Food Oils and Fats: Chemistry & Technology

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Week 1: Course Overview and Introduction

Lecture 1: Oil & Fats Processing Industry - Current Status, Issues and Challenges

Hello everybody. Namaskar. I welcome you all to this NPTEL course on Food, Oils and Fats, Chemistry, and Technology. In this lecture today, we will briefly first discuss the course. Then we will also take a general overview of food, oils, and fats and their health benefits. We will also discuss the food, oils, and fats market, global and Indian status, factors responsible for the growth of edible oils and fat markets, and issues and challenges facing the food, oils, and fat sector. Finally, we will also touch up on some points that the initiative that has been taken by the Government of India to boost the food, oils, and fat sectors.

Course Introduction

Course duration

- 12 Weeks course having 60 Lectures of 30 min each
- 12 Assignments, 01 at the end of every week
- Online examination at the end of the course

Broad areas covered

- Nature and occurrence of food lipids; their physical, chemical & nutritional characteristic; quality deterioration processes like rancidity, autooxidation, polymerization and their prevention like using antioxidants, etc.
- Edible oil extraction : Pretreatments, mechanical expression, solvent extraction, novel techniques.
- Edible oil refining, modification of fats and oils, recovery of fats from animal sources.
- Commercial cooking and frying oils, speciality oils; by-product & waste utilisation, existing laws and regulations applicable to food oils & fats sector.

This is a 12-week course having 60 lectures of 30 minutes each. There will be 12 assignments in the course, one at the end of every week. Finally, there will be one online examination at the end of the course. The broad areas that will be covered in this course include the nature and occurrences of food lipids, their physical, chemical, and nutritional characteristics, quality deterioration processes like rancidity, auto-oxidation, polymerization, and their prevention using antioxidants etcetera. Edible oil extraction is what are the various pretreatments, then mechanical expression, solvent extraction, or other novel technologies will be covered. Then we will also cover edible oil refining, modification of fats and oils, and recovery of fats from animal sources. Finally, we will include or we will discuss commercial cooking and frying oils, specialty oils, byproducts, and waste utilization, existing laws and regulations applicable to food, oils, and fat sectors.

Course content

Weeks	Topics
1	Course Overview and Introduction
2	Food Lipids – Nature & Occurrences
3	Edible Oils - Chemistry & Properties
4	Expelling of Oils from Plant Sources
5	Solvent Extraction of Edible Oils
6	Edible Oils Refining & Deodourization
7	Modifications of Oils and Fats
8	Recovery of Fats from Animal Sources
9	Commercial Cooking & Frying Oils
10	Specialty Oils and Fats Products
11	By-product Utilisation & Valorisation of Oil Processing Industry Waste
12	QA/QC, Laws, Regulations and Policies

The week-wise course content given in this table like in the first week 5 lecture will be included to give an overview and rather an introduction of the fats and oil sectors. Then in the second week, we will take up food lipids, their nature and occurrences and in the third week we will discuss the chemistry and properties of edible oils. Then fourth, and fifth weeks will be devoted to the recovery and expelling of oils from plant sources like mechanical expression, solvent extraction etcetera. In the sixth week and seventh week, we will discuss the edible oil refining and deodorization process and other modification processes of fats and oils. That eighth week we will be devoted to recovering fats and oils from animal sources. In the ninth week commercial cooking and frying oils and specialty oils and fat products will be discussed in the tenth week. Then in the last two weeks, we will take up byproduct utilization and valorization of oil processing industry waste, QAQC, and laws and regulations prevailing in the fats and oil processing sector.

In this I have given you suggested readings. There are 10 books that will be useful in this course like Bailey's Industrial Oils and Fat Products, and Edible Oil Extraction Processing and Application by S. M. Chemat. Then fats and oils formulating and processing for application like by Richard D. Oberon, oils and fats in the food industry by Frank D. Gunsmun and practical handbook of soybean processing and utilization or rice bran and rice bran oil their chemistry processing and utilization, and finally, the tenth book is the specialty oils and fats in food and nutrition, their properties, processing, and applications. So, this is the list of books that will be beneficial and I advise you all to refer to these books all these books are available online.

Food Oils and Fats

Oils and fats

- Extracted from seeds or recovered from other parts of plants and animals.
- Mixture of mixed triglycerides.
- May contain phospholipids, sterols, free fatty acids , antioxidants, etc.

Source: https://www.amazon.in

Oils

- Liquid at room temperature

✓ Vegetable oils

- Peanut, Soybean, Mustard, Sunflower, Palm oil, etc.

✓ Animal-based oils

-Fish oil

Now, let us see what are foods, oils, and fats. These oils and fats are extracted from seeds or recovered from other parts of the plants and animals. They are generally a mixture of mixed triglycerides. What are triglycerides? We will take it up in the next class. Oil may contain phospholipids, sterols, free fatty acids, antioxidants etcetera. Generally, oils are liquid at room temperature for example, vegetable oil like peanut oil, soybean oil, mustard oil, animal-based oil, fish oil etcetera.

Food Oils and Fats (Contd...)

Fats

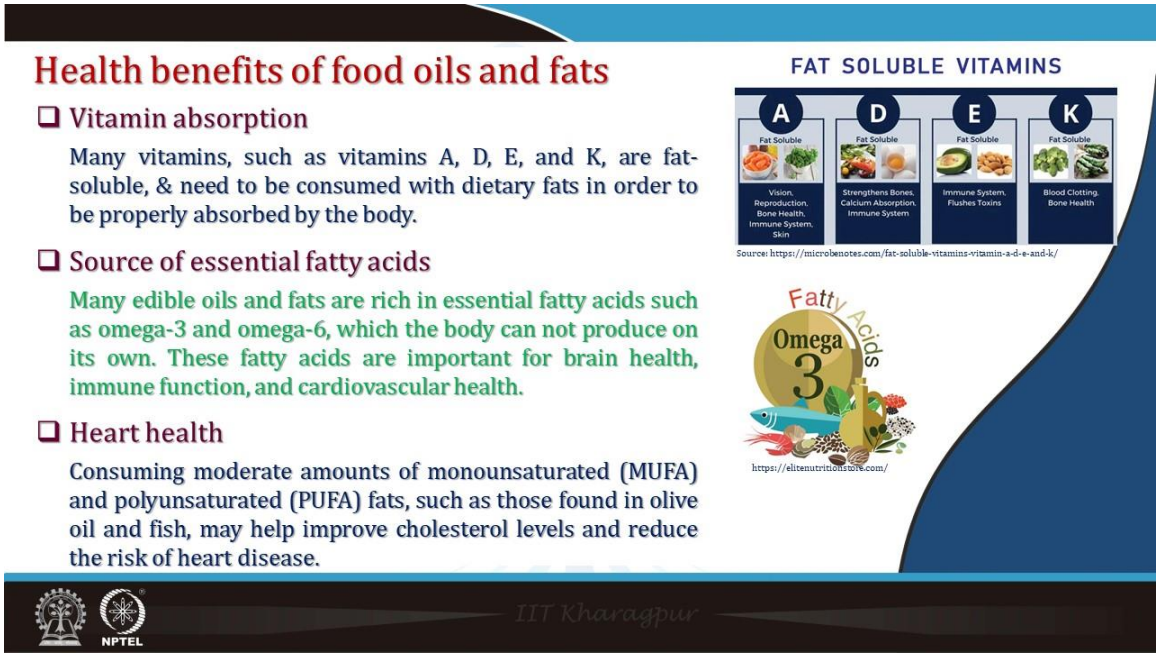
- Solid at room temperature
  - Butter, margarine, shortening, and various types of animal fats.

Applications

- Cooking
- Frying (deep and shallow)
- Baking
- Salad dressing
- Margarine and spreads
- Emulsifier
- Texture enhancer
- Processed food
- Flavouring
- Cosmetic and personal care
- Preservation
- Nutritional supplements
- RTE and convenience foods
- Animal feed production

Then fats are solid at room temperature, for example, you know butter, margarine, shortenings, and other various types of animal fats. These fats and oils are used extensively in various food process operations like cooking, frying, baking, salad

dressing, preparation of margarine and spreads, as an emulsifier, as a texture enhancer and so and so on. They are used in many processed foods ready to eat and convenience foods, they are used as nutrition supplements, even they are used sometimes the byproducts for animal feed productions etcetera.



If you look at the health benefits of food, oils, and fats, you see that many oils and fats contribute to vitamin absorption in the body. Many vitamins such as vitamins A, D, E, and K are fat solvents and need to be consumed with dietary fats in order to be properly absorbed by the body. The oils and fats are sources of essential fatty acids, they are rich in fatty acids like omega 3 and omega 6 which the body cannot produce on its own. So, these fatty acids are important for brain health, immune function, and cardiovascular health and it becomes very important that we should consume the oils and fat which are rich in these fatty acids. Also consuming a moderate amount of mono-unsaturated and polyunsaturated fats such as those found in olive oil, fish oil etcetera may help improve cholesterol levels and reduce the risk for heart diseases.

Some edible oils such as olive oils and coconut oils contain compounds that have been shown to have anti-inflammatory effects in the body which may help reduce the risk of chronic diseases such as arthritis and other certain diseases like cancer etcetera. Oils and fats improve brain function particularly the consumption of omega-3 fatty acids that is which are found in fish oils may help improve cognitive functions and reduce the risk of dementia and Alzheimer's diseases.

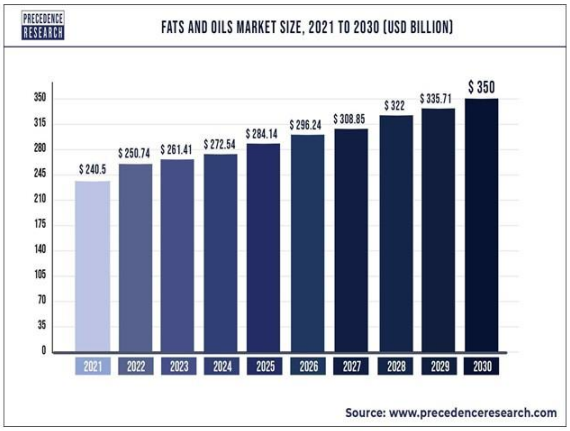
- **Anti-inflammatory effects**
  Some edible oils, such as olive and coconut oil, contain compounds that have been shown to have anti-inflammatory effects in the body, which may help reduce the risk of chronic diseases such as arthritis and certain cancers.
- **Improved brain function**
  Consuming omega-3 fatty acids, such as those found in fish oil, may help improve cognitive function and reduce the risk of dementia and Alzheimer's disease.
- **Skin health**
  Some edible oils, such as coconut and avocado oil, may help improve skin health and appearance due to their moisturizing and antioxidant properties.

https://vibrantblueoils.com/

Source: https://www.amazon.in

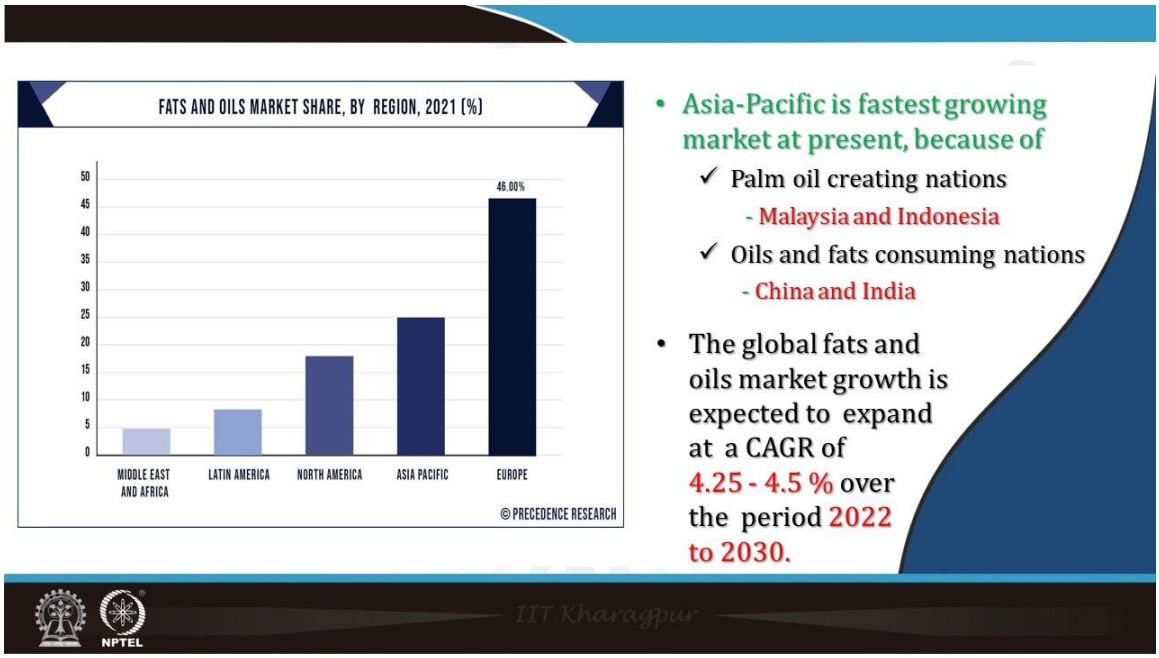
Oils are very good medicine for skin health, some edible oils such as coconut and avocado oil may help improve skin health and appearance due to their moisturizing and antioxidant properties.

Food oils and fats market : Global status

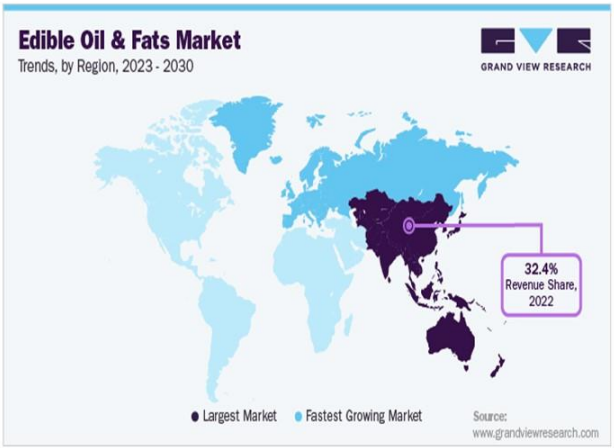


- The oils and fats market has been filling consistently in created nations and arising nations, like the US, Brazil, China, India, and Indonesia.
- Europe accounted largest share of the market (46%).
- Among vegetable oils, palm oil stayed the most well-known with around 30% share.

Now, let us have a glance at the food oils, and fats market. First, we will take up the global status and then we will switch over and discuss the Indian status. So, the oils and fats market has been filling consistently in created nations and rising nations like the US, Brazil, China, India, and Indonesia. Europe accounted largest share of markets which is 46 percent. Among vegetable oils palm oil stayed the most well-known with around 30 percent of the share and if you can see here that fats and oil market size from 2021 to 2023 every year the scenario it is increasing the production as well as availability is increasing.



Then Asia Pacific is the fastest growing market at present because of the palm oil creating nations like Malaysia and Indonesia as well as oils and fats consuming nations like India and China. The global fats and oil market growth is expected to expand at a CAGR of 4.25 to 4.5 percent over the period from 2022 to 2030 and in this slide I have tried to give you the data regarding fats and oil market share by region and this includes the data of 2021 where Europe has a share of around 46 percent in the market.



Asia Pacific Market (2022)

- Global revenue share : 32.4%
- Sale volume : 1,09,179.8 kilo ton

One of the key factors propelling the growth of the edible oil market is the rise in consumer inclination for nutritional enhancements.

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Key global industrial players vegetable oil market

- Associated British Foods PLC (UK)
- Archer Daniels Midland Company (ADM) (US)
- Bunge Limited (US)
- Wilmar International Limited (Singapore)
- United Plantations Berhad (Malaysia)
- Unilever PLC (UK)
- Ajinomoto Co., Inc. (Japan)
- Mewah International Inc. (Singapore)

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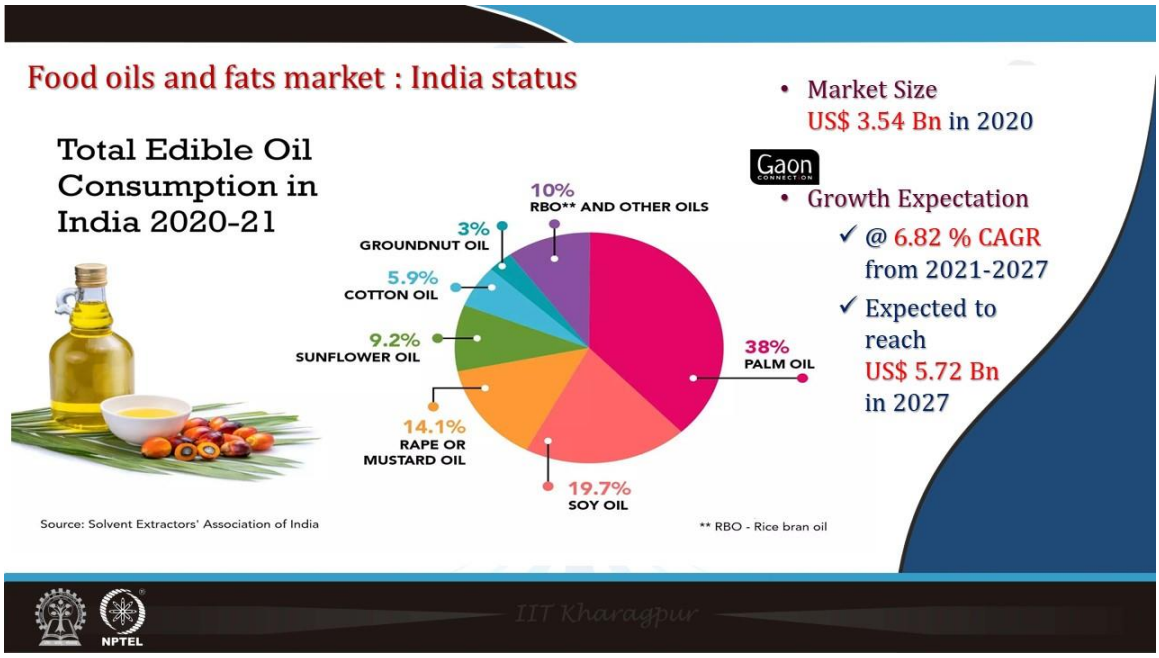
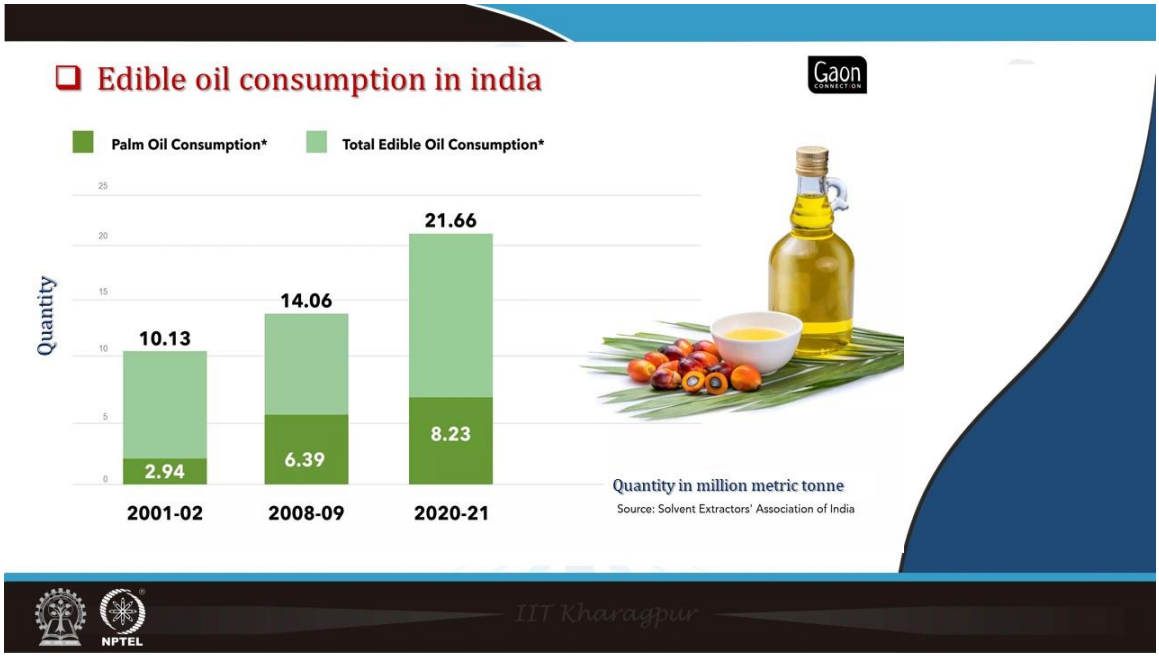
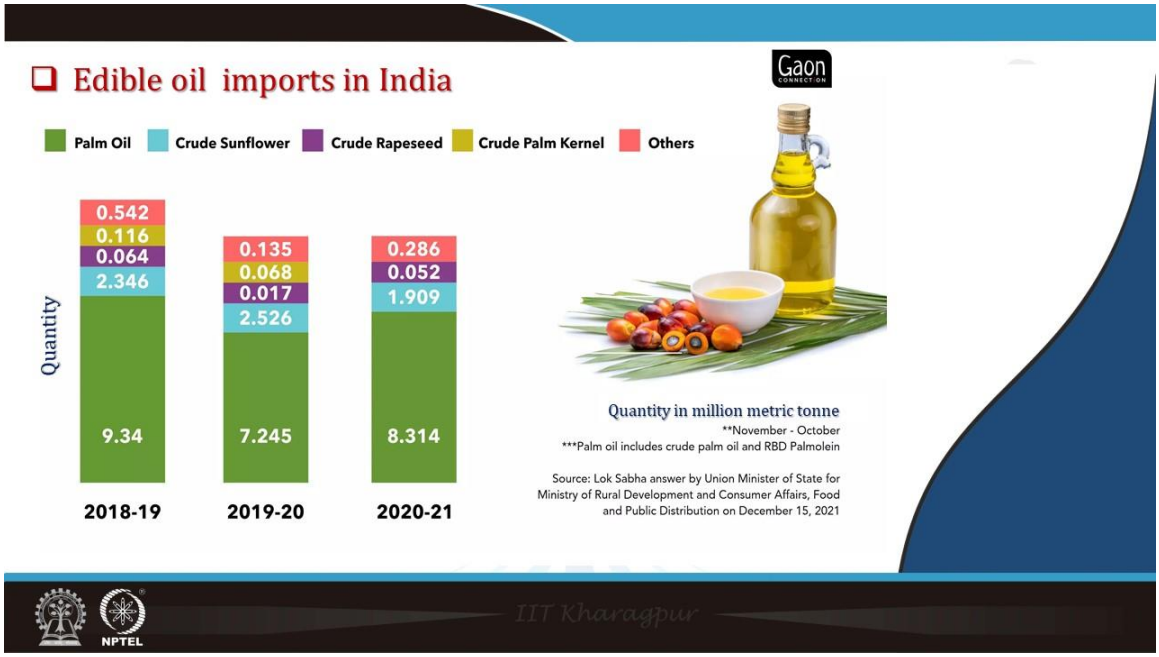
The Asia Pacific market in 2022 that is global revenue share included 32.4 percent whereas, the sale value was 1,09,179.8 kilo ton. One of the key factors propelling the growth of edible oil market is the rise in consumer inclination for nutritional enhancement. The key global industrial players of vegetable oil market include Associated British Food, Archer Daniel Midland Company, Wilmar International Limited and Unilever PLC, Mewah International Incorporation of Singapore etcetera.



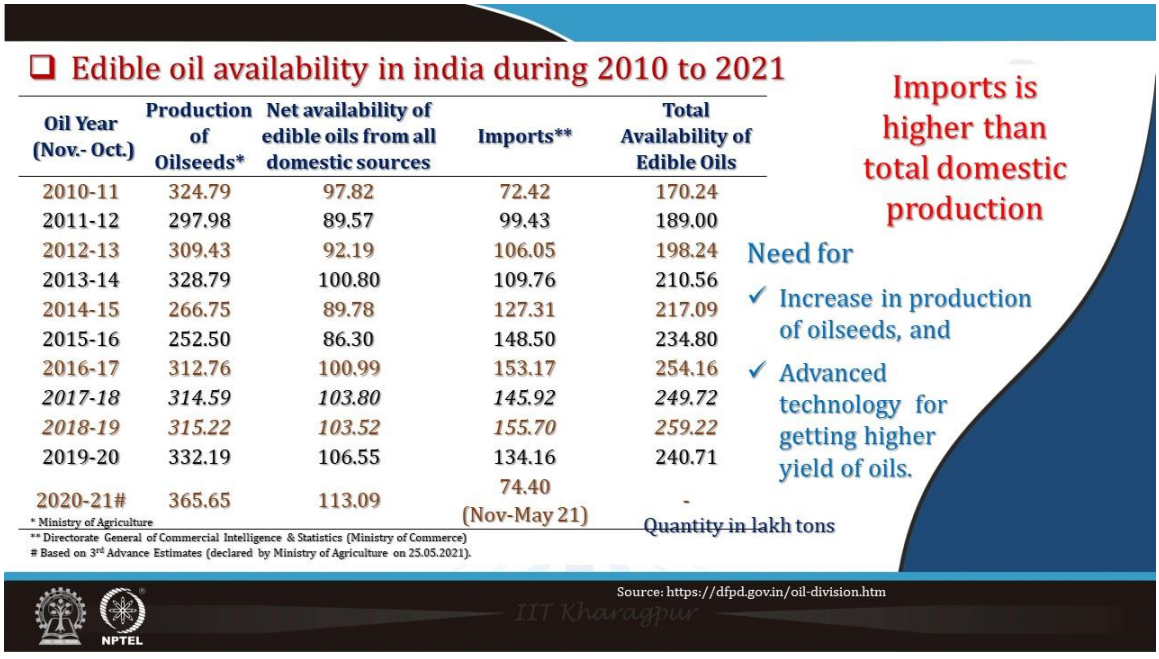
So, as far as the Indian status is concerned the market size in 2020 of Indian oil and fats was about US dollar 3.54 billion. The Indian fats and oil markets are increasing at a rate of 6.82 percent CAGR from 2021 to 2027. It is expected to reach US dollar 5.72 billion in 2027. If you look at the various oils that dominate in the market the pie chart, pie figure shows that palm oil with 38 percent share is the dominating oil which is followed by soy oil with 19.7 percent share, rapeseed or mustard oil with 14.1 percent, sunflower oil 9.2 percent, cottonseed oil 5.9 percent, groundnut oil 3.1 percent and 10 percent rice bran oil and other oils.



As far as the data for edible oil consumption in India is concerned you can see palm oil is the dominating the total edible oil consumption in 2020-2021 was 21.66 million metric tons, the palm oil itself included 8.23 million metric tons. So, almost one-third approximately of the total oil consumed in India is palm oil.

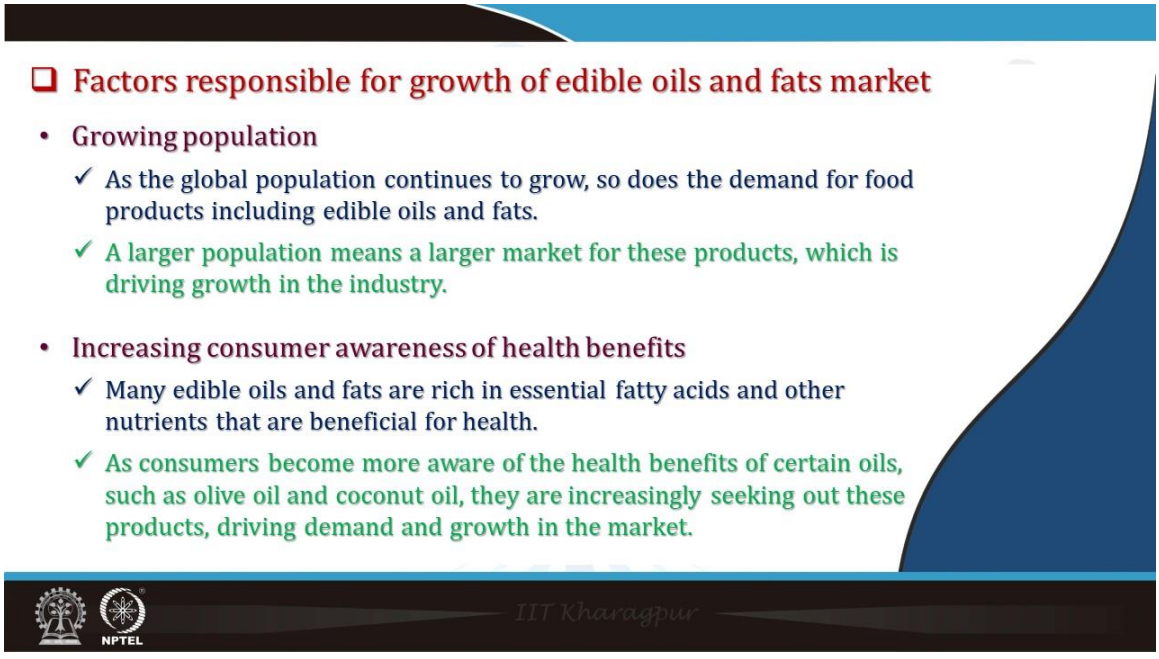


This slide shows here that data on palm oil, crude sunflower oil, crude rapeseed oil, crude palm oil, and other oils imports that is India that is there as you can see in this figure India imported a lot of oils in the year 2018-19 about 9.34 million metric ton palm oil was exported in the country and other oil, crude sunflower rapeseed also were also imported significant quantities. In 2021, 8.314 million metric tons of palm oil, and 1.909 million metric tons of crude sunflower oil were imported in the country.

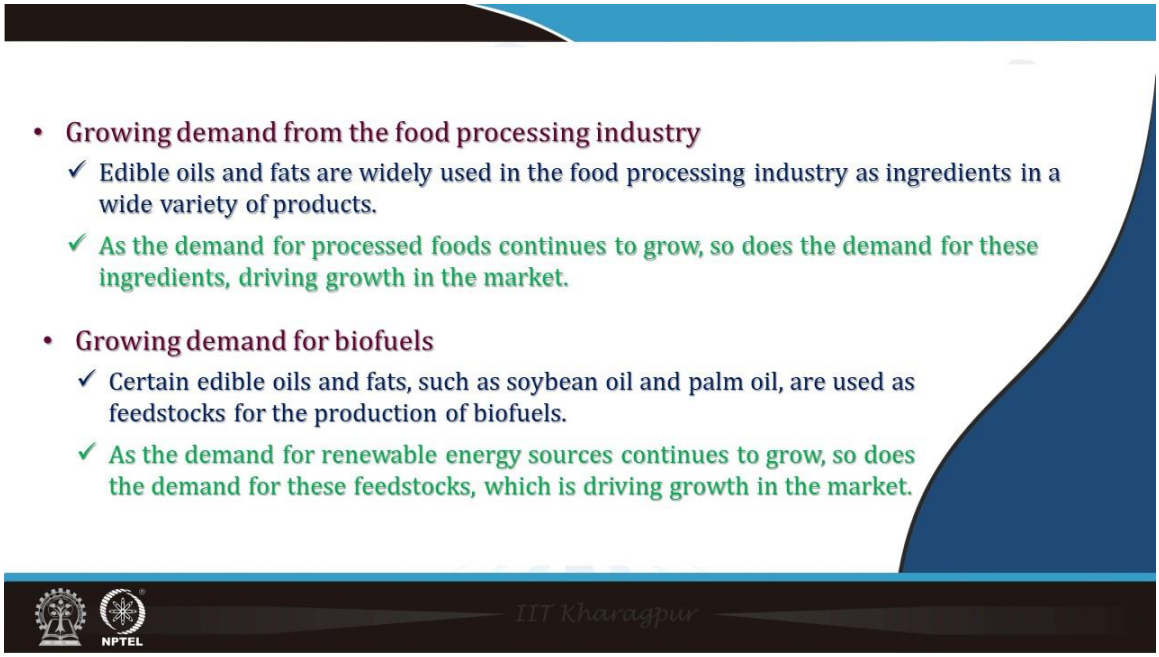


This table shows the edible oil availability in India during 2010-2021 and you can if you look at the data on the domestic production and the imports we find that the imports data is higher means that we are not able to meet our requirement by our domestic production. So, we are importing every year at the data for the last 10 years shows. So, what does it say that there is a need to increase the production of edible oil, particularly the oil seed which can be used for the extraction of oils. Also, there is a need to have advanced technology for getting a higher yield of oil from these oil-bearing materials.

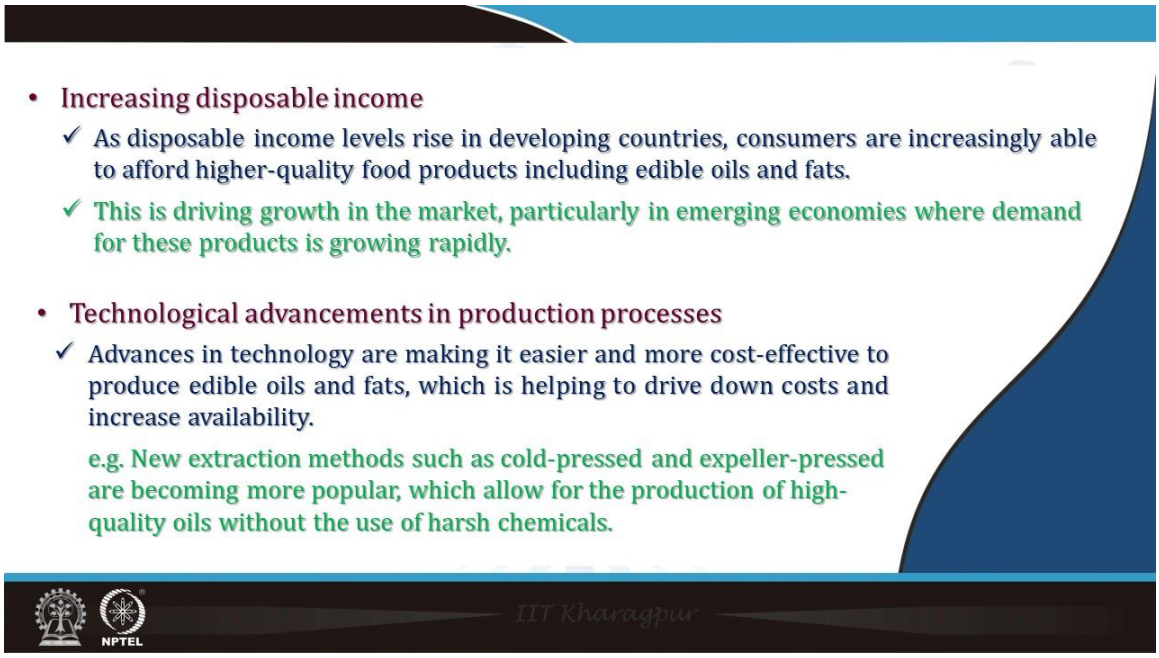
The key industrial players in Indian vegetable oil markets include Adani Wilmer Limited, Ruchi Soya Industrial Limited, Mariko Patanjali Oil Limited, Mother Dairy, Imami Agrotech, Gokulri Oils, Vijay Salvex, Kamani Oils Limited etcetera.



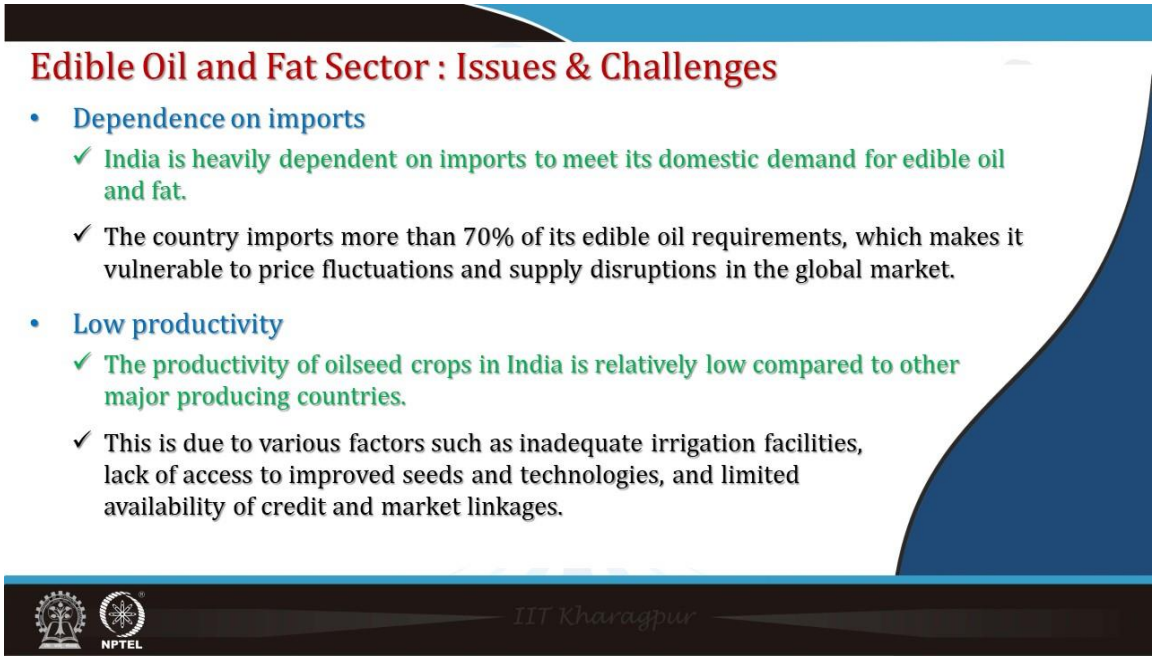
The factors that are responsible for the growth of the edible oils and fat market in the country include the most important factor is the growing population. As the global population continues to grow so does the demand for food products including the edible oils market and a larger population means a larger market for these products which is driving growth in the industry. Another factor is the increasing consumer awareness of health benefits. Many edible oils and fats are rich in essential fatty acids and nutrients that are beneficial for health. As consumers become more aware of the health benefits of certain oils such as olive oil and coconut oil they are increasingly seeking out these products driving demand for growth in the market.



The growing demand from the food processing industry for oils and fats is another factor that drives the food processing industry. Edible oils and fats are widely used in the food processing industry as ingredients in a variety of products. As the demand for processed foods continues to grow so does the demand for these ingredients driving growth in the market. Certain edible oils and fats such as soybean oil and palm oil are also used as feedstock for the production of biofuel. As the demand for renewable energy sources continues to grow so does the demand for these products which is driving growth in the oils and fats markets. Increasing disposable income of the consumer particularly the level of disposable income in rising developing countries the consumers are increasingly able to afford higher quality food products including edible oils and fats. And this is driving growth in the market, particularly in emerging economies where demand for these products is growing rapidly. Technological advancement in the production process is another factor that is the driving force for the industry. Advancements in technology are making it easier and more cost-effective to produce edible oils and fats which is helping

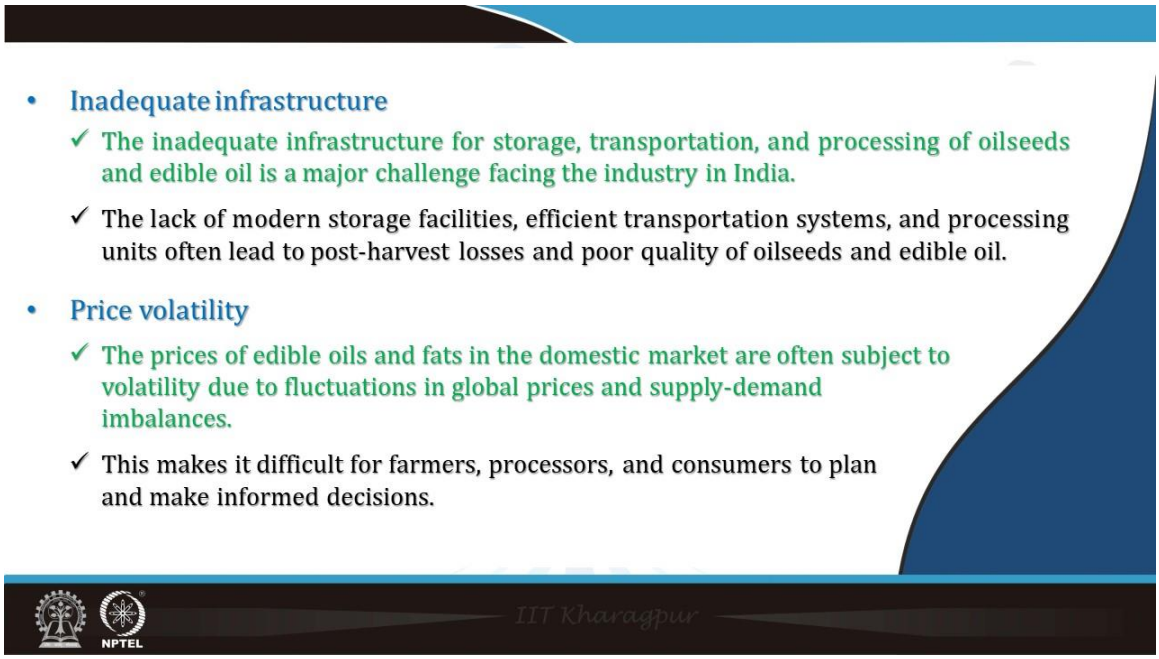


to drive down cost and increase availability. For example, new extraction methods such as cold-pressed and expeller-pressed oils are becoming more popular which allow for the production of high-quality oils without the use of harsh chemicals etcetera.



Right now having this brief introduction about the edible oils and fats sectors let us see what are the various issues and challenges that are facing the edible oils and fats sectors in our country. The number one biggest challenge is the dependence on imports India is heavily dependent on imports to meet the domestic demand for edible oil and fat as you can see in the earlier slide in the showing the data. So, the country imports more than 70

percent of its edible oil requirement which makes it vulnerable to price fluctuations and supply disruptions in the global market. The productivity of oil crops in India is relatively low compared to other major producing countries and this is due to various factors such as inadequate irrigation facilities, lack of access to improved seeds and technologies and these are limited availability of credit and market linkages. So, we need to improve the productivity.



Then inadequate infrastructure is another challenge facing the fats and oil sector. The inadequate infrastructure for storage, transportation, and processing of oil seeds and edible oils is a major challenge facing this industry. The lack of modern storage facilities, efficient transportation systems, and processing units often leads to post-harvest losses and poor quality of oil seed and edible oils. The prices of edible oils and fats in the domestic market are often subject to volatility due to fluctuations in global prices and supply-demand imbalances. This makes it difficult for farmers, processors, and consumers to plan and make informed decisions.

Quality issues are another challenge like adulteration, contamination, and poor packaging are major concerns in the edible oil and fat industry in India. These issues pose a serious health risk to consumers and also affect the marketability of the products. The lack of awareness and knowledge among farmers and other stakeholders regarding the latest technologies and best practices for oil seed production and processing is another challenge facing the Indian fats and oil industry. This often leads to the suboptimal use of resources and poor quality of the produce.

- Quality issues
  - ✓ Quality issues such as adulteration, contamination, and poor packaging are major concerns in the edible oil and fat industry in India.
  - ✓ These issues pose a serious health risk to consumers and also affect the marketability of the products.
- Lack of awareness
  - ✓ The lack of awareness and knowledge among farmers and other stakeholders regarding the latest technologies and best practices for oilseed production and processing is another challenge facing the industry in India.
  - ✓ This often leads to suboptimal use of resources and poor quality of produce.

Government of India Initiatives to Boost the Production of Edible Oils and Fats

❑ National Mission on Edible Oils (NMEO)

Potential Area :
- 27.99 lakh Ha.

Area Covered :
- 3.50 lakh Ha.
- i.e. 13%

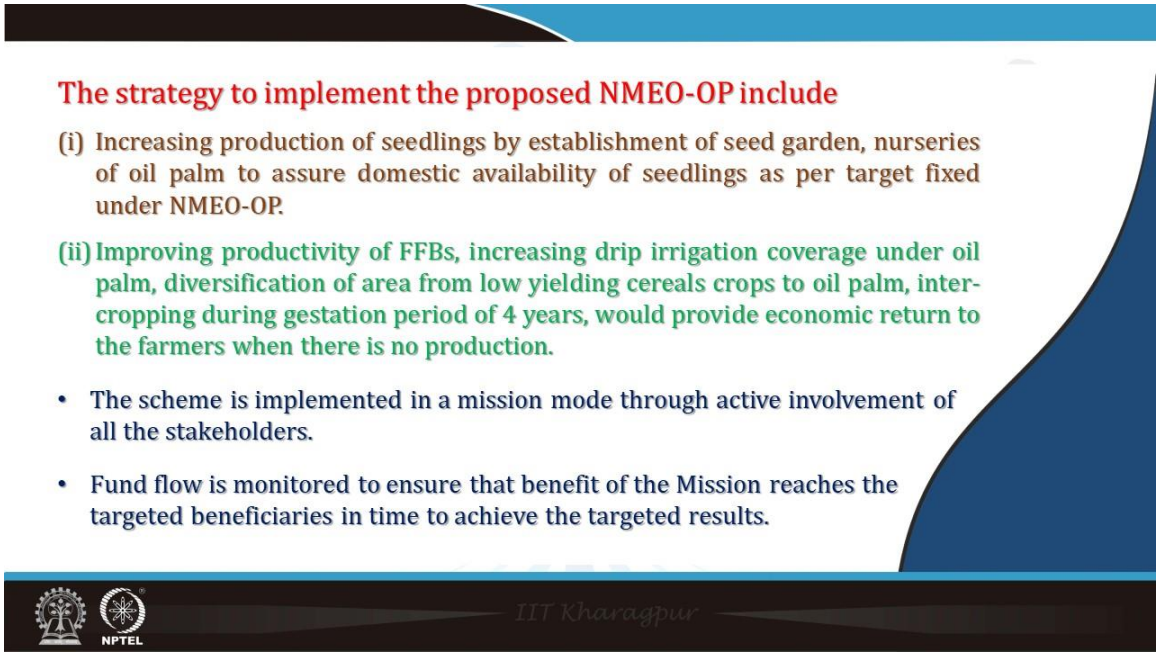
Fruiting Area
- 1.89 lakh ha

- Around 9 MT of palm oil is imported every year to the tune of Rs. 40,000 crore which is around 56% of the total imports of edible oil.
- At present against a total potential area of around 28 lakh hectares, only 3.7 lakh hectares is under oil palm cultivation.

The government of India has taken certain initiatives to boost the production of edible oils and fats in the country and it has created a national mission of edible oil NMEO, particularly for the oil club. Around 9 metric tonnes of palm oil is imported every year to the tune of rupees 40,000 crore which is around 56 percent of the total imports of edible oil. So, at present against a total potential area of around 20 lakh hectares, only 3.7 lakh hectares are under oil palm production. So, in this figure, you can see that India figure that is the areas what is the potential area that is 27.99 lakh hectares is the potential area where palm oil can be grown, but at present the area covered is just 13 percent of the

available that is 3.5 lakh hectares and the fruiting area is further less that is 1.89 lakh hectares. So, the government of India has taken an initiative to improve both this area covered under palm oil cultivation as well as in increasing the availability of the fruiting area.

Increasing production of seedlings by establishment of seed gardens, nurturing of oil palm to assure domestic availability of seedlings and for the target fixed by NMEO oil palm as well as the improving productivity of FFBs increasing drip irrigation coverage under oil palm, diversification of areas from low yielding cereal crops to oil palm,



intercropping during gestation periods of 4 years would provide economic return to the farmers where there is no production and these are the strategies to implement the proposed NMEO oil palm. The scheme is implemented in a mission mode through the active involvement of the stakeholders. Fund flow is monitored to ensure the benefit of the mission research, and the targeted beneficiary in time to achieve the targeted result. Another important initiative of the government of India to boost the oil and fat sector is the creation of a direct rate of oil seed development and it is a subordinate office of the department of agriculture and farmer welfare in the ministry of agriculture and farmer welfare. It is involved in the formulation of schemes such as the preparation of plant documents for oil seed schemes, and the identification of potential areas for oil palm cultivation in India. Looking after the monitoring of oil seed development programs and oil palm development program schemes implemented in the country and also in the central sector schemes of the ministry in the assigned states of Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, and Telangana are the responsibilities of the directorate of oil seed development, Hyderabad. This directorate assists the states, and union territories to plan, formulate, and implement crop programs to increase the production and productivity of nine oil seed crops and area expansion under oil palm through

focused interventions. It also assists the department of agriculture and farmer welfare and fixes the target of production.

So, finally, I would like to summarize this course that the global edible oil and fat market is expected to continue growing in the country in the coming years driven by factors such as population growth, rising disposable income, and changing dietary habits. Asia Pacific is the largest market for edible oils and fats according to over 50 percent of the global consumption. India and China are among the largest consumers of edible oils and fats in the region. The high level of imports of edible oils and fats in many countries such as India highlights the need for increased investment in domestic production and supply chain infrastructure. Efforts are underway to promote sustainable palm oil production practices. In this lecture, I gave you an overview of the current status of the fats and oil processing and production sector, as well as the various issues and challenges, but in India, we need to as you can see the data of the production and imports. Although we produce a sufficient quantity of oil seeds and other plants that are used for the extraction of oils including both from plant sources as well as animal sources, we are not able to meet our required requirement fats and oil requirement in the country. So, there is a great need to increase the production productivity of the materials having these oils and also the technological advancement in recovery and extracting, refining, processing, and converting these value-added products of this sector.

Thank you very much, these are some of the references that have been used in this lecture you can refer. Thank you and Jai Hind.

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