FOOD SCIENCE AND TECHNOLOGY

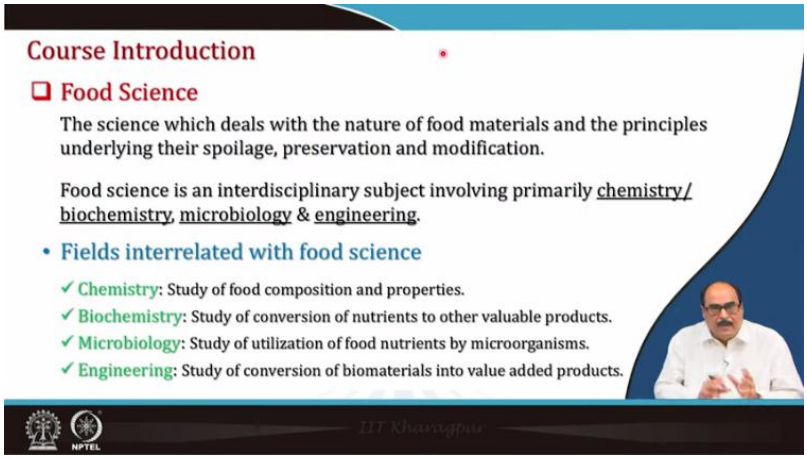
Lecture01

Lecture 1: Course Introduction, Food and Health

Hello everyone, Namaskar. Let us now start this subject, Food Science and Technology.

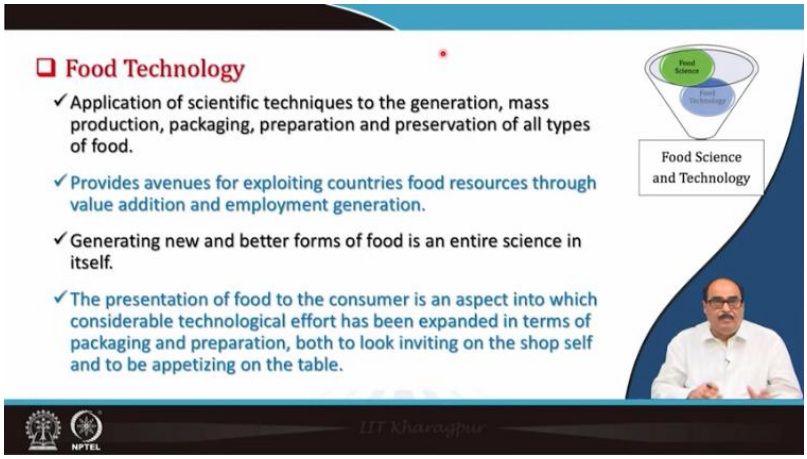
In this module 1, which is devoted on food sustainability and health, and this lecture will include course introduction and Food and health. The concepts which will be covered in this half an hour or so lecture are the course introduction, definition, nature and types of food,

food, society and culture, effect of food on physical, mental and emotional well-being, and finally, we will also touch upon some aspects of food production, which is the current national scenario.

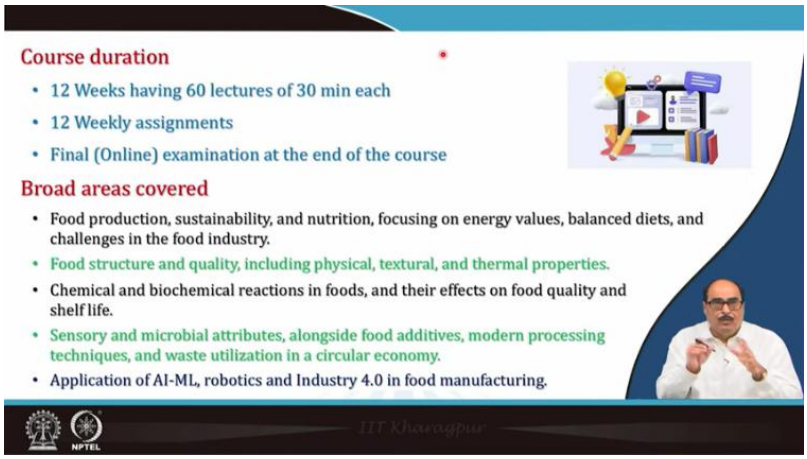


Let's see the introduction of the course. The food science, what is it? It is the science which deals with the nature of food materials and principles underlying their spoilage, preservation and modification. Food science is an interdisciplinary subject involving primarily three major branches that is chemistry, microbiology, and engineering. If you talk about nutrition, then biochemistry becomes another major branch. So, the interrelated fields with the food science include the chemistry, which studies mainly the composition and properties of food materials. In biochemistry, conversion of nutrients to other valuable products, which is finally assimilated in the body are discussed. Microbiology includes utilization of food nutrients by microorganism that is what microorganism will grow in a food, how they spoil the food, many a times even some microorganisms are beneficial for the food. So all these aspects are included in microbiology and finally engineering that is, the study of conversion of these biomaterials into value-added products, and edible products. Whatever agricultural produces are there not all are readily consumable. So, by applying engineering and technology principles, we convert these materials into edible form. There are proper interrelations between all these subjects, like for preservation of food, by applying engineering principles, we can preserve the food to increase its shelf life. So you know mainly the microorganisms are the major culprits in the food spoilage. Therefore, the microbial growth kinetics and other things are needed to control its growth as well as development in food to extend its shelf life. The preservation technologies and manufacturing technologies are guided mainly by microbiology

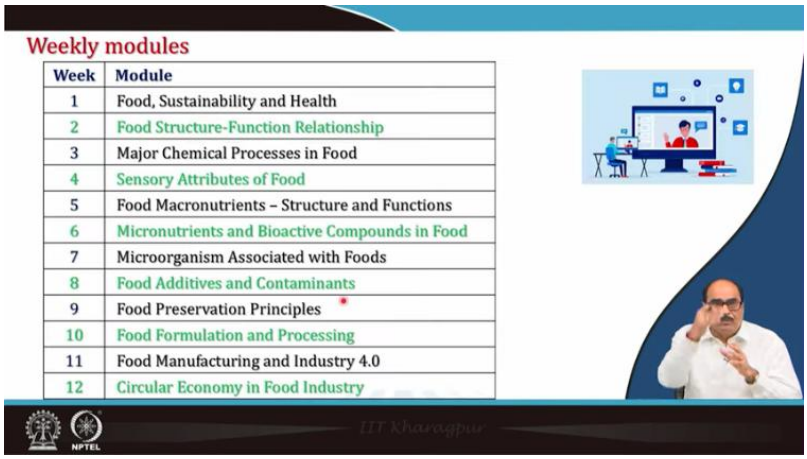
and microbiology is dictated by chemistry that is which microorganism will grow in one food is depend mainly upon the constituents which are present there in the food and these constituents are utilized by the microorganisms to grow and multiply. So basically microbiology is dictated by chemistry and engineering is dictated by microbiology and sometimes even chemistry also plays an important role because we have to see that during processing and manufacturing operations the properties and characteristics particularly, valuable input material and the food's bioactive nutrients are not destroyed during processing. Then comes to the food technology. Food technology is the application of scientific techniques to the generation, mass production, packaging, preservation and preparation of all types of foods.



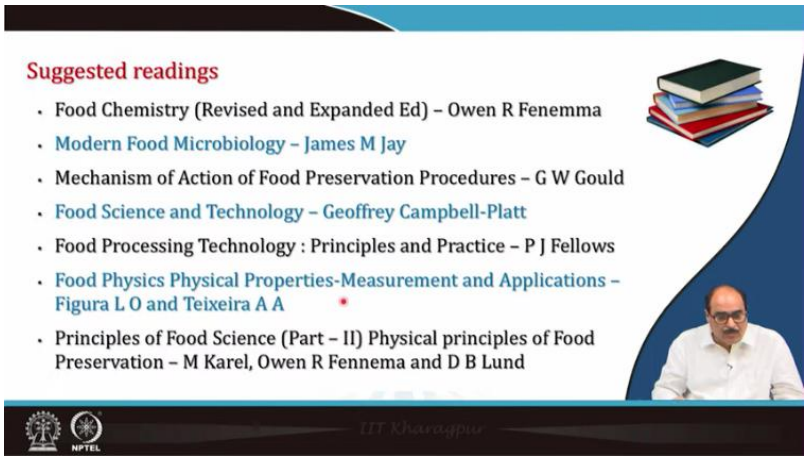
It provides avenues for exploiting the country's food resources through value addition and employment generation. And since most of the raw materials of food is produced in the villages, the food technology helps to create more and more rural employments. Also, at the same time, in the city, the industry is there, so it creates employments. So overall it is a very good industry or sector to give employment to the people. As you know, generating new and better forms of food is an entire science in itself. The presentation of food to the consumer is an aspect into which considerable technological effort has been expanded in the terms of packaging and preparation and both to look inviting on the shop shelf. Therefore, when you go to the market, you can see that a particular food is nicely prepared, and nicely packed, and you get attracted to buy it. Similarly, when the food is laid on the consumer table, you feel like eating it. So all of this includes in the food technology. Overall, it should be prepared or packaged or displayed in such a way that people are tempted to consume it, inviting to the shop self and it is appetizing on the table.



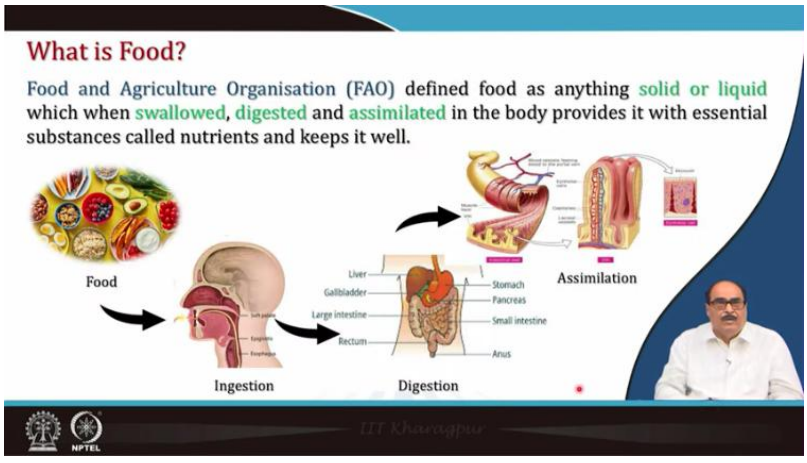
It is a 12 week course having 60 lectures of 30 minutes each. There will be 12 weekly assignments and finally one examination will be conducted at the end of the course. There are a specific set of guidelines of the NPTEL through which the course will be evaluated and the participants will be given the certificate of successful participants. Broad areas that are covered in this subject include food production, sustainability and nutrition, focusing on energy values, balanced diet and challenges in the food industry. Food structures and quality including physical, textural and thermal properties are discussed. Chemical and biochemical reactions and their effects on food quality and shelf life, sensory and microbiological attributes alongside food additives, modern processing techniques and waste utilization in circular economy are also discussed. The other very important aspect which you will not find in many other courses is that we have included here is artificial intelligence, machine learning, robotics, industry 4.0, as these are coming in a big way. in the next generation is of these sciences. At this artificial intelligence, machine learning, robotics, etc., have a very good potential for application in food industry. and that also we will discuss. We will devote completely one module on this application of AI technology, and ML as well as robotics and industry 4.0 concepts in food manufacturing.



The weekly modules are listed here. Week 1 will be food sustainability and health. The second week will be devoted to food structure function relationship. Then in the third week, we will discuss major chemical properties of food. In fourth week, sensory attributes related to food, that is what are the various sensory organs, how the food is evaluated organoleptically and what are the organoleptic characteristics of the food will be discussed. In the fifth module, it will be devoted food and food macronutrients, the structure and functions of major macro or major components of the food, macronutrients, protein, carbohydrate. fats, etc. Sixth week will be devoted on micronutrients and bioactive components in food. Microorganisms associated with food, that is food microbiology related concepts will be discussed in seventh week. Eighth week will be devoted on food additives and contaminants. In the 9th week, we will talk about food preservation principles and 10th week will include how to formulate a food and processing of food. 11th week, we will talk about food manufacturing in industry 4.0 including AI and ML and finally in the 12th week, circular economy in the food industry and circular economy concept that is the zero waste processing as well as resource reutilization. Reutilization of all the food wastes will be discussed in the 12th week.

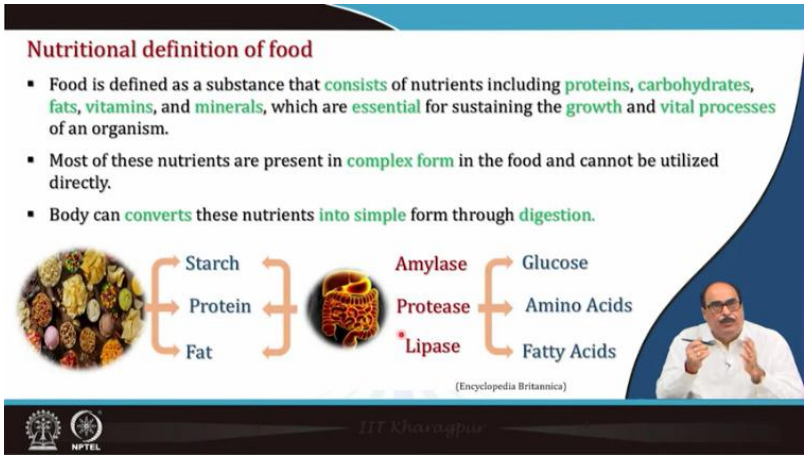


Now this slide gives you the suggested reading materials. There are several books, but I have listed a few books here, which I will be also consulting in this lecture series as well as you can also. All these books are available online and you can find out from my TAs. I will advise them and they will upload these books on the course module if possible and you can otherwise download it as these are available for free downloads on the Google. So, you can also download it and read it, but I will suggest you that please to get a good mark as well as to have a good certificate with A grade or excellent, please read the books. So food chemistry, revised and expanded edition by Owen R. Fenema. Food microbiology, James N. Jay. Mechanism of action of food preservation procedures by G. W. Gould. Food science and technology or even food processing technology: principles and practices by P. J. Fellows. Then food physics, physical properties, measurement and applications, then principles of food science part 2: physical properties of food preservation are the books which will be beneficial. Now let us start with the technical aspect. Everybody eats food. So what is a food? As per the food and agriculture organization, food is anything solid or liquid Which when shallowed, digested and assimilated in the body provides it with essential substances called nutrients, and these nutrients keep the body well, keep us emotionally, mentally, physically well and healthy. So, you see here in this figure that the food when it is taken into the mouth that is the soft palate, it is broken down into a smaller and then finally it goes to the oesophagus etc. Then comes into the digestive system where it is further digested and broken down into small molecules and these biomolecules are absorbed and assimilated in our system, particularly in the body physiological processes and then it is utilized and does its different purpose or functions in the body.



So that is food which basically provides various nutrients to meet the requirements of the body.

Nutritional definition of a food: it is defined as a substance that consists of nutrients including protein, carbohydrate, fats, vitamins and minerals.



These are essential for sustaining the growth and vital processes of an organism. Most of these nutrients are present in complex form in the food and they cannot be utilized directly as I told you earlier also. So, when we take the food, inside our body with the physiological process, with the microbiological process, with the enzymes involved and other complex reactions these complex molecules or macromolecules are converted into a smaller into a simple form through the digestion process and then it is finally used by the body for various purposes. For example, among starch, protein and fat, starch is converted into glucose by various enzymes and various other process; then protein, there are protease enzyme, which converts the protein into amino acids and lipase converts fat into fatty acids and these are finally utilized by the body for various purposes.

Now let's discuss a little bit cultural context of food. In fact, food is very very important as far as our society and culture is concerned. The collective habits, rituals, beliefs, values

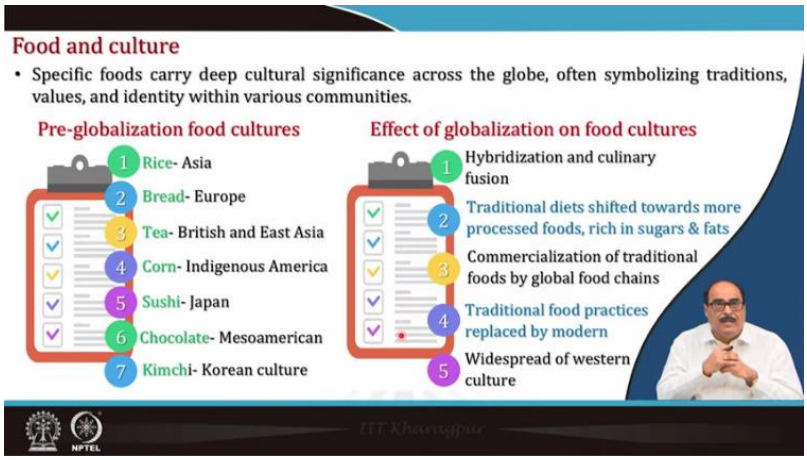
and practices regarding food is termed as food culture. The key aspect of cultural definition of the food; number 1, is the historical context. Even ancient and medieval societies, extravagant banquets hosted by kings in power or aristocrats. You know, now Sita Rasoi is still very popular. We know that in ancient times how food science and various food were developed. Then in the second point you can say that food is a symbol of hospitality. When we go anywhere or when some visitors come to your place, offering sweets and tea is a way to express hospitality and make guests feel welcome. Then ritual celebrations. Food is served during weddings, religious holidays, cultural festivals, in any gathering, etc. Depending upon our capacity, capability, etc., we offer the food. The food is important for bonding and connections. It brings people together through a casual meal with friends or festive holidays, a feast, having an icebreaker in gatherings, etc. Again, there are healthy and specialized diet which is the food to maintain fit and healthy life, like organic food, gluten-free food, vegan food, and many other healthy lifestyle foods are there. Finally we can say special foods are also there, which has a very important association with the culture like food served for special occasions like birthdays, wedding, traditional holidays, etc. There are various societies where special items are prepared on special occasions.

Then similarly, the food is important in our religious practices as well. Like Hinduism, it promotes vegetarianism. Restrictions on beef and other non-veg foods etc. are there. During fasting like Shivratri and Ekadashi, it is preached.

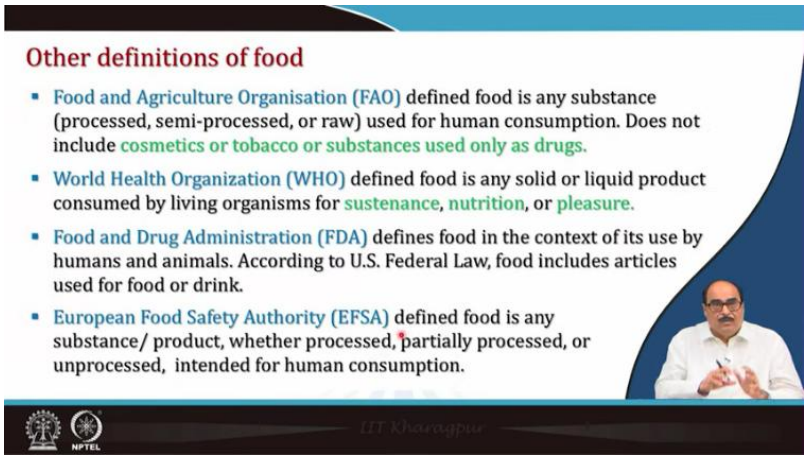
Even feasting, Diwali, Holi or such other festivals, we offer sweets etc. In the Islam, Halal dietary laws prohibited pork and alcohol etc. They also encourage fasting in Ramadan etc. or feasting like Idul Fitr. Buddhism promotes vegetarianism, restrictions depending on sect like fasting during Purnima days and feasting like Vesak. Sikhism also

encourages simple and pure food with vegetarianism often practiced. Fasting is generally not considered in Sikh religion, but feasting, yes, they have very langer. Then in Christianity, the fasting rituals or restrictions are done during Lent. So, fasting is Lent and feasting at the time of Christmas or Easter etc. Similarly, Judaism, Koshar laws, prohibition of pork, shellfish and rules about mixing dairy and meat, fasting Yom Kippur and Tisha and feasting Passover and Purim. So, these are obvious that in different religions different types of food are taken.

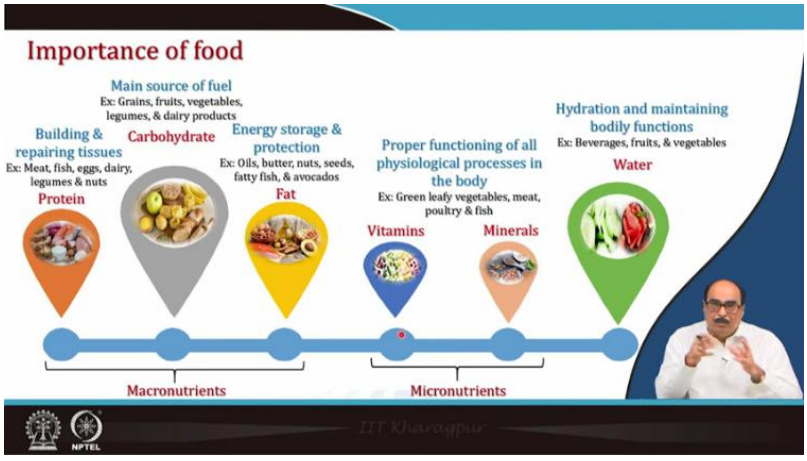
Then food and culture, if you discuss briefly, that specific food carry deep cultural significance across the globe, often symbolizing traditions, values and identity with various communities. Like you see from the pre-globalization food cultures in Asia, basically rice is the major staple diet. In Europe, it is the bread.



In British and East Asia, tea is considered from the pre-globalization time. In indigenous America- corn, Japan -sushi, Mesoamericans-chocolate and Korean culture-kimchi are consumed from pre-globalization period. But now if you look at the Post globalization that is after globalization what was its effect on food culture. There has been hybridization and culinary fusion. Traditional diets shifted towards more processed foods which are rich in sugar and fat. Commercialization of traditional foods by global food chains came into practice. Traditional food practices replaced by modern foods, etc., modern food processes and wide spread of western culture is also seen in the food utilization patterns, etc.

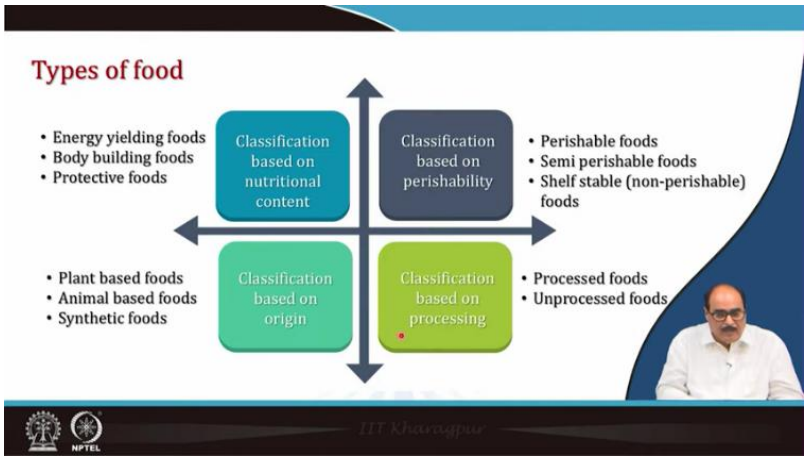


Other global agencies also have defined food in different ways. Like food and agricultural organization as I told you earlier also it defined food is any substance which is processed, semi-processed or raw used for human consumption. It does not include cosmetics or tobacco or substances used only as drugs. According to the WHO, food is any solid or liquid product consumed by living organisms for sustenance, nutrition and pleasure. The FDA, that is Food and Drug Administration of US defines food in the context of its use by humans or animals. According to the US federal law, food includes articles used for food or drink. European Food Safety Authority, EFSA, defined food is any substance or product, whether processed, partially processed or unprocessed, which is intended for human consumption.



Now let's talk about importance of food. As I indicated you earlier also that food contains various macronutrients like protein, carbohydrates and fats and the micronutrients, vitamins, minerals and one another major component of the food is water. Protein is a body building and repairing material. For example, meat, fish, egg, dairy, legumes, nuts, etc. are rich in protein. Carbohydrate is the basically source of energy for the body. It

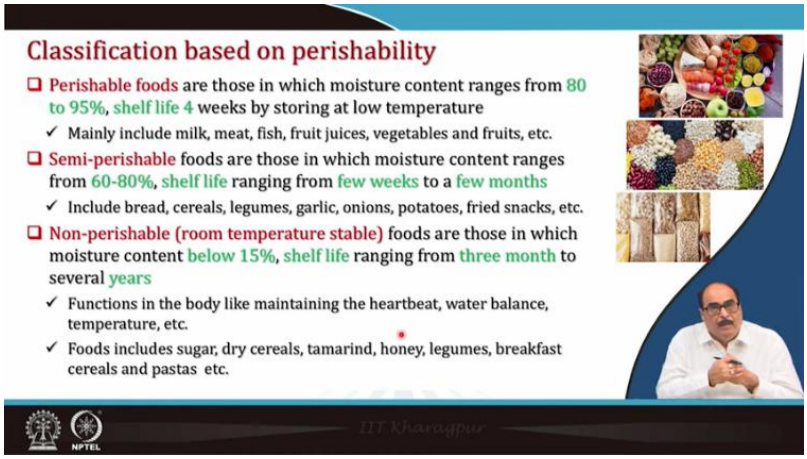
provides major source. Fat also consider as major source of energy storage and protection. Now coming to vitamins and minerals. Particularly the fruits and vegetables, green leafy vegetables, meat, poultry, fish, etc. contain lot of vitamin and minerals and these are required for proper functioning of all physiological processes in the body. Water, a very very important, very essential component of our life which maintains hydration as well as maintains other physiological processes of the body, body functions etc. The major source of water in the food include beverages, fruits, vegetables and others According to their composition, food can be classified into different groups like one classification based on their nutritional content. Like energy yielding food, body building foods or protective foods, depending upon whether food is rich in fat and carbohydrate or rich in water and fat or rich in protein-containing materials. In fruits and vegetables, vitamins, minerals, etc. are available in substantial amount.



Then food is also classified on the basis of their perishability. Some foods have a very small short shelf life depending upon the presence of various component in it. Highly respiring foods and some foods are defined as perishable foods, other are semi-perishable food and then self-stable or non-perishable foods. Food can also be classified on the basis of processing status like processed foods, unprocessed foods, ultra processed foods etc. Then another classification is on the basis of their origin like plant based foods, animal based food or even now completely synthetic foods or formulated foods etc.

Now let us briefly discuss these different types of food according to the classification discussed earlier.

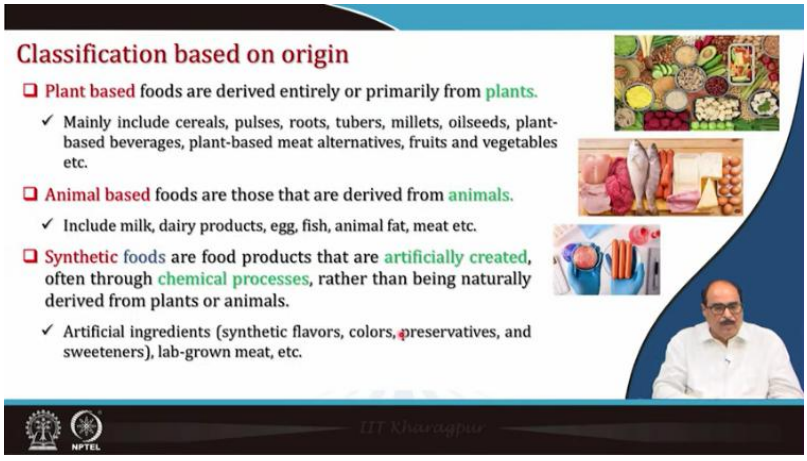
So nutritional classification like energy foods, energy yielding foods are mostly rich in carbohydrates and fatty foods. Even 60% of the body energy requirements generally comes from carbohydrates and about 30% from protein-based and other foods which mainly include cereals, pulses, roots, tubers; fat and oil from oil seeds, fatty fish, various plant oil, vegetable seeds like sunflower seeds, and other edible oil seeds. Then second is the body building food particularly protein and water which help to grow and building the muscles etc. and these foods include milk, egg, fish, meat, pulses, oil seeds and nuts. The productive foods which are rich in vitamins and minerals and they help in keeping us in healthy emotional health, physical health, mental health, etc. Vitamins and minerals maintain different the functions in our body like heartbeat, water balance, temperature, etc.



These are available mostly green leafy vegetables, fruits and so on. The perishable foods are those which contain very high moisture which may range from 80 to 95 percent or even more in some cases. It has a very high respiration rate and shelf life may be a few days or few hours depending upon the conditions of storage and other environmental

factors. This food mainly includes milk, meat, fish, fruit juices, some vegetables, fruits etc. Semi-perishable foods which are provided by nature some resistant materials etc. like shell in the egg and in the outer cover peel etc. in the fruits etc. and medium to high moisture content like up to 80 percent in some cases. Therefore, the shelf life also ranges from few weeks to a few months depending upon the environmental conditions. These foods include bread, cereals, legumes, garlic, onions, potatoes, fried snacks, etc. Then non-perishable food or you can say it is not always correct word to say non-perishable, but better word is to say it is room temperature stable foods. Those foods are made stable at room temperature by using a suitable technology. They have moisture content comparatively very low, maybe even sometime 1 or 2 percent, and their respiration rate almost depending upon the processing conditions, etc. Sometime respiration in the processed food, etc., is reduced to almost zero and it may have shelf life ranging from three months to several years. These non-perishable foods also have function in our body like maintaining the heartbeat, water balance, temperature, etc. Foods include sugar, dry cereals, tamarind, honey, legumes, etc. and so on.

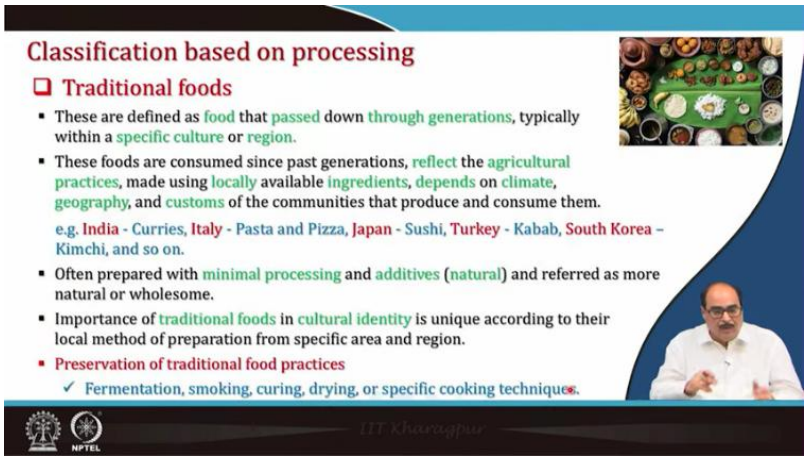
Now, classification based on origin like plant-based foods are derived entirely or primarily from plants, which mainly include cereals, pulses, root, tubers, millets, oilseeds, plant-based beverages, even plant-based meat alternatives, fruits and vegetables, etc. Animal based foods are those that are derived from animals. They include milk, dairy products, egg, fish, animal fat, meat and so on.



Synthetic foods are the food products that are artificially created often through chemical processes rather than being naturally derived from plant or animals. Like the artificial ingredients are used for making synthetic fluids such as synthetic flavors, colors, preservatives, sweeteners. Even lab grown meat, a animal meat like material is grown

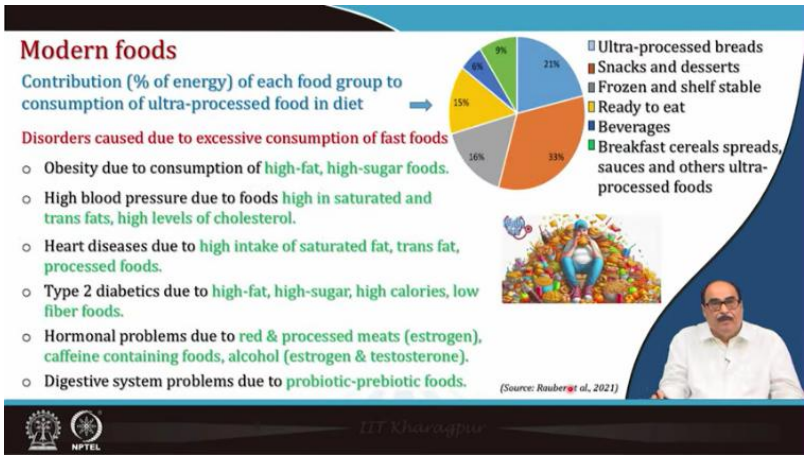
into the laboratory using tissue culture technology. So, these are some of the you can say synthetic foods.

Now the traditional foods are defined as the food that passed down through generations, typically within a specific culture or region. These foods are consumed since past generations, reflect the agricultural practices made using locally available ingredients. They depend on climate, geography and customs or communities that produce and consume them. For example, in India-curries, in Italy- pasta and pizza, in Japan- sushi, in turkey- kebab, in South Korea- kimchi and so on. There are many traditional foods like that. These traditional foods are often prepared with minimal processing and using additives.

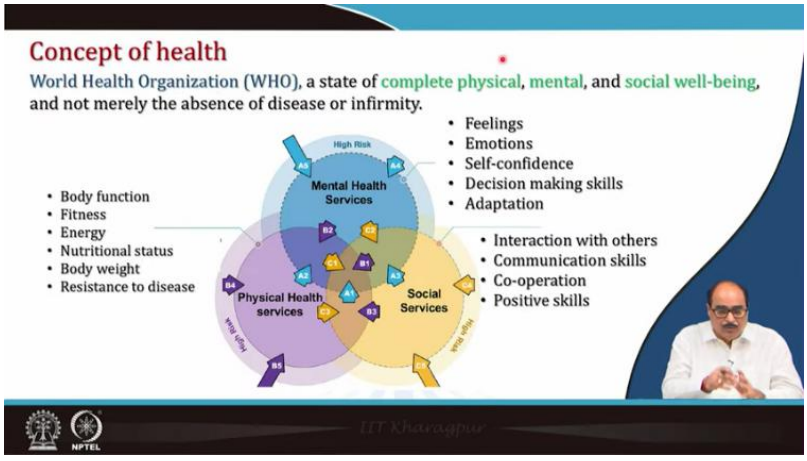


They are mostly natural and referred as more natural or wholesome. The importance of traditional foods in cultural identity is unique according to their local method of preparation from a specific area and region. The technologies which are used for preserving traditional foods include old technologies like fermentation, smoking, curing, drying or even some specific cooking techniques as well.

In this figure you can seen that the modern food, processed food or ultra-processed food and different types of foods, and the percentage of their energy contribution in our diet. Through the consumption of processed food in the diet, like you see 21% from the ultra-processed foods, 33% is snacks and desserts, about 18% from the frozen self-stable food, about 15% from ready to eat foods, and beverages contribute 6% and breakfast cereals, spread sauces, etc. contribute to 9% and in the modern day life, it is said that food is the one major

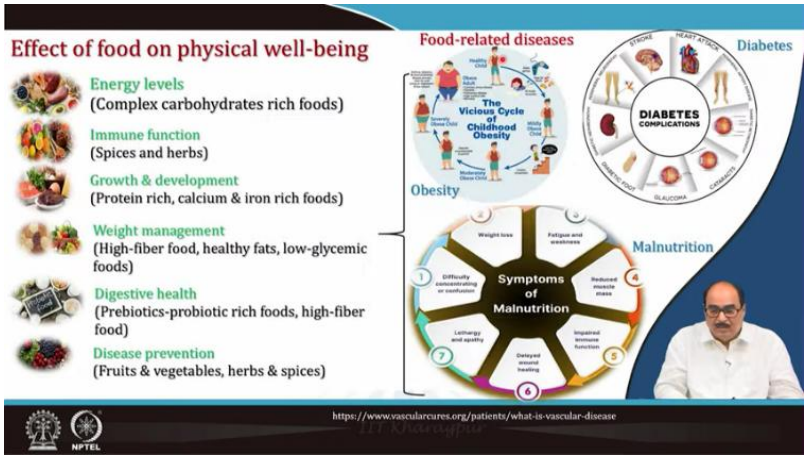


culprit also. Food is a very important component for our life. At the same time, if one is not consuming food in a proper manner, and nowadays means in this coming era, even ultra processed foods etc. causes diseases which is also known as lifestyle diseases like obesity due to consumption of high fat and high sugar foods. There is a high blood pressure due to foods contains high saturated and trans fats. If you take food consisting of high level of cholesterol, etc., it results into high blood pressure. Similarly, the heart diseases are there due to high intake of saturated fat, trans fats, or ultra processed foods. Type 2 diabetes due to high fat, high sugar, high calories, low fiber foods, etc. Even hormonal problems are there due to red and processed meats (estrogen), caffeine containing foods and alcohol if you take more and more alcohol. Then digestive system problems due to probiotic, prebiotic foods, etc. If they are not taken into proper proportion, or if you do not take much probiotic food, etc. there may be a problem in the digesting system. So, these are some of the disorders which are caused due to excessive consumption of fast food or ultra processed food or very highly processed foods.



Now let us discuss briefly about the concept of health. According to the WHO, a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. Means if we are not having any disease, we say that we are healthy. No, that is not correct. It is a complete physical, mental and social well-being if one is fit physically, Mentally and socially. So that you can say he or she is in a good state of health. There are even various services like mental health services, social services, physical health services, etc.

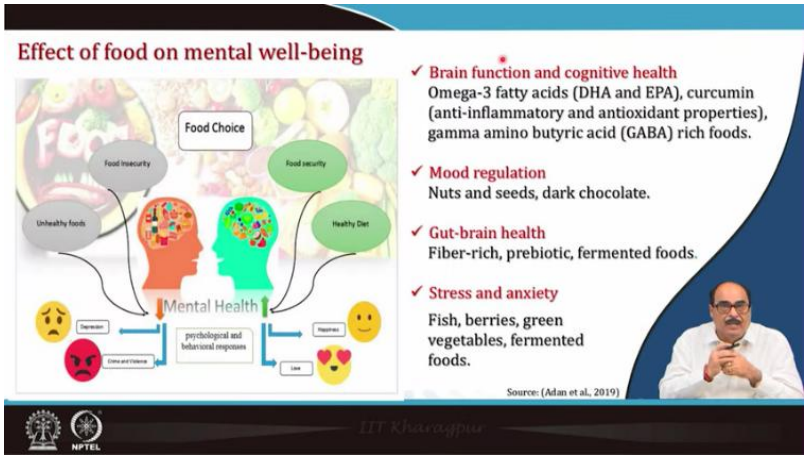
Physical health services like body functions, fitness, energy, nutritional value, body weight, resistance to diseases and so on. Similarly mental health denotes expression of feeling, emotions, self-confidence. So, if you are fit mentally, you have a good decision-making skills, adaptation, etc. Similarly, social services like interplay, interaction with the others, communication skills, cooperation. So, if you are mentally fit, physically fit and socially fit, all these actions you can perform nicely.



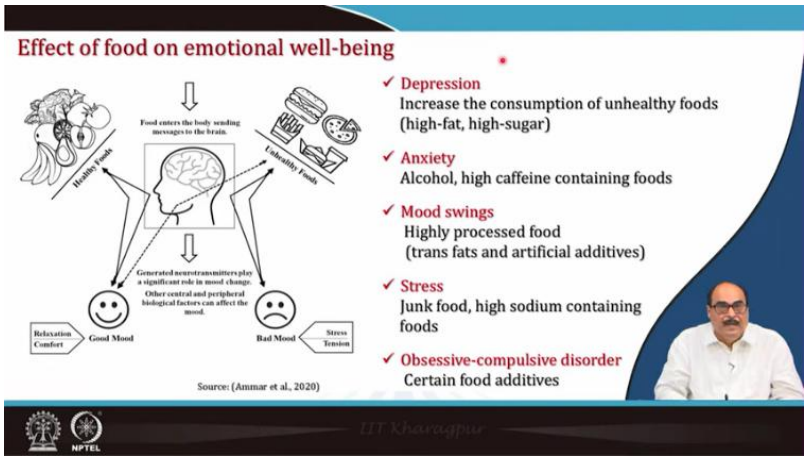
Similarly, you see here that effect of food on physical well-being. If you take energy level, complex carbohydrates foods provide it. Immune functions, it is properly provided by spices and herbs. Growth and development, weight measurement, digestive health and disease prevention all these these are various types of food sector I have already listed. So they will be proper if you control the food in a proper way means if you take a food in the proper amount, the proper type of food you can manage very well various food-related diseases like obesity and malnutrition, diabetes. Means diseases can be managed properly if one takes proper amount of food in proper condition.

Then here is one example like effect of food on mental well-being. You can see here that if you are having a food insecurity, or if you are taking unhealthy food, you might be in depression or you may be involved in crime and violence, etc. So all this, the food

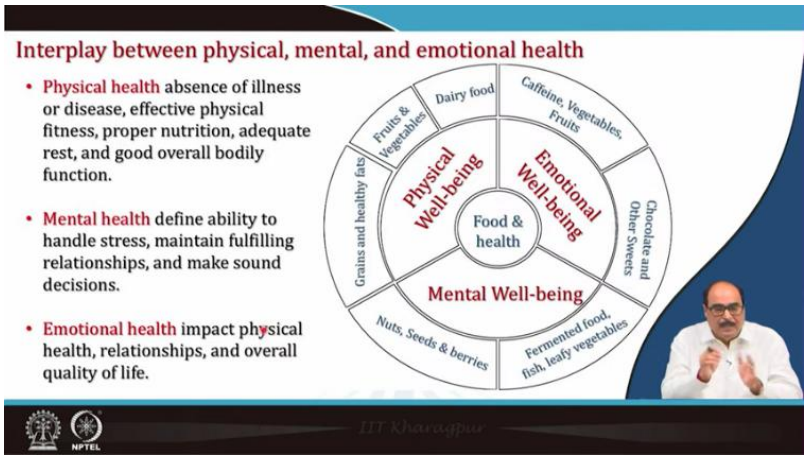
insecurity or unhealthy food eating, etc. may lead to that. But if on the other hand, if you are having a proper food security,



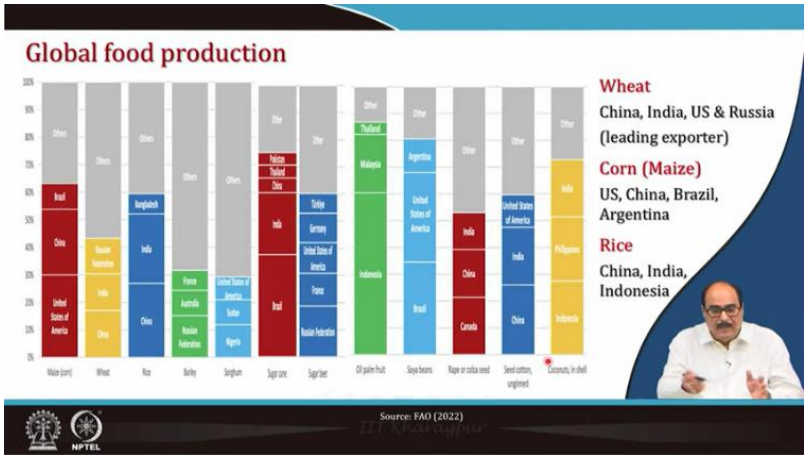
you are eating good food, Diet, healthy diet, etc. it will lead to you always happy and you will love each other. So if the food gives the physiological and behavioural responses both are managed by whether you are having a food security or food insecurity that is brain function and cognitive health, mood regulation, gut brain health, stress and anxiety and all these things are managed by proper foods, etc.



Here you see the effect of food on emotional well-being. If the food is in touch with the body, it sends messages to the brain immediately that you are taking healthy foods. Then you will be in a good mood, relaxation comfort etc. If you are taking unhealthy foods, means your food is sour or it is not good or it is not healthy, you will immediately get stressed or tensed, etc. Therefore, depression, anxiety, mood swings, stress, obviously, compulsive disorders, etc. are the all effect of food and emotional well-being.



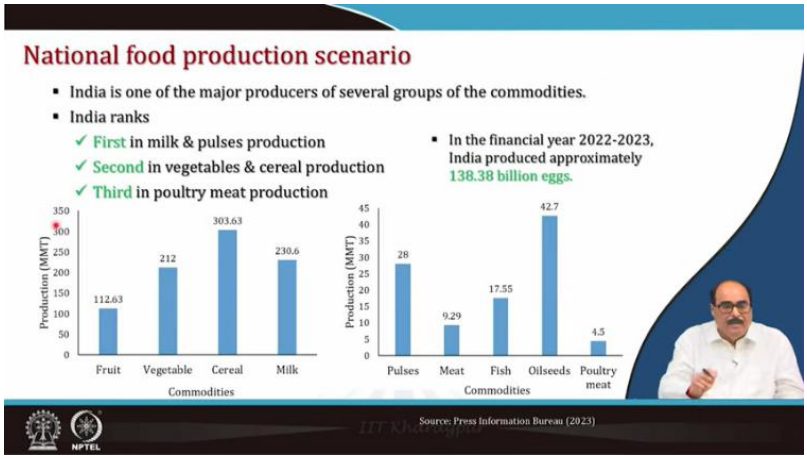
Then, talk about interplay between physical, mental and emotional health. Physical health: It is related to the absence of illness or disease, effective physical fitness, proper nutrition, adequate rest, and good overall bodily function. Mental health defines ability to handle stress, maintain fulfilling relationships, and make sound decisions. Whereas the emotional health is the impact of physical health, relationship, and overall quality of life. So you can see the food and health, they are directly interrelated. For the physical well-being, dairy foods, fruits and vegetables and grains and other healthy fats etc. can be consumed. For emotional well-being, even caffeine, vegetables, fruits, chocolate and other sweets, but of course caffeine etc. provides stimulation. So, the proper quantity is very important, even for good nutrients and good component also if you take excessive that will have negative effect. So, for mental well being nuts, seeds and berries, fermented foods, fish, leafy vegetables etc. can be consumed. Here, you see in this slide, global production of food like various commodities, maize, wheat, rice, barley, etc.



You can see in this slide, the percentage contribution by a particular country and the global food production of staples like wheat in China, India, US and Russia. They are the

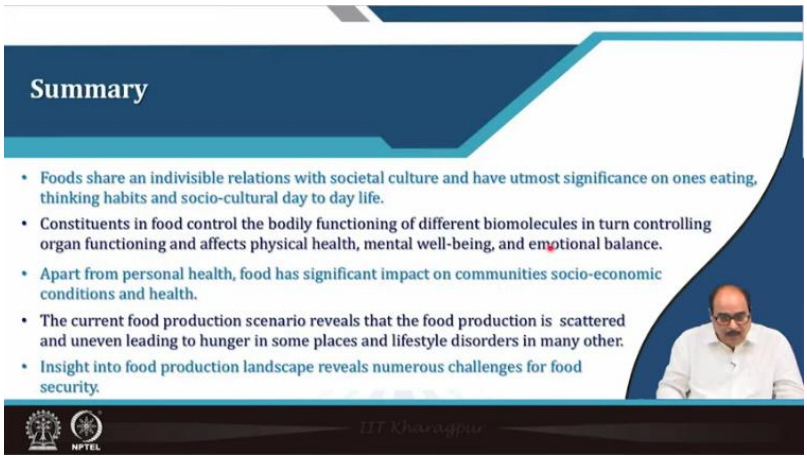
major contributor in the wheat production and they are also leading exporters. U.S., China, Brazil, and Argentina are the major producers of the corn or maize, whereas China, India, and Indonesia, they contribute to the major production in rice.

Here, national food production scenario, India is one of the major producers of several groups of the commodities. India ranks first in milk and pulses production, second in vegetables and cereal production and third in the poultry meat production.



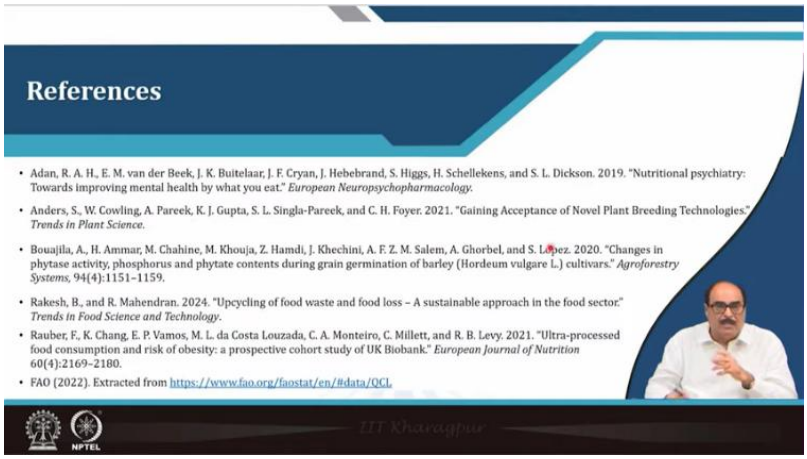
You can see here fruits and vegetables production data is given here. I will not read this, but you can see like there are about 303.63 million tons of cereals are produced. India produces milk around to 30.6 and these data are taken from the Press Information Bureau 2023 of India. Even in the financial year 22-23, India produced approximately 138.38 billion eggs. Oil seed about 42.7 million tons had been produced in the country.

Now, to summarize this, I will say that the food shares an individual relationship with social, cultural and have almost or utmost significance on one's eating, thinking habits and socio-cultural day-to-day life. Constituents in food control the body functions of different biomolecules which in turn controls organ functioning and affects physical health, mental well-being and emotional balance. Apart from personal health, food has significant impact on communities.



and socio-economic conditions and health. The current food production scenario reveals that the food production is scattered and uneven, leading to hunger in some places and lifestyle disorders in many others. Insight into food production landscape reveals numerous challenges for food security.

These are the suggested references from where the various different data etc. are taken.



Thank you very much for your presence hearing. Thank you.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