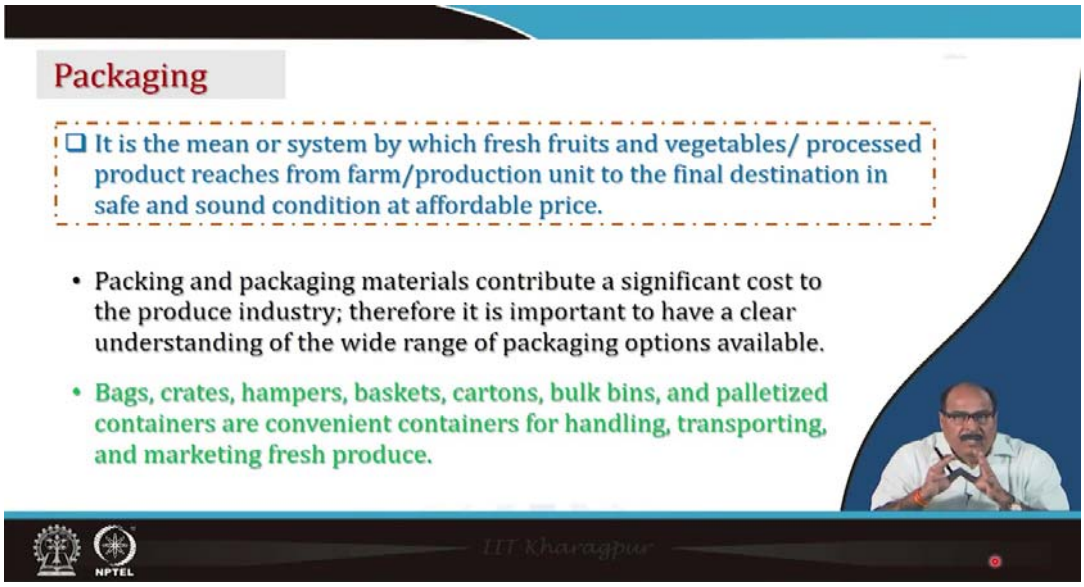
Post-Harvest Operations and Processing of Fruits, Vegetables, Spices and Plantation Crop Products

Professor H. N. Mishra
Agricultural and Food Engineering Department
Indian Institute of Technology, Kharagpur

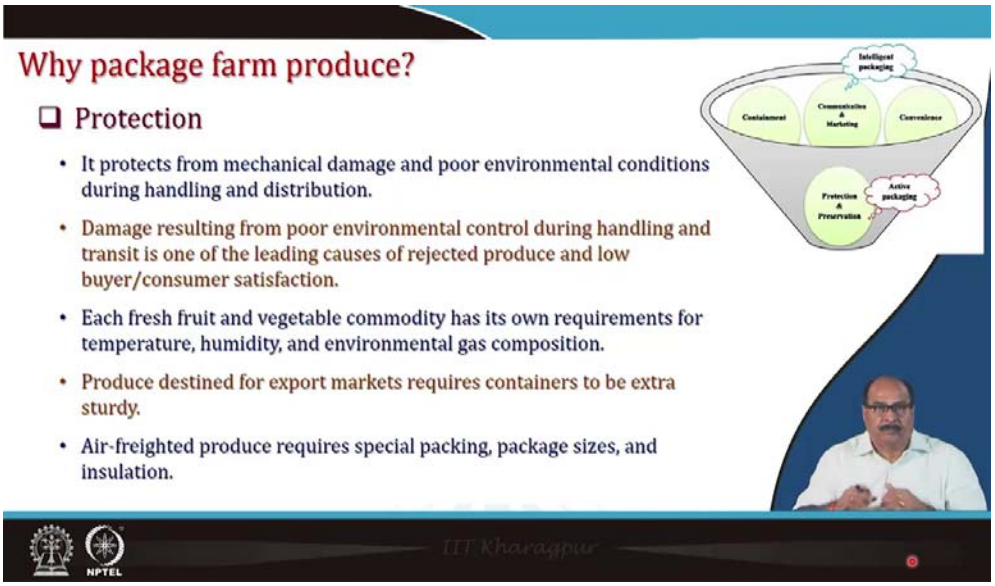
Lecture 19
Containers and Packaging Materials for Fresh Produce

This lecture covers containers and packaging requirements of fresh produces, selection of container and packaging materials, container used for packing fresh fruits and vegetables, packaging materials and technologies for press produces.



Packaging

It is the mean or system by which fresh fruits and vegetables/ processed product reaches from farm/production unit to the final destination in safe and sound condition at affordable price. Packing and packaging materials contribute a significant cost to the produce industry; therefore it is important to have a clear understanding of the wide range of packaging options available. Bags, crates, hampers, baskets, cartons, bulk bins, and palletized containers are convenient containers for handling, transporting, and marketing fresh produce.



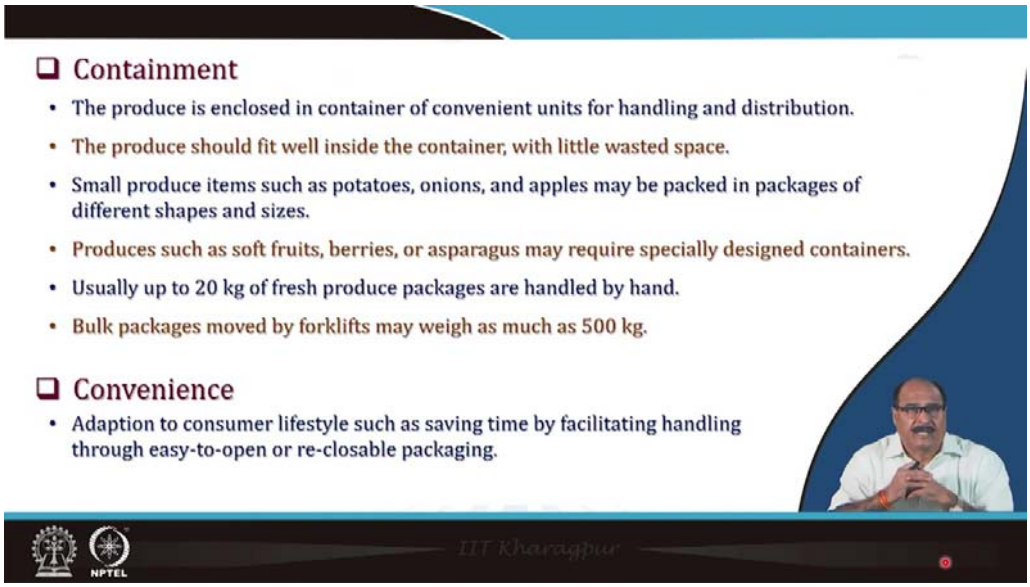
Why package farm produce?

Protection

It protects from mechanical damage and poor environmental conditions during handling and distribution. Damage resulting from poor environmental control during handling and transit is one of the leading causes of rejected produce and low buyer/consumer satisfaction. Each fresh fruit and vegetable commodity has its own requirements for temperature, humidity, and environmental gas composition. Produce destined for export markets requires containers to be extra sturdy. Air-freighted produce requires special packing, package sizes, and insulation.

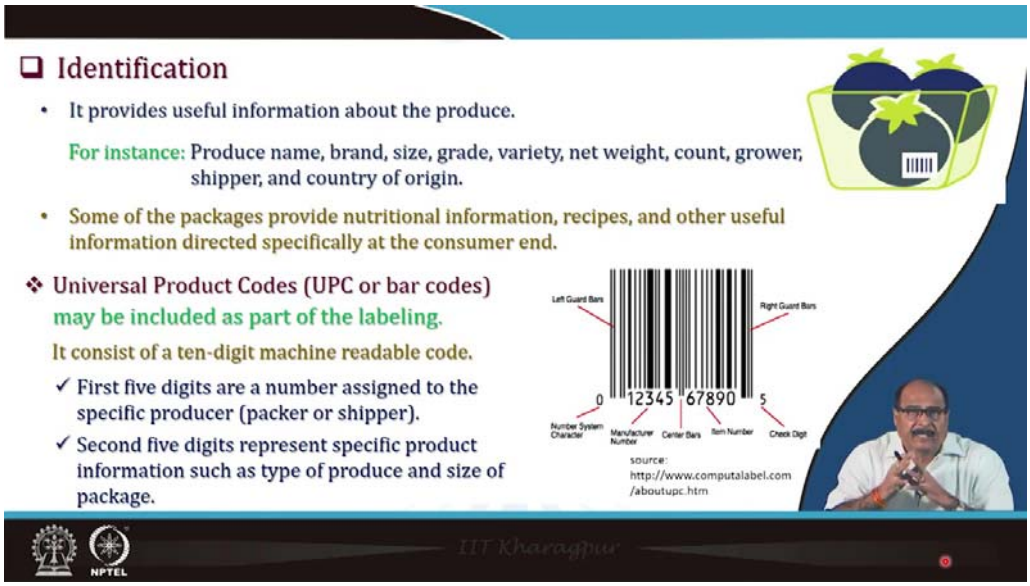
Containment

The produce is enclosed in container of convenient units for handling and distribution. The produce should fit well inside the container, with little wasted space. Small produce items such as potatoes, onions, and apples may be packed in packages of different shapes and sizes. Produces such as soft fruits, berries, or asparagus may require specially designed containers. Usually up to 20 kg of fresh produce packages are handled by hand. Bulk packages moved by forklifts may weigh as much as 500 kg.



Convenience

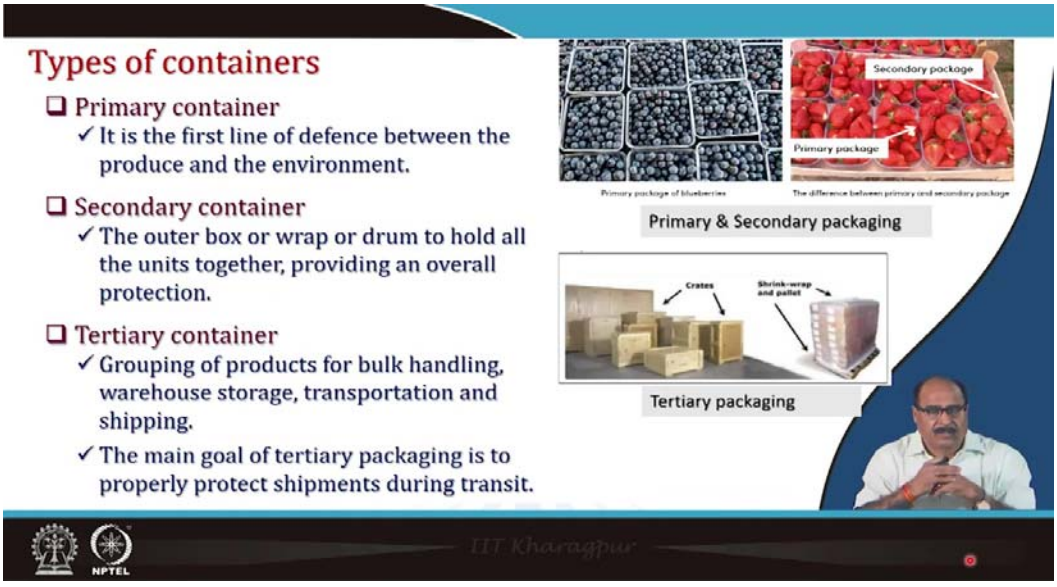
Adaption to consumer lifestyle such as saving time by facilitating handling through easy-to-open or re-closable packaging.



Identification

It provides useful information about the produce. For instance: Produce name, brand, size, grade, variety, net weight, count, grower, shipper, and country of origin. Some of the packages provide nutritional information, recipes, and other useful information directed specifically at the consumer end. Universal Product Code, UPC or bar codes may be included as a part of the labeling. It consists of ten-digit machine readable codes. The first five digits are a number assigned to the specific producer (that is packer or shipper) and the second five digits represent the specific product information such as type of the produce, and size of the package, etc.

The packaging materials should be non-toxic and compatible with the specific produce being targeted to be packaged, it should be having sufficient resistance to temper, ease of opening and disposal, it should be low cost, adherence to the standards in shape, size and weight limitations, provide protection against moisture, air and light to the commodity, should be appealing in appearance, and printability and more importantly, it should be recyclable or it should be as far as possible, biodegradable.

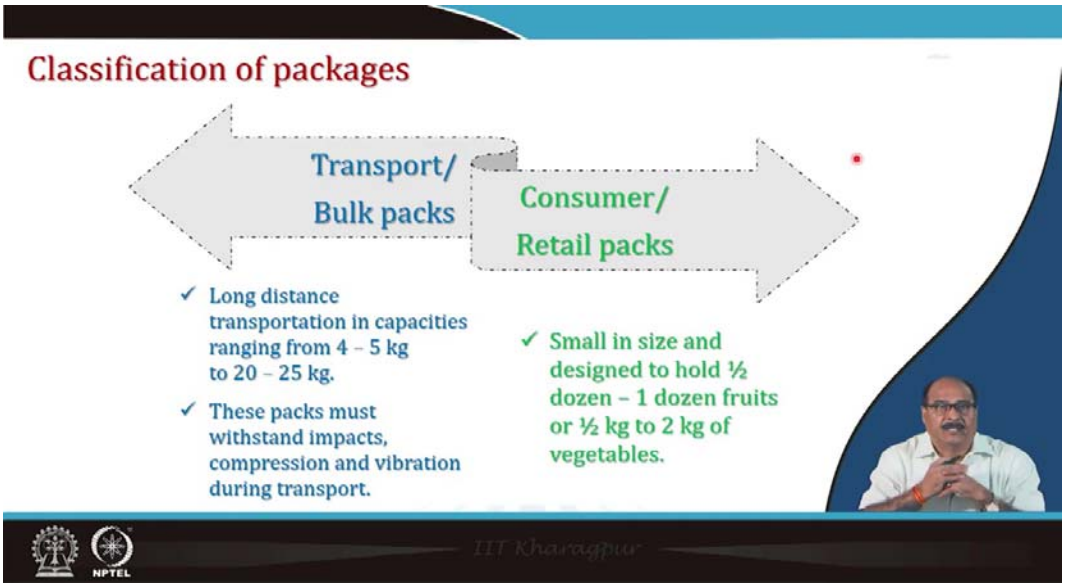


Types of containers

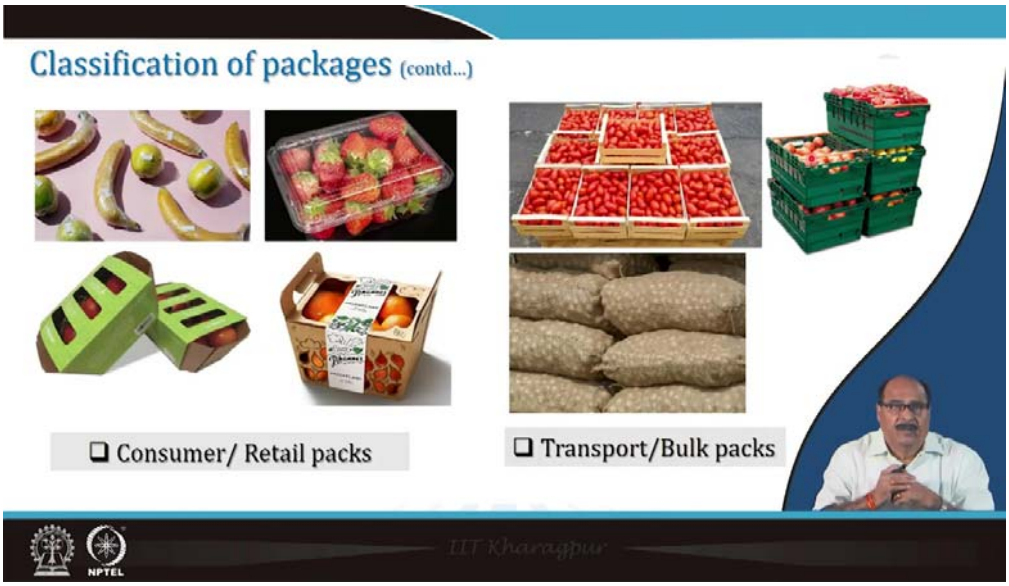
Primary container: It is the first line of defence between the produce and the environment.

Secondary container: The outer box or wrap or drum to hold all the units together, providing an overall protection.

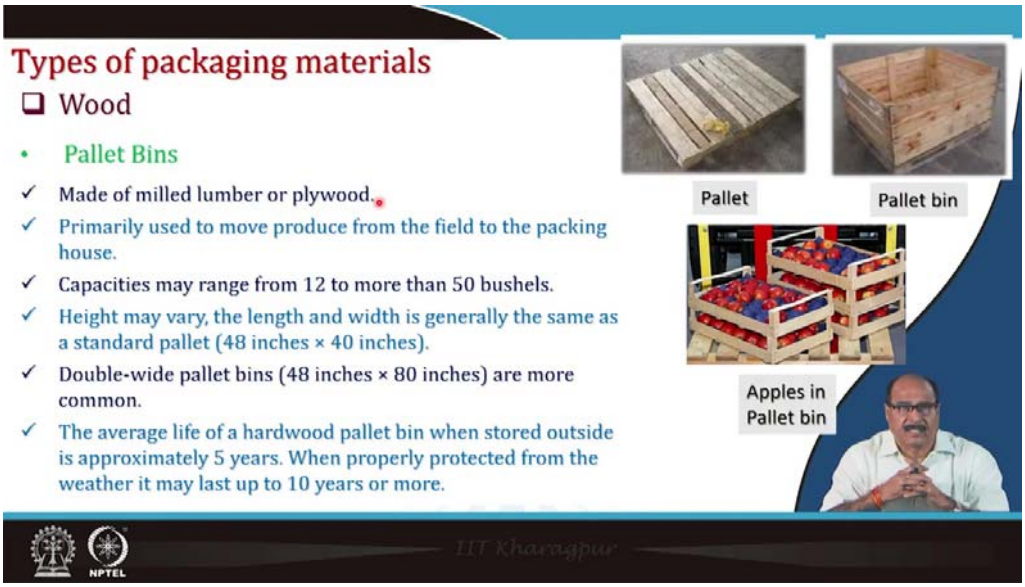
Tertiary container: Grouping of products for bulk handling, warehouse storage, transportation and shipping. The main goal of tertiary packaging is to properly protect shipments during transit.



The package may be classified as transport or bulk packs, which is used for long distance transportation in capacity ranging from 4-5 kg to 20-25 kg and these packs must withstand impact, compression and vibration during the transport, and the consumer or retail packs, which are small in size and designed to hold half a dozen, to 1 dozen fruit or half kg to 2 kg of fruits or vegetables.



The images of consumer/retail packs and transport/bulk packs for fruits and vegetables are presented in this slide.

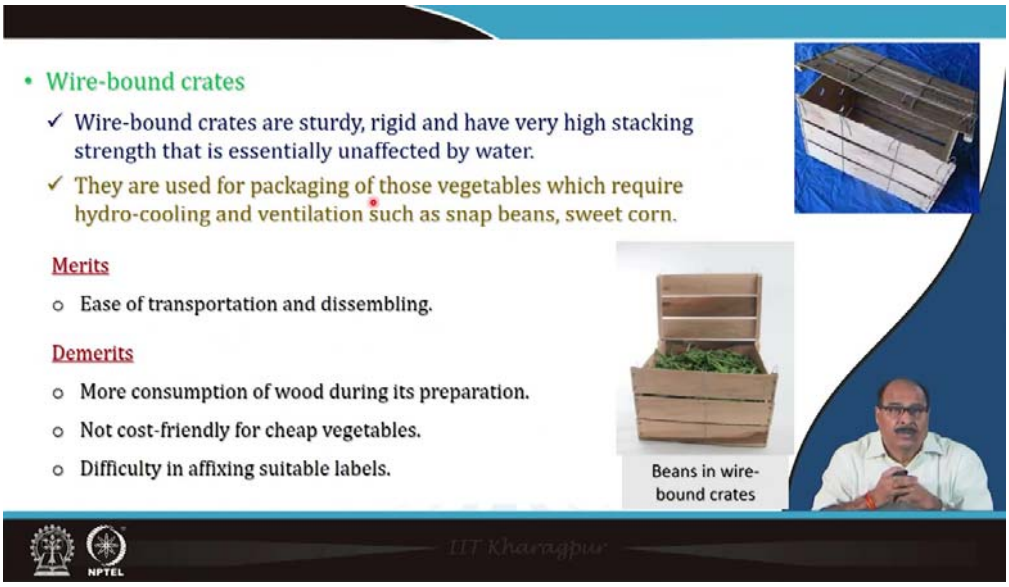


Types of packaging materials

Wood

Pallet bins

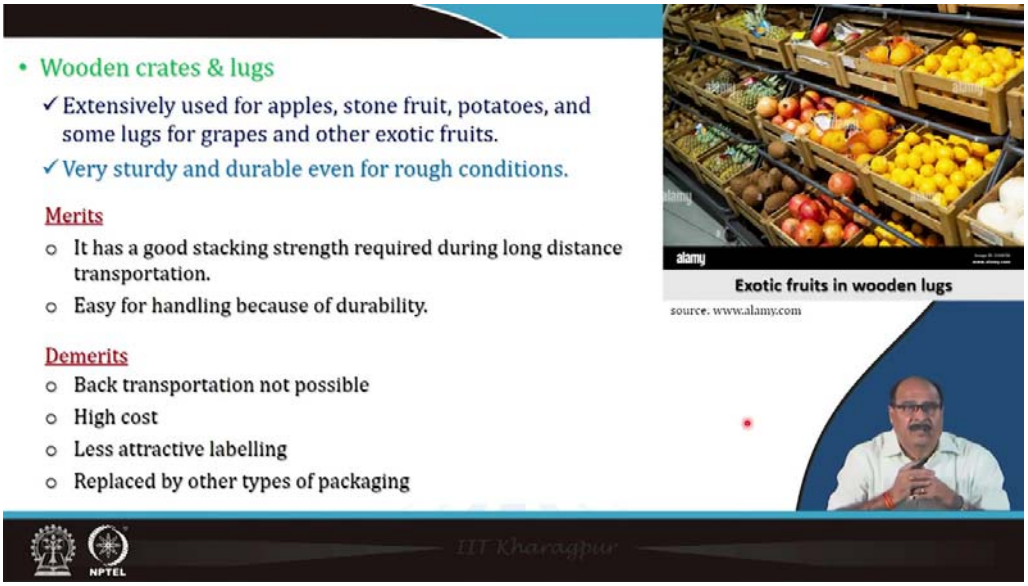
These are made of milled lumber or plywood. These are primarily used to move produce from the field to the packing house. The capacities may range from 12 to more than 50 bushels with height may vary, the length and width is generally the same as a standard pallet (48 inches × 40 inches). Double-wide pallet bins (48 inches × 80 inches) are more common. The average life of a hardwood pallet bin when stored outside is approximately 5 years. When properly protected from the weather it may last up to 10 years or more.



Wire-bound crates

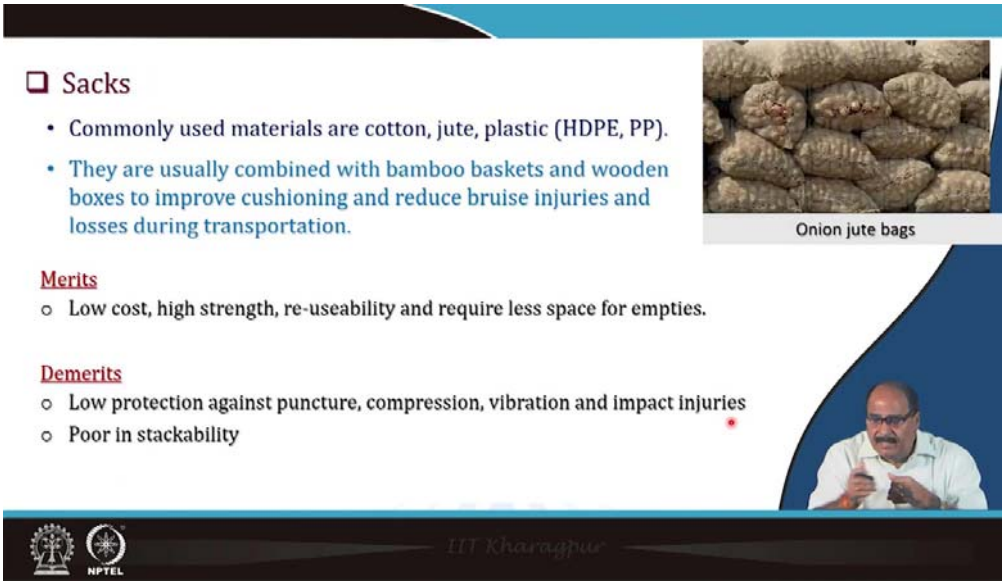
Wire-bound crates are sturdy, rigid and have very high stacking strength that is essentially unaffected by water. They are used for packaging of those vegetables which require hydro-

cooling and ventilation such as snap beans, sweet corn. The merits are like ease transportation and dissembling. However, it has demerits like it requires more consumption of wood during its preparation, it is not cost-friendly for cheap vegetables and also there is difficulty in affixing suitable labels.



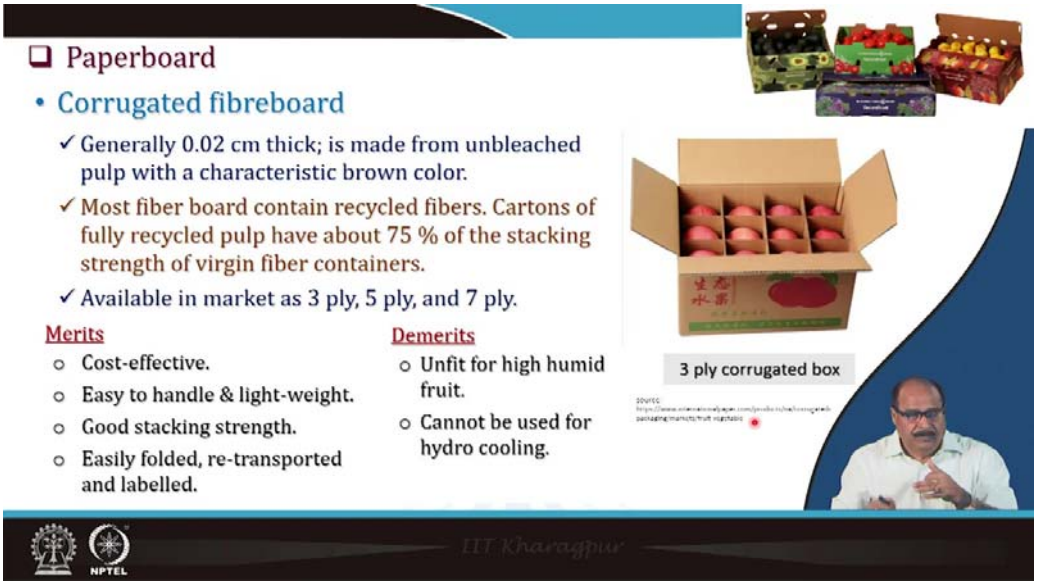
Wooden crates & lugs

These are extensively used for apples, stone fruit, potatoes, and some lugs for grapes and other exotic fruits. These are very sturdy and durable even for rough conditions. It has a good stacking strength required during long distance transportation. It is also easy for handling because of durability. However, the bulk transportation of this type of packages are not possible, it involves high cost, less attractive labeling and it is replaced by other types of packaging.



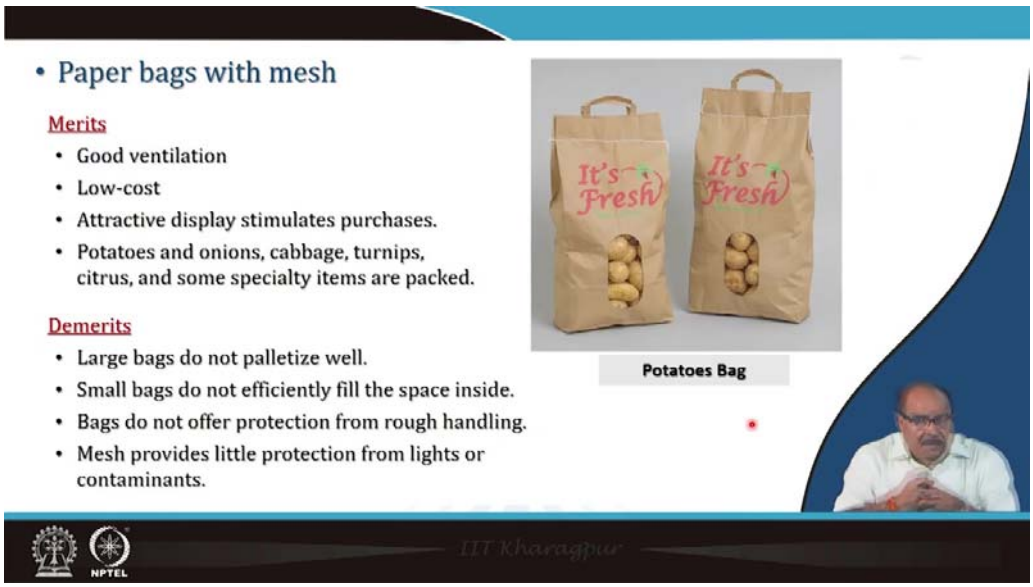
Sacks

The commonly used materials are cotton, jute, plastic like HDPE and PP, they are usually combined with bamboo baskets and wooden boxes to improve cushioning and reduce bruise injuries and losses during transportation. These are low cost, have high strength, reusability and require less space for empties. However, these have low protection against against puncture, compression, vibration and impact injuries as well as these are poor in stackability.



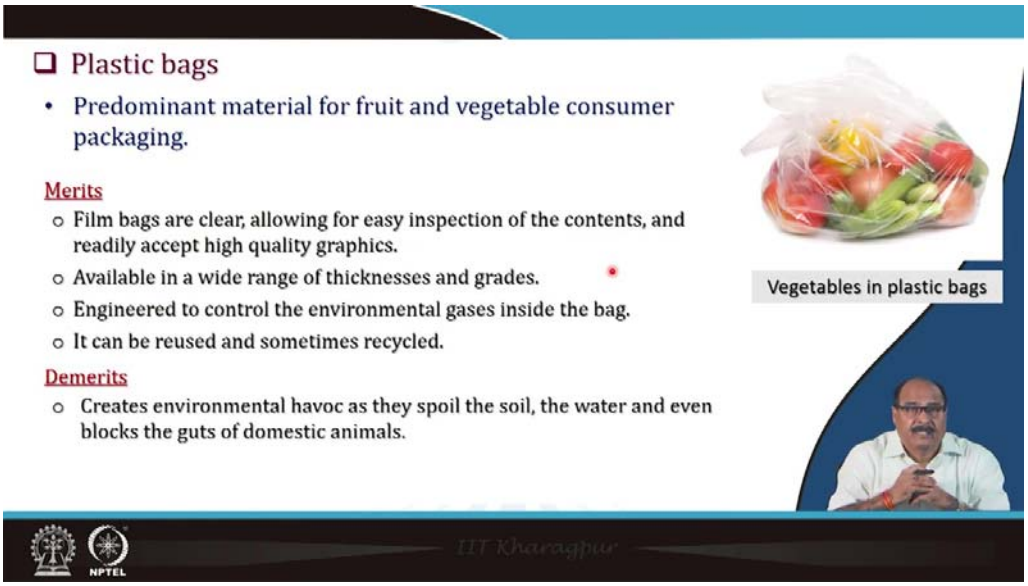
Paperboard

Corrugated fibreboard is generally 0.02 cm thick; is made from unbleached pulp with a characteristic brown color. Most fiber board contain recycled fibers. Cartons of fully recycled pulp have about 75 % of the stacking strength of virgin fiber containers. These are available in market as 3 ply, 5 ply, and 7 ply. These are cost effective, easy to handle and are lightweight, these have good stacking strength, and are easily folded and re-transported and labelled. However, the demerits for these type of packs include these are unfit for high humid fruits or cannot be used for hydro cooling of materials.



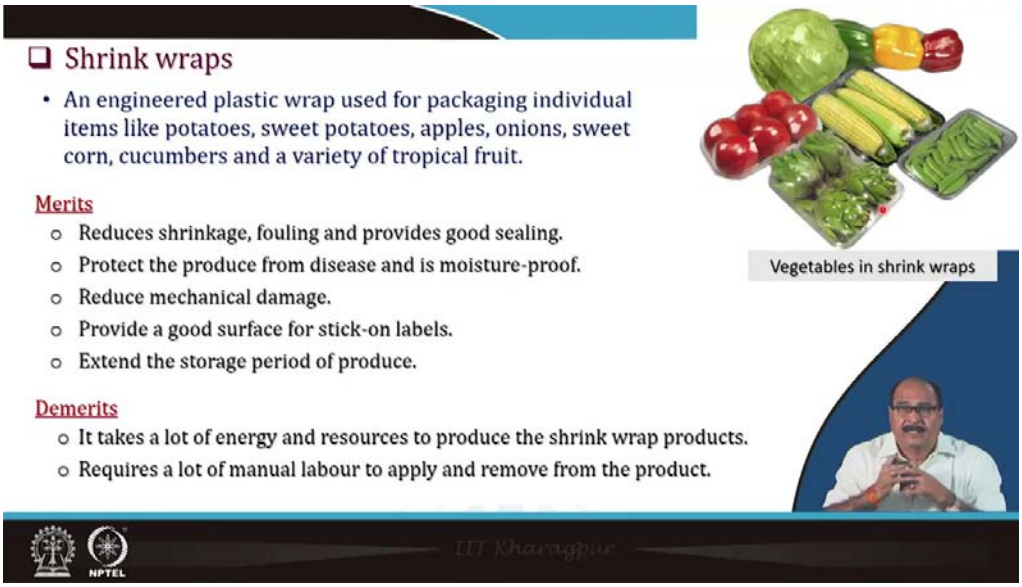
Paper bags with mesh

It has good ventilation, low cost, attractive display, stimulates purchases, potatoes and onions, cabbage, turnips, citrus fruits and some specialty items are bagged. However, these large bags do not palletize well, small bags do not efficiently fill the space inside. Bags do not offer protection from rough handling. Mesh provides little protection from lights or contaminants.



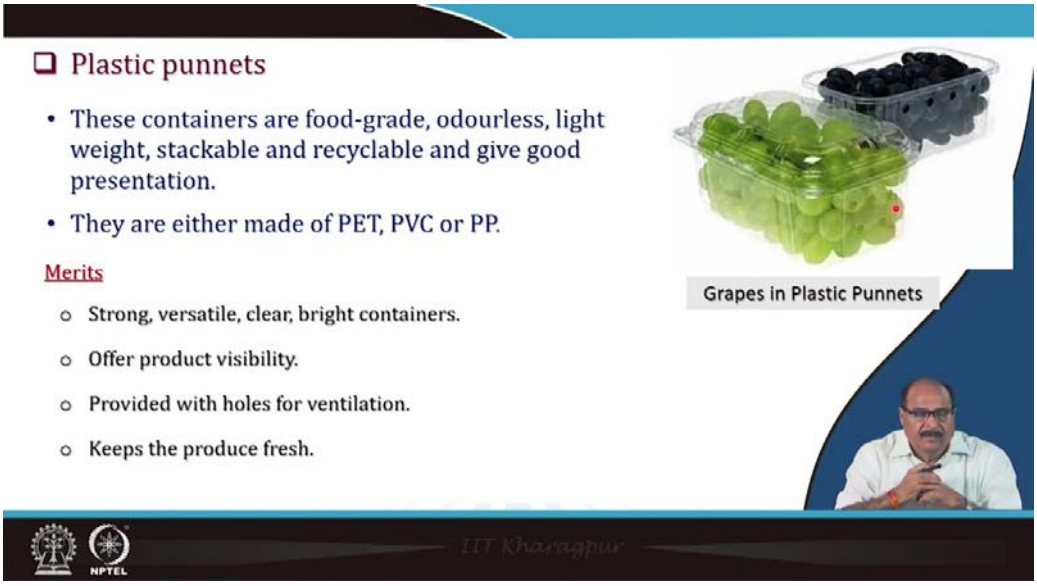
Plastic bags

These are predominant material for fruits and vegetable consumer packaging. It has the merits like film bags are clear, allowing for easy inspection of the contents, and readily accept high quality graphics, is available in a wide range of thickness and grades. These are engineered to control the environmental gases inside the bag and it can be reused and sometimes even recycled. However, it creates environment havoc as they spoil the soil, the water and even blocks the guts of the domestic animals. So, from that point of view, the plastic is in many countries is banned and it is a serious environmental concern.



Shrink wraps

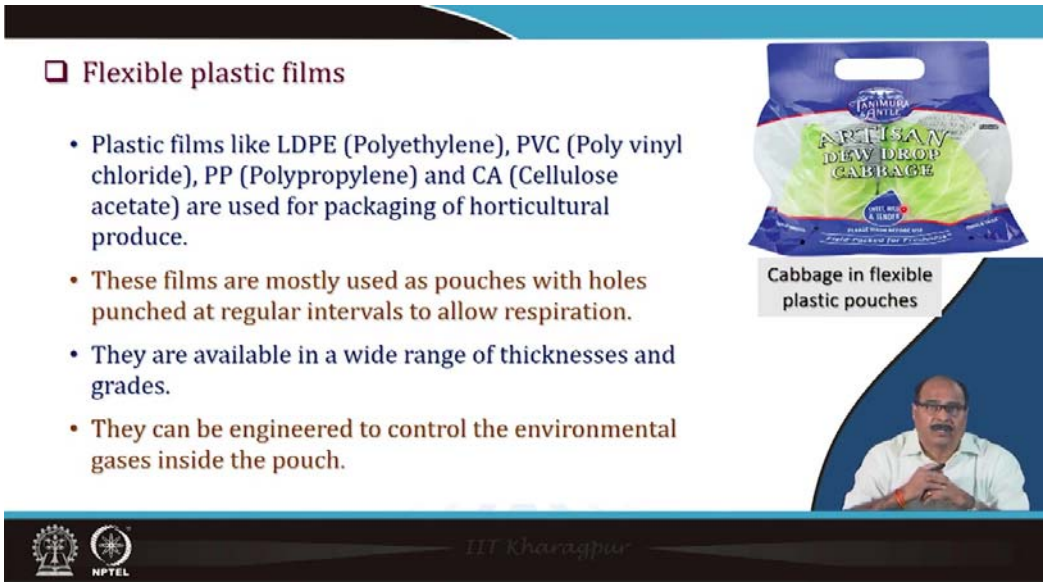
It is an engineered plastic wrap used for packaging individual items like potatoes, sweet potatoes, apples, onions, sweet corn, cucumbers, and a variety of tropical fruits. It reduces shrinkage, fouling and provides good sealing, it protects the produce from disease and is moisture proof, it reduces the mechanical damage, provides a good surface for stick-on labels, it extends the storage life of produce. However, the demerits of this wrap include it takes a lot of energy and resources to produce the shrink wrap products. It requires a lot of manual labor to apply and remove from the product.



Plastic punnets

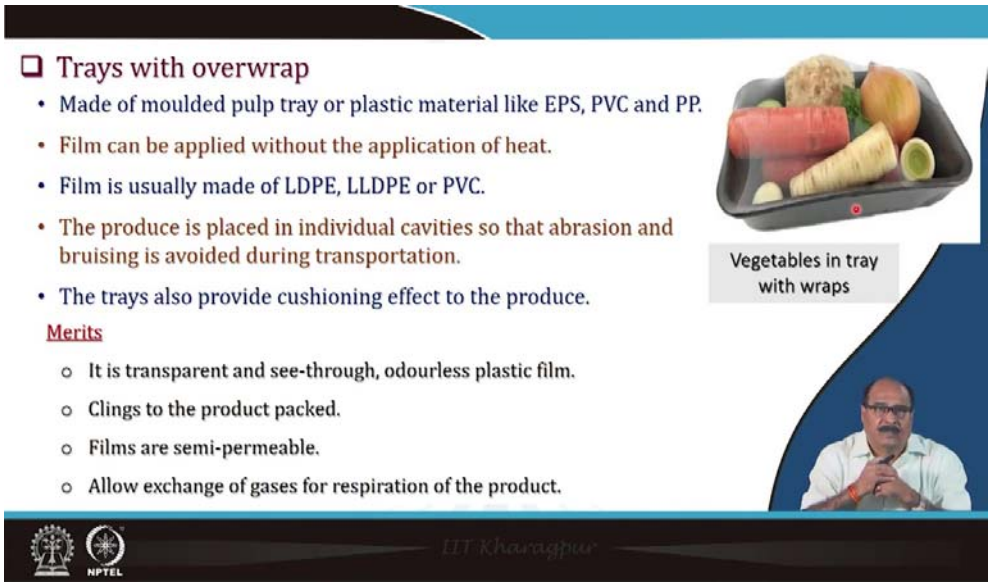
These containers are food grade, odourless, lightweight, stackable and recyclable and give good presentation. They are either made of PET, PVC or PP. The merits of these plastic punnets include these are strong, versatile, clear and bright containers, they offer product

visibility, provided with holes for the ventilation and keep the produce fresh and it very attractive way of packaging product from the consumer point of view.



Flexible plastic films

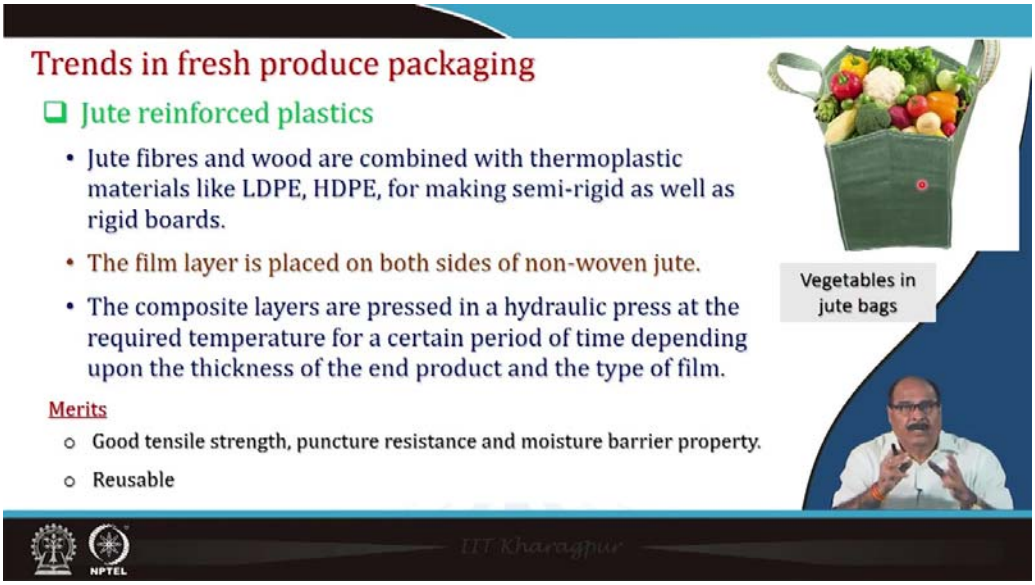
Plastic films like LDPE (Polyethylene), PVC (Poly vinyl chloride), PP (Polypropylene) and CA (Cellulose acetate) are used for packaging of horticultural produce. These films are mostly used as pouches with holes punched at regular intervals to allow respiration. They are available in a wide range of thicknesses and grades. They can be engineered to control the environmental gases inside the pouch.



Trays with overwrap

These are made of moulded pulp tray or plastic material like EPS, PVC and PP. Film can be applied without the application of heat. Film is usually made of LDPE, LLDPE or PVC. The produce is placed in individual cavities so that abrasion and bruising is avoided during transportation. The trays also provide cushioning effect to the produce. The merits of this

type of system include that it is transparent and see-through, odourless plastic film, clings to the product packed, films are semi-permeable and allow the exchange of gases or respiration of the produce.



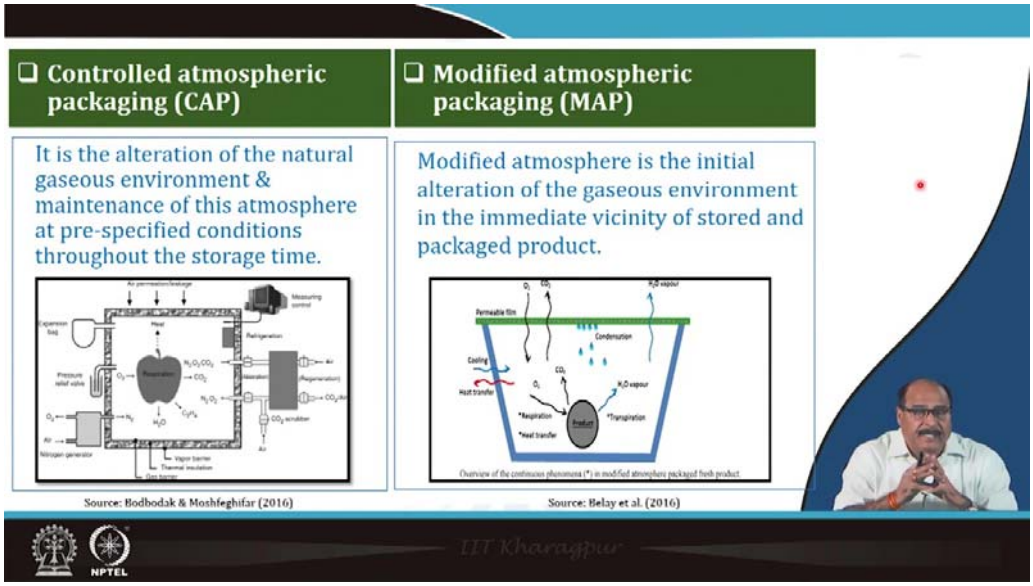
Trends in fresh produce packaging

Jute reinforced plastics

Jute fibres and wood are combined with thermoplastic materials like LDPE, HDPE, for making semi-rigid as well as rigid boards. The film layer is placed on both sides of non-woven jute. The composite layers are pressed in a hydraulic press at the required temperature for a certain period of time depending upon the thickness of the end product and the type of film. The merits of this system include it has good tensile strength, good puncture resistance, and moisture barrier properties as well as it is reusable.

Mesh/Net bags

A string/ net/ mesh bag is an open bag constructed from strands, yarns, or non-woven synthetic material into a net-like structure. This is ideal for thick skinned produce like apples & oranges, or root vegetables like onions, potatoes, & garlic, and for produce that needs ventilation.

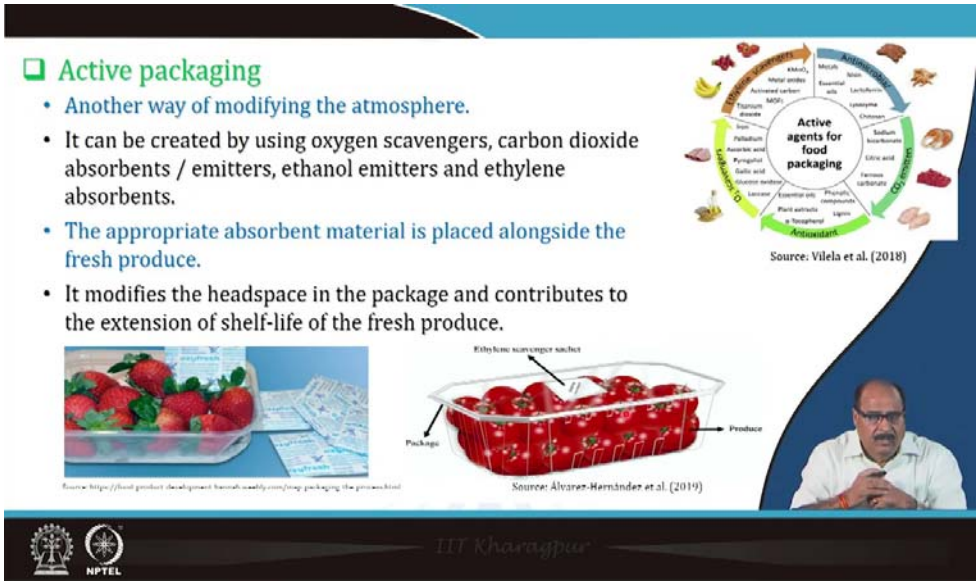


Controlled atmospheric packaging (CAP)

It is the alteration of the natural gaseous environment & maintenance of this atmosphere at pre-specified conditions throughout the storage time.

Modified atmospheric packaging (MAP)

Modified atmosphere is the initial alteration of the gaseous environment in the immediate vicinity of stored and packaged product.

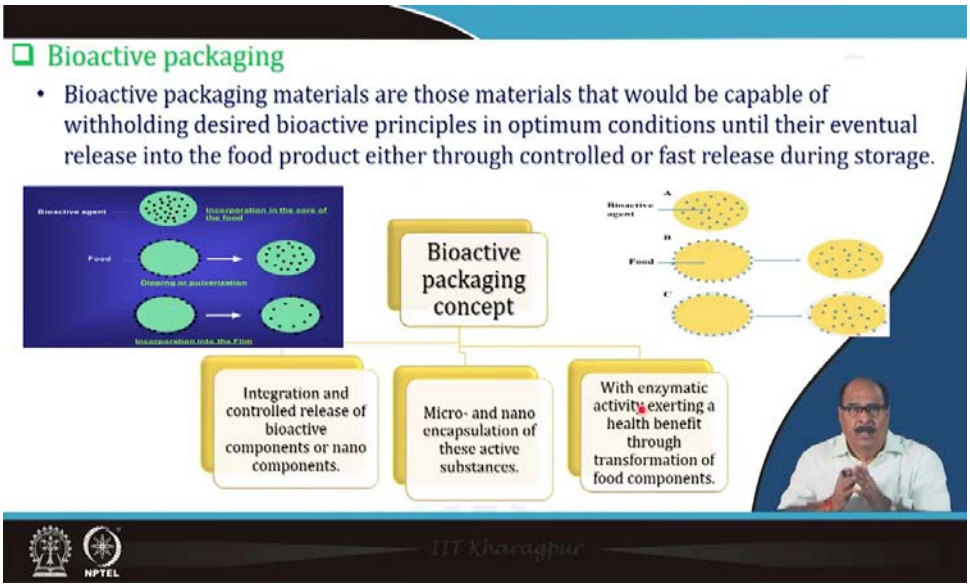


Active packaging

This is another way of modifying the atmosphere. It can be created by using oxygen scavengers, carbon dioxide absorbents / emitters, ethanol emitters and ethylene absorbents. The appropriate absorbent material is placed alongside the fresh produce. It modifies the headspace in the package and contributes to the extension of shelf-life of the fresh produce.

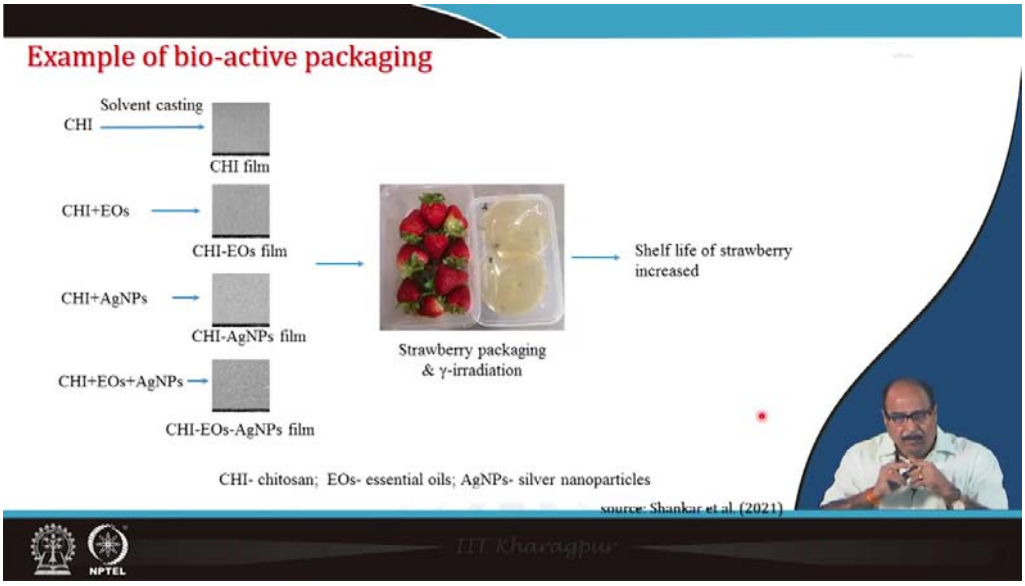
Smart/Intelligent packaging

Intelligent packaging system use communication functions to facilitate decision-making aimed at preserving food quality, extending shelf life and improving overall food safety. It is capable of carrying out intelligent functions such as sensing, detecting, and tracing, recording and communicating certain types of information. Here that is the various RFID, biosensors, gas indicators, bar coding techniques or time temperature indicators etc. are used This TTI indicators may provide any major attribute, the intelligent packages or smart packages provide the consumer about the quality of the product inside. It is capable of carrying out intelligent functions such as sensing, detecting, tracing, recording and communicating these quality attributes to the consumer and they can replace the micro sensors, sachets etc. These can be put into the packet.

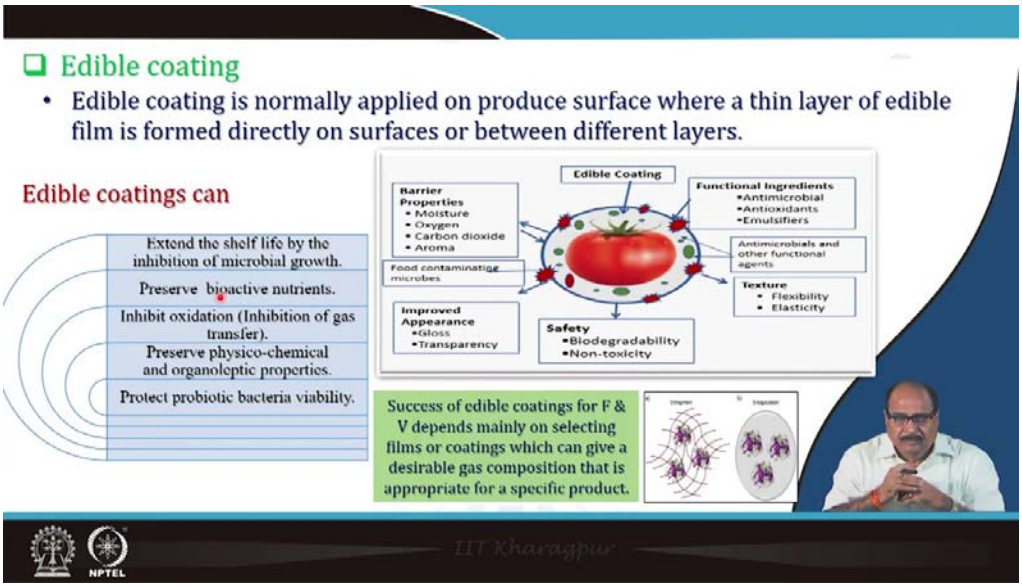


Bioactive packaging

Bioactive packaging materials are those materials that would be capable of withholding desired bioactive principles in optimum condition until they are eventually released into the food product either through control or fast release during the storage. So, the overall concept of the bio packaging is integration and control release of bioactive compounds or nano components by micro and nano encapsulation of these active substances and finally, the enzymatic activity exerts a health benefit through the transformation of the food components. So, they are the concept of the bioactive packaging.



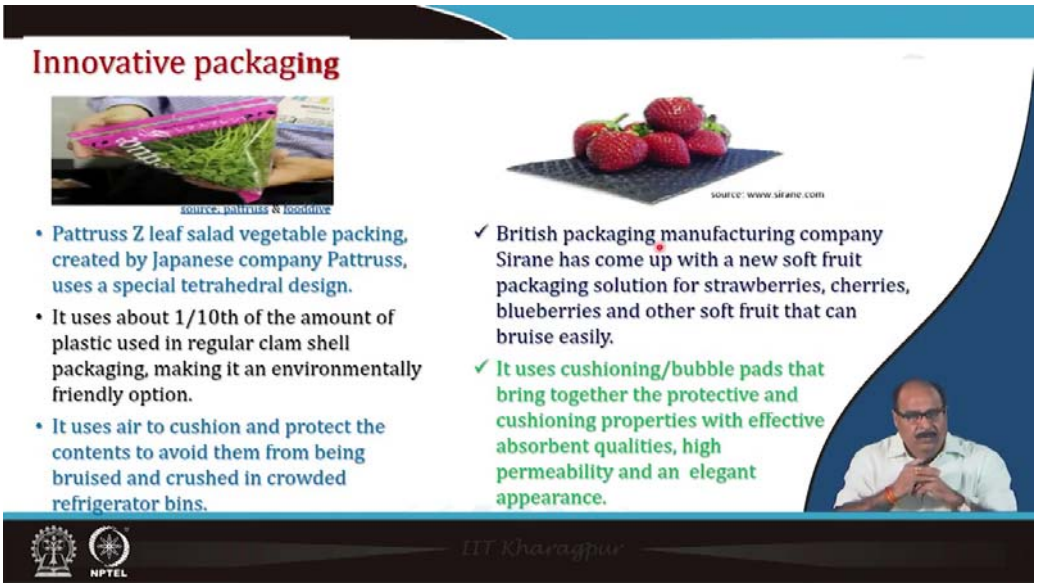
The examples of the bio-active packaging are chitosan. The solvent casting method is used for making chitosan film or chitosan with the essential oil. Chitosan film introduced with silver nano particles. It is used for wrapping of strawberry followed by the gamma irradiation so, this enhances the shelf life as well as some bioactive components can be introduced or retained more for a longer period and it can be introduced into the commodities.



Edible coating

Edible coating is normally applied on produce surface where a thin layer of edible film is formed directly on surfaces or between different layers. These edible coatings may contain the functional ingredients like antimicrobial, antioxidant, emulsifiers etc., it may have improved appearance, glass and transparency, it may improve barrier properties of the materials etc. So, these components are present on the outer surface, though create if any microbial microorganism tries to contaminate the commodity. So, this antimicrobials provide hinderance to that and also this coating is should be properly done, so, as to allow the respiration continuous respiration at its lowest possible rate.

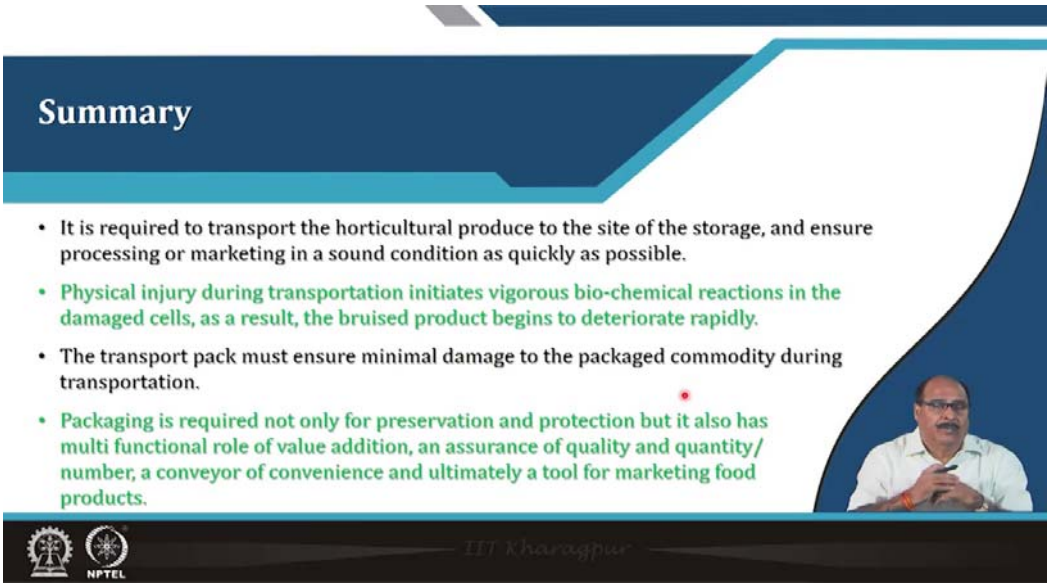
So, the successful success of edible coating of fruits and vegetables depends mainly on selecting the film or coating, which can give a desirable gas composition that is appropriate for the specific product. So, in general, edible coating can extend the shelf life by inhibition of the microbial growth, it can preserve bioactive nutrients, it can inhibit oxidation or in with gas transfer, it can preserve physico-chemical and organoleptic properties or even it can protect probiotic bacteria viability in the food.



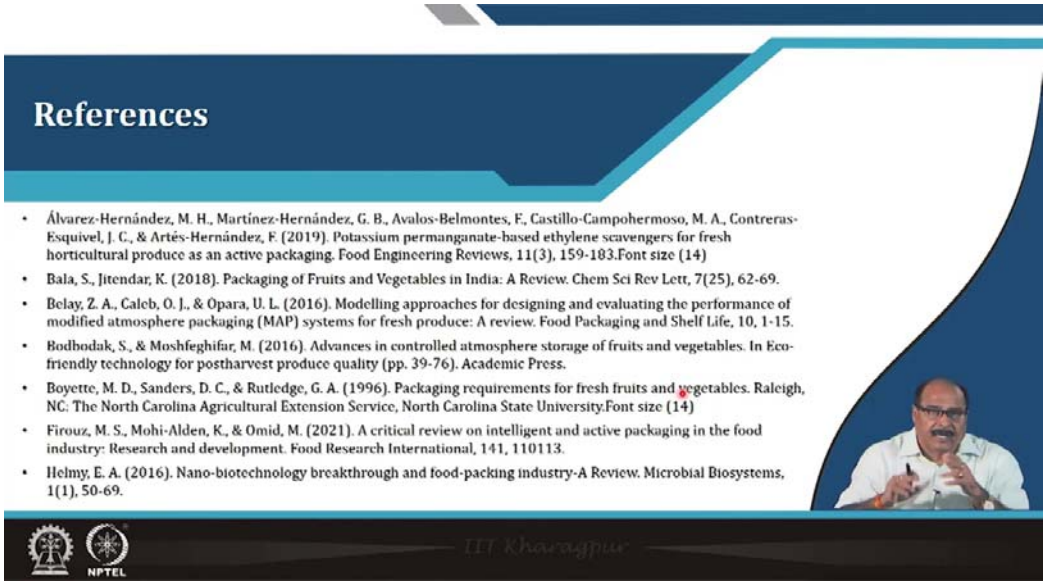
Innovative packaging

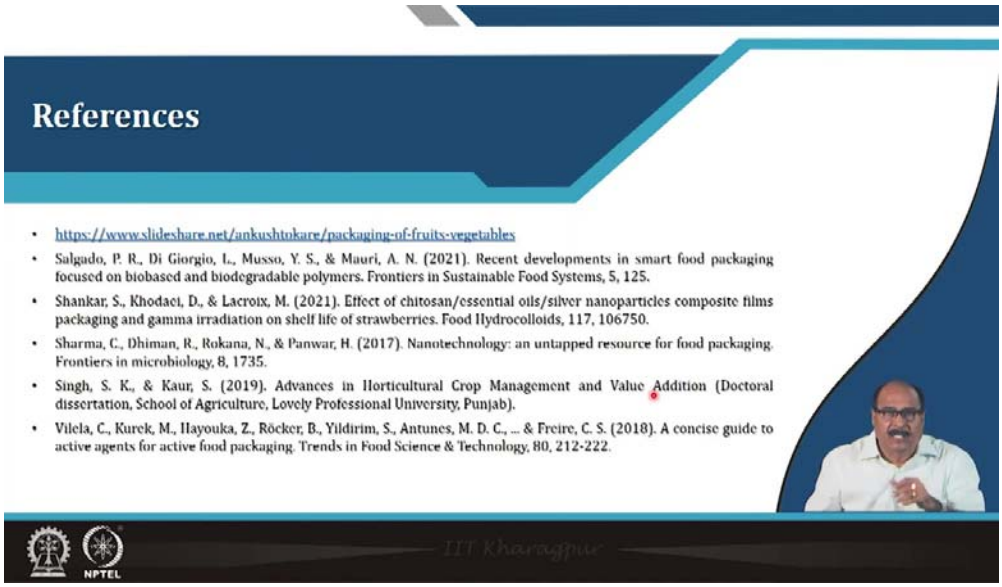
Pattruss Z leaf salad vegetable packing, created by Japanese company Pattruss, uses a special tetrahedral design. It uses about 1/10th of the amount of plastic used in regular clam shell packaging, making it an environmentally friendly option. It uses air to cushion and protect the contents to avoid them from being bruised and crushed in crowded refrigerator bins. British packaging manufacturing company Sirane has come up with a new soft fruit packaging solution for strawberries, cherries, blueberries and other soft fruit that can bruise easily. It uses cushioning/bubble pads that bring together the protective and cushioning properties with effective absorbent qualities, high permeability and an elegant appearance.

Southern Lettuce brand produces container for lettuce leaves. The container itself mimics the shape of the green leaves, with additional strength added through interlocking tabs. The proposed material to construct is a biodegradable, water-resistant sealant made out of sugar that will gradually break down over time. The container is printed with vegetable inks so that the design is truly green.



In summary, it is required to transport the horticultural produce to the site of the storage, and ensure processing or marketing in a sound condition as quickly as possible. Physical injury during transportation initiates vigorous bio-chemical reactions in the damaged cells, as a result, the bruised product begins to deteriorate rapidly. The transport pack must ensure minimal damage to the packaged commodity during transportation. Packaging is required not only for preservation and protection but it also has multi-functional role of value addition, an assurance of quality and quantity/number, a conveyor of convenience and ultimately a tool for marketing food products.





These are the references for further study. Thank you.