2 exchange, which induces anaerobic respiration and increases ethanol and acetaldehyde levels. In addition, along with the increasing lobby of avoiding postharvest treatments with chemicals, edible coating is further explored. Comparing to traditional commercial wax, locust bean gum (LBG)-based coating performances good in controlling weight loss, improving color and reducing ethanol level of 'Fortune' mandarins (Rojas-Argudo et al., 2009).

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Drying

Drying is to remove excess moisture from outer skin and neck of fruits and vegetables to reduce storage rot. Fruits and vegetables need to be dried after washing and waxing with water emulsion. Two drying methods are used commercially to dry waxes and water on fruits and vegetables. Hot air (48 to 66 ^{0}C) drying is the traditional method. The most commonly used drying machine is convection dryers. Air is heated by water or gas using heat exchanger and recirculated. It takes only 2.5 minutes to dry a waxed orange in air at 49 ^{0}C. Cold air (0 ^{0}C) drying emerges recently. Some investigation indicates that no advantages of cold drying in apple quality during storage (Drake and Nelson, 1990). However, waxed pears with cold dried have better firmness and slower color development than those dried by hot air (http://postharvest.tfrec.wsu.edu/pages/PC97E).

Snap beans drying process was observed in Florida Specialist. The water of snap beans was mainly removed by high-speed conveyer shaking. Then they were packed directly into cartons. This method may remove most of water on washed snap beans. However, it cannot thoroughly dry the beans since the drying time is very short and it is difficult to avoid the

stacking of beans. The remaining water may cause serious storage rot problem.

Figure 11. Snap Bean Drying in Florida Specialist

Sorting

Significance of quality control

Quality of fruits and vegetables includes sensory attributes, mechanical properties, functional properties, nutritive values, chemical constituents, and so on. Producers will focus on high yield, ease of harvest, appearance, and the property of standing long distance shipment. Wholesale managers and retail sellers focus on the appearance, firmness and shelf-life of a produce. Consumers determine if they want to buy the produce or not by merely the appearance of the fruits and vegetables, for example, the color, shape, size, and freshness.

USDA standard for quality classification

To make a standard for the quality of fruits and vegetables, USDA developed the requirement for U.S. extra fancy, U.S. fancy, U.S. No. 1, U.S. utility, and combination produces. To meet a certain grade, the appearance (size, shape, color, gloss, and freedom from defects), texture (firmness, crispness, juiciness, meatiness, and toughness), flavor (sweetness, acidity, astringency, bitterness, aroma, and off-flavors), nutrition (sources of vitamins, minerals, and fiber) must meet certain requirements for specific fruits and vegetables. These requirements also provide a common language among growers, sellers, and researchers.

As an example, the following picture Fig. 12 gives a general idea of U.S. No. 1 potato size requirement, which was posted in Troyer Brothers potato packing house. Since the potatoes in this packing house were produced by themselves in the morning, fresh from the field, the requirement mainly focuses on size. It shows that the consistence of the size is the matter for separating the tomato into different grade. For example, for round variety potatoes of 2 inches diameter level, the diameter error must be within 3/8 inch, and for the ones of 4.5 inches diameter level, the diameter error must be within 1.5 inches.

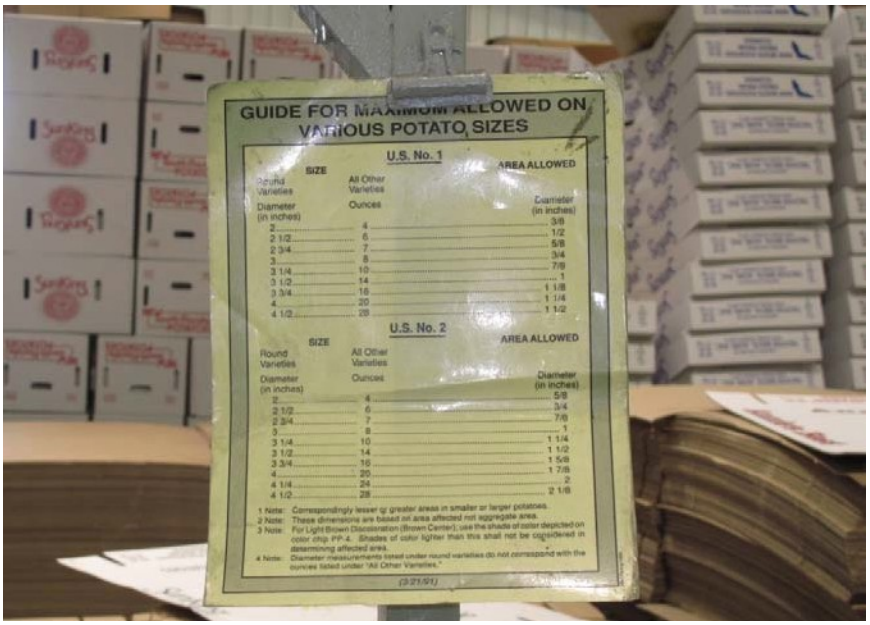

Figure 12. Standard of U.S. No. 1 (and No. 2) potato

Growers produce relatively continuous quality of fruits and vegetables due to standard nutrition input, pest control, and so on. The difference of appearance is the major issue. It decides directly whether consumers like the produce or not. Therefore, among all the packing houses during the field trip we visited, they mainly sort produces by appearance. In the example above, the potatoes are sorted by size. According to the manager's information, they will also pay attention to skinning problem. If the skin of a potato is rubbed off a lot, the potato should be removed from the conveyor.

Sorting methods

In actual packing house, grading fruits and vegetables can be either machinery sorting or manual sorting. In the past, labors were widely used along the packing line to insure the quality of fruits and vegetables. All produces with unacceptable appearance, such as small size, color

defection, blemishes, would be removed manually along the conveyor. Different sizes were also collected by labors. Nowadays, due to the property of some produces, manual sorting is still in use in many conditions.

Manual sorting

One simple manual sorting example is the sorting of strawberry. Strawberries are hand-picked and field-packed. The main reason is that the texture of strawberry is soft and easy to damage. To prevent too much loss of the produce, strawberry growers prefer manual sorting and packing in the field. Workers collect strawberries by the red color percentage on the surface of the strawberry. Only the strawberries with 75% or more red area percentage can be admitted to the market. Before getting on the truck, which transfers the strawberry flat to the cooling house, some of the strawberry clamshells will be opened randomly by the supervisor for quality control. If fruits in the clamshell do not meet the requirement, the clamshell is pulled out as an exception. But it depends on the judgment of the supervisor. Also fruit damage happened when the labors fitted the strawberries in the clamshells.

Figure 13. Field-sorted Strawberries

Some vegetables are difficult to grade. In this condition, labors are used for merely picking out the damaged produces and debris coming from the transporting equipment. Green bean is a good example of this kind of produce. A heavy loaded conveyor of green bean is only supervised by two to three workers, whose job is to pick out the broken beans and debris, such as leaves, branches. The sorting of green beans is shown in Fig. 14

Figure. 14 Sorting of green beans

Mechanical sorting

However, due to high cost of labor and the requirement of improved working environment for workers, more machinery sorting systems are being used in recent years.

Image processing, in other words machine vision, is developed for the detection of color, shape, and blemishes. Color is the basis for sorting products such as tomatoes. RGB image is the most widely used color model in image processing. It includes the information from the three color channels: red, green, and blue. By analyzing each color channel or color combination of the image, color, size and blemish information can be obtained easily. For actual use in packing house during the field trip, the images were used for detecting blemishes and sizes. In the Troyer Brothers' packing house, the potatoes were sorted by both cameras and labor. Potatoes were first sorted by their diameters in the photos, which were taken by six cameras, and then double-sorted by labor to make sure no exceptions in the grade. In Sunharvest Gift Fruit Market, citrus was first loaded from the truck, went into the conveyor to get cleaned, dried, and waxed. Then labors were sitting along the conveyor to pick out damaged fruits. Before they were sorted into different grade boxes, the citruses went through a box with sufficient illumination and taken pictures by four cameras. On the screen of the sorting machine, the operator could see

how each citrus was sorted. Color, size, and percent of blemishes were all detected. The threshold for color, size, and blemish percentage were input to the system as the standard, and the system will separate the citruses into various size stages. The ones with large blemish percentage or too small size would be delivered to the end of the conveyor and thrown into a huge white plastic bin. They use black band on top of each bin to protect the high quality fruits from being damaged when falling into the bins. Fig.15 shows the detailed working procedure of the gift fruit sorting line. Many vision systems are available in the market for sorting fruits and vegetables. This technique is being widely used for either small retailers or huge processing manufacturers, such as Tropicana Juice Cooperation. However, since some of the programs have user interfaces that are not friendly enough, it usually takes a lot of time for the packing house to figure out how to operate and maintain the mechanical system.

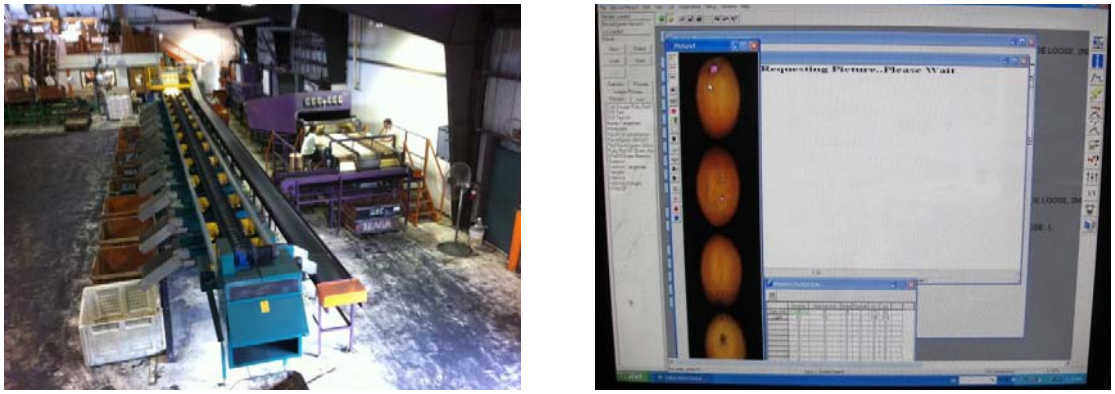

Figure. 15 Working procedure in the gift fruit market packing house

Another way of mechanical sorting is to design a conveyor with different size of holes on it. When the fruits or vegetables travel on the conveyor, they will fall down to grading conveyors, which are orthogonal to the top conveyor. As the fruits and vegetables travel further, only the ones of big size can be left on the top conveyor and finally fall down to the conveyor of the highest grade. In Six L's tomato packing house, the working procedure as described above is shown in Fig. 16. We can see the tomatoes of the largest size, meaning of the highest quality, travel the longest distance to get sorted. This may cause damage to the tomatoes, or decrease the shelf life of the highest grade tomatoes.

Figure 16. Tomato sorting system

Optical properties are also being researched by scholars for deciding the quality of produces. The principle of this technique is that light reflected from the product carries spectral information. That is, the reflectance of some wavebands is highly related to the color or content of a specific nutrient, such as sugar content, acidity of fruit, protein content, and so on. Also the decision can be made based on transmittance, absorbance, or scatter of light on the surface of a produce.

Discussion and conclusion

- Manual sorting is widely applied among produces which are delicate, easy to damage, or too difficult to sort by machinery. Since the sorting is controlled by human eyesight, the quality control is within an acceptable error range. But the problems are: labor cost is much higher than that of machinery sorting; manual sorting can be very subjective; damage to delicate produce cannot be thoroughly avoided.
- Mechanical sorting is developing very fast since it has a lot of advantages. Also the packing houses have many choices of machines from various machinery companies. Some advantages include low cost, uniform quality control. However, there are still many problems with mechanical sorting, such as damage to produce, for which the tomato sorting is good enough to prove. Also misclassification happens and labors are needed for double-

checking. In addition, due to the technology applied in mechanical sorting, some programs are difficult for the packing house to easily access. It may take a lot of time for the packing house to get the machinery work properly.

Packing (Boxing)

After sorting, the produce needs to be transported to the sealing area. In the past, people put there produce in wood boxes and transport it. Nowadays, the produce is put in an appropriate box with an optimum dimension to increase the shelf life of the produce. Meanwhile, many waxed boxes are resistant to moisture. There are many types of boxes such as corrugated fiberboard box with wax or without, plastic boxes etc. These boxes made in different dimension depending on the type of the produce and the amount of the produce is packed.

The boxing operation can be divided into two different types: hand packing and mechanical packing.

Hand packing operation

There are two reasons for using this type of packing: first, the price of the produce cannot meet the expense of the mechanical packing. Second, the produce need an additional care for packing it which may not be possible in machine packing (Kader et al. 2002).

In the hand packing, when the produce is ready for packing, the labor will put it in a suitable box carefully to keep these produce in a healthy environment so it will have longer life. The produce is packed, weighed, inspected and labeled by the, as shown in these pictures.

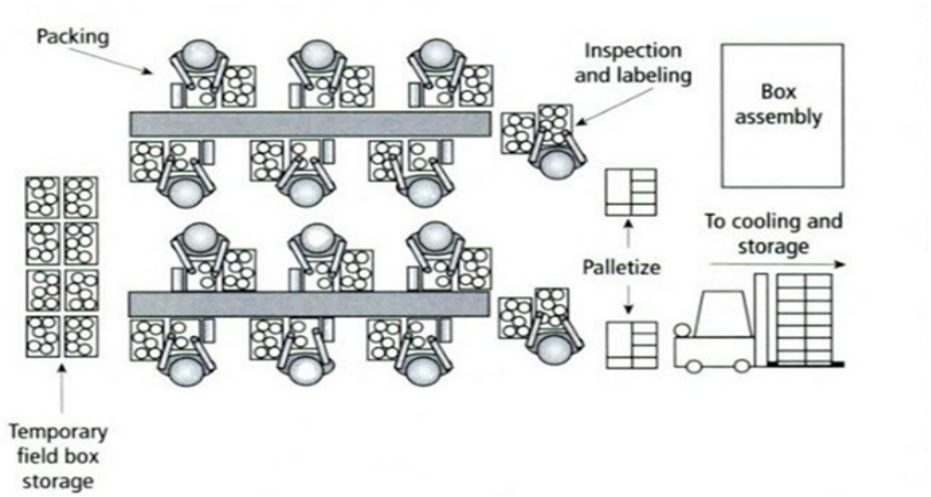

Figure 17. The hand packing operation and inspection

Figure 18. Hand packing for cabbage using waxed boxes and weighing by the mechanical scale
These two pictures were taken in the Hearne Produce.

The side wall of the box must be strong to carry many boxes above it, otherwise will affect the quality of the produce. The box should be resistant from moisture. Finally, the box should be clean free from dirt for safety of the produce.

Mechanical packing

In this system will be used a machine for filling the boxes after the produce was sorted. In the same time, the boxes collected and moved one by one on a roller conveyor at a certain point the container will be stopped to fill with the produce for certain time or by using a load cell to give the machine an order to move it to fill the next box. This system is usually deals with a huge amount of produce each day with a high speed for filling (Kader A.A. et al. 2002). In addition, there are some disadvantages for this system which are: first, it cannot deal with a sensitive produce. Second, the produce gets some impact because dropped from a high place while filling in the box. Third, the initial cost for this machine is high.

As shown in the pictures below were the potato drop from a high approximately 3-4 feet. In the beginning this impact will be unseen for many days but after that it will be seen as a dark spot when cut this potato.

Figure 19. The mechanical packing for potatoes. These two pictures were taken in the Troyer Brothers.

Discussion --- Packing (Boxing) Operation

The hand packing for the cabbage was overfilling the boxes over the maximum capacity which leads to damage some heads after putting many boxes over this box. As a solution for this problem they can chose small heads in the top to not exceed the maximum or make the boxes bigger.

Figure 20. The mechanical and manual packing for tomato. These two pictures were taken in the Six L's Packing

As shown in these pictures above that the operation for mechanical packing for a small size tomato in a plastic box, all the steps are done by the machine except collecting these small boxes in to a big box is done by labors. This operation keeps the produce clean and protects it from contamination. The machine must be cleand every day to remove all the dirt. In addition, the mechanical packing for the green beans have some disadvantage like the machine losses in packing mechanism as shown in the picture above. A solution for this is to reduce the time to fill the boxes to prevent overflow of the product.

Figure 21. Mechanical packing for green bean **Figure 22. Covering operations for the boxes**

These two pictures were taken in the Florida Specialties.

Also, the potatoes drop from a height (3-4 feet) during the packing operation. In the beginning this impact will be unseen for many days but after that it will be seen as a dark spot on the potato, as a solution of this they can put some cushioning to reduce the velocity of the impact.

Conclusion

Packing of fruits and vegetables reduces significant wastage of crops, providing protection from mechanical damage, undesirable physiological changes and microbial disintegration during storage and transportation. Flavor and freshness can be maintained for a longer time by proper packing of fruits and vegetables and increase their shelf life. Weight loss is a major disadvantage in fruits and vegetables and this can be overcome by moisture retaining packaging, especially for leafy vegetables and root crops. Moisture proof cellulose film reduces weight loss in tomatoes to one fourth than those non-wrapped tomatoes. The following picture briefly summarized the packinghouse operations from fruits or vegetables receiving to cooling. To maintain good quality of produce using postharvest treatment, each stage of packing operations should be designed and completed very carefully.

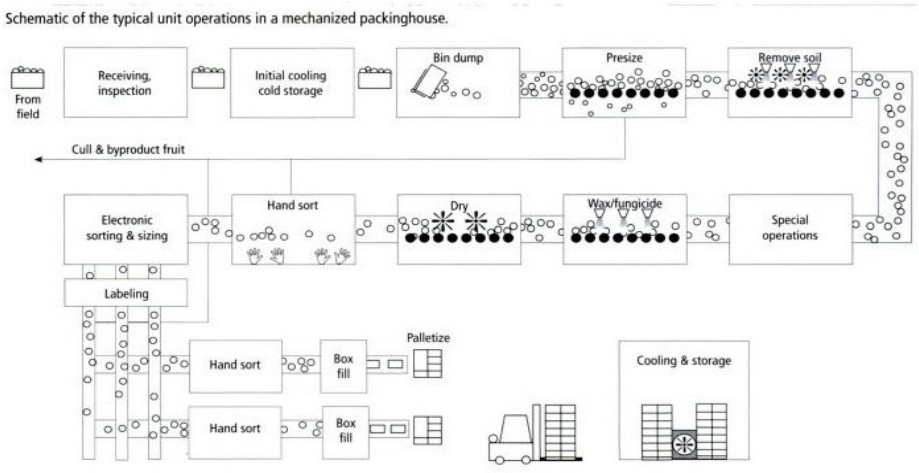

Figure 23. The packinghouse operations (Kader A.A. et al. 2002).

Remarks: For the report, introduction, dumping and washing are completed by Sweeya; Field packing, waxing, drying, conclusion and finalization are completed by Tingting; Sorting is finished by Ce; Packing part is done by Mahmoud.

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