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

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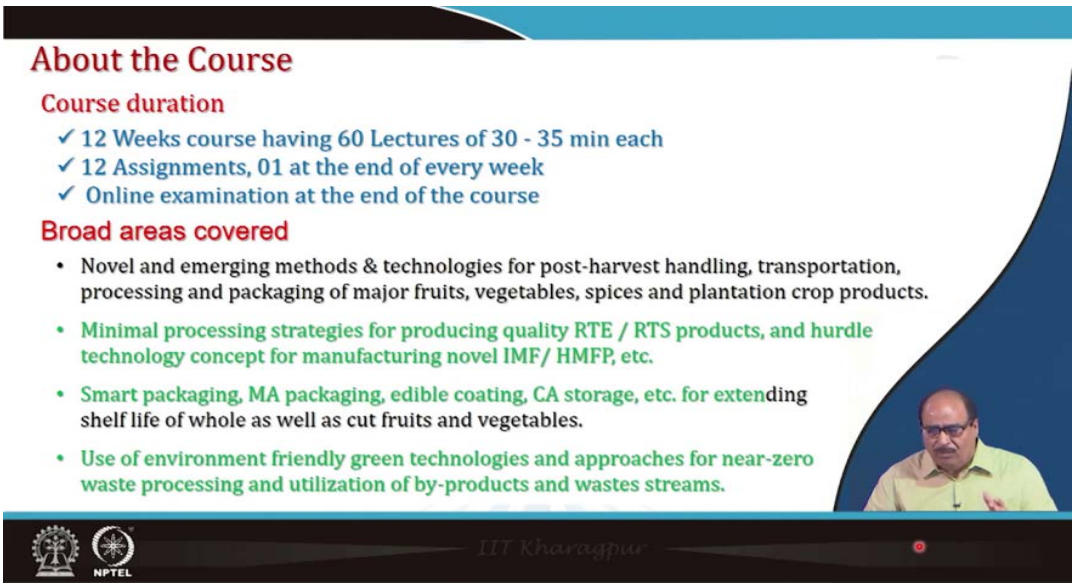
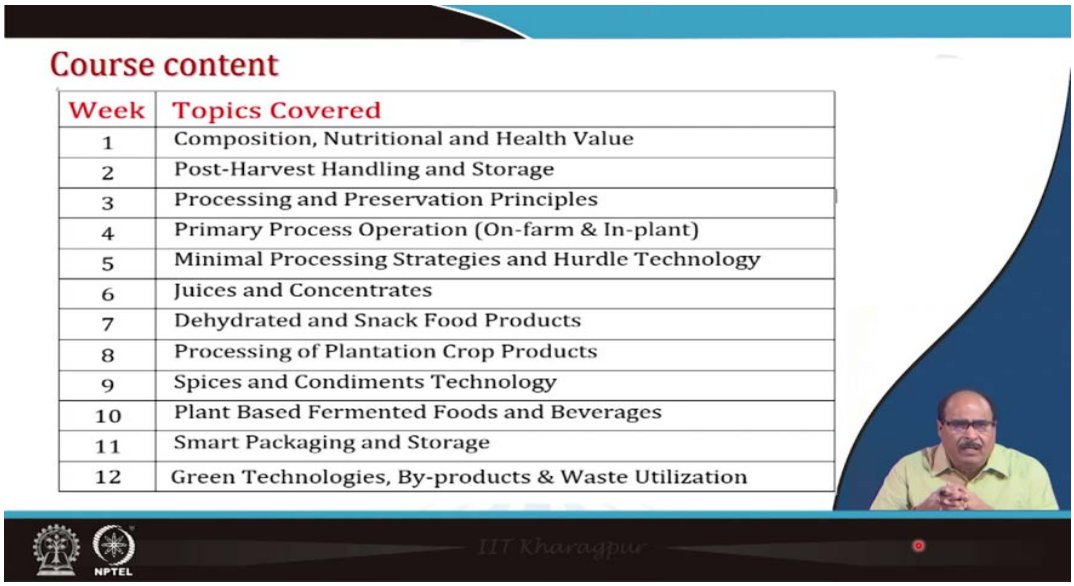
Lecture 01
Course Introduction

In the first lecture, a brief introduction of the course followed by a concise discussion on the current scenario particularly the production statistics, consumption pattern, and market insights along with the associated issues and challenges in the horticultural and plantation crop sector in India will be emphasized.



This is a 12 week course having 60 lectures of 30-35 minutes each. There will be 12 assignments, most probably one at the end of every week. There will be one online examination at the end of the course. The broad areas that will be covered in this course include novel and emerging methods and technologies for post-harvest handling transportation processing and packaging of major fruits,

vegetables, spices and plantation crop products. In addition, the course will also illustrate on the minimal processing strategies for producing high quality ready to eat, ready to serve products and hurdle technology concept for manufacturing of novel intermediate moisture foods and high moisture fruit products. Different smart packaging technologies, modified atmosphere packaging, edible coating, control atmosphere storage for extending the shelf life of whole as well as cut fruits and vegetables will be discussed. Also towards the end of the course, the application of environment friendly green technologies as well as the approaches for near zero waste processing and utilization of by-products and waste streams will be discussed.

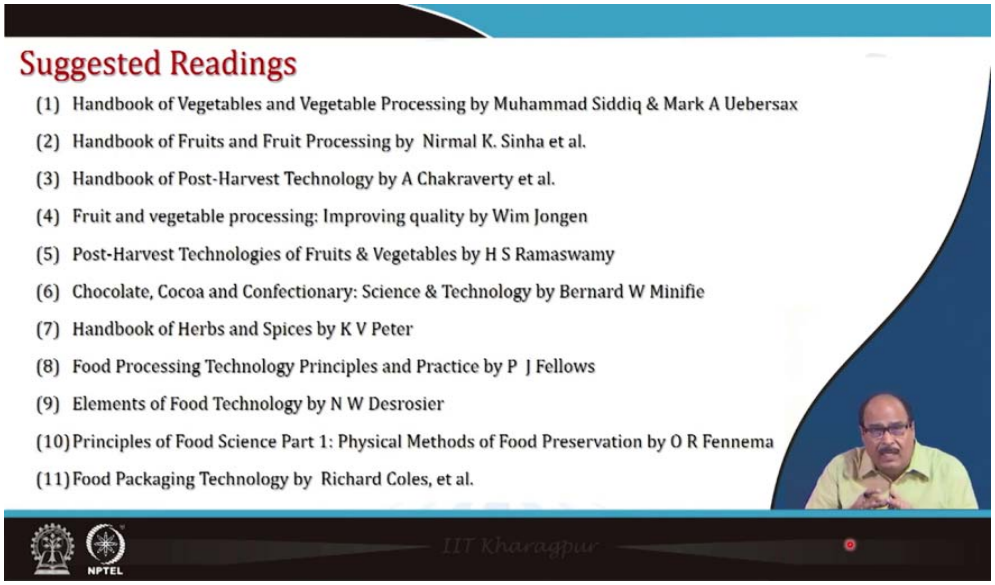


The topics that will be covered in this course include:

In the first week, various aspects related to composition, nutrition and health values of fruits, vegetables, spices, and plantation products will be discussed. In the second week, the post-harvest handling and storage aspects followed by processing and preservation principles will be covered in the third week. A brief overview on the primary process operations both on farm and in plant will be emphasized on the fourth week and the fifth week will cover the minimal processing strategies and hurdle technology. The 6th and 7th weeks will involve the development and processing of juices and concentrates and dehydrated and snack food products, respectively. The processing of plantation crop products and the science and technologies involved in spices and condiments will be discussed in the eighth and ninth weeks, respectively. The 10th week will be devoted on plant-based fermented foods and beverages. The overview on the smart packaging and storage of the fruits and vegetables, spices, plantation crop products will be taken up in the 11th week and finally the last week (12th week) will include a brief insight on the green technologies, by products and waste utilization.

A list of the suggested readings i.e. the books which might be useful for this course is given here.

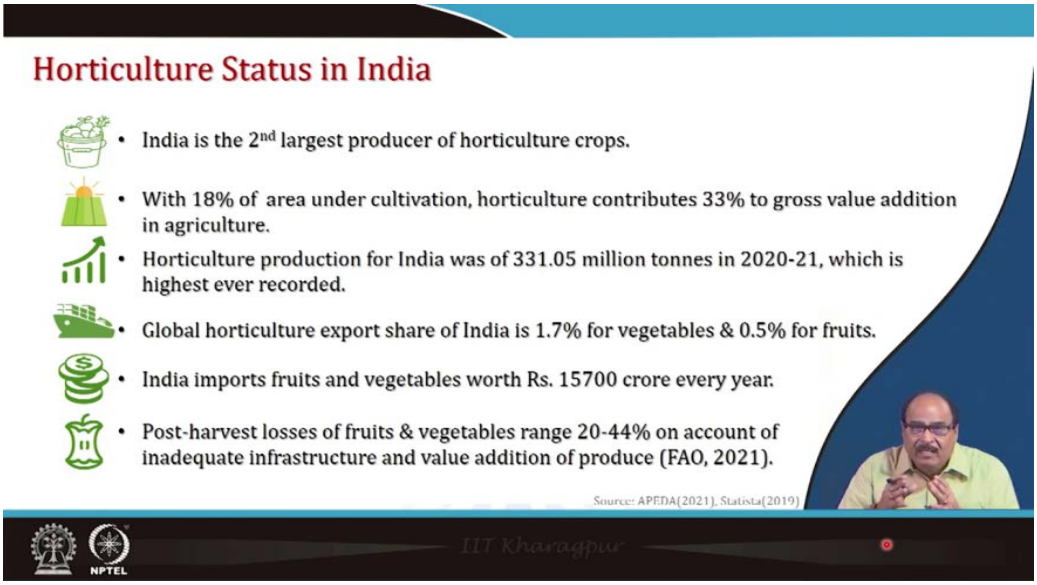
- Handbook of Vegetables and Vegetable Processing by Muhammad Siddiq & Mark A. Uebersax



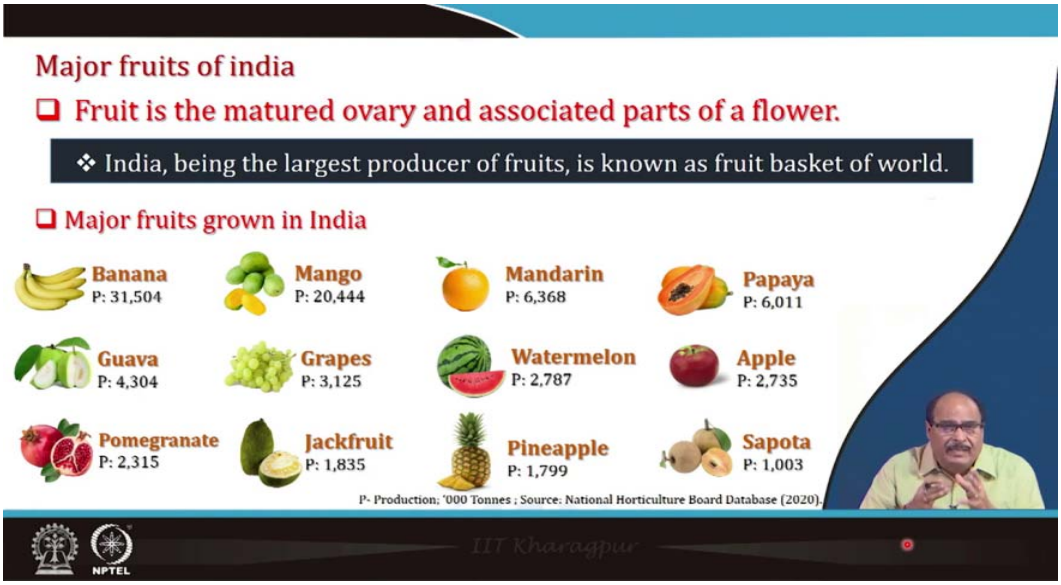
- Handbook of Fruits and Fruit Processing by Nirmal K. Sinha et al.
- Handbook of Post-Harvest Technology by A Chakraverty et al.
- Fruit and vegetable processing: Improving quality by Wim Jongen
- Post-Harvest Technologies of Fruits & Vegetables by H S Ramaswamy
- Chocolate, Cocoa and Confectionary: Science & Technology by Bernard W. Minifie
- Handbook of Herbs and Spices by K V Peter
- Food Processing Technology Principles and Practice by P. J Fellows
- Elements of Food Technology by N. W. Desrosier
- Principles of Food Science Part 1: Physical Methods of Food Preservation by Owen R Fennema
- Food Packaging Technology by Richard Coles, et al.

Horticultural status in India:

India is the second largest producer of horticulture crops with 18% of area under cultivation. Horticulture contributes 33% to the gross value addition in agriculture. Horticulture production for India was of 331.05 million tons in 2021 which is the highest ever recorded.

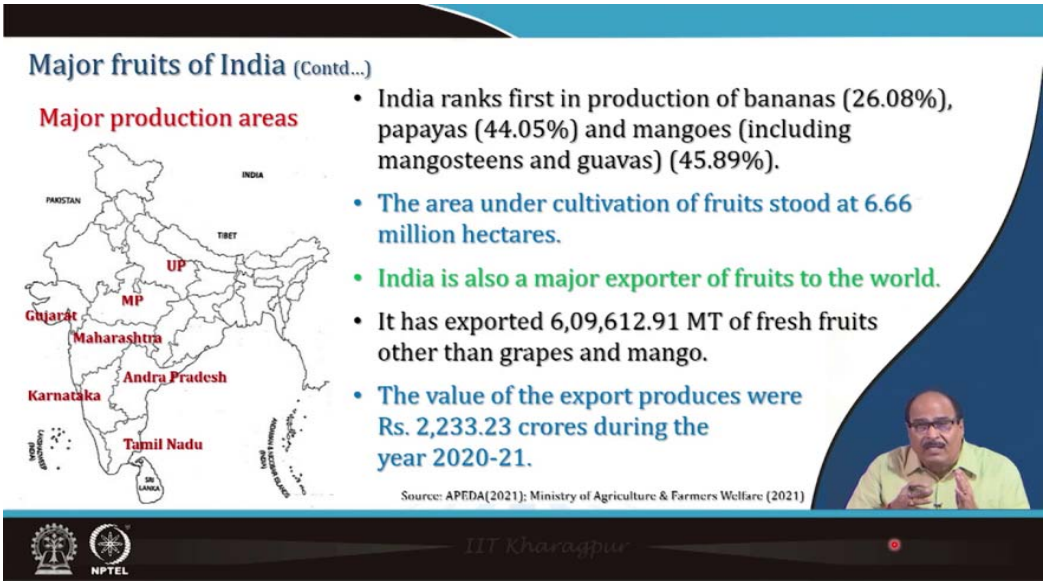


Global horticulture export share of India is about 1.7% for vegetables and 0.5% for fruits. Also, India imports fruits and vegetables worth Rs, 15,700 crores every year. Post-harvest losses of fruits and vegetables in India range to the tune of 20 to 44% on the account of inadequate infrastructure and value addition produce of the produce according to the report of FAO, 2021.

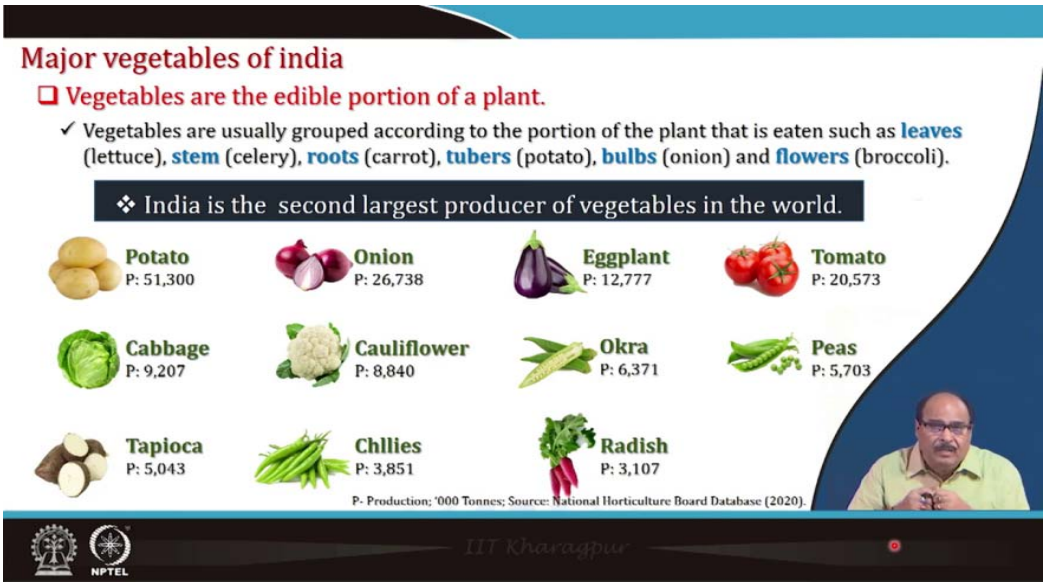


Major fruits of India

Fruit is the matured ovary and associated parts of a flower. India being the largest producer of fruits is known as fruit basket of the world. Major fruits grown in the India include banana, mango, mandarin, papaya, guava, grapes, watermelon, apple, pomegranate, jackfruit, pineapple, and sapota. The data for the production of these fruits given in the slide has been taken from the National Horticulture Board Database (2020).



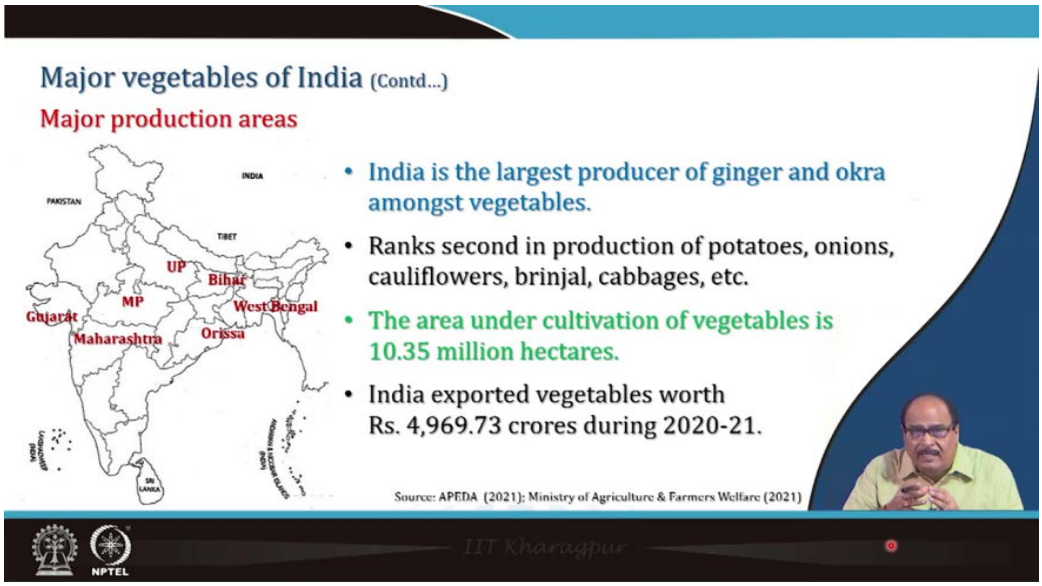
The major production states of fruit in India include Uttar Pradesh, Madhya Pradesh, Gujarat, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu. India ranks first in the production of banana (26.08%), papaya (44.05%), and mangoes including mangosteens and guavas (45.89%). The area under cultivation of fruits is about 6.66 million hectares in the country. India is also a major exporter of fruits to the world. Recently, India has exported 609612.91 metric ton of fresh fruits other than grapes and mango. The value of the export produces were to the tune of around Rs. 2233.23 crores during the year 2021.



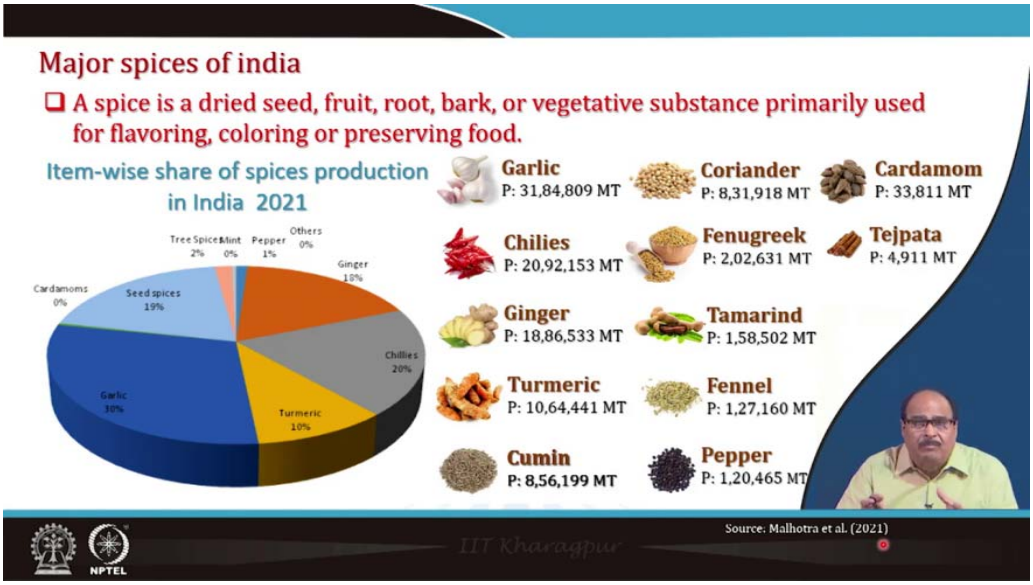
Major vegetables of India

Vegetables are the edible portions of a plant. Vegetables are usually grouped according to the portion of the plant that is eaten for example leaves (lettuce), stem (celery), roots (carrot), tubers (potato), bulbs (onion), and flowers (broccoli). India is the second largest producer of vegetable in the world.

The major vegetables produced include potato, cabbage, tapioca, onion, cauliflower, chili, eggplant, okra, radish, peas and tomato.



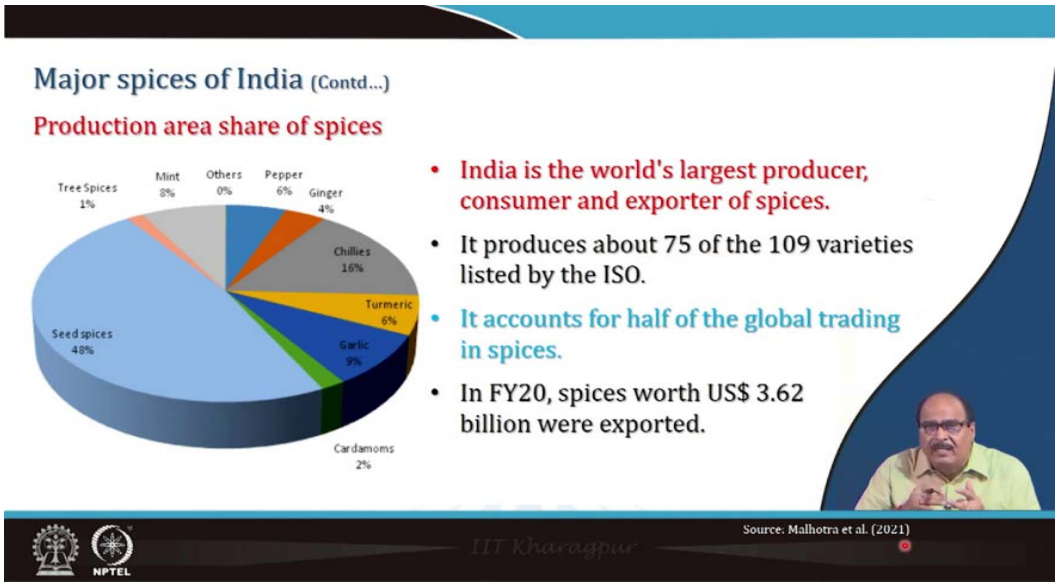
The major production areas of vegetables in India include Uttar Pradesh, Bihar, West Bengal, Odisha, Madhya Pradesh, Maharashtra and Gujarat. India is the largest producer of ginger and okra among the vegetables. India ranks second in the production of potatoes, onions, cauliflower, brinjal, cabbages. The area under cultivation of vegetable is to the tune of around 10.35 million hectares. India exported vegetables worth Rs. 4969.73 crores during the year 2020-21.



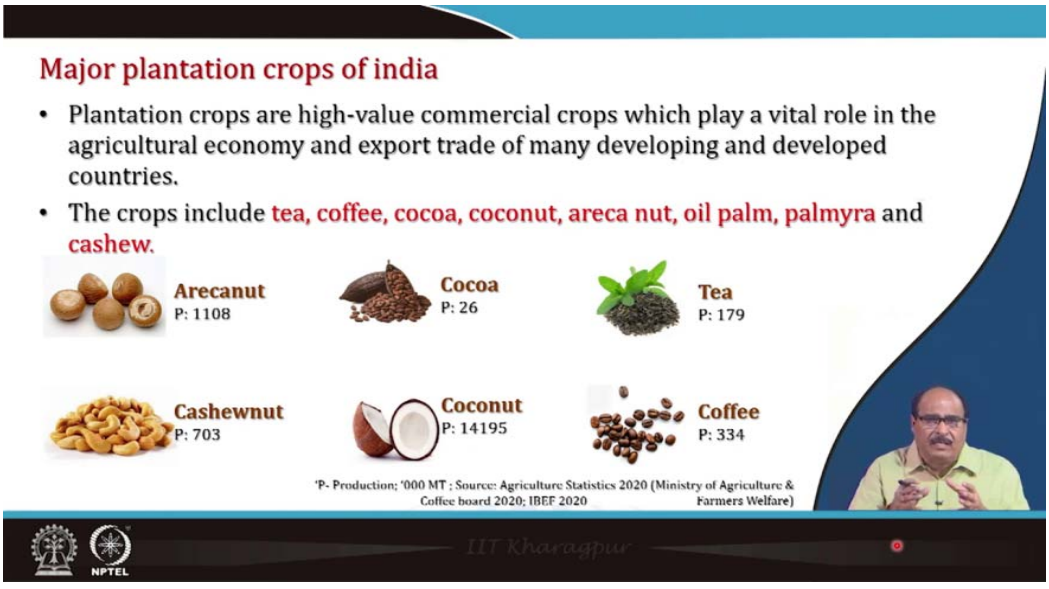
Major spices of India

Spices is a dried seed, fruit, root, bark or vegetative substance primarily used for flavoring coloring or preserving a food. In 2021, the percentage share of different spices of total production in India contributed as: garlic: 30%, chilies: 20%, seed spices: 19%, ginger: 18%, and turmeric: 10%. The

production data of the major spices like garlic, coriander, cardamom, chilies, fenugreek, tejpata, ginger, tamarind, turmeric, fennel, cumin, and pepper are given in the slide.



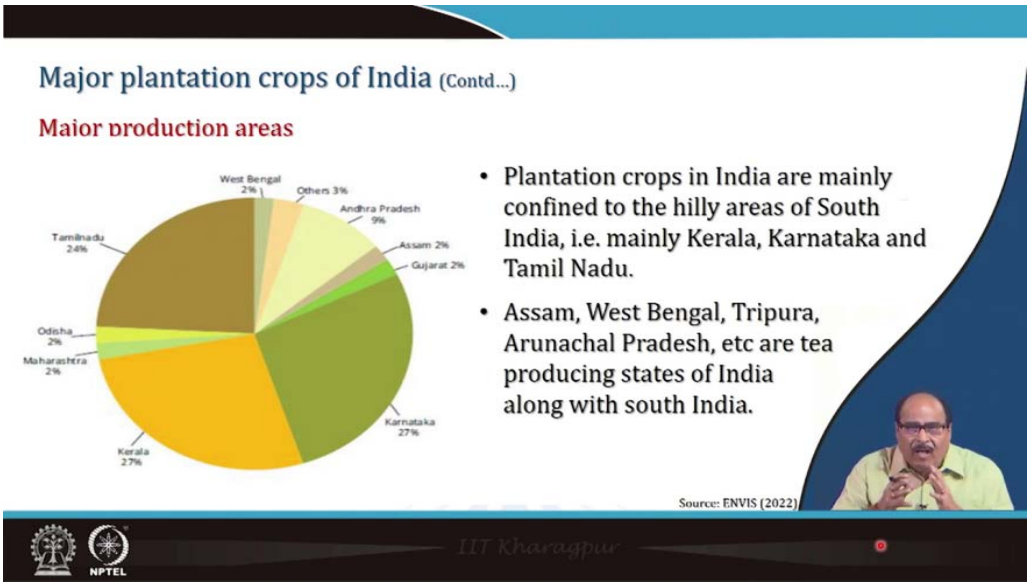
The percentage share of production of spices (in the area wise): about 48% i.e. half of the area under-spice cultivation contributes to the seed spices followed by 16% belonging to chilies, garlic and mint share 9 and 8%, respectively, and 6% of spice cultivation belonging to turmeric and so on. India is the world's largest producer, consumer and exporter of spice. 75 out of the 119 varieties of spices listed by ISO are produced in India, which accounts for half of the global trading in spices. In the financial year 2020, spices worth US$ 3.62 billion were exported from India.



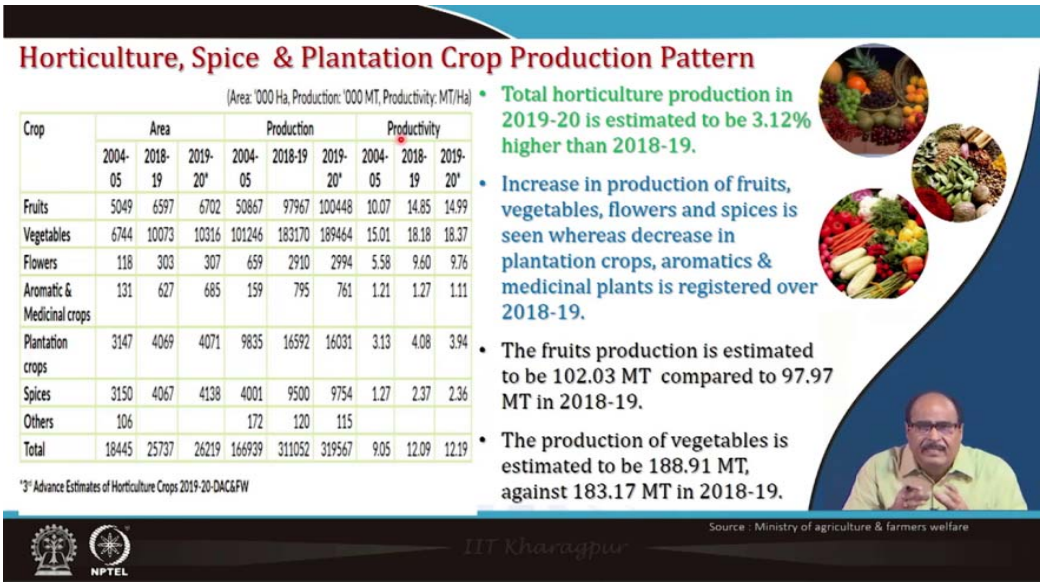
Major plantation crops of India

Plantation crops are high value commercial crops which play a vital role in the agriculture economy and export trade of many developing and developed countries. The crop which come under the

plantation crop include tea, coffee, cocoa, coconut, areca nut, oil palm, palmyra and cashew. The production data of all these plantation crop products is given in the slide.



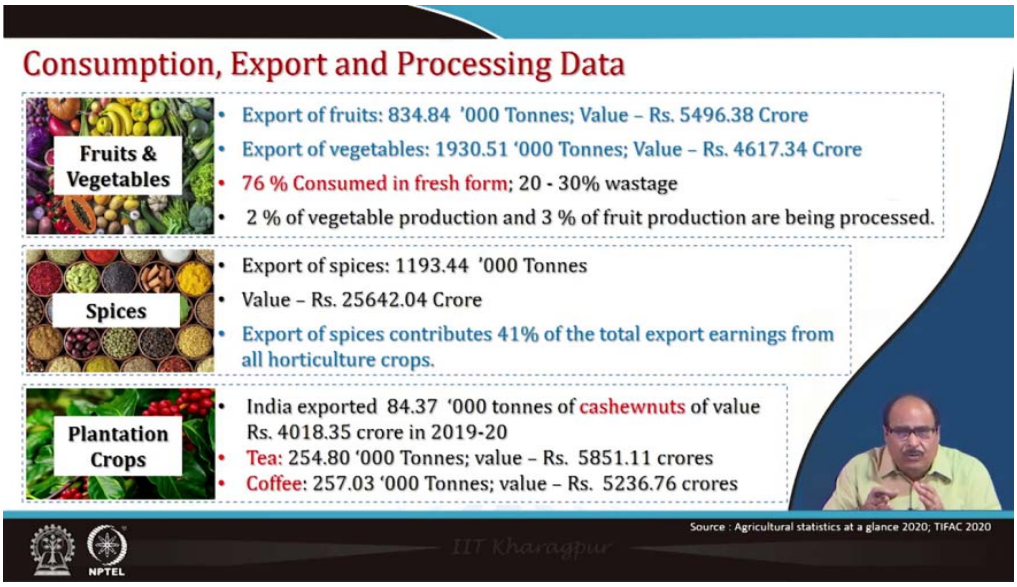
Major production areas of plantation crops in India are mainly confined to the hilly areas of southern part of our country i.e. mainly Kerala (27%), Karnataka (27%), Tamil Nadu (24%), and Andhra Pradesh (9%). The major parts of the coconut or other plantation crop products are produced in these four major southern states. Assam, West Bengal, Tripura, Arunachala Pradesh are along with the southern states the major tea producing states in India.



Horticulture, spice and plantation crop production pattern

The area under cultivation, production, and productivity of horticultural crops, spices and plantation crop in the year from 2004-05 to 2018-19 and 2019-20 is given in the table, which indicate that total horticulture production in the 2019-20 was estimated to be 3.12% higher than in the year 2018-19. Increase in the production of fruits, vegetables, flowers and spices are seen whereas there is a

decrease in the plantation crops, aromatics, and medicinal plants is registered over 2018-19. The fruit production is estimated to be 102.03 MT as compared to 97.97 MT in the 2018-19. The increased production of vegetables was estimated to be around 188.91 MT against 183.17 MT in the year 2018-19.

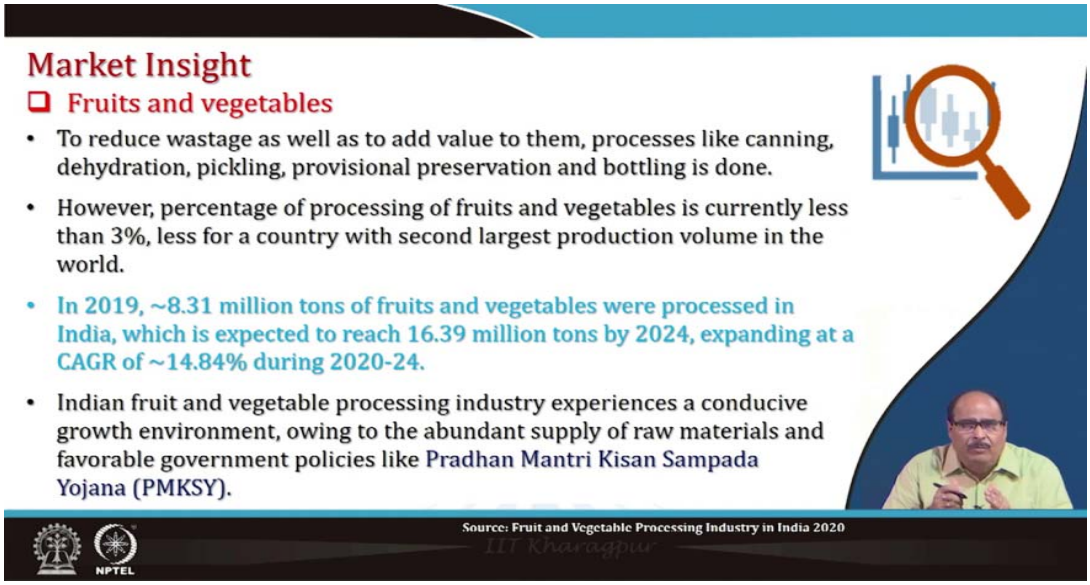


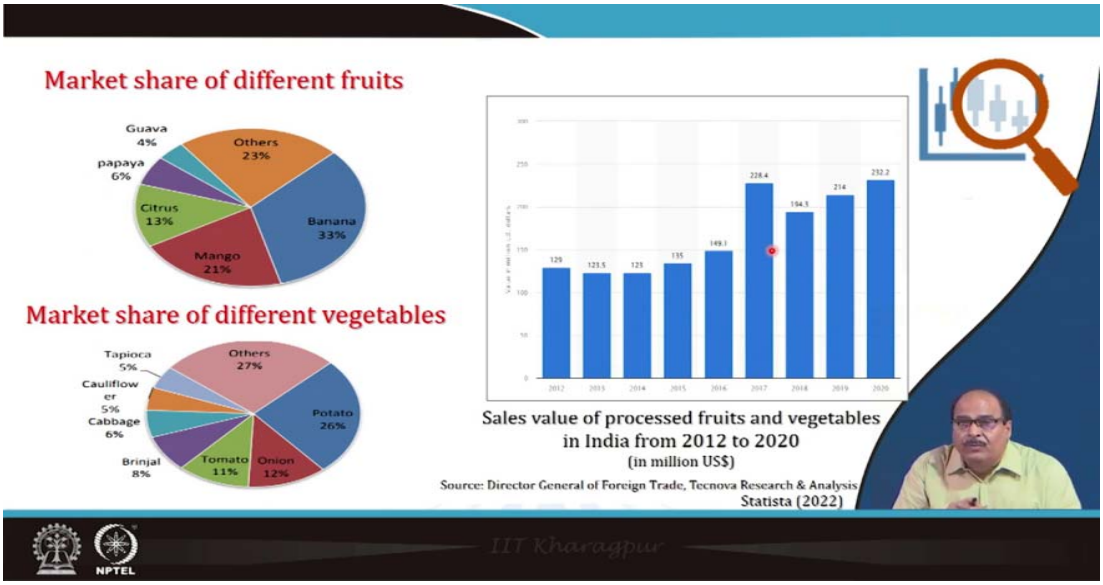
Consumption, export and processing data

Export of fruits is estimated to be around 835,000 tons which values at Rs. 5,496.38 crores. Similarly, export of vegetables is estimated to be around 1931 thousand tons valued at Rs. 4617.34 crores. Around 76% of the fruits and vegetables are consumed in fresh form, 20 to 30% is wasted, and 2% of the vegetable production and approximately 3% of the fruit production are being processed and converted into value-added products. For spices, the export is around 1193.44 thousand tons which is valued at Rs. 25642.04 crore. Export of spices contributes to 41% of the total export earnings from all horticultural crops. The plantation crop is exported 84.37 thousand tons of cashew nuts which is valued at Rs. 4018.35 crores in the year 2019-20. The tea production in India is around 254.80 thousand tons which is valued at Rs. 5851.11 crores and for coffee, the production is around 257.03 thousand tons that valued at Rs. 5236.76 crores.

Market insight of fruits and vegetables

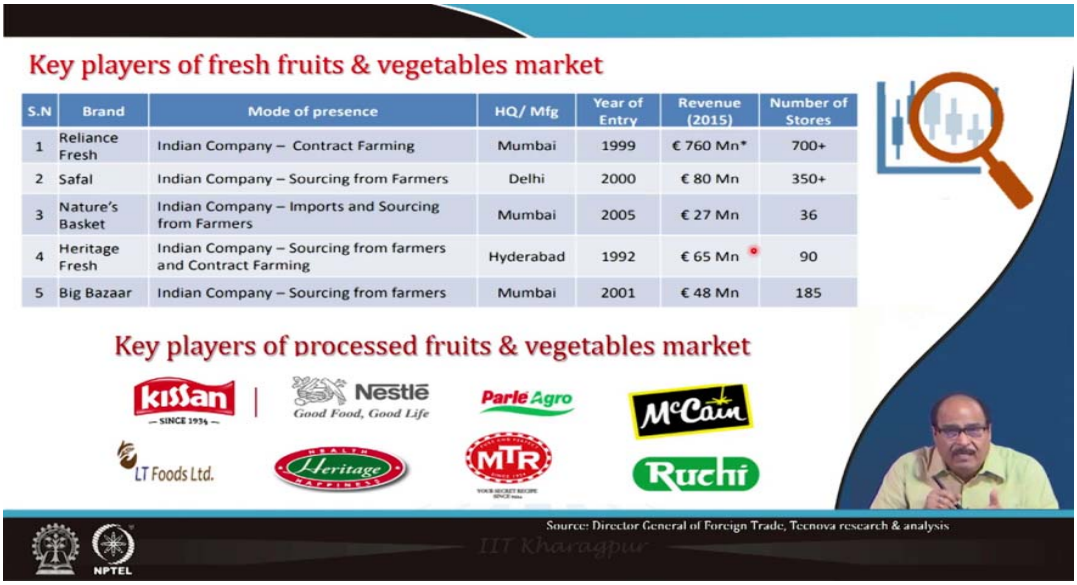
To reduce wastage as well as to add value in the fruits and vegetables processing traditional methods such as like canning, dehydration, pickling or provisional preservation and bottling are adopted. However, the percentage of processing of fruits and vegetables is currently less than 3%, which is far less for a country with the second largest production volume in the world. In the year 2019, approximately 8.31 million tons of fruits and vegetables were processed in India which is expected to reach about at 16.39 million tons by 2024 expanding at a CAGR of approximately 15% during the year 2020-2024. Indian fruits and vegetable processing industry experiences a conducive growth environment owing to the abundant supply of raw materials and the favorable government policies like Pradhan Mantri Kisan Sampada Yojana (PMKSY).



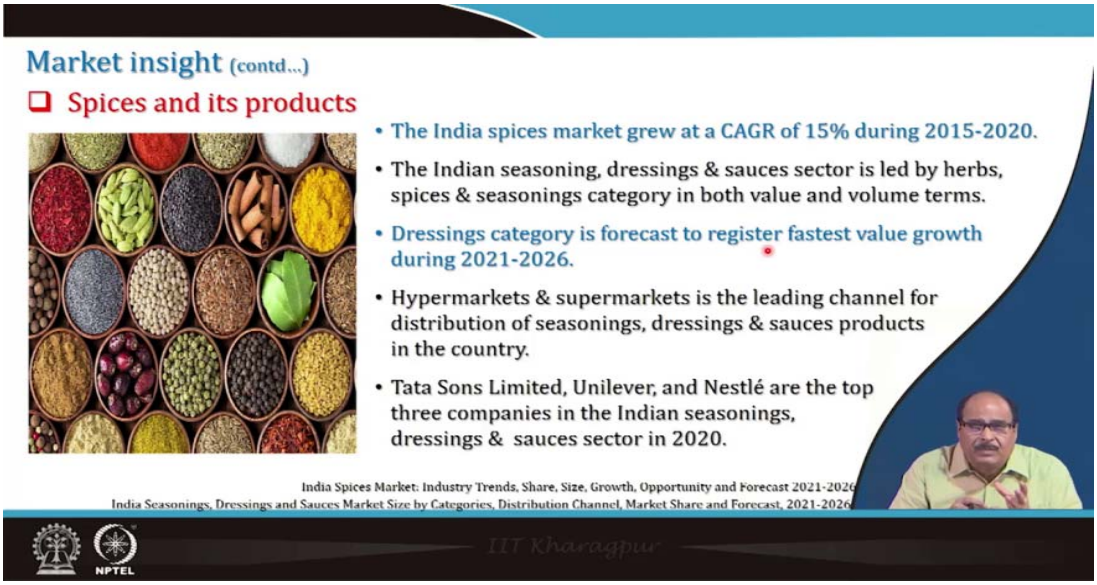


From the market share of different fruits, it can be clearly observed that banana contributes the highest i.e. 33% followed by mango (21%), citrus fruits (13%), papaya (6%), and guava (4%). Similarly, among vegetables potato contributes the highest percentage of market share (26%) followed by onion (12%), tomato (11%), brinjal (8%), cabbage (6%), and cauliflower along with tapioca (5%).

The graph represents the progressive increase in the sales value of processed fruits and vegetables in India from the year 2012-20. In the year 2017, the total sale value of fruits and vegetables was estimated as around 228.4 million US dollars. In 2020, amid COVID period the total sale value of fruits and vegetables was around 232.2 million US dollar.

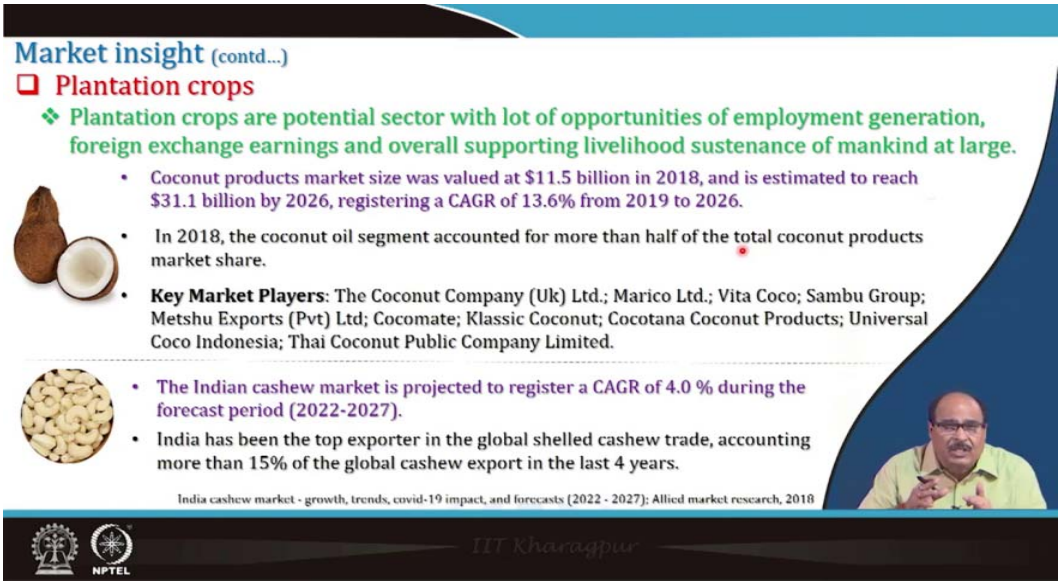


Key players of fresh fruit and vegetable market in India include Reliance fresh, Safal, Nature's basket, Heritage fresh and Big bazaar. They operate either through contact farming or sourcing directly from the farmers. Major key players, major players of the processed fruits and vegetables in India include Kissan, Nestle, Parle Agro, McCain, Ruchi, MTR, Heritage and LT foods Ltd.



Market insight of spices and its products

The India spice market grew at a CAGR of about 15% during years 2015-20. The Indian seasoning, dressing and sauces sector is led by herbs, spices and seasonings category in both value and volume terms. Dressing category is forecast to register fastest value growth during 2021-2026. Hypermarkets and supermarkets are the leading channels for distribution of seasonings, dressings and sauces products in the country. Tata sons limited, Unilever, and Nestle are the top three companies in the Indian seasonings, dressings, and sauces sector in the year 2020.



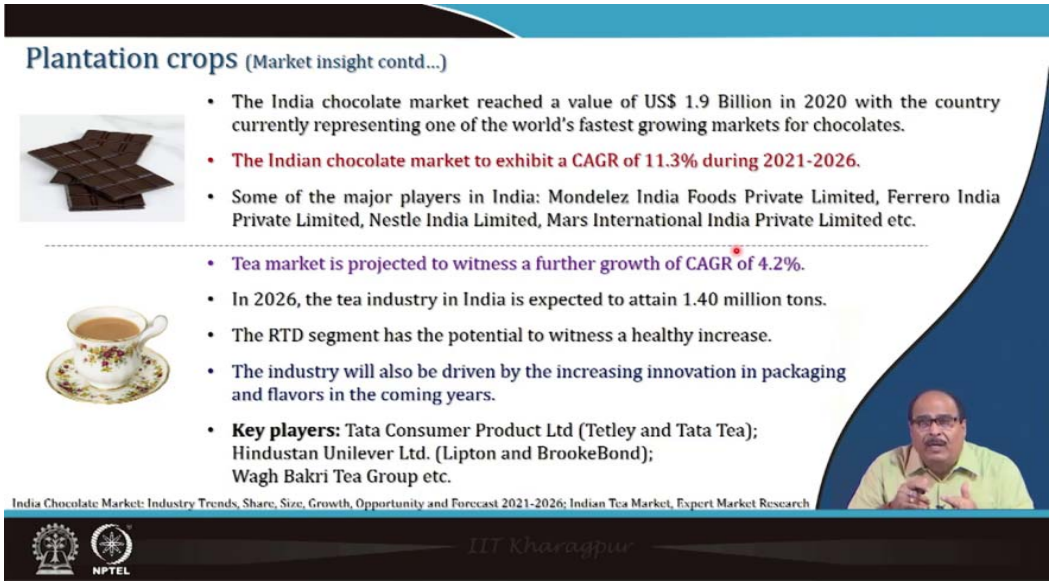
Market insight of plantation crops

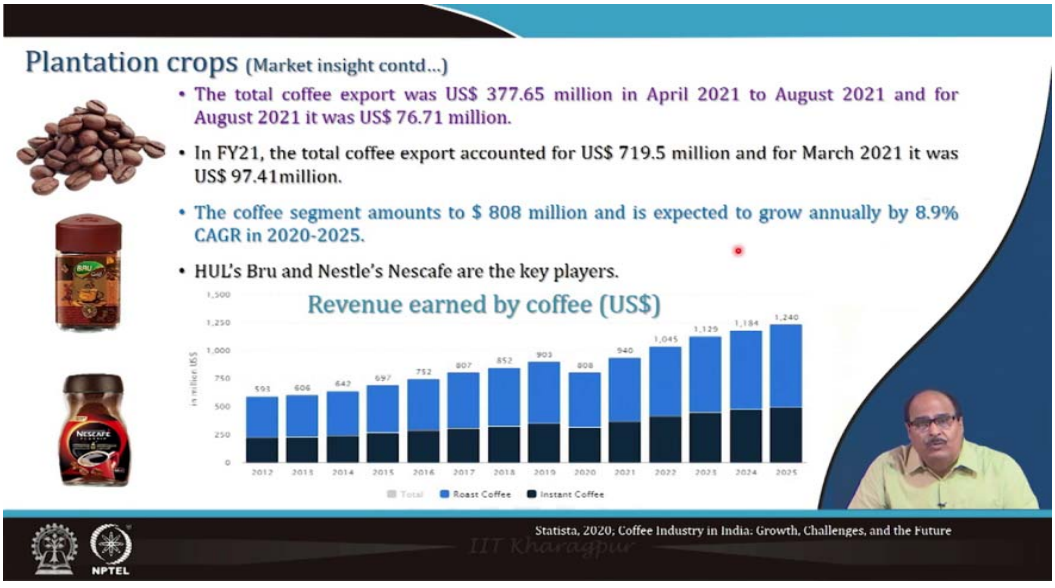
Plantation crops are the potential sector with lot of opportunities of employment generation, foreign exchange earnings and overall supporting livelihood sustenance of mankind at large. These plantation crops are considered as cash crops in the country. Coconut products market size was valued at 11.5 billion US dollar in 2018 and is estimated to reach 31.1 billion dollar by 2026 registering a CAGR of 13.6% from 2019 to 2026. In 2018, the coconut oil segment accounted for more than half of the total coconut products markets share. The current major key market players in the coconut industry include The Coconut Company (UK), Marico Ltd., Vita Coco, Sambu Group, Metshu Exports (Pvt) Ltd, Cocomate, Klassic Coconut, Cocotana Coconut Products, Universal Coco Indonesia, Thai Coconut Public Company Limited. The Indian cashew market is projected to register a CAGR of 4% during the forecast period 2022-2027. India has been the top exporter in the global shelled cashew trade, accounting more than 15% of the global cashew export in the last 4 years.

The India chocolate market reached a value of US 1.9 billion dollar in 2020 with the country currently representing one of the world fastest growing market for chocolates. The Indian chocolate market is expected to exhibit a CAGR of 11.3% during 2021-2026. Some of the major players in India in the chocolate sector are Mondelez, Ferrero, Nestle, Mars international etc.

In India, the tea market is projected to witness a future growth of CAGR of 4.2%. In fact, Indian tea particularly Darjeeling tea is known worldwide for its flavor and aroma. In 2026, the tea industry in India is expected to attain 1.4 million tons. The ready to drink segment has the potential to witness a healthy increase. The industry will also be driven by the increasing innovation in packaging and flavors in the coming years.

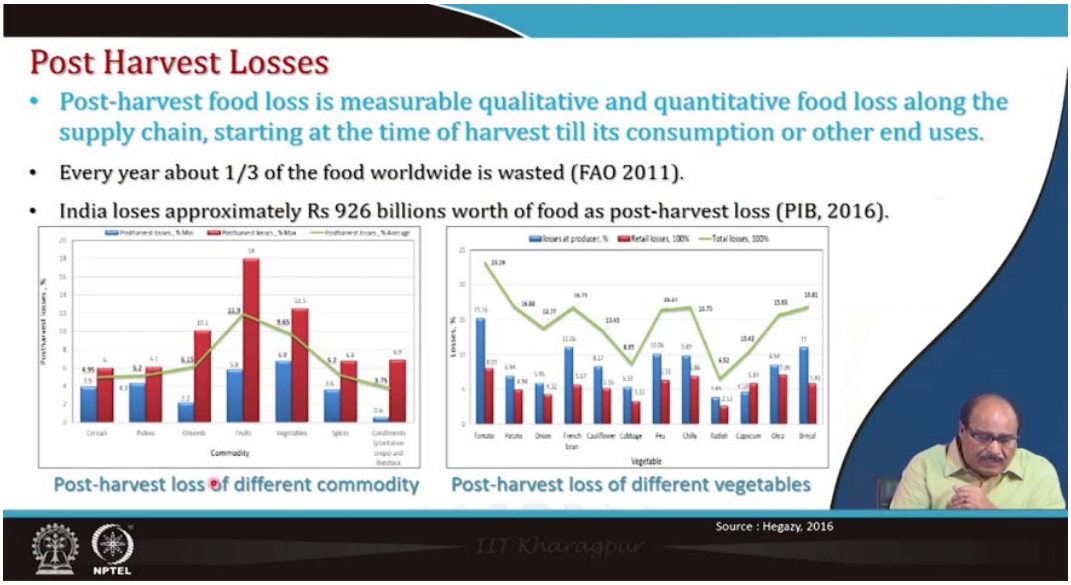
Major players in the tea sector in the country include Tata consumers product limited (Tetley tea and Tata tea), Hindustan Unilever Ltd. (Lipton and Brookebond), Wagh Bakri Tea Group etc.





The total coffee export was US 377.65 million dollar in April 2021 to August 2021 and for the august 2021 it was US dollar 76.71 million. In the financial year 21, the total coffee export accounted for US dollar 719.5 million and for March 2021 it was US dollar 97.41 million. The coffee segment amounts to 808 million US dollar and is expected to grow annually by 8.9% CAGR in 2020-2025.

HUL's bru and Nestle's Nescafe are the key players in the coffee sector in India. In the slide, the revenue earned by coffee including roasted and instant coffee (in the US dollar) from the year 2012 to 2025 has been shown, which also represents the progressive increase in the revenue earned by coffee annually.



Post-harvest losses

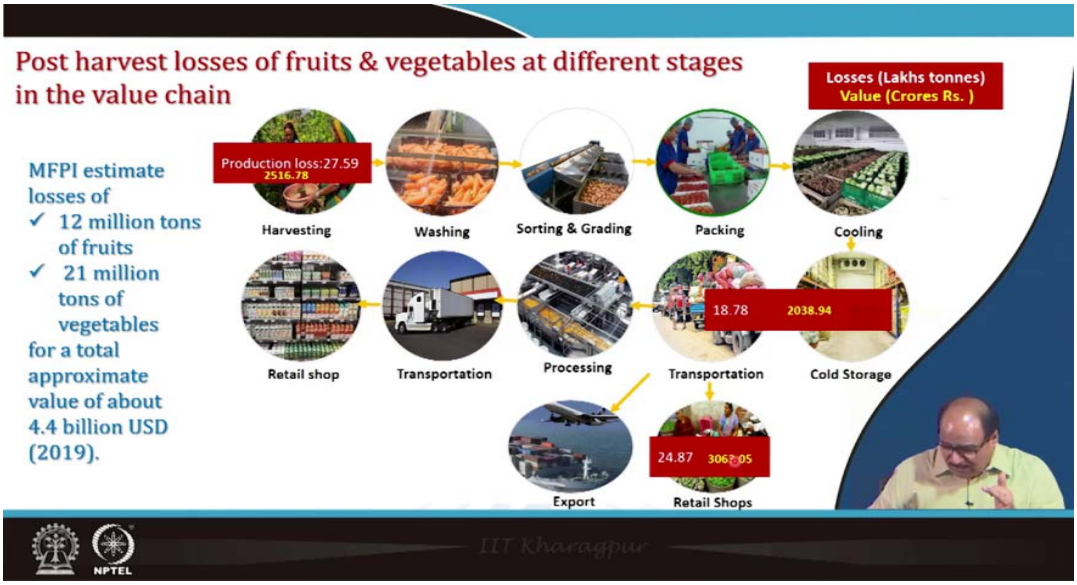
Post-harvest loss is a measurable qualitative and quantitative loss along the supply chain, starting at the time of harvest till the produce reaches to the consumer table, it has to pass through various stages and each stage in the value chain, there is a significant quantity of the product loss in India.

FAO, 2011 reported that every year about one third of the food worldwide is wasted. Fresh information bureau data in the year 2016 reported that India loses approximately Rs. 926 billion worth of food as post-harvest loss and a developing country like India cannot afford to such a huge loss or such a luxury of huge wastage of fruits, vegetables and other important produces.

The left hand side graph represent the post-harvest losses of commodities including cereals, pulses, oilseeds, fruits, vegetables, spices, and condiments with their maximum, minimum, and average values indicating in red, blue, and green color, respectively. The right hand side plot shows the post-harvest losses of vegetables at different stages (producer and retail) as well as total losses indicating in blue, red, and green color, respectively.

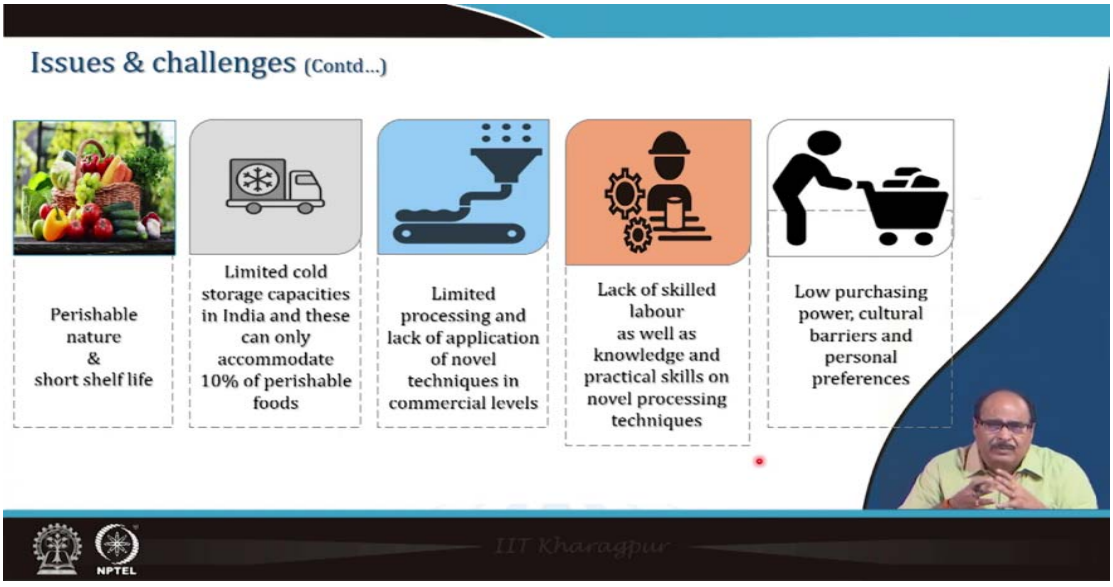
Post-harvest losses of fruits and vegetables at different stages in the value chain

The value chain consists of different stages starting from the harvesting, washing, sorting, grading, packing, cooling, storing at cold storage, transportation to export, or directly to retail shop or processing unit followed by transporting to retail shop. In the production stage about 28 lakh ton of the produce is getting wasted at the farm level. Then in the cold storage and transportation section approximately 18.78 or approximately 19 lakh tons of the produce gets wasted. Finally the fresh produce gets wasted (around 25 lakh tons) in the retail shop. The wastage value at the farm gate is Rs. 2516.78 crores, during storage and transportation around Rs. 2039 crores and in the retail shops it is around Rs. 3063 crores. The Ministry of Food Processing reported that there was 12 million tons loss of fruits and 21 million tons loss of vegetable, which accounted around approximate value of US dollar 4.4 billion in 2019.



Issues and challenges

Horticulture in India contributes about one third of the Indian agriculture GDP and its expenditure shares of the total Indian GDP are about 4.7%. Despite of the significant production, average fruits and vegetable consumption in India is still relatively very low and highly unequal due to underdeveloped supply chains for the distribution of fruits and vegetables. It has been reported that huge quantity of fruits and vegetables produced in India are lost in the supply chain between harvest and consumption. The major reasons are perishable nature and short shelf life of the fruits and vegetables as well as the poor storage infrastructure, poor transportation facilities and poor supply chain models.

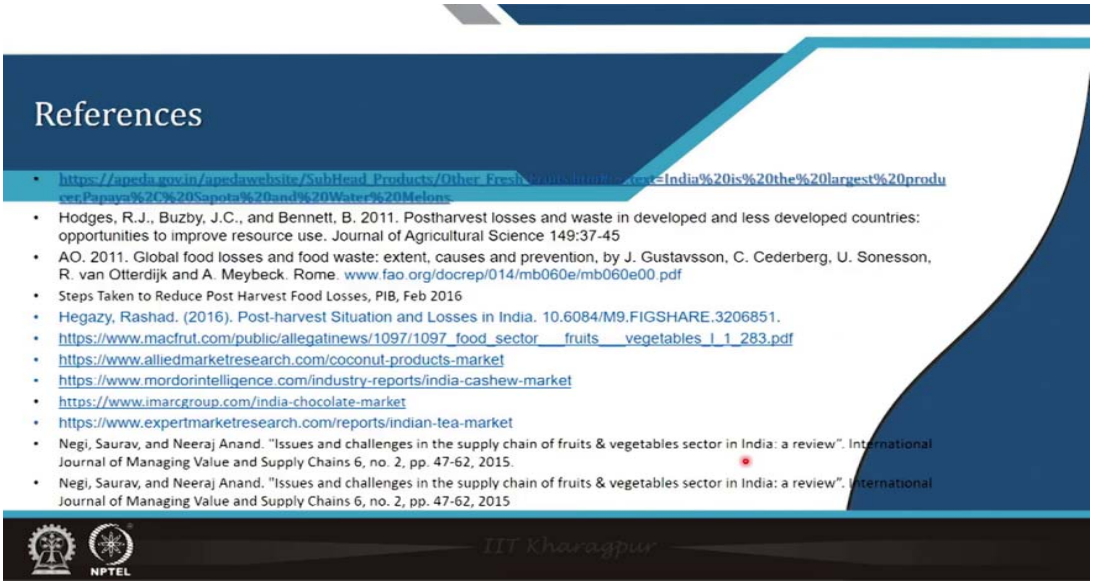


So, the major issues which need to be resolved are the perishable nature and shelf life of fruits and vegetables, limited storage capacity in India and these can only accommodate 10% of the total perishable produced in the country. So, there is need to increase the storage capacity, cold storage

chain for the horticultural and plantation crop or perishable crop sectors. Also, there is a limited processing, lack of application of the novel technologies particularly at the commercial levels, lack of skilled labour as well as knowledge and practical skills on novel processing techniques, low purchasing power, cultural barriers and personal preferences. So, this course will provide sufficient knowledge, information and will be useful for the participant and it will help to create more entrepreneurs startups and even the existing industries.

Summary

India is the second largest producer of horticultural crops in the world. Irrespective of the highest production, only 2-3% of the producers are processed. So there is a need for skill development and application of novel processing technologies to capitalize the opportunity and fulfill the demand. This course will be helpful to gather knowledge for improving or modernizing the storage and processing facilities in order to add value to the product so that the level of processing is increased, losses are minimized and the industry is able to give quality products which good nutritional value because fruits and vegetable are the hub of the micronutrients.



The references for this lecture are given here for further study. Thank you.