EAT RIGHT
A Food Systems Approach

Pawan Agarwal
Pulkit Mathur
It shows the systems leadership in food – interlinkages and connectivity. It forms the word – food. It represents wave forms of earth, water and air.
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Foreword

All of us are part of the food system, as consumers, many as producers, processors or as part of the vast network of food supply chains. Food is connected to our health and well-being. It provides livelihood opportunities for a large number of people. It affects our environment and ecology. It defines our culture and tradition. It is now being recognised that the food system can be unjust and discriminatory. It can cause irreversible damage to the health of people and the planet. Food is, therefore, integral to human life.

Over the past couple of years there has been tremendous interest in trying to unravel the complexity of the food system and to fix it. At FSSAI, we have made a modest effort to address the multiple challenges in our food system focusing around food safety, nutrition and sustainability through the nation-wide Eat Right Movement that adopts a food system approach and works through partnerships, collaborations and networks. Needless to say, much more is required to be done. Of particular importance is to develop a next generation of leadership that takes a holistic rather than a compartmentalized view of the food sector.

In the above context, the book, ‘Eat Right: A Food System Approach’ is very timely. Targeted at students pursuing higher studies in areas related to the food sector, the book would provide a broad understanding of all related issues and bring out clearly the interconnected nature of these issues. I hope universities and colleges would consider introducing courses for such a holistic study of food systems. This is necessary to equip the next generation of leadership to address new and emerging challenges in an increasingly complex environment in the food sector in future.

I congratulate former CEO, FSSAI, Shri Pawan Agarwal and Dr. Pulkit Mathur, who conceived of this book project. They have brought in many experts as contributors to bring this book project to reality. I hope the book would be found useful by students and professionals working in food and nutrition to better appreciate the systems approach to food.

Rita Teaotia
Chairperson, FSSAI
Preface

Food is essential for nourishment of our bodies. It is needed for our health and wellness. Food connects us all to our communities, institutions, culture, personal identities and each other. It has sensorial power to ignite creativity and spark joy in us. Food means different things to different people. For a farmer, it is livelihood, for a chef, it is about creating new dishes that people enjoy, for a dietician, it is about nourishing body and soul, for a doctor, it is medicine, for a food technologist, it is about preservation and shelf life. Thus, food could be seen through the lens of a multitude of interconnected food systems. Transforming food systems requires diversity of thought, perspectives, and solutions. At the end of it all, the food system should enable people to eat right, help them to choose the right food and ensure that such food is available. Thus, Eat Right is a food systems approach to not only food and nutrition, but also livelihoods and sustainability.

It is in the above context that Eat Right India movement was started by the Food Safety and Standards Authority of India (FSSAI) in 2017 to help bring healthy and safe eating to the fore at a policy level as well as in the minds of the citizenry. It is grounded in the belief that food is fundamental to India’s public health and the environment. With the tag line “Sahi Bhojan, Behtar Jeevan” (Right Food, Better Life), it seeks to redefine how the citizens of the country relate to food. Eat Right India strives to make “If it is not safe...it is not food; if it is not healthy...it is not food; and if it is not good for the environment...it is not food” the most significant dialogue related to food across the country.

This book is divided into five sections that set the context of the movement, covering safe eating, healthy and sustainable diets, managing partnerships and emerging issues related to food. Section I of the book outlines the nation’s vision for 2050 in the context of food and nutrition. This is followed by a brief chapter on Mahatma Gandhi’s views on food and diets, which are very relevant even today. This is followed by a chapter on an overview of Eat Right India movement, bringing out the elements of the movement as it evolved. As a movement, it was found to be completely aligned with thinking around the world on large scale change and system leadership. Chapter 4 looks at the Eat Right Movement in the context of these developments. Finally, chapter 5 provides a historical and global context to the food and nutrition sector.

The global challenge today is to provide all with safe, affordable and nutritious food to alleviate the burden of malnutrition, foodborne and food-related chronic diseases. Section II reminds us that keeping food safe is everyone’s business. The basic concepts of food safety, hazards lurking in our food supply, the regulatory system and ensuring food safety in all food categories from the ‘farm gate to the plate’ is paramount to ‘Eat Safe’.

Equally important are the consequences of diets deficient in nutrients and bioactive substances, healthy diets through the lifecycle, factors which determine our food choices and behaviour change strategies to help consumers make healthier choices. ‘Eat Healthy’ in Section III makes it clear that food is not just a meal, but much more.

But what efforts are needed to eat sustainable diets? The planet is plagued by climate change, which is affecting the nutritive value of crops. Eating local and seasonal, along with conservation of resources while preserving the food ecosystem, helps lessen the burden on the environment. Section IV ‘Eat Sustainable’ helps understand how sustainable diets play a role in health and nutrition.
Section V illustrates how partnerships should be forged between the government, industry, scientists, educationists and consumers. Co-ordinated efforts are needed in tackling emerging issues related to health, safety and sustainability of diets.

Chapters in this book have been contributed both by practitioners and people from the academic community, thus the book blurs the boundary between theory and practice. It also breaks siloes in which food is often divided. It is envisioned as a textbook for ability enhancement or foundation courses in universities to sensitise every student of India to the concept of eating right. It is also a good handbook for officials in FSSAI and State Food Safety departments as well as those who wish to be recruited in these departments. Professionals in the health and food industry can also benefit from this book as it presents a holistic approach to look at issues of health, nutrition and food safety. This book captures the history of FSSAI’s effort and brings to light the valuable contributions of several nutrition and food safety experts from across the country.

This book is a culmination of efforts of several professionals committed to the cause of the Eat Right India Movement. We are grateful to Ms Rita Teotia, Chairperson, FSSAI for her encouragement and support for this project. We are grateful to all Contributors – Research Scientists, Professors of different Universities, Dieticians, Nutritionists, Food Technologists, NetProFaN members, FSSAI Officials and Consultants for their patience and effort in making this book possible. A team of professionals has contributed to each chapter according to their area of expertise. We thank the Reviewers of the book for their valuable comments and suggestions in improving the book. We are grateful to Dr Joshita Lamba Saini for her immense hard work in coordinating this work. We are grateful to Ms Inoshi Sharma, Director, FSSAI and the Eat Right India Team for allowing reproduction of the India Food System Vision 2050 in this book.

We hope the book will encourage the readers to join the Eat Right India movement and help transform the food-scape of our country.

Pawan Agarwal and Pulkit Mathur
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Editors

Pawan Agarwal was CEO, FSSAI for four years (2016 – 2020). During his tenure at FSSAI, he led transformation of FSSAI as a public institution and initiated large scale change in the area food and nutrition, the Eat Right movement. This initiative was globally recognised by under the Food System Vision 2050 by the Rockefeller Foundation. Earlier, he worked in various key positions in the Government of India and the West Bengal Government primarily in the domains of agriculture and cooperatives, skill development, higher education and science and technology. He was Fulbright New Century Scholar on Higher education from India for the year 2005-06. He has written articles in various newspapers, magazines, academic and research journals on education, skills, food and nutrition. His book, ‘Indian Higher Education: Envisioning the Future’ is an authoritative book on practice and policy of higher education in India. He is currently in the rank of Secretary to the Government of India responsible for logistics and supply chain. Currently, he is focussed on transformation of large and complex systems such as food systems.

Dr. Pulkit Mathur is a Senior Faculty at Department of Food and Nutrition, Lady Irwin College, University of Delhi with over 25 years of experience in research and teaching. A gold medallist from University of Delhi, she has to her credit more than 80 publications in National and International Journals, books and periodicals. She worked for her doctorate degree at the Food and Drug Toxicological Centre of National Institute of Nutrition, Hyderabad on risk analysis of food adulterants. She is a National Resource Person under the FSSAI’s FoSTaC programme and has contributed immensely to various initiatives under the Eat Right India movement. She is also a member of the National Committee of the International Union of Nutritional Sciences, Convenor of the Nutrition Society of India, Delhi Chapter and Executive member of the Association of Food Scientists and Technologists of India, Delhi Chapter.

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Section 1: Setting the Context

1. India Vision 2050
2. Eating Right – The Mahatma’s Way
3. Eat Right India: An Overview
4. Large Scale Change and System Leadership
5. Historical and Global Context
Chapter 1: India Vision 2050

This India Food Vision 2050 document submitted to Rockefeller Foundation by FSSAI as a part of their Food System Vision Prize 2050 that invites organizations from across the globe to develop a Vision of the regenerative and nourishing food system that they aspire to create by the year 2050.

FSSAI received global recognition and was declared among the top ten for the Food System Vision Prize from a pool of more than 1,300 applicants across 110 countries. The Vision was conceptualized by the Eat Right Team under the leadership of Shri Pawan Agarwal. In its communication, the Rockefeller Foundation has stated, ‘Your vision inspires. If implemented, it can transform. It feels lofty yet feasible – audacious yet vital. It can reveal a path forward to a nourishing, resilient, sustainable and equitable food system for 2050, if not well before.’

We spoke to various stakeholders and partners - urban farmers, nutritionists, food experts, international agencies, design thinkers, the government and the civil society. Here’s what we visioned together for the nation by 2050 - a future that’s possible, sustainable, and harmonious - just as Nature intended!

How do we get to this vision of food secure, healthy and sustainable India? We took a Design Thinking approach to answer 4 key questions - What is? What if? What works? & What wows?

Here are some key highlights of the India we wish to see in 2050-

- More Indians would prefer to live or spend time on farms than ever before. As a result, produce will become those fruits and vegetables that people pull out of the ground or off a tree than buy at the store. Not only people will be more connected to where their food is coming from, they will be fundamentally more in rhythm with the natural and seasonal cycles.

- Indians are naturally blessed with traditional systems like Ayurveda and Naturopathy, which will make a huge comeback. An average person will know his or her constitutional profile and will manage their diet accordingly. More number of traditional therapists and consultants will coach people on mindful eating and sustainable lifestyles.

- The once nuclear, fragmented families of the cities will be part of active, connected, and vibrant communities back home with many cases of reverse migration.

- More number of professionals will become part-time proud ‘farmers’ networking with an ecosystem of responsible producers serving ever increasing and conscious consumers. Bio-dynamic and organic farming will be ubiquitous. Weekend getaways are about visiting one’s farm. This growing set of farmers will also help in reviving extinct seed banks and expanding diversity of indigenous fruits and vegetables.

- Forest produce will increase the nutrition and therapeutic value of food. Indiscriminate urbanization will be halted, and nature will have its rightful claim to large parts of any city, town, and village.
• Unlike the fast food era, the cooking will be slower with emphasis on preserving the nutrition level of the food. Even the cooking technique will be shifted to more traditional ways like outdoor stone ovens, surrounded by shady herb gardens.

• There will be cafes and juice bars in every park.

• People will be encouraged to share their meals and work up a good sweat at these parks and arboretums.

• Many native species of trees will be revived and along with several species of birds, insects and animals will make a comeback. There will be robust activism in preserving natural forests and ecosystems. In cities people would grow their personal supplies of vegetables in balconies, terraces, gardens, and community farms.

• Buying local will get the citizens significant energy credit points. Treating oneself to expensive and exotic fruits or vegetables will only be an occasional indulgence. Buying local and seasonal will be the norm and very few people will see merit in doing otherwise.

What is? - A glimpse of the current trends and projections

Population

India’s population is projected to be around 1.64 billion by 2050, one sixth of the world’s population.

Malnutrition

Quarter of children and adolescents in the country are stunted; more than 50% of women of reproductive age group and children are anaemic; overweight and obesity has doubled over the last decade in both rural and urban areas. Further, one in ten school-age children and adolescents are pre-diabetic. The country faces huge economic loss due to food borne diseases (FBD) – going up to 0.5% of GDP. It is estimated that in a business as usual scenario, number of cases of FBDs in India would increase from 100 million (in 2011) to about 150-177 million (in 2030) with children under-5 being most vulnerable.

Poor Diet

The Indian diet is predominantly cereal based (rice and wheat), protein-deficient, lacking in fruits and vegetables and rising consumption of fats and sugars. Per capita per day consumption of calories is still lower than the global recommendations (2500 kcal/day) and is unequally distributed across regions, gender, and age-groups. Simple carbs contribute majorly to these calories while proportion of protein, fats and vegetables is minimal. Consumption of refines oils and sweeteners is disproportionate. Low ratio of price/100 kcal of cereals as compared to milk and meat is a major reason for Indians eating a cereal centric diet.
Food Waste

An average of 20 percent of food being wasted in the country. Lack of warehousing, processing and cold storage facilities are the key reasons for food wastage. Fruits and vegetables (40%), milk (40%) and meat (20%) are the ones wasted the most in the sector. Given the high nutritional deficiency in India, reducing this waste needs to be addressed on priority.

Safety & Hygiene

Microbial contamination especially of milk, meat and fruits and vegetables, improper temperature control and adulteration are key issues.

Environmental Degradation

Food sector is the biggest contributor of plastics in the country. High use of pesticides and chemicals in farming, mono-cropping patterns (rice and sugarcane) contribute to depleting water tables and burning of rice stubbles as source of air pollution have already become serious challenges for the country.

Livelihood and Employment

Food sector directly and indirectly employs about 2/3rd of all Indians. Much of this workforce are migrants who have been quit farming to move to urban centres.

A mass reverse migration due to COVID-19, effecting nearly 10 million migrant workers, may throw up unique challenges.

What if? - The ‘Eat Right Movement ’ transforms India‘s food environment?

Eat Right Movement has an ambitious vision of transforming India’s food environment. It adopts a judicious mix of regulatory, capacity building, collaborative and empowerment tools and combines supportive actions to its primary regulatory mandate. It adopts a ‘food systems approach’ to address the issues in a holistic manner.

To achieve this vision, these things need to happen:

Robust food regulatory system that includes setting science-based, globally benchmarked standards, credible food testing, surveillance, and enforcement activities. Setting standards on use of excess salt, sugar and fat; use of recyclable plastics and tougher implementation of safety and health standards.

Finest hygiene and sanitation standards across the value chain through a graded approach. Capacity building through training and certification for all businesses including
unorganized micro food vendors, hygiene ratings for medium and small businesses, and organizing vendors in clean clusters and hubs.

**Conscious consumption** by changing food environments by taking a settings-based approach and targeting people at home, school, workplace and outside through training and capacity building and generating awareness.

**Mass mobilization and behavioural shifts** to nudge citizens to eat right and waste less. To initiate a people’s movement to create demand side push for safe food, healthier and suitable diets is needed.

**Produce enough without destroying the environment** our primary farm production could be driven by small-scale farmers, connected through agri-food value chains, benefiting from economies of scale. Integration of traditional knowledge with new technologies and robust logistics would provide eco-friendly solutions. A community-driven approach could create self-sufficient local food ecosystems reducing storage and transport costs and post-harvest losses. The majority of farmers in India are engaged in organic farming using a wide variety of alternatives to chemical fertilizers to enrich soil. Drip irrigation and water harvesting could be mainstreamed and help India to achieve zero-water wastage. The production of crops could shift to millets, traditional food crops and regional grains as per local needs. The food industry would need to transform to accommodate small scale production units resulting in self-sustaining local economies with minimal environment consequences.

**Ensure food security for all.** Food-based schemes for the vulnerable already caters to around 230 million people covered under the National Food Security Act. However, how long would such schemes scale to feed an ever-increasing population? Encouraging people to be self-sufficient and give them access to nutritious and affordable food without increasing burden on the government, is the need to the hour.

**Provide adequate and proper nutrition** by scaling production of large variety of healthy foods that are also affordable. That would reduce the need for food fortification and artificial additives. Shifting the consumption behaviors toward low salt, low refined sugar with elimination of trans fats is also needed.

A shift towards personalized diets can be anticipated due to increase in purchasing power and technology-led platforms. Consumption of regional, local and seasonal produce could be the norm. A rejuvenation of traditional culture emerging from Ayurveda can be expected. A food culture of traditional, indigenous and aligned with India’s ancient wisdom of Ayurveda can be mainstreamed through small-scale local entrepreneurs.

Smart packaging and labeling systems could not only deliver fresh and healthy food, it could educate people on amount of refined salt, sugar and oils. Moreover, subsidies and tax-cuts for healthier food options, particularly plant-based, local, regional and seasonable wholefoods could be provided. Unhealthy and processed food could be taxed to extinction!

**Adopted sustainable diets and conscious consumption** to maintain a resilient food system in the future. Its key components could include production and consumption of local and seasonal foods that not only help in reducing greenhouse gases but also encourages regional trade practices.
Our production policies can ensure judicious land and water use for agricultural production, prescribing crops by region for maximum productivity, allowing only organic farming and biological solutions to control of pesticides. Furthermore, policies could limit food loss along the food value chain. Community-level practices could great reduce waste and promote recycling and reuse. Policies to encourage regional trade practices could be effective.

**Sustainable economic costs and pricing models** could improve wages thereby improving purchasing power and reducing rural distress. With more rural money, growth of local economies that are majorly driven by female workforce, could result in community level development, bridge the gender gap and promote equitable economic growth. Additionally, with efficient agricultural operations and with the use of technology, a substantial section of the labour force could move up the ladder and be employed in allied activities, logistics, supply chain and food processing.

**Eliminated Food Borne Diseases** (FBD) through stringent laws and robust recall mechanisms and consumer awareness eliminate FBD. This could reduce an economic burden of more than 0.1% of the GDP.

**Technology made possible** like big data, Internet of Things, block-chain, agricultural biotechnology, and artificial intelligence & Machine Learning became mainstream and affordable.

The data gathered from farms and food distribution networks could enable better traceability of food, quantification of the impact on the ecosystem and helped eliminate food wastage and over-production. Such technology could be used by resource-poor small and marginal producers. A rental market for farm machinery with women’s self-help groups (SHGs) jointly owning and leasing out machines. Additionally, more organizations like Gold Farm would be set up that use Farming as a Service (FaaS) model where farm equipment can be hired through cell phones or call centers.

Smartphones and body wearable devices could provide personalized information to monitor diet-linked health parameters.

Micro-irrigation technologies and Community irrigation facilities such as water user groups for farmers could help judicious use of water resources.

To enable the current workforce to effectively transition to the envisioned technological changes in the future food system we’d need an enabling environment for entrepreneurial ventures and create data repositories on all aspects food, encompassing traditional recipes, taste/flavour, nutrition, and health.

Big Data networks could be used to build Dynamic Pricing Models. Rich algorithms that allow equitable ‘Return on Investment’ on any crop. This would greatly encourage all kinds of farmers (big/small) in growing diverse crops and crop species.

‘Whole of the Government’ to ‘whole of society approach’. Government policies are critical to creating an enabling environment to ensure safe, healthy and sustainable diets. Currently, the Food Safety and Standards Authority of India (FSSAI) is India’s apex food body with a mandate to ensure safe and wholesome food to all citizens at all times. Its mandate is gradually being expanded for improved multi-sectoral and multi-issue
coordination. This could be renamed as the ‘Food Authority of India’ and take not only ‘whole of the Government’, but ‘whole of society approach’ in dealing with issue of food in a holistic and integrative manner for inclusive, equitable and sustainable food system to achieve the Sustainable Development Goals (SDGs).

Built strong networks and partnerships. Eat Right movement is one such programme that requires convergent action in order to overcome all the barriers to improve health of the citizens.

It’s numerous platforms could scale to engage a larger diversity of stakeholders and benefit from their technical expertise. It must continue to grow its various platforms like network of professionals in food and nutrition (NetProFaN) to leverage the expertise of professionals in reaching out to consumers with scientifically sound messages; its network of scientific organizations (NetScOFaN) to participate in standard-setting processes; and a consumer organization network (NetCOFaN) to communicate consumers’ concerns to the food authority and vice versa (Figure 1).

Figure 1.1: The Whole of Society Approach
What works? - This is how people are making it happen!

Here are 2 short case studies to show how our Systems Approach has worked in the real world.

**Eat Right follows a graded approach** to working with industry that focuses on promoting a culture of self-regulation among businesses, working with the informal food sector, and developing and harnessing a private sector food ecosystem. Along with this, large-scale capacity building through private players is an effective strategy to improve the quality of food served by these businesses.

*‘Kalpavriksha’ programme was launched by Marico Industries* with a focus on enhancing farm productivity of Coconut Farmers. It resulted in 13% increase in yields. Training & Awareness programmes propagating scientific farm practices were conducted with on field support provisions. This program also promoted water conservation practices in farms.

*Mondelez India’s* Cocoa Life program covers a wide spectrum of activities starting from supporting Cocoa agriculture research at Universities in South India, producing quality planting materials, offering free technical advice to farmers through a massive farmer-outreach program, farm-gate procurement of Cocoa beans from the farmers eliminating middlemen, promoting drip irrigation and undertaking community programs like women training, school support and tribal farmers support. Program has successfully enrolled over 3000 marginalized tribal farmers into cocoa planting creating livelihood opportunities for them. Over 5500 children in the remote cocoa communities are benefited through schooling infrastructure.

What wows? – Our Vision for India in 2050

Instead of a dystopian outcome, of food being fed out of tubes in premixed nutritional format, we will move to far more natural, flavoursome, safe and healthy food for all. Closer to nature, as nature intended.

A nation where we manage to beat hunger and malnutrition forever. There will be food security for all as a fundamental right.

We will have local self-governance with community ownerships - central and state governments will help with larger logistics, health, policies, training and certification, and other facilitation like exports. Government labs will also help with Data and Analytics, crop distributions, crop health and diversity, acquiring Geographical Indicators (GIs) and adjusting Pricing Models (Figure 2).
Even the financial models can be re-imagined and reinvented. Instead of 'money' we can have credits. All work obligatory or voluntary will earn people more credits where complex algorithms will help define credits of the work done based on many factors.

Workplaces will change significantly. Each citizen will typically have 2 jobs - primary and secondary. Where they could earn credits from your secondary role that must contribute to your local communities. People can acquire new skills by taking weekend classes and by doing voluntary works.

Pricing of a product will be affected by how far produce travels from its origin. There will be no more incentives to grow only a certain variety of a crop - special algorithms calculate credit pricing so that local varieties are as profitable as any other.

Government can suggest a percentage of the produce/crop that can be used for local needs, a certain percentage that can be shipped to nearby or needy states, and another percentage that can be exported or stored or processed for emergency use. There is also a percentage that is left for the birds and other animals.

People will be encouraged to travel to enjoy local flavours rather than import them. Imported food cost more as energy miles are added on every item shipped.

In fact we imagine the whole concept of a city been changed - it is more about history and historical artifacts rather than business. With the advent of high bandwidths, modern transportations - people can moved on from cities, being truly location independent.

Food packaging and transport will slowly become more natural, reusable and trackable. Transport modules (of varying sizes) will be powered by solar and other renewable energy sources. They will maintain natural humidity and temperature of the produce. Number of miles traveled will be constantly updated and tracked which can be collated and shared.

Figure 1.2: Key Concepts for Vision 2050
with all communities and authorities for further improvements. Regulators can keep a strict watch on diversity and amount of food produced. Only a limited amount of excess is allowed as emergency supplies.

In this way, we want the world to move away from a producer-consumer paradigm, so everyone has a relationship (direct or indirect) with how food is grown, distributed and partaken.

Figure 1.3: Four pillars of the Eat Right India initiative
Chapter 2: Eating Right – The Mahatma’s Way

Long before regulatory bodies were set up to monitor food quality and nutritionists advised people on what to eat, Mahatma Gandhi wrote and preached extensively on the subject. For him food and eating needed both – mindfulness and moderation – a message still relevant today. He was also a known advocate of hygiene and sanitation.

Eating safe

Mahatma Gandhi once said that it was a matter of great sorrow and shame that rampant adulteration existed in essential food stuffs such as oil and ghee in the bazaars of pre-independence India. He encouraged people to never be satisfied with whatever is available commercially and be very patient and diligent in procuring good quality food. If necessary, he even advocated the use of hand pressed oil. He also worried about the risk of infections getting passed on from diseased cattle, given that in his time such safeguards were not in place. He called for change in the status quo through appropriate legislation and education.

The Mahatma was a torch bearer for change in the sorry state of sanitation in pre-Independence India. He is known to have said, "Cleanliness is next to Godliness". He proclaimed that unless we "rid ourselves of our dirty habits and have improved latrines, Swaraj can have no value for us." Side by side with the struggle for India’s independence, Bapu strived to improve sanitation, cleanliness and waste management. He dealt with these problems in meticulous detail and at a systemic level, including all aspects viz. social, technical and economic. He stressed on the direct link between sanitation and disease and called for people to raise their standards of hygiene.

His desire for each house, even in the villages, to have a latrine was visionary, to say the least, in a poor country saddled with multiple issues and struggling for its independence. The “Swachh Bharat Abhiyan” launched in 2014 ingrains the principles preached by the Mahatma.

Eating Healthy

“It is health that is real wealth and not pieces of gold and silver”

– Mahatma Gandhi

Gandhiji preached more than 75 years back what a modern nutritionist recommends even today. He encouraged people to consume cereals that had been hand ground without sieving to retain the nourishment and roughage provided by the husk. He placed great emphasis on the fact that polished rice or wheat flour devoid of its bran supplies only pure starch to the body and should be avoided.

Gandhiji acknowledged the role played by pulses in providing an economical source of protein to those who could not afford milk. However, he was not in favour of pulses to be consumed too frequently especially by those in a sedentary occupation on account of the fact that most pulses were difficult to digest.
He placed great importance on consumption of fresh vegetables and decried the fact that these were often unavailable at reasonable prices, especially in rural India. He prioritised green leafy vegetables and said that certain vegetables viz. cucumber, tomatoes, mustard, garden cress (Chandrashoor) and other tender leaves need not be cooked and should be washed properly and eaten raw in small quantities. He de-emphasised potatoes, sweet potatoes and yam, which he classified along with starch-supplying cereals.

On fruits, Gandhiji recommended a diet inclusive of seasonal fruits, e.g. mangoes, grapes etc. He said that the best time for taking fruits is in the morning. According to him a perfect breakfast consisted of milk and fruits, especially banana. He felt that the juice of two sour limes should be taken every day in water or with vegetables.

Gandhiji preferred the use of ghee over oil as he felt that ghee was easier to digest and nutritionally superior to oil. He lamented the undue prominence given to sugar, especially by city folk through their over-consumption of milk-based sweets and warned of the harmful effects of sugar. For both, fats and sweets he recommended moderation.

Gandhiji initially considered milk to be an animal product and felt that it had no place in a vegetarian diet. Moreover, his view was that man had no moral right to consume any other milk other than mother’s milk in infancy. However, after a severe bout of dysentery and resultant extreme loss of weight, he reluctantly accepted medical advice to take goat’s milk to overcome his malnutrition. He acknowledged the beneficial impact that it had on his recovery and revised his original opposition to milk. He also recommended milk for being a source of protein which was relatively easy to digest as compared to vegetarian sources of protein.

Gandhiji’s frequent fasting as a part of his Satyagraha movement is also well known. But for him, fasting was not only a means to rally the masses to a cause but also a path to good health. Prior to commencement of a fast he would usually fortify himself with lemon juice honey and warm water. Importantly, he also believed that fasting was the “truest prayer” and that it cleansed the soul and led to spiritual upliftment.

In fasting, Gandhiji proved his prescience. It is only recently that science has recognised the benefits of fasting in detoxification of the body and utilisation of unused fat deposits, amongst many others. The 2016 Nobel Laureate, Dr Yoshinori Ohsumi discovered the process of autophagy through which the body degrades and recycles damaged cells, proteins and toxins. Other benefits such as a decreased risk of diabetes and cardiovascular disease, protection from cancer and inflammation, balanced lipid profiles, lower blood pressure etc. are also known to be associated with fasting.

**Eating Sustainable**

Mahatma Gandhi’s principle of non-violence is very well known across the world. But not many may be aware that his principle extended beyond how we treat our fellow human beings to how we treat the denizens of the animal kingdom. Indeed, his strong espousal of vegetarianism was rooted in that thought. He famously said, “Man was not born a carnivorous animal, but born to live on fruits and herbs that the earth grows”.

Gandhiji preferred a simple diet of brown rice and seasonal, locally grown vegetables and snacks made of plantain with groundnut paste. He opted for jaggery rather than refined
sugar as a sweetener. His advocacy of a whole-food and a plant-based diet is in harmony with the latest scientific research that proclaims this as the healthiest way to eat. He was thus, in many ways, much ahead of his times as a champion for healthy and sustainable eating, decades before organic foods became the rage they are now, or the term “superfood” was even coined.

**Eating Mindfully**

Gandhiji knew of the fact that carbohydrate digestion begins in the mouth. He recommended that carbohydrate rich foods like *chapati* should not be dipped in *dals* and curries before eating. Instead they should be eaten separately—in the dry form. This way they would demand more chewing and hence greater saliva production resulting in better digestibility. He believed that good mastication helped in better digestion of food. He was also very particular about his meal timings and felt it was enough to eat three main meals. He frowned upon nibbling in between meals.

Gandhiji regarded food as a source of energy and of curative powers, rather than merely a means to satisfy one’s palate and hence encouraged moderation in eating. He opined that gastronomical pleasure should come from the satisfaction of real hunger and that relish is dependent upon hunger and not outside it. We all need to train our bodies to be self-aware of what our system really requires rather than indulge in consumption without need or thought.

Mankind would benefit greatly by paying heed to his approach and pivot its largely obsessive and hedonistic association with food and drink to one that is more sustainable and need based.

**References**

Chapter 3: Eat Right India: An Overview

This chapter provides an overview of the key challenges in the food and nutrition space that the Eat Right movement seeks to address and bring out complementarity between this movement and the government’s other ongoing programmes.

In July, 2017, Food Safety and Standards Authority of India (FSSAI) under the Ministry of Health and Family Welfare, Government of India had initiated the programme, Eat Right India to transform the country’s food system in order to provide people safe food, healthy and sustainable diets. The programme is inspired by and is aligned with the Government’s vision of achieving ‘ease of living’ for all. National Health Policy, 2017 has focussed on preventive and promotive healthcare, wherein the consumption of safe and wholesome food is important.

Multiple actions, primarily on the supply-side, but also on the demand-side are needed to ensure that our food is safe and wholesome. Thus, the Eat Right India adopts a judicious mix of regulatory, capacity building, collaborative and empowerment approaches to ensure that our food is good both for the people and the planet. It takes regulatory and supportive actions and adopts “food systems approach (FSA)” to address these issues in a holistic manner.

Further, it builds on the collective action of all stakeholders - consumers, food businesses, community organizations, experts and professionals, and the government. Eat Right adopts not merely, ‘whole of government’, but ‘whole of society’ approach. This is a novel and innovative approach especially for a developing nation like India with its unique challenges in terms of its overall size, complexity, diversity of food, varied dietary habits and large unorganized sector.

Even though, Eat Right India movement is still in its early stages, it has managed to galvanize key stakeholders. Flywheel of support and lessons learnt so far would be useful for rapid scale up. Country’s large unorganized food sector would be reached through scalable models and innovative approach. A clearly defined blueprint, high quality content, prototypes for various initiatives and models of people’s engagement are now available. The time is therefore opportune to scale-up Eat Right India so as to make it a national movement and bring about transformational changes in the food sector.

Key challenges

Food is a fundamental need and a right. It is also a commodity, a product, a meal and source of nutrition which is deeply engraved in our culture, heritage and identity. At every stage along the food value chain – primary producers, processors, buyers, packagers, distributors, regulators and consumers play a role in shaping its safety and quality, its environmental footprint and its ability to feed citizens healthily and sustainably. Food is also a common thread linking all 17 UN Sustainable Development Goals (SDGs), given the interconnected economic, social and environmental dimensions of food systems. Thus, food has a critical role to play in shaping and determining the health and nutrition outcomes of the country.
Food safety is a critical link for good health and nutrition but is often neglected. In India, food-borne illnesses remain a threat to entire population and their consequences in terms of suffering, disability, and loss of life, or foregone incomes and wages, these personal and social costs are usually very high. Burden of foodborne illnesses is comparable to malaria, HIV/AIDS and tuberculosis. It is estimated that every year 100 million cases of foodborne diseases (FBD) are reported in India and it costs $15 billion annually to the country. Expected foodborne disease burden is set to rise from 100 up to 170 million people per year in 2030 in business as usual scenario – increasing from one out of 12 to one out of 9 people falling sick on average. Recent research has unveiled a strong interconnection between unsafe food and adverse health and nutrition outcomes. Infection by food borne pathogens results in poor absorption of nutrients from food, particularly of vitamins and minerals that impact nutritional status of an individual.

India has persistently high prevalence of under-nutrition with rising incidence of over-nutrition and non-communicable diseases. Recent national data indicate that more than one-quarter of children and adolescents in India are stunted – 35% of pre-schoolers, 22 per cent of children in school, and 24% of adolescents¹. Micronutrient deficiencies, including anaemia (>50% women, 1/4th of adolescents, school-age children and men are anaemic), and deficiencies of vitamin A, D, B12, and folate are pervasive across age groups as seen in figure 1. The findings are significant and point to the need for urgent action across age groups. Further, India is going through an epidemiological shift from communicable to non-communicable diseases. As a result, there is rising burden of diet-related diseases such as diabetes, hypertension, and obesity.

![Figure 3.1: Extent of malnutrition in India](image)

**Of 1.35 billion Indians…**

<table>
<thead>
<tr>
<th>Count</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>47m</td>
<td>Stunted Of 116.4m children</td>
</tr>
<tr>
<td>25m</td>
<td>Wasted 6 years</td>
</tr>
<tr>
<td>196m</td>
<td>Chronic hungry</td>
</tr>
<tr>
<td>500m</td>
<td>Micronutrient deficient</td>
</tr>
<tr>
<td>180m</td>
<td>Overweight / Obese</td>
</tr>
<tr>
<td>100m</td>
<td>Foodborne cases</td>
</tr>
</tbody>
</table>

**Source:** Comprehensive National Nutrition Survey (2016-2018)

In addition to high malnutrition, the country faces a myriad of other challenges, including water crisis, high food loss and waste, and rising ill effects due to climate change. Nearly 40% of the food produced in India (costing one lakh crore rupees) is wasted or lost every year. The proliferation of plastic packaging and the improper disposal of plastics negatively impact the marine environment as well as terrestrial and groundwater ecosystems.

¹ Comprehensive National Nutrition Survey (2016-18)
Further, a quarter of all greenhouse gases are released by food production. According to the Intergovernmental Panel on Climate Change (IPCC), current conventional farming practices will be unable to support “large human civilizations” in about 30 years. Unpredictable weather conditions are damaging food systems and there is less nutritious food, reduced diversity and yields in crops and poorer soil. Thus, apart from impact on health, unsafe food and poor diets have grave social, economic, trade, tourism, and environmental consequences ranging from land degradation, water and air pollution, and biodiversity loss – directly or indirectly affecting the food consumed by the citizens.

About Eat Right India movement

India’s food regulatory system has expanded its focus from merely preventing food adulteration towards a more holistic approach to ensure safe and wholesome food for all citizens. In an endeavour to transition from merely an ‘enforcer’ to also an ‘enabler’, the food regulatory body conceived ‘Eat Right India’ movement.

Further, recognizing that ‘food systems’ approach is critical to transform the ‘food environments’ in the country, the Eat Right India movement adopts a mix of regulatory, capacity building, collaborative and empowerment tools to provide safe and wholesome food to people everywhere. It complements Government policies and strategies to address malnutrition and its resulting health consequences by providing a holistic solution with primary focus on food safety. The movement has four key pillars –

I. Food safety: the focus is on ensuring personal and surrounding hygiene, maintaining hygienic and sanitary practices through the food supply chain, combating adulteration, reducing toxins and contaminants in food and controlling food hazards in processing and manufacturing processes.

II. Healthy diets: the focus is on promoting diet diversity and balanced diets, eliminating toxic industrial trans fats from food, reducing consumption of salt, sugar and saturated fats and promoting large-scale fortification of staples to address micronutrient deficiencies.

III. Sustainable food systems: actions under this pillar promote local and seasonal foods, prevent food loss and food waste, conserve water in food value chains, reduce use of chemicals in food production and presentation and use of safe and sustainable packaging.

IV. Mindful eating: this pillar promotes practices like eating less, consuming meals on time, making conscious eating decisions, identifying cues to hunger and adjusting actions accordingly.

Further, the movement targets people across ages, gender, regions, and socio-economic groups. It brings together food-related mandates of the agriculture, health, industry and environment ministries with a ‘whole of government’ approach. It has forged partnerships with not only flagship programs of the country but also with professionals and other stakeholders.

Core regulatory functions: Setting of food standards and monitoring programmes
Over the years, the Food Authority has taken informed steps to formulate new and strengthen the existing food standards in the country. The Authority keeps itself abreast with recent developments in the food sector both at national and global levels. Although food standards are revised from time to time, it is felt that there is a continuous need to monitor them and update them to meet the new challenges and to make them at par with global standards.

Poor availability and quality of data pertaining to food safety is a perpetual challenge that the Authority faces. Although the Authority has recently undertaken two large surveys in the country, there is a need to develop robust frameworks and protocols to monitor food safety more closely and regularly. As mentioned earlier, policy instruments and regulatory frameworks are largely in place for the country, there is an enhanced need to strengthen the monitoring of food safety in the country.

A glimpse of breadth of activities currently undertaken by the Food Authority in this area are given below:

### Setting food standards

Availability of comprehensive science-based food standards is critical to ensure safe food and healthier diets for all. FSSAI, since its inception (with process accelerating in the past few years), has worked on this front on priority (please see box below). For this, the Authority has formulated 21 Scientific Panels and a Scientific Committee. Further, eight Stakeholders’ Committees (with consumer organizations and food industry representatives) have been formed to provide inputs to related Scientific Panel. Recently in 2018 and 2019 the Food Safety and Standards for Alcoholic Beverages, Irradiated Foods and Milk and Milk Products have been notified.

### Box 1: Food Standards Score Card

1. Commodity/General Standards - 694
2. Food Additives - 4497 MLs covering 334 additives/groups of additives
3. Contaminants - 605 MLs covering 28 Contaminants
4. Pesticides Residues - 1096 maximum residue levels (MRLs) covering 213 pesticides
5. Residues of antibiotics and pharmacologically active substances - 353 Tolerance Levels covering 49 antibiotics and pharmacologically active substances
6. Regulations defining standards in specific cases - Alcoholic beverages, milk and milk products, fortified foods, organic foods, labelling, claims and advertisements, packaging and materials in contact with food, irradiated foods, food supplements and nutraceuticals.
7. Methods of Analysis - 15 Manuals for methods of analysis for various foods/ food additives / contaminants etc.

*Data up to December 2019*

FSSAI has also put in place a system of approval of non-specified food and food ingredients on the basis of risk assessment on case to case basis in order to encourage
innovation and enable introduction of new food products in the market. A process for approval of the same has been laid down in the Food Safety and Standards (Approval for Non-Specified Food and Food Ingredients) Regulations, 2017.

**Standards promoting healthy and sustainable food**

Over the years, the authority has kept itself abreast with the changing food basket and consumption patterns in the country. Various standards have been put in place to empower consumers to make healthy food choices with a special focus on children.

- In 2011, the Food Safety and Standards (Packaging and Labelling) Regulations were notified. Since then, eight amendments to these regulations have been made and a complete overhaul of these regulations is now underway.

- In 2016, FSSAI notified standards for various types of functional foods (health supplements, nutraceuticals, foods for special dietary use, foods for special medical purpose, functional foods and novel foods).

- In 2017, standards for organic food were notified, again with a focus to make safe and healthy food commodities available to the masses.

- The year 2018 saw notification of plethora of standards having direct impact on health and nutrition outcomes - standards for fortification of foods, regulations to limit trans fats in fats and oils, packaging regulations, and regulations to check misleading claims and advertisements of food products.

- In addition, new Food Safety and Standards (Labelling and Display) Regulations are in draft stage which will focus on provision of per serving information on calories (energy), saturated fat, trans-fat, added sugar and sodium as percentage of recommended dietary allowance (RDA) on the front of the pack. Further, FSSAI has made menu labelling mandatory for food service establishments with central licenses or having outlets at 10 or more locations. This would inform the consumers about calorific value and nutrient content of food and provide information on allergens. The labelling provisions for sweeteners have also been reviewed in order to provide information regarding judicious use of sweeteners to the consumers. FSSAI has also envisaged for certification and logo for whole grain to encourage whole grain consumption by Indian population.

Attractive logos and symbols have been developed and propagated to enable masses to make informed food choices. For example, ‘+F’ logo to identify fortified food products; ‘jaivik bharat’ logo for organic products; ‘trans fat free’ logo to assist consumers in making informed food choices. Further, the authority has proposed to limit trans fats to not more than 2 percent by weight in all fats and oils by January 2022 – a year ahead of the global target.
Scientific Cooperation for standards setting

Under Section 16 (3) (e) of the Food Safety and Standards Act, 2006, FSSAI has recently established a 'Network for Scientific Cooperation for Food Safety and Applied Nutrition (NetSCoFAN). This network is created with a vision to facilitate scientific cooperation through exchange of information, development and implementation of joint projects, the exchange of expertise and best practices in all fields under FSSAI’s responsibility and in particular, this would be used to provide scientific inputs for standard setting through risk assessment process. The network would also provide inputs to set science-based food standards, codes of practices and guidelines at par with global best practices and food testing methodologies and techniques.

Currently, the network comprises of eight groups (aligned to the 21 scientific panels) with 42 top science and research institutions and over 100 scientists and experts. Each group has a lead institution and multiple partner institutions. This would be strengthened and streamlined over the next five years. An online platform, namely Indian Food Verification System is also put in place to ensure linkages between food standards and licensing and compliance system.

India has been a member of Codex since 1964. After it was established, FSSAI was designated as the National Codex Contact Point (NCCP). India is currently the coordinator for the ‘Coordinating Committee for Asia’. India through FSSAI has played an active role in supporting the codex activities through participation in electronic working groups, submission of monitoring and / or occurrence data and providing inputs on standards and guidelines in various stages of development. Apart from this, India has harmonized the country’s standards with Codex.

1.4 Food testing, surveillance and monitoring

India has a large network of Laboratories for food testing. There is regulatory mechanism to recognise and notify food laboratories under the Food Safety and Standards Act, 2006. Currently, there are 261 FSSAI notified food laboratories that are reasonably well-distributed across the country. Private food laboratories are also allowed to be notified under the regulations. Currently, more than half of the FSSAI-notified laboratories are in the private sector. Fourteen National Reference Laboratories have been identified for the purpose of method development and validation, training, capacity building and R&D.

Laboratory Information Management System (INFoLNET) has been institutionalized for the purpose of knowledge management, traceability and efficient communication across labs. To address data accuracy, validity and reliability, effective mechanisms have been put in place for method harmonization and verification for e.g., method review group, scientific panel; approval system for conventional and rapid methods; commodity specific methods manual(s); collaboration with method setting bodies like AOAC.
Box 2: Food Testing System Score Card

1. Total number of food testing laboratories 262
2. Primary food testing laboratories 243
   - State government food testing laboratories 78
   - Supported through central grants 36 in 28 States / UTs
3. Mobile food testing laboratories (Food Safety on Wheels) 46 in 31 States / UTs
4. Laboratories staff trained over past 3 years 1250
5. Food analyst / public analysts 410
6. Junior Analysts 345

Data up to December 2019

As part of Residue and Contaminant Control Programme, FSSAI is required to have monitoring, directed sampling or surveillance, compliance testing, pre-market surveys, post-market surveys and all other data gathering activities for various contaminants and toxins. Currently, only national level monitoring of pesticide residues is being done on a regular basis. In addition, one time milk safety and quality survey, survey for heavy metals in vegetables, survey of packaging materials, and safety and quality of milk products (in Delhi-NCR only), and quality and safety of edible oils (in Delhi-NCR only) have been carried out. Findings of these monitoring and surveillance activities are given in Box below.

Findings of Recent Monitoring and Surveillance Activities

1. National level monitoring of pesticide residues: 2.2% of the 23,660 had pesticide residues above the maximum residue level (MRL)
2. National milk safety and quality survey, 2018: 6432 samples - Adulterated (0.18%); Antibiotic residues (1.2%); Aflatoxin M (15.7%) and Substandard (39.0%)
3. Monitoring heavy metal contamination in vegetables (2713 Samples): samples with residues more than prescribed limit of Lead (7.0 %); Cadmium (1.1%) and Arsenic (0.07%)
4. Survey on food packaging materials (1250 samples): migration limits
5. Survey on safety and quality of 5 milk products (in Delhi-NCR only): 1040 samples: Adulteration with vegetable oil, hygiene and sanitation parameters
6. Survey of edible oil - levels of industrial trans-fats in various edible oils
7. Survey of antibiotic residue in poultry

Moving forward, along with ongoing tasks the Authority will focus on monitoring of contaminants, toxins, antibiotic and veterinary drug use in food and nurture and support NetSCoFaN. Specifically, over the next five years, there will be enhanced focus on:

- Develop/ strengthen protocols and monitoring systems to track the presence of toxins/antibiotics/veterinary drugs in food for human consumption.
- Develop/strengthen surveillance, testing, traceability and recall mechanisms.
- Strengthen and expand accredited food testing network across the nation. This will include setting up state food laboratories, provision of mobile food testing laboratories and setting up sampling units and cold chain equipment.
- Support NetSCoFaN to provide high-quality inputs to the standard setting process.

Therefore, the activities under this action area will contribute to reducing the availability of unsafe, misbranded and non-standard foods in the market. This will help to inspire public trust in food available to people in the market and through the government programmes.

**Improve hygiene and sanitation across the value chain through a graded approach**

It is critical to understand that addressing food or nutrition security is not limited to actions addressing the shortages in food supply or availability, but also includes addressing issues of food contamination or foodborne outbreaks that indirectly contribute to food losses and adversely affect health. Food may be contaminated with variety of microorganisms at various stages of the food chain – on farm during harvesting, storing, processing or during handling operations as a result of the behaviour of farmers, processors, retailers or consumers.

To provide assurance of food safety, the Authority through its Schedule 4 of the act ensures that food businesses implement an effective Food Safety Management System (FSMS) based on Hazard Analysis and Critical Control Point (HACCP) and suitable prerequisite programmes by actively controlling hazards throughout the food chain starting from food production till final consumption. Schedule 4 introduces the concept of FSMS based on implementation of Good Manufacturing Practices (GMP) and Good Hygiene Practices (GHP) by food businesses.

The Food Authority also acknowledges the fact that apart from large established food companies, the Indian food sector is dominated by large informal and rapidly growing small and medium enterprises catering to the majority of the population. Thus, ensuring safety of food requires both the regulatory and supportive approaches to regulate the variety of food establishments. For this the Authority has adopted a ‘graded approach’ which combines traditional enforcement and inspections with soft interventions or capacity building approaches. The section below elaborates on this graded approach adopted by FSSAI.

**For large food businesses: Traditional regulatory and enforcement approaches**

The Indian food and grocery market is the world's sixth largest, with retail contributing 70 per cent of the sales. The Indian food processing industry accounts for 32 per cent of the country’s total food market, one of the largest industries in India and is ranked fifth in terms of production, consumption, export and expected growth. The Indian gourmet food market is currently valued at US$ 1.3 billion and is growing at a Compound Annual Growth Rate (CAGR) of 20 per cent. India's organic food market is expected to increase by three times
by 2020\(^2\). The online food ordering business in India is in its nascent stage but witnessing exponential growth. Ensuring safety of food across this huge spectrum of business is indeed a colossal task for which the Authority has strengthened its traditional regulatory instruments and tools with focus on schemes of testing and inspections.

Moving forward, the plan is to enhance the focus on expanding the food labs owned by food businesses for self-compliance and foster third-party audits. The newly created cadre of ‘food safety mitras’ will be critical for putting stringent enforcement in place.

**For small and medium food businesses: Capacity building and implementation of hygiene rating**

The Micro, Small and Medium Enterprises (MSME) sector has emerged as a highly vibrant and dynamic sector of the Indian economy over the last five decades. The food processing industry under the SMEs flourished with the introduction of the food packaging technology and the improvement of the storage facilities in the cold storage units in the Indian market. The emergence of retail food chains, the acceptance of packaged food and the emergence of food courts in urban India has contributed greatly to the food processing unit of the SMEs. In addition to these, trend of eating outside too has accelerated the growth of the food processing industries in the Indian economy.

To cater to this sector which is not formally organized but is rapidly growing, the Authority focusses on capacity building and hygiene ratings to promote self-compliance. The purpose is to improve the hygienic conditions especially at the manufacturers level, for which the Authority has initiated two key initiatives:

**Food Safety Training and Certification (FoSTaC):** This is a competency-based training ecosystem to ensure compliance to hygiene and sanitary practices in handling of food by all food businesses. All food businesses are required to have a food safety supervisor for every 25 food handlers. The food safety supervisors are expected to train the food handlers periodically. There are 19 certification courses available under FoSTaC. The duration of a course varies from 8 to 12 hours spread over 1 to 2 days. These courses are offered at three levels: Basic, Advanced & Special. The courses cover general hygiene or manufacturing practices as detailed under Schedule 4 of FSS Regulation and are being delivered in face to face classroom training either in the premise of food businesses (in-house training) or in the premises provided by training partners (open class). Till, there were 176 Training Partners across the country, more than 1600 trainers had been trained, 7000 training programmes had been conducted and nearly 200,000 food safety supervisors had been trained under FoSTaC. Large-scale programme for training of trainers and third-party online assessment is being taken up to further strengthen the training ecosystem under FoSTaC.

**Hygiene Ratings:** Under the hygiene-rating programme, food businesses are given a rating (five to one) on the basis of the hygiene and food safety compliance. Hygiene rating is a simplified version of third-party audits and are being made mandatory for large food businesses but not for SMEs. The programme involves physical inspection by an auditor from a third-party audit agency or ‘Audit Mitra’ under the ‘Food Safety Mitra’ initiative and a

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\(^2\) India Brand Equity Foundation, 2017
rating assigned to it based on a checklist. This rating is to be displayed at the food establishment. In case the rating is low, improvement notice is given to the food business. This rating enables consumers to make informed choices about the hygiene status of the food establishment and motivates businesses to improve their hygiene standards and thus reduce the incidence of food borne illness. Currently, standalone restaurants and small hotels, meat and fish shops, sweets and halwai shops, places of worship are covered under the hygiene-rating programme. Each one of them have a separate checklist and are branded for easy recall. The purpose of the rating is two-fold, (i) it enables the consumer to make informed choices about the hygiene status of the food establishment and (ii) it motivates businesses to improve their hygiene standards and thus reduce the incidence of food borne illness.

**For petty businesses: Cluster approach**

The authority adopts a ‘cluster approach’ - a systematic process of gap analysis, filling infrastructure gaps, training and capacity building and certification. This is a systematic way to ensure compliance to food safety standards and helps to organize hawkers and petty food vendors to improve food safety and hygiene. It is also an important convergence point as local municipal authorities take a lead in setting up clusters (e.g., clean street food hubs, vegetable and fruit markets, to name a few) and with other government programs like Swachh Bharat Abhiyan for special cleanliness drives and with Jal Jeevan Mission with focus on potable water supply would help. Currently, street food vendors, fruit and vegetable markets and micro-food processing businesses are covered under the cluster certification programme. Each one of them have a separate checklist and are branded for easy recall. One of the most successful initiatives is - FSSAI’s Clean Street food Hub initiative.

To keep the culture of street food alive but to make it safe, the authority is determined on making 144 street food clusters across the country that would be jointly audited with state authorities for cleanliness and hygiene. These clusters would be encouraged to comply with certain standards and those meeting the criteria would get a “clean street food hub certificate”. A successful example of this initiative is the Ahmedabad’s Kankaria Lake area. Several others are in the pipeline. Setting up of a ‘hub’ is a perfect example of on-ground convergence and coordination of various stakeholders and massive capacity building efforts by the Food Safety Officers and auditing by the Food Safety Mitras or third-party audit agencies.

Moving forward, along with expansion of ongoing activities as listed above, the Authority will specifically focus on:

1. **Capacity building especially for small and medium enterprises** to ensure food safety at the manufacturing level. In coordination with the line ministries/departments trainings for primary producers will also be undertaken to limit the use of chemicals/pesticides at the farm level. FSSAI will play a key role in developing high-quality resource material and state-specific action/roll-out plans for training. The implementation will be done in coordination with concerned departments/ministries.

2. **Institutionalization of hygiene rating program for small and medium enterprises.** Under hygiene rating program, food businesses will be given a rating (five to one) on
the basis of the hygiene and food safety compliance. Although this will be compulsory for the large businesses, under the project standalone restaurants and small hotels, meat and fish shops, sweets and halwai shops, places of worship will be primarily targeted. Third-party audit agencies and ‘Audit Mitras’ under the ‘Food Safety Mitra’ initiative will play a crucial role in this program and hence there will be efforts to build capacity of Food safety mitra cadre.

3. **Setting up of demonstration units/prototypes with petty food businesses to be replicated at the state-level.** This will include developing SOPs and guidelines for implementation of ‘clusters’ or ‘hubs’ at the state level.

**Catalyze actions to improve food choices and food environments**

We eat food at home, at school, at workplace, or outside. Settings in which we eat food determine our choice of food. In home setting, we have near full control of food supplies. In school and workplace environment, respective managements could exercise some control over food supplies, however, outside there is somewhat limited control.

Government policy and regulation are expected to ensure availability of only safe food. Proportion of healthy and not so healthy food in markets is largely determined by the food businesses. The businesses would obviously want to ensure supplies of food that moves fast and unfortunately some of the unhealthy food is also addictive and therefore businesses tend to supply more of it. Policy and regulation can however play a key role in changing food environments overall.

Under the Eat Right India movement, we have customised interventions for a variety of settings to ensure people have access to safe, healthy, environmentally sustainable food wherever they are. These settings are homes, schools, colleges, workplaces and campuses, railway stations, jails and tea estates.

**Food @Home**

Over 90 per cent of people in India eat home-cooked food, not only at home, but even at school or at work. While, home kitchen earlier occupied a central place in our homes, its role got marginalised in recent decades with changing lifestyles. In many middle class and most upper class households, home kitchens are almost entirely run by domestic help. Convenience and taste, rather than nutrition determine food choice. Tradition and conventional wisdom on food hygiene and healthy diets – passed from generation to generation, is almost entirely lost. Safety and hygiene get compromised. Home kitchen is therefore where action lies to bring about change transforming the way we eat. FSSAI has developed resource books, audio-visual material and orientation and training module for home makers and domestic helpers to engage people more deeply with home kitchens and transform it.
For engaging people with their kitchens, FSSAI has developed ‘The Pink Book’, a simple and illustrated guidebook on food and nutrition. Recognizing that concerns about adulteration of food are high on people’s mind, ‘The DART Book’ provides simple tests to check for common food adulterants in home environment. Rich repository of credible and engaging videos, training modules, and short clips from experts are housed in ‘FSSAI’s Online Video Library’. These cover a variety of topics related to food safety, nutrition, sustainable food practices, and on mindful-eating. From time to time, FSSAI releases ‘Guidance Notes’ for citizens on emerging concerns on food safety and nutrition to help people become food-smart consumers.

Households in India increasingly hire domestic help not only for cooking but a variety of chores. They are mostly from extremely poor households with low levels of literacy. FSSAI has developed simple and interactive training modules for them. Training sessions have been organised for them in partnership with Domestic Workers’ Sector Skill Council (DWSSC) under the Ministry of Skill Development, Resident Welfare Associations (RWAs) and NGOs. This package of content and activities form the FSSAI’s ‘Eat Right @Home’ initiative. Nation-wide scale up of this initiative can transform the Indian kitchen and give back the Indian Kitchen, pride of place in Indian homes.

Food @School

Habits are formed early in childhood and are hard to unlearn. The food habits that children form when young affect not only their cognitive growth and physical development but also their health later in life. Good nutrition, proper hygiene, physical activity and healthy habits in early life lead to better health, better performance in school, greater job productivity and earnings and an overall higher quality of life. These benefits are passed on to future generations, so society as a whole develops in a positive direction.

Typically, schoolchildren bring food from home that reflects their food culture at home. However, the influence of peers and teachers also plays a large role in what schoolchildren eat, particularly when choosing from the school canteen or vendors around the school premises. Therefore, it is important to target the school environment along with the home environment. But first and foremost, school children themselves need to be engaged because their habits shape their behaviour. Schools are well poised to influence dietary practices and promote lifelong healthy habits, as students spend an average of 7-8 hours per day in school and can be considered captive audience.

While young children are quick learners, they have to be engaged in interesting ways to be receptive to what is taught. Food is fundamental to human experience and culture and can serve as a wonderful pedagogical tool to educate children about food safety, nutrition, environmental sustainability and mindfulness.
For this, FSSAI has created credible, interactive and activity-based resources like The Yellow Book to educate schoolchildren about eating right and imbibing healthy habits in the form of ‘Food Fundas.’ These books have been widely disseminated in schools for curricular and extra-curricular activities around healthy habits. To conduct these activities, Health and Wellness Ambassadors are being created in schools through an online certification programme by FSSAI. These can be teachers, senior students or parents who would like to impart knowledge to school children. Thus, healthy habits are being inculcated in schoolchildren by creating a community of ambassadors around them.

Since superheroes often capture the imagination of children and have a huge influence on their minds, life-sized Mascots- Master and Miss Sehat have been created to impart these food fundas to children through games and skits. These mascots activations have happened in 1800 schools across 14 cities in the country reaching 10 million citizens.

Children are born scientists, researchers and explorers. To test for the unknown, discover the unexpected is a great way for them to spend time in the school laboratory. Science can be made relevant by applying it to their everyday lives. Food is an ideal springboard to bring a host of science-concepts to life in the classroom. FSSAI has tapped this by developing a ‘Food Safety Magic Box’. It has 79 super-easy tests for common food adulterants so that children can learn to check if their food is safe. These are simple but mind-blowing, hands-on science experiments that can be performed using materials in the school laboratory and those provided in the Magic Box using the manual accompanying it. This helps to not only build scientific temperament but engages school students to learn about food safety through fun experiments.

Since learning occurs best through experience, an innovative approach to bring food from textbooks to life has been adopted in the form of Eat Right Innovation Labs (ERIL). These have been envisioned as physical and intellectual state-of-the-art laboratory spaces in schools. Through activity-based tools, resources and materials they would engage young people and help imbibe right eating habits through exploration, experimentation and experience thereby promoting nutrition literacy. These labs would complement, support and reinforce the existing syllabus and theoretical aspects with carefully curated and scientifically accurate content that would be applicable to a variety of school curricula. This kind of practical training would further empower schoolchildren to influence their home environments positively towards better dietary practices.

All of these efforts would be in vain if they are not support by an enabling environment in and around schools through a regulatory framework. For this, FSSAI has drafted Food Safety and Standards (Safe Food and Healthy diets for School Children) Regulations, 2019. This is a legislative & regulatory framework to facilitate the promotion of Eat Right habits in schools by ensuring and promoting safe and healthy food in and around school premises, regulating food marketing and advertisement to school children, monitoring and surveillance and overall guidance for providing safe and wholesome food to children.

The Mid-Day Meal (MDM) Scheme serves 10.03 crore children in India providing hot cooked meals for them. Therefore, it is important to ensure the food served is prepared and served hygienically and safely. A guidance note for safe and nutritious food in the Mid-Day Meal programme has also been developed based on Schedule 4 of the FSS Act, 2006.
All of these elements have been integrated into a comprehensive structured engagement programme for schools called Eat Right School. An Eat Right School matrix has been created with parameters to be adopted by schools in three main areas—Eat Right Education, Healthy and Safe Environment and Responsible Practices. Schools would be rated based on this matrix and certified as Eat Right School if they meet the criteria. As of..., over 35,000 schools had been enrolled. In order to mobilize schools and support them to implement this programme, an SNF (Safe and Nutritious Food) Fellowship programme has been launched. Under this fellowship, college students are provided CSR funds to reach out to schools.

From time to time, FSSAI has been conducting various large-scale outreach activities to engage students. The Eat Right Creativity Challenge was launched to unleash the creativity of the Indian youth and spread awareness on eating right. It comprised a pan-India ‘On the spot Poster’, ‘Paint a Wall’, and ‘Digital Creative’ competition on the ‘Eat Right’ themes. Over 70,000 students participated in this challenge, empowering the youth to use their creativity towards a good cause.

Children can be powerful agents of change. Therefore, Eat Right India aims to scale up this initiative to reach all 1.5 million schools in the country and usher in a culture of eating safe, eating healthy, eating sustainably and eating mindfully for generations to come.

Food @Campus

A vast majority of people eat at least one meal outside the home on a regular basis in a campus-like setting. This includes places like colleges, workplaces, hospitals, railway stations or certain micro-ecosystems such as jails and tea estates. While we have control over the food we eat at home, when outside, we are at the mercy of what is available and accessible to us. Even when food is packed from home, there are certain constraints or additional factors that influence our choice of food. Social milieu, trends, work or college culture, group affiliations and peers, conversations, economic reasons, convenience, schedules and the overall physical environment of the campus, all influence our food choices.
Food-service establishments in campuses include in-house canteens, catering and food delivery services, restaurants and cafes and food vendors. Many people bring packed lunches from home or use home-based services like the dabba-system. There are multiple issues that need to be addressed in these settings such as ensuring food safety and hygiene standards, availability of healthy food options, environmentally sustainable food practices and empowering consumers to make right food choices.

For this, a comprehensive checklist has been developed by FSSAI along with a resource book on best practices called ‘The Orange Book’. Any campus that meets the threshold criteria mentioned in the checklist, after evaluation by a third-party audit agency, is declared as an ‘Eat Right Campus’. This certification recognizes the efforts of the campus, adds prestige and brand value to its name and enables it to inspire others to adopt these best practices.

A six-step general procedure has been set up to certify campuses. It begins with self-assessment or pre-audit of the campus based on the checklist. This is followed by gap analysis, training, capacity building and taking other measures to address gaps. Next, a third-party audit takes place based on which a rating is awarded. Campuses with a 3-star rating and above are awarded certificates. Sustenance of the campus is ensured by appointing a nodal person to continue these efforts. Regular inspections by the Food Safety Department or audit agencies take place for monitoring.

The campus initiative covers almost half a billion of workers in India in offices, institutes, organizations, hospitals and 37 million students and teachers in colleges. Scaling-up this initiative nationally would enable almost half of the population to eat right and stay healthy. For those who are already suffering from medical conditions such as diabetes, hypertension, stomach disorders, a resource book on general guidelines for diets for these medical conditions has been created by FSSAI, called ‘The Purple Book’.

In special environments such as tea-estates that employ a large number of people, particularly those from the vulnerable sections of the society, this initiative would improve the overall nutrition profile of people and their future generations.

This approach to preventive and promotive healthcare along with disease management through diets, would significantly boost productivity, reduce absenteeism and the burden of healthcare costs and ultimately lead to the economic growth of the country.

Railway stations, particularly the 200 large junctions in the Indian Railway network, see a huge influx of passengers numbering over 8 billion every year. The certification of these stations would assure passengers of safe and healthy food even while traveling. This would further boost tourism and bring in revenue.

Last but not the least, over 4 lakh inmates in over 1400 jails would also benefit from this initiative and contribute to their rehabilitation, thus improving the social environment of the country as well.

After its launch, 7 Eat Right Campuses were recognized on 7th June 2019, World Food Safety Day and 7 more campuses have been added to the list with several in the pipeline.
IIT Gandhinagar awarded as ‘Eat Right Campus’ by Hon’ble Health Minister, Dr. Harsh Vardhan on 7th June 2019.

**Food @Places of Worship**

India is a country of many religions. Religious practices, particularly visiting places of worship, are deeply ingrained in the Indian psyche. While some people visit places of worship only during festivals or special occasions, for others it is a daily ritual.

Many temples, Gurudwaras and monasteries regularly provide ‘prasad’ or ‘holy food’ to devotees. Even around the temple or mosque premises, there are vendors and food service establishments, which devotees frequently visit. The roads to pilgrimage spots are lined with shops, restaurants, vendors that see a vast number of visitors particularly during special occasions or seasons.

To ensure safety and hygiene standards of food in this setting is critical since visitors come from around the country and even the world to visit places of worship on a daily basis. There are challenges around addressing issues of food waste, plastic use given the huge volume of food served.

Therefore, FSSAI has developed a Guidance Document on ensuring safe, healthy and sustainable food in places of worship. A system of third-party audits based on a pre-defined checklist has been created to evaluate and certify places of worship based on ratings. Training of Food Safety Supervisors for these places of worship is done to ensure that good hygiene and sanitary practices are adopted and implemented. All of these steps are packaged under the ‘BHOG’ initiative of FSSAI- Blissful Hygienic Offering to God.

**Food@Anganwadi Centres**

The Integrated Child Development Services (ICDS), as one of the flagship programmes of the Government of India, represents one of the world’s largest and unique programmes for early childhood care and development. It provides a range of services to 9.83 crore mothers and children and 10.03 crore children that includes providing hot-cooked meals and take-home rations.
These Anganwadi centres are mini environments, where mothers and children from vulnerable sections, from largely rural backgrounds are served. They are counseled about nutrition and need to learn about safe food practices. Anganwadi workers are the frontline health-workers, who educate and engage these women and children. FSSAI has created the ‘Eat Right Toolkit’ to train these Anganwadi workers. This toolkit is an interactive training module on safe food practices, personal and surrounding hygiene, combating food adulteration, healthy eating habits, food fortification and healthy diets. An online course on the same has also been developed. By embedding this module into the regular training module for Anganwadi workers, they can reach out to the community at the grass roots level and enable them to adopt healthy practices.

**Food @Government Settings**

Government premises, offices, canteens and programmes are also unique settings in which food is prepared and served regularly. FSSAI has come out with procurement guidelines for safe and healthy food in Government departments.

A guidance note for safe and nutritious food in the Mid-Day Meal programme has been developed. Similarly, a guidance manual for ICDS includes good hygienic and sanitary practices to be followed based on Schedule 4 of the FSS Act, 2006.

**Influencing food choices: People’s movement or Jan Andolan through ‘whole-of-government’ and ‘whole-of-society’ approach**

Food choices are influenced by a variety of factors. These include individual factors, which are a product of tastes, preferences, values, beliefs, ingrained habits, emotions and heuristics (mental shortcuts) and cognitive biases, social factors such as cultural norms and narratives, influence of peers and social identity and finally, physical and economic environments, advertising, mass and social media, pricing, accessibility, availability and convenience.

Eat Right India is geared towards shifting these food choices towards healthier alternatives. Campaigns for citizens and food businesses have been launched under various initiatives of Eat Right India. These campaigns are designed to bring about large-scale behaviour change among consumers using the ‘EAST’ approach. i.e. making desired behaviours Easy, Attractive, Social and Timely around each of the key messages of Eating Right. These messages include reducing salt, sugar and fat, promoting fortified foods and organic food, following safe and healthy cooking practices, minimizing food waste and eliminating plastic waste. Nudges have been introduced to make right food choices more attractive to citizens by simple changes in choice architecture such as prominent displays of healthier food options. Incentives to food businesses have been provided in the form of Eat Right Awards for following best practices.
Reducing consumption of fat, particularly saturated fat, sugar and salt

Reducing the consumption of fat, particularly saturated fat, sugar and salt in the daily diet is critical to reducing the risk of non-communicable diseases such as obesity, diabetes, hypertension and heart disease. To nudge citizens to eat less salt, sugar and fat, engagement materials such as a TVC starring Rajkummar Rao, posters, videos from experts and other materials have been created and widely disseminated. These are being disseminated through various channels such as television, social media and outreach events to educate citizens on behaviour change strategies to enable them to make informed food choices. These activities fall under the ‘Aaj Se Thoda Kam’ campaign that outlines various strategies for behaviour change to reduce the intake of salt, fat and sugar. These strategies, follow the EAST approach and include easy, attractive, social and timely steps such as eating healthy alternatives such as lemon instead of salt for flavouring, whole fruits instead of fruit juice or desserts etc.

Trans-fat free India

Elimination of industrial trans-fats that are harmful to health is the goal for 2022, a year ahead of WHO's goal by 2023. While regulatory actions are being taken for food businesses, campaigns to educate citizens to eliminate trans-fat have been launched under ‘Trans-fat Free India’. A public service announcement on the ill-effects of trans-fats has been created and disseminated. Engagement material such as posters and videos have been created with steps to eliminate trans-fat in the diet by following healthy frying practices, avoiding commercially fried foods, reading labels on trans-fat content on food packages and so on.
Food Fortification

While eating a healthy, varied and balanced diet is the ideal way to get all the nutrients people need, it is often not practical. The variety of food is not always available, accessible and affordable to everyone. Similarly, taking nutrient supplements is also not always feasible and is often expensive and requires the supervision of a medical doctor. Eating fortified foods is a simple, inexpensive and easy way to get the required key vitamins and minerals for good health. FSSAI has already notified standards for five fortified food staples namely, wheat flour, rice, oil, milk and salt. The Food Fortification Resource Centre (FFRC) has been specifically set up at FSSAI to promote large-scale food fortification in collaboration with development partners. However, public awareness campaigns are necessary to create demand for these fortified foods. For this, the +F logo has been created to help citizens to identify and choose fortified foods. TVCs with celebrities starring Virat Kohli and Sakshi Tanwar, social media campaigns and outreach events such as the Swasth Bharat Yatra, a pan India cyclothon led by FSSAI in 2018 and Eat Right Melas. These campaigns serve to market fortified foods as value-added products to make them more attractive to citizens.
Promoting Organic food

An important part of eating healthy is eating local and seasonal food. Many people prefer to take organic food as it is free from pesticides and other chemicals. Since it does not use preservatives, it has to be consumed locally and seasonally. The public is often unaware about authentic organic foods. For this, FSSAI has created a logo to mark organic food creating an identity for them. Moreover, a directory of organic food producers has also been created and uploaded on FSSAI’s website for ready reference. All these steps have been taken under the Jaivik Bharat initiative which certifies authentic organic food to empower consumers to make informed choices.

Safe and Healthy Cooking Oil

Using safe and healthy cooking oil is essential for good health, particularly in the light of growing incidence of diseases like cancers and heart diseases. FSSAI has launched awareness campaigns on promoting safe and healthy cooking practices among citizens to safeguard their health under the RU CO campaign. Through various engagement material such as a TVC starring Virat Kohli, posters, videos, social media posts, citizens are being educated about not using the same oil for frying repeatedly, changing cooking oils regularly, filtering harmful dark particles in oil. Citizens are also empowered to make informed decisions about eating at food establishments that follow best practices for used cooking oil.
No Food Waste

Since India is a country of contrasts with several million people going hungry every day and a large section of the food produced going waste. In order to encourage and educate citizens to reduce food waste at the household level, awareness materials and guidance documents have been created and disseminated. These include simple tips such as responsible buying of food, recycling food, reusing leftovers and sharing surplus food. To facilitate food donation, Regulations for safe storage and transport of donated food have been released. A network of food collection agencies called Indian Food Sharing Alliance (IFSA) has been created by FSSAI to distribute surplus food to those in need. A mobile app and single contact number is being provided to citizens for easy access to these agencies. Various schemes to motivate people to easily donate surplus food during weddings and social functions have also been initiated. Thus, by making food donation easy, attractive, social and timely, citizens are being nudged to share surplus food.

No Plastic Waste

Plastic waste, especially from food packaging is a hazard for the environment as well as human health, if it is consumed. This includes plastic cups and plates used for serving and packing as well as plastic packaging in processed foods etc. Therefore, various drives to promote environment-friendly materials instead of plastic and collect plastic waste are being implemented. Short videos, posters and engagement materials are also being widely disseminated. Citizens are encouraged to use cloth bags or ‘jholas’ instead of polythene bags.
Nudging the Food Industry: Eat Right Awards and Eat Right Start-Up Awards

While the above-mentioned campaigns nudge citizens to eat right, incentives have been created to nudge the food industry as well on the supply-side. These are in the form of awards based on their commitment and actions to promote safe, healthy and sustainable diets. These awards recognize food businesses, start-ups and individuals for their exemplary contribution to reformulate to produce healthier food options, promote healthier food options, provide innovative solutions to public health nutrition issues and so on. Eat Right Awards and Start-Up Awards have already been given to a number of industry players and individuals on the culmination of the Swasth Bharat Yatra and 7th June, World Food Safety Day, 2019.

Approaches for ‘Jan Andolan’

To implement Eat Right India as a true people’s movement, FSSAI has taken the Whole of Government and Whole of Society Approach to transform the food culture of the country.

Whole of Government Approach

Eat Right India requires multiple interventions targeting all parts of the food value chain that span all levels of governance and include representation from a wide range of stakeholders. Given that mandates of most of the ministries/departments relate to food in one way or another, ‘whole government approach’ is necessary. This happens through vertical and horizontal linkages with Government departments and convergence with government flagship programmes. A list of ministries / departments and their area(s) of interface is given in the annexure.

In order to limit residues of pesticides, veterinary drugs and antibiotics, heavy metals and Aflatoxin in food, intervention is required at primary production stage itself. Since, primary production is outside the remit of the Food Authority, involving the Ministry of Agriculture Cooperation and Farmer’s Welfare, and the Ministry of Animal Husbandry, Dairying and Fisheries is essential to promote good practices for agriculture, dairying, poultry and aquaculture. Animal feed industry in the country is currently not regulated. It is proposed to bring animal feed under the regulatory remit of FSSAI as is the practice in most parts of the world. With this, India too would be able to take ‘One Health’ approach for holistic and effective action against various public health threats.

Various initiatives such as food fortification and promoting safe and healthy cooking oil under RUCO require concerted efforts by line ministries such as Women and Child Development, Consumers Affairs, Food and Public Distribution and Human Resource Development, Petroleum and so on. FSSAI brings all these central ministries and state departments under a single platform so that efforts are implemented cohesively.

Along with horizontal linkages with the Government’s central ministries, FSSAI also works with Departments vertically. For instance, Clean Street Food Hubs, Clean and Fresh Fruit and Vegetable markets, outreach events such as Eat Right Melas to engage citizens require the cooperation of City Municipalities, Sanitation and Drinking Water supply departments and so on.
There are various Government programmes that already work within the domain of food and public health. Leveraging their reach and collective strength is critical for the successful implementation of these programmes. Therefore, convergence is a critical strategy of Eat Right India. For instance, special cleanliness drives in fruit and vegetable markets, street food vending areas in cities/towns are being jointly taken up under the Swachh Bharat Abhiyan. Frontline health workers are being trained on food safety and nutrition under Ayushman Bharat through the Eat Right Toolkit.

FSSAI has developed the ‘Eat Right Toolkit’ and online courses to empower frontline workforce and enable them to bring about change in the community. This could also be used for training of Anganwadi Workers under Poshan Abhiyan and complement their own training efforts. Efforts to promote food fortification have been clubbed with Anaemia Mukt Bharat and the Poshan Abhiyaan to address micronutrient malnutrition more effectively. Jal Shakti Abhiyan has been brought into special focus to ensure potable water supply in clusters of petty food vendors in places such as street food hubs, vegetable, fruit, meat markets. Thus, synergies with overlapping departments and programmes have given a boost to Eat Right India.

Whole of Society Approach

FSSAI works with stakeholders such as intergovernmental organizations and religious institutions, civil society, academia, the media, voluntary associations to bring about a change in food culture. It influences and mobilizes local and global culture and media, rural and urban communities, and all relevant policy sectors such as education system, the transport sector, the environment and even urban design. This Whole of Society Approach complements the Whole of Government approach.

Eat Right Challenge for Districts and Cities

Combining the Whole of Government and Whole of Society Approaches, FSSAI is scaling up Eat Right India by leveraging federal competitiveness. Food is a state subject and it is upto the state to adopt, fund and implement these initiatives and campaigns to reach all sections of the society. To motivate states, specifically districts and cities, that can be considered administrative and social units the ‘Eat Right Challenge’ has been conceived.

This challenge supports, acknowledges and rewards the efforts by districts and cities to adopt and scale-up initiatives under Eat Right India. This would not only create a sense of competition among districts/cities motivating better performance but also inspire others to join.

The first hundred districts/cities to register that fulfil essential pre-defined criteria would be eligible to participate. A nodal person from each participating district/city would be appointed for coordination. Each district/city would be provided with a toolkit to implement these initiatives and programmes and technical support through mentors from FSSAI, State/Govt. Officers and professional networks created by FSSAI. Financial support would also be provided as seed money to kick-start these initiatives.
Districts/cities would choose programmes/initiatives to implement from a menu. They would be evaluated based on a matrix based on the number of programmes implemented, scale of outreach, responsiveness within the given timelines and local resources mobilized. Monthly reviews would be conducted to evaluate the progress of these initiatives.

Creating an Enabling Environment

Networks of professionals in food and nutrition, higher education institutes, consumer organizations, scientific researchers and entrepreneurs have been created under Eat Right India to reach out to citizens and provide the necessary technical support and resources on a continuous basis to sustain the movement nationally.

Voluntary Consumer Organizations

NetCOFaN is a Network of Consumer Organizations in Food and Nutrition that has been created to bring these organizations on a common platform to generate awareness among consumers and empower them to make informed choices. This network would function as a dissemination vehicle for correct messaging on eating right through various chapters of these organizations across India.

Institutions of Higher Education

NetHIFaN is a framework with a four-pronged strategy for a structured, holistic engagement with higher education institutions that has been created under the Network of Higher Education Institutes in Food and Nutrition (NetHIFaN). With the help of Industry, Academia, Associations and other stakeholders, the framework offers a host of partnership opportunities for Higher Education Institutes (HEIs) to mainstream curricula and certification of food and nutrition courses, provide hands on training to the budding professionals, offer scholarship and incentives to students along with the opportunity for practical training.

Professionals in Food and Nutrition

NetProFaN: Network of Professionals in Food and Nutrition (NetProFaN) is a network that has been created to leverage their collective strength and expertise systematically to support both demand and supply side initiatives of Eat Right India. It consists of seven associations, namely Indian Medical Association, Indian Dietetic Association, Nutrition Society of India, Association of Food Scientists and Technologists of India, Association of Analytical Chemists, Indian Public Health Association and India Federation of Culinary Associations. It would function as a self-sustaining model at national, state and city levels, through its chapters, to adapt and implement activities to address the local needs and issues on safe, healthy and sustainable diets. This would ensure that Eat Right India reaches all sections of the society.
In an endeavour to make Eat Right India as a people’s movement, the authority is planning for Jan Andolan around safe and healthy diets. Over the years, large-scale citizen-centric campaigns have been launched to bring social and behavioural change. These interventions are purely demand-side and complement the supply-side interventions such as setting standards and training and capacity building of FBOs. Some of the initiatives undertaken by the authority include - ‘Aaj Se Thoda Kam’ campaign, Trans-fat free India, Food fortification, promoting organic food, reducing food waste, RUCA, reducing plastic waste, among others already discussed.

**Future Challenges and Opportunities**

Future challenges and opportunities lie in according priority to strengthen and expand the core regulatory functions of the authority, support the nation-wide rapid, time-bound scale-up of the Eat Right India movement to positively transform the ‘food environments’ in the country. A results-based approach should be taken with focus shifting from inputs to achieving outcomes and results, thus driving the achievement of planned results at national, state, district and city level in a time-bound manner.

Implementation and scale-up by states will be key to the success of Eat Right India. There are several World Bank projects that have effectively used incentives to build higher priority and commitment for project activities in States that has led to implementation scale-up and effectiveness. The concept of ‘Challenge Fund’ introduced under the Bank’s support to the Integrated Child Development Services (ICDS) and the National Nutrition Mission (NNM) has been very effective. Under this, the first three states to achieve the selected results were awarded with an additional fund of USD 250,000. This amount is treated as ‘flexible fund’ which the state can spend on State priorities as they wish to. Similar approach can be tried under this proposed project as well. Adding a ‘flexi component’ as a budget head – FSSAI can have a flexible budget component to provide flexibility to the States to spend on their needs/innovations etc. A Memorandum of Understanding (MoU) could be signed with the States wherein states agree to carry out certain tasks and activities under the project with incentives to the forerunners.

Eat Right India presents a new approach that has great potential to inform worldwide food regulatory systems, particularly in developing countries and therefore requires high quality research to not only inform Eat Right refinements as it moves forward; it also requires to be studied by and informed by global experts, renowned global institutes.

With the overall goal of transforming the ‘food environments’ in the country to address India’s malnutrition and public health challenges, it is important to:

1. Support rapid, time-bound and quality scale-up of Eat Right India across the country;

2. Build capacities (human and institutional), especially at the state and local levels to achieve scale; and

3. Institutionalize sustainability mechanisms, within and outside the government.
While, essentially, a regulatory authority for food safety, the FSSAI has played a key role in addressing issues arising from foodborne illnesses, malnutrition in its various forms, rising incidence of NCDs and obesity and promoting sustainability. In these efforts, FSSAI is required to coordinate with multiple central ministries and agencies and the state governments. Under the Food Safety and Standards Act, 2006, States/UTs are primarily responsible for implementation of provisions of FSS Act, 2006 and Rules and Regulations made thereunder through the Food Safety Commissioners who are assisted by the Designated Officers (DOs) and Food Safety Officers (FSOs). FSSAI faces challenges both at the national level and working with the States. These are listed below -

- Institutional capacity in terms of infrastructure and facilities, staff and HR practices, financial and audit systems, digital platforms and IT support and system of monitoring and evaluation.

- While, there is strong strategic planning capacity built in the organization, however state-level implementation is weak.

- States / UTs accord low priority to food safety and eat right movement and therefore infrastructure and facilities, size and capacity of staff in the States and at local levels.

- There is inadequate support for food testing laboratories in the States with lack of infrastructure, equipment and supplies in most of them.

- There is lack of IT support system for effective surveillance and monitoring activities.

- There is lack of appreciation about close interconnection between food safety, nutrition and rise of NCDs and obesity, therefore integration of Eat Right movement with existing State health systems is poor.

- There is lack of awareness about the initiatives and programmes, and resources potentially available from FSSAI.

Government of India has increased investment on food safety and nutrition significantly in recent years. Outlay for FSSAI has increased by five-fold over the past 5 years from Rs.60 crore in 2015-16 to 300 crores in 2019-20. While, some States/UTs are providing adequate resources and giving necessary attention to food safety, many States / UTs are lagging behind. They need to catch up. An additional investment of Rs. 500 crores is estimated to strengthen food safety administration in the States/UTs, particularly weaker States / UTs over the next 5-year period. Most of the other activities would be accommodated through FSSAI’s annual grants or by a mix of innovative fund mobilization strategies. For e.g., training and certification of food safety supervisors could be managed directly by food businesses while capacity building in informal sector could be managed through CSR funding. To carry out the proposed system strengthening and scale-up activities, a budget of approx. 3000 crores is estimated over the five-year period.
Outcomes

Eat Right India would be fully scaled-up to reach all States and UTs. All food businesses (big, small or petty) would be brought under licensing and registration regime over the next five years. Most of them would also be hygiene rated. There would be increased availability of safer food to consumers: (i) Unsafe food availability reduced to <1%; (ii) Misbranded foods to <1%; (iii) Non-standard foods to <5%. Fully matured and functional IT system for effective monitoring and evaluation. Globally benchmarked food standards, codes of practices and guidelines in the country. India takes global leadership position in adopting food systems approach for healthy and sustainable solutions for our citizens.

Eat Right India would positively impact nation’s health and environment and would provide significant economic and social benefits. Private ecosystem that would develop to support food administration would create close to half a million new jobs. These would be in FSSAI-notified food laboratories, food business owned food laboratories, third party audit agencies, food safety training partners, and as ‘Food Safety Mitras’ who would facilitate food businesses in licensing and registration work. Further, new jobs would also be created in new ecosystem for collection, aggregation, cleaning and processing of used cooking oil and its conversion to biodiesel.

Systematic efforts to simplify, streamline and strengthen food safety compliance using technology would ensure transparency, replicability and predictability resulting in ease of doing business and spurring growth of the food processing sector. The cluster initiatives such as clean street food hubs; clean and fresh fruit and vegetable markets would help organize hawkers and petty businesses and improve hygiene and food safety and also increase their productivity. These certified clusters would improve the livelihoods of the most vulnerable section of our society and yield rich health and environment dividends.

A recent study suggests that prevention of foodborne illnesses due to unsafe food alone will save India $28 billion that is about 0.5% of its GDP every year. Cost of micronutrient deficiencies and non-communicable diseases is estimated in trillions of dollars. Modest investment in on what and how people eat would result in significant savings in curative healthcare. There would also be environmental benefits through waste re-cycling, plastic reduction and conversion of used cooking oil to biodiesel (RUO - Repurpose Used Cooking Oil). Bio-diesel from used cooking oil also supports import substitution and energy security. Finally, safe food and healthy diets under this programme would contribute to ease of living overall.
Figure 3.2: Policy and program framework to improve public health in the country

Each program has a unique space to contribute to the common goal of advancing public health – Eat Right Strategy to address food system challenges to improve public health and environment

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<tr>
<td>Improving Public Health in the Country: addressing its multiple challenges challenges:</td>
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<td>Policy frameworks to improve public health</td>
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<td>Major programs to improve public health</td>
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<td>All contribute to the common goal of improving public health and complement each other through different sets of services, reaching different target population.</td>
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Figure 3.3: Analysis of different program framework working to improve public health in India

<table>
<thead>
<tr>
<th>OBJECTIVES</th>
<th>SERVICES/ACTIVITIES</th>
<th>BENEFICIARIES</th>
<th>AREAS COVERED</th>
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<tr>
<td>Reduce under-nutrition, anaemia, low birth weight</td>
<td>Delivery of nutrition services at the frontline through the ICDS platforms, AWCs and ASHAs. Services include: • Supplemental feeding for pregnant &amp; lactating women and children (6-36 months) • Nutrition education and home visits • Immunization • Health checkups and referral</td>
<td>Pregnant &amp; lactating women • Children below 3 years of age</td>
<td>Rural, peri-urban populations, lower SES</td>
</tr>
<tr>
<td>Reduce IMR, MR, TFR</td>
<td>Main programmatic components include: • Health System Strengthening • Reproductive-Maternal-Neonatal-Child and Adolescent Health (RMNCH+A) • Communicable and NCDs</td>
<td>All citizens for universal access to equitable, affordable &amp; quality health care services</td>
<td>Covers both rural and urban population especially the vulnerable and disadvantaged population</td>
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<td>Prevention and reduction of anaemia in women aged 15–49 years</td>
<td>Intensive behaviour change activities at the grassroots level</td>
<td>Rural and Urban areas</td>
<td>Outreach primarily in rural areas through SBM (Gramin) and SBM (Urban) covers the urban areas.</td>
</tr>
<tr>
<td>Prevent and reduce mortality &amp; morbidity from communicable, NCDs</td>
<td>Aims to address food related aspects of public health - reduce foodborne illnesses, non-communicable diseases (overweight and obesity), micronutrient deficiencies through food fortification</td>
<td>All citizens (men, women, children, elderly) across all income groups.</td>
<td>Outreach to all population groups irrespective of age, sex &amp; SES; special platform for outreach to middle &amp; upper SES</td>
</tr>
</tbody>
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Chapter 4: Large Scale Change and System Leadership

In designing the program, FSSAI realized that it would need to go beyond the traditional standard setting and regulatory-only approaches of many developed countries and it took a different approach. Integrating food safety, public health nutrition, and environmental sustainability, the program goes beyond preventing unsafe food to proactively promoting safe, healthy, and sustainable food; creates consumer awareness and demand; works with industry, using a mix of regulatory, enabling, and capacity-building approaches, and goes beyond traditional food safety regulatory mechanisms in an effort to tackle the informal economy.

Initiatives

Eat Right India packaged complex elements into three simple themes that are easy to understand and remember: Eat safe, Eat healthy, and Eat sustainable. It developed a wide range of initiatives to reach its multiple audiences in a variety of ways. Among its initiatives are the following:

- To disseminate its messages, it engages networks of research and academic institutions, consumer organizations, and professionals in food and nutrition.

- To enhance citizens’ knowledge of the basics of food safety and nutrition, it developed a toolkit, e-courses, an online quiz, and materials for school children.

- It builds the capacity of food handlers at places of worship to adopt and maintain food safety and hygiene; enables the collection of used cooking oil for conversion to biodiesel fuel; and reduces food waste by connecting food business operators, surplus food distribution organizations, and people who need food.

- It works with street food vendors to raise the quality, hygiene, and safety of their food; and it provides hygiene ratings to food service establishments, empowering consumers to make informed choices when they eat out.

Potential for Large-Scale Change

Over the next five years, FSSAI intends to scale up Eat Right India across the nation, involving individual states and both broadening and deepening its initiatives. Mapping the key elements of Eat Right India to the Large-Scale Change Model developed by England’s National Health Service reveals that the program is well grounded in the 10 principles that underpin large-scale change.

1. It is moving toward a new vision, one that is not incremental but transformational.
2. It has identified and communicated key themes that people can relate to and that will make a big difference: Eat safe, Eat healthy, and Eat sustainable.
3. It involves “multiples of things”—that is, multiple stakeholders, agendas, points of view, needs and wants, details, and systems that need change.
4. To distribute leadership, it has framed the issues in ways that engage and mobilize the imagination, energy, and will of a large number of diverse stakeholders.

5. Its changes are mutually reinforcing across multiple processes and subsystems—that is, its many activities connect with others and allow audiences to receive its messages and participate in the movement in many ways.

6. The leaders of the program have continually refreshed the story, with constant framing and reframing of the vision and varied means of communication, attracting new and active supporters.

7. The program’s planning and designs has been based on monitoring progress and have been adapted in response to feedback.

8. It has been open to the contributions of many sources of leadership.

9. It has begun transforming mind-sets, leading to inherently sustainable change.

10. As the program moves forwards, it will be important to bear in mind the need to maintain and refresh the leaders’ energy over the long haul. Large-scale change can take time, and it is important that the leaders not run out of steam.

**Systems Leadership**

It is well understood that leaders play a key role in conceptualizing and driving change. A comparison of the key aspects of the leadership FSSAI has exerted in creating and launching Eat Right India with the elements highlighted in the Harvard Kennedy School’s Systems Leadership Model\(^2\) indicates that FSSAI has applied the essential skills:

- Understanding the system that shapes the challenge they seek to address;
- Catalyzing and supporting collective action among relevant stakeholders; and
- Listening, learning, and leading through coordination with and empowerment of others.

**Leading Systems Change**

The Systems Leadership Model further set out five key elements of the system change process. The FSSAI leadership has shown success in implementing the first two elements, Convene and Commit, and Look and Learn—that is, they effectively convened and engaged with a range of stakeholders, and they draw ideas and learning from many stakeholders and brainstorming sessions, getting perspectives from several quarters. They have demonstrated promise in the third element, Engage and Energize, by successfully engaging with and mobilizing a wide range of stakeholders. However, FSSAI has some way to go to show success in the two elements of Act with Accountability and Review and Revise: it will be crucial to establish and agree on frameworks for mutual accountability for results in pursuit of the larger goal, and to establish systems for “review and revision.”
Areas for Further Attention

The analyses clearly bring out that Eat Right India has made a very promising start. Although it is a relatively new initiative, its vision, design, and early implementation reflect all the elements of large-scale-change and a systems leadership approach. Thus, it has the potential to bring about sustainable change. At the same time, it has a long and challenging journey ahead. Several points will need attention as Eat Right India is scaled up. Leadership development efforts will need to be designed, implemented, and institutionalized at all levels—national, state, and local. For rapid scale-up, it will be important to get states on board and to develop systems to build their capacity and share new developments, tools, and resources.

- To institutionalize the change, it will be important to give attention to establishing relevant policies (central and state), realigning organizational structures at FSSAI and its regional offices and at state health departments, and establishing accountability systems for collective action.

- FSSAI should set up platforms with defined structure, function, and resources to fulfil the national and international learning needs and the knowledge creation and exchange needs of Eat Right India. Linkages and partnerships with national and international schools and universities could add value to the research and learning from Eat Right India.

- Eat Right India needs to develop a comprehensive conceptual framework for knowledge management, including a strong monitoring and evaluation system. Specifically, a state-of-the-art management information system to meet the monitoring needs of Eat Right India and a dashboard to monitor progress and share it widely with all stakeholders will be key.

Furthermore, periodic assessments and evaluations to determine the impact of current strategies and approaches and to inform future directions and improvements is important.

To ensure that resource availability matches the program scope and scale, FSSAI should undertake a full resource mapping and planning, including at the state level, and should urge/engage with/incentivize states to commit and allocate greater resources for Eat Right India. xiv I. Introduction

References


Chapter 5: Historical and Global Context

“How can you know where you are going if you don’t know where you have been”

Alfred D Chandler Jr.

Did you know that most of the food we see on the shelf of the supermarkets today, wasn’t available a 100-150 years from now? This was because there were very few techniques to preserve food. The food would spoil very fast and a lot of people suffered from food poisoning and even death. The food we eat today, is completely taken for granted because it is cheap and easily available.

The food you and I are eating today has been possible because of the efforts of a lot of scientists, researchers, engineers, food technologists and nutritionists - the food we eat is safe, nutritious and healthy. But the process of developing food was not invented overnight. In order to understand the historical and global context, it’s imperative to think like a historian and appreciate the dynamic nature of the food industry.

Preservation of food has been practised since early humans started farming. Early humans realized the fact that they could not always hunt for animals or pluck fruits from trees every day. And if they stored food commodities like meat, milk etc., they spoiled very fast. So, they had to develop some preservation techniques for consuming safe food even when they could not hunt, or when fruits and vegetables weren’t available.

Some of the earliest preservation techniques included sun-drying, smoking, freezing, salting, fermenting and pickling. The downside of the early preservation techniques was that they changed the flavour and texture of the food along with huge loss of vitamins most of the time. These techniques were not very effective for travellers and soldiers who needed a healthy diet.

In 1795, Napoleon offered 12,000 gold francs to anyone who could develop a method for preserving food for the military. The prize was won by a French confectioner named Nicolas Appert. He sealed food in a glass jar and then heated the jar, the time depending upon the type of food.

The invention of canning is considered as the major turning point in the history of food technology and food science. Nicolas Appert is also known as the ‘Father of Canning’ because of his remarkable contribution, and canning is sometimes referred to as ‘Appertization’. Although canning was successful but the science behind its success wasn’t known until 50 years later, when a French microbiologist and chemist named Louis Pasteur showed that growth of micro-organisms is responsible for the spoilage of beverages. He also invented a process where milk was heated to a specific temperature for a specified time to kill the spoilage micro-organisms.

The process he invented is still prevalent in the dairy industry and wine industry as well. In honour of Louis Pasteur, the process is known as ‘Pasteurization’. In 1895, almost 30 years later in Boston, Massachusetts, William Lyman Underwood from a canning company
worked with Samuel Prescott to develop the research which would further lead to the concept of ‘Thermal Death Time’. A lot of people don’t consider this event when it comes to the history of food technology, but this was also one of the turning points in history as their research was important to determine the time-temperature combination for a food. That means, for how long a food needs to be cooked and at what temperature.

Since then, a lot of research and discoveries were done but in the 20th century, food safety was still an issue. In 1960, the Pillsbury Company, NASA and the USA army laboratories collaborated to develop safe and healthy food for the astronauts. Eventually, they developed a systematic preventive approach to ensure food safety and that came to be known as ‘HACCP’ or Hazard Analysis Critical Control Point. HACCP is a preventive tool used in food industry to ensure safety of the food. HACCP is prevalent today in every food industry and food safety is incomplete without the implementation of the HACCP program. Since the development of HACCP, there has been rapid growth in the food technology. Industrialists have adopted newer technologies to process the food in a faster and efficient way.

Figure 1 demonstrates how the demands related to food have transitioned from staple foods to the overall wellbeing of the consumers. In the nineteenth and early part of twentieth century the consumer wanted food to simply satisfy hunger. Wars and famines plagued most parts of the world and there was a lot of food insecurity. As agriculture progressed and economies advanced in the twentieth century, the consumers now food secure, looked for variety in their food. The role of food changed from merely satisfying hunger to providing pleasure. A lot of processed, ready to eat and convenience foods made their way into the market. It was only in the twenty first century that health, wellness and nutrition gained ground as the criteria for food selection. This was also the period when people understood the relation between exponential rise in the incidence of non-communicable diseases and diet. The future demand for food is projected to be centred on wellbeing.

![Figure 1: Eating to Promote Wellbeing](image)

*Source:* Brabeck-Letmathe, 2016
During the 1950s, India also underwent a transition in terms of technological advancements. The years from 1951 to 1964 were those of maturity and achievement. A look at landmark developments of the era would paint a picture.

A major achievement was in the field of scientific research and technological education. In 1950, CFTRI (Central Food Technological Research Institute) was set up in Mysore as a constituent laboratory of the Council of Scientific and Industrial Research, New Delhi. By 1964, the two-year M.Sc Food Technology course commenced with the establishment of International Food Technology Training Center (IFTTC).

Additionally, processed food products entered into the Indian market as the food production began shifting from home to the factory. Some of the companies set up in the late nineteenth and early twentieth century, can be considered as the torch bearers for the evolution of the food industry in India. One such example is that of Britannia which was established in 1892 in Kolkata. The first product they made were biscuits mainly for the British families. The company today is a market leader in several product categories. Bikanervala is another such company which was set up in 1905 in a town called Bikaner. It is now a household name for sweets and snacks in India and indeed an international brand. In 1924, another popular household name, MTR Foods was set up as a restaurant. They later diversified their business into convenience foods and instant mixes. In 1925 Keventers, the milkshake brand, was established in India. After a shutdown in 1970, the brand has received an overhaul by young entrepreneurs.

Parle Products, established in 1929, started as a single confectionery brand named ‘Orange candy’. It is now a large food company dealing in a number of products like biscuits, cakes, rusks, chocolates, snacks and staples. Kissan was the first brand in vegetable and fruit processing in India which came up in 1934. It is now a market leader in Jams and ketchups. In 1946, the first Dairy Cooperative – Amul was established in India. Amul spurred India’s white revolution making the country the world’s largest producer of milk and milk products. Several other companies have since come up and contributed to the growth of the food processing and manufacturing sector in the country. The Ministry of Food Processing Industries has mentored entrepreneurs and food businesses to increase production as well as innovate. The scheme of Mega Food Parks provides a mechanism to link agricultural production to the market. They typically consist of supply chain infrastructure including collection centres, primary and central processing centres, cold chain and have provisions for entrepreneurs to set up food processing units.

The Indian Standards Institution (Certification Marks) Act was legitimized in 1952. The scheme was formally launched in 1955-56 and enabled to grant licenses to manufacturers who produced goods in conformity to Indian standards. Around the same time, Fruit Products Order (1955) was promulgated under Section-3 of the Essential Commodities Act. The Prevention of Food Adulteration Act was passed in 1954 as a central legislation to address ‘food adulteration’.

Mandatory fortification of hydrogenated vegetable oil (Vanaspati) began in 1953. In the next few years, a community based controlled trial was initiated in Kangra Valley. The study period was approximately 16 years (1956-1972) and observed goitre prevalence amongst 100,000 school aged children. As a result, the National Salt Iodization programme was started in 1962. This was a classic case of research based policy planning culminating into a nationalized programme to address iodine deficiency.
Despite the existing challenges with agricultural productivity and food insecurity, India witnessed remarkable developments in allied fields of food science innovation, strengthening of academic capabilities and regulatory framework. In the 1960’s, many illustrious institutions came into existence for example, Defence Food Research Laboratory (1961); Paddy Processing Research Centre (1967) to name a few. The impetus on food exports was strengthened with the passing of Export (Quality control & Inspection) Act (1963) by Ministry of Commerce and Industry. Furthermore, India gained global recognition by becoming a member of Codex Alimentarius Commission in the year 1964. The first wave of Green Revolution began in the 1960s and was largely confined to ‘wheat’ and the northern most parts of the country. This laid the foundation of self-sufficiency in crop production many years later.

‘Necessity is the mother of all invention’ implying that the primary driving force for all inventions is a need. The next couple of decades saw an evolution of consumer needs, opening and deregulation of markets, enhanced scientific and technical understanding within the food and nutrition domains, growing regulatory complexities and challenges. During this journey, many crucible moments altered the face of regulatory ecosystem in India and paved way for the Food Safety and Standards Act of 2006. This includes (but is not limited to) the Behala oil tragedy (1988-90), Delhi epidemic dropsy disaster (1998), Pesticides in carbonated beverages and bottled water (2003).

As we reflect on the past, it dawns on us that there are many factors that go into making national food law and a food regulatory ecosystem. A sampling of these factors includes history, culture, traditions, international obligations, institutions, political commitment, resources and social norms. The triggers for any transformational change often come in the form of public health issues and related constructive activism, domestic and/or international incidents, scientific developments, innovations and collaborative problem solving.

The future presents a myriad of complex challenges to address. On one hand we are bound to experience climate change, reduced agricultural productivity, scarcity of resources, rising population and a demographic shift to an ageing cohort, improved life expectancy and associated quality of life. While on the other, we would have to stay ahead of the curve when it comes to technological advancements, their applications as well as the related misuse including economically motivated malpractices.

The bottom line however is one cannot fix the symptoms in isolation without looking at the entire food ecosystem holistically. With this philosophy at its core, the ‘Eat Right’ textbook puts a magnifying lens at the multi-faceted and inter-linked dimensions of the food ecosystem. It allows the reader to reflect on the past, deliberate on the present and build a collective future.

References
Section 2: Eat Safe

6. Understanding Food Hazards
7. Safe Food at Primary Production Stage
8. Food Safety Law: Safe food from farm gate to plate
9. Safe Food Everywhere
10. Food Safety Risk by Food Categories
11. Regulatory Food Testing Ecosystems
Chapter 6: Understanding Food Hazards

- **Foodborne illness**
  - Extent of problem
  - Effect on health
  - Economic cost

- **Food hazards**
  - Types of hazards
  - Sources of food hazards
  - Adverse health effects
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- **Food allergies**
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Chapter 6: Understanding Food Hazards

‘If it is not safe, it is not food!’ Food nourishes our body and is vital for survival. If food becomes contaminated with substances that are harmful for our health, then it becomes unfit for human consumption. Such food can lead to debility, illness and even death. The public health impact of contaminated food is borne out by the facts that 1 in 10 people worldwide fell ill after consuming contaminated food in 2010 (WHO 2015). An understanding of the different types of food hazards, how they enter the food chain and how food can turn from being a source of sustenance to a health hazard is important for all. Equally important is to learn about how we can reduce our exposure to these hazards. Food allergens are another type of hazard present in foods. Severe reactions to certain ingredients in food can be fatal and hence one must be aware of foods which contain these allergens and understand how to avoid consuming them. One of the major sources of foodborne illness is contaminated water. Ensuring potable water for all is a challenge in a big country like India with a diverse geography. Sanitation has also been linked with the health status of the population as poor hygiene breeds infections and dilutes efforts being put in for providing safe and wholesome food for all.

Foodborne illness

Intake of food contaminated with microbes or chemicals can lead to illness and even death. Lack of adequate hygiene and sanitation is primarily responsible for food becoming contaminated with microbes. Chemicals may either be added intentionally to foods or may enter unintentionally because of poor agricultural or manufacturing practices. Food can become contaminated at any point during slaughtering or harvesting, processing, storage, distribution, transportation, preparation and consumption.

Extent of problem

In a report, WHO has provided the first-ever estimates of the global burden of foodborne diseases. The report presented the burden of foodborne diseases caused by 31 foodborne agents (bacteria, viruses, parasites, toxins and chemicals) at the global and regional levels. An estimated 600 million, almost 1 in 10 people in the world fell ill after eating contaminated food and 4,20,000 died in 2010. Children under 5 years of age carry 40% of the foodborne disease burden, with 1,25,000 deaths every year. Diarrhoeal disease agents were the leading cause of foodborne disease burden in most sub-regions, causing 550 million people to fall ill and 2,30,000 deaths every year (WHO, 2015). In India most foodborne illnesses go unreported. Media reports outbreaks only if a large number of people are affected and usually these reports are only from urban areas. The analysis of Integrated Disease Surveillance Programme (IDSP) data from 2011-16 shows food-borne outbreaks constituted nearly half of all reported outbreaks in India (NCDC, 2017).

Effect on health

Unsafe food creates a vicious cycle of disease and malnutrition, particularly affecting infants, young children, elderly and the sick. Illness can result from consumption of food
which is contaminated with chemicals or microbes. Repeated episodes of illness can adversely affect the nutritional status resulting in a state of malnutrition. Malnourishment further brings down the immunity level making individuals susceptible to infections!

Food borne diseases can be of two types – food poisonings or food infections. **Food poisoning** is caused by the ingestion of toxins produced by a microbe, plant or animal or ingestion of a toxic chemical. **Food infection** is caused by the entry of a microbe into the body through ingestion of contaminated foods and the reaction of the body to them or to their metabolites. Infections are usually transmitted from person to person through the faecal-oral route. Poor personal hygiene, cross contamination from raw foods to cooked foods, touching food with bare hands, all facilitate transmission of microbes. Intoxications are more a result of inadequate cooking of foods and cooked foods being stored at room temperatures, allowing microbes to multiply and produce toxins. Intoxications can't be transmitted from person to person.

Most foodborne illnesses reported have been due to biological hazards. Microbes like bacteria, fungi, virus and protozoa have been implicated in different food borne disease outbreaks. Some are mild episodes with gastro-intestinal symptoms while others can be fatal.

A large number of chemical hazards in food could lead to illness and even death. People can be exposed to low levels of these chemicals over an extended period of time (chronic exposure) resulting in diseases like cancer, neurological disorders, etc. Acute outbreaks of chemical poisoning only occur when a large dose of the toxin has been consumed at a single time point or for a short while.

Foodborne illness outbreaks have been reported from several parts of the country for instance, when pesticides have been inadvertently used as a food ingredient during cooking. Symptoms have ranged from gastrointestinal (abdominal cramps, vomiting) to neurological resulting in death. Shellfish poisoning is another example of acute poisoning. Paralytic shellfish poisoning causes the most severe symptoms of all the shellfish poisonings. This is due to the presence of a toxin known as Saxitoxin. Within half an hour of consumption the initial symptoms of numbness and tingling in the extremities appear which soon spread to the whole body causing loss of co-ordination and inability to move, speech defects, nausea and vomiting. If the respiratory system is affected, it may lead to death. Pufferfish poisoning or blowfish poisoning is caused by Tetrodotoxin, a neurotoxin which is one of the most poisonous substances found in nature. Its consumption can result in death in as few as 20 minutes of ingestion. Mushrooms are also referred to as toadstools coming from the German word *Todesstuhl*, meaning death's stool. Symptoms of mushroom poisoning can include hallucinations, sweating and shortness of breath. Some varieties of wild mushrooms are highly poisonous and can lead to death.

**Economic cost**

Foodborne diseases impede socioeconomic development by straining health care systems, and harming national economies, tourism and trade. The economic consequences of a food borne illness are also massive involving money spent on medical treatment, decrease in work capacity due to weakness after a food poisoning episode and loss of man hours spent away from work. Foodborne diseases resulted in a burden of 33 million DALYs (Disability Adjusted Life Years) in 2010 (WHO, 2015). According to the World
Bank (2018), food borne diseases cost India about $28 billion (Rs1,78,100 crore) or around 0.5% of the country’s gross domestic product (GDP) every year.

Food supply chains now cross multiple national borders. Rejection of food exports as a result of contamination can lead to a huge loss of business. In 2010, there were 240 rejections of agrifood products exported from India by the European Union (EU) and 1023 rejections by the US. The fish and fishery products losses were estimated at 2 million US dollars and herbs and spices losses at 1.4 million US dollars in 2010 due to rejection by the EU (UNIDO, 2015).

Thus, to reduce the economic burden, India needs to invest in ensuring robust food safety systems.

**Food hazards**

A food-borne hazard is a substance or organism which can increase the risk of illness or adverse health effects when present in a food item. These hazards can be of different types.

**Types of hazards**

Food hazards can be classified as:

- Physical
- Chemical
- Biological

**Physical hazards** include items like straw, husk, chips of stones, bone, shards of glass, iron filings, etc. anything physically present in food which can cause damage to our teeth when we bite the hard substance or irritate/damage the gastrointestinal tract in case it is a sharp object.

Some foods like tea leaves and semolina (suji) are processed in between iron rollers. As a result, small iron filings scrape off the rollers and may get mixed with these foods. Unintentionally several harmful things may find their way into our food and drink like shards of glass from the mouth of a bottle or cup/glass, bits of plastic/porcelain from chipped cutlery, bits of straw or tiny stones in grains, etc.

**Chemical hazards** as the name suggests are chemical substances which may enter food via different routes and are harmful for our health. These include residues of pesticides, drugs administered to animals (veterinary drug residues), heavy metals, toxic chemicals naturally present in plants and animals, chemicals which leach out of packaging material or food contact surfaces and chemicals which get formed during cooking or processing.

If a crop has recently been sprayed with a **pesticide**, a suitable time gap should be given before the crop is harvested depending on how long it takes for the residues of the pesticides to dissipate. Pesticides even in small quantities can prove to be hazardous as our body finds it difficult to excrete them. These tend to accumulate in our bodies and have
been known to cause cancer, birth defects, liver damage, reduced sperm count, sterility, miscarriage and nerve damage.

A variety of veterinary drugs are used to raise and maintain livestock like antimicrobials to treat infections, hormones to stimulate growth or increase milk production etc. When treating livestock with any veterinary drug it is important to wait for a specified period of time till the drug residues are out of the animal’s system before milking or slaughtering the animal. Residue laden milk, meat and eggs especially antibiotic residues may result in the development of resistance to the antibiotic. Allergic reactions in sensitive people have also been reported. The food industry is also adversely affected as these residues interfere with the bacterial cultures used to make cheese, curd and other fermented products.

Metals like arsenic, antimony, aluminium, cadmium, chromium, copper, lead, mercury, nickel and tin released as untreated effluent by several industries, mines, or by volcanic eruptions, etc. into the seas and rivers or simply buried in soil can enter the food chain and lead to serious harm. Plants take up these metals from the polluted soil and water. Sea and river fish may get contaminated with the metals. Metals may also enter food from metallic cans and containers in which the food is packaged, stored or cooked. Acidic conditions in the food products may cause the surface layer of the containers to dissolve. Some of these metals, especially the heavy metals like mercury and lead can be very toxic. They can damage our vital organs like brain, liver, kidneys, etc. and seriously affect the nervous system.

A wide range of other chemical hazards can find their way into our food. Plastics are widely used in food processing equipment, utensils, and as packaging material. In their manufacture, numerous additives like plasticizers are used. In addition, the polymerization process may leave trace quantities of residual monomer or low-molecular-mass polymer in the plastic. Bisphenol A (BPA), phthalates and polychlorinated biphenyls (PCBs), used for making plastic equipment or plasticisers, coatings or lubricants, can leach out into food and water. They are very harmful for our body, affecting the action of natural hormones in the body (endocrine disruptors). They are also potentially carcinogenic (cancer causing). Dioxins are a group of chemicals which are persistent organic pollutants being formed as a by-product of industrial processes and can have a broad series of toxic effects. The production of toxic chemicals in foodstuffs through processing is a recently discovered phenomenon, for instance, formation of acrylamide, polycyclic aromatic hydrocarbons (PAH), advanced glycation end products (AGEs), heterocyclic amines, nitrosamines, etc. in food by traditional cooking methods at high temperatures such as baking, frying, grilling and roasting.

Foods also contain a wide range of natural chemical compounds which may act as toxicants or anti-nutritional factors which interfere with the way our body utilizes nutrients. The harmful effects of consuming these range from mild symptoms of gastric distress to even death. Some examples of naturally occurring toxicants are seafood toxins, biogenic amines, alkaloids and toxic amino acids. Shellfish poisoning, epidemic dropsy and lathyrism are some of the disease conditions arising out of consuming foods containing these natural toxins. Some of the chemicals which act as anti-nutritional factors are trypsin inhibitors, phytates, oxalates, tannins and cyanogenic glycosides. They interfere with the absorption or utilization of nutrients by our body. Sometimes chemicals are intentionally added to foods for a technological purpose like to impart colour and flavour to the food, to increase the shelf life of the food or to impart desirable texture to the finished food product. These chemicals are known as food additives and these can turn
problematic when they are consumed in large quantities as some additives like preservatives and colouring agents have been associated with allergic reactions in sensitive people. The malpractice of adding inferior quality ingredients and masking their use with the help of additives is also widely prevalent in India. These inferior quality ingredients are called **adulterants**, and at times can be very toxic mostly because of the use of inedible substances.

**Biological hazards** include microbes like bacteria, viruses, fungi, protozoa and helminths which can lead to several food borne illnesses (Figure 1).

![Biological hazards present in food](https://www.dpd.cdc.gov/dpdx/HTML/ImageLibrary/Trichinellosis_il.htm)

![Biological hazards present in food](https://commons.wikimedia.org/wiki/File:Ameba_002.jpg)

![Biological hazards present in food](https://commons.wikimedia.org/wiki/File:Coli3.jpg)

![Biological hazards present in food](https://commons.wikimedia.org/wiki/File:Norovirus_virions_white_background_NIH_21348.jpg)

![Biological hazards present in food](https://commons.wikimedia.org/wiki/File:Schimmelmandarijn.jpg)

**Sources of images:**

http://www.dpd.cdc.gov/dpdx/HTML/ImageLibrary/Trichinellosis_il.htm
https://commons.wikimedia.org/wiki/File:Ameba_002.jpg
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https://commons.wikimedia.org/wiki/File:Norovirus_virions_white_background_NIH_21348.jpg
https://commons.wikimedia.org/wiki/File:Schimmelmandarijn.jpg
**Bacteria** are single-celled organisms present all around us in the soil, water, dust and air as well as present in our body. Some bacteria are useful to man helping us digest food, synthesize vitamins, preventing the growth of bad microbes, and also helping in preparation of fermented products like *idli-dosa*, *dhokla*, etc. and beverages (wine, apple cider, etc.). Other bacteria however can be harmful. Consumption of food contaminated with bacteria and their toxins makes us ill. Some diseases caused by bacteria include typhoid, cholera, diphtheria, dysentery, etc.

**Mold** or **Fungi** are typically multicellular and filamentous. The mass of intertwined filaments growing on the surface of food is visible to the naked eye. Sometimes this may be coloured - green, blue-green, yellow, orange, pink, lavender, brown, gray, black, etc., the colour being used to identify the type of mold. Molds can be problematic for man and animals as some of them produce toxic substances known as **mycotoxins**. Aflatoxin, a mycotoxin, has been implicated as a cause of liver damage and cancer. Ergot alkaloids cause Ergotism, a disease with symptoms of nausea, vomiting, giddiness and sleepiness. Fumonisins have resulted in a fatal disease in horses and in humans it has been linked to cancer of the oesophagus.

**Yeasts**, which are unicellular fungi, can cause spoilage of food products for instance various species of the genus *Candida* lead to spoilage of butter, margarine and foods high in acid and salt. *Torulopsis* spp. ferments lactose and may spoil milk products.

**Viruses** can only be seen with the help of powerful microscopes like electron microscopes because of their minute size. They require living cells to grow and reproduce and hence sometimes are referred to as **obligate intracellular parasites**. Viruses cause diseases not just in humans but also plants, animals and other microorganisms. When not inside a cell, viruses exist as independent particles known as virions.

Several viruses have been known to cause diseases in humans. Viruses that infect our intestinal tract are shed in extremely high numbers in the faeces of infected individuals and current sewage water treatment practices fail to ensure the complete removal of these pathogens. We are exposed to enteric viruses through various routes: shellfish grown in contaminated waters, food crops grown in land irrigated with wastewater and/or fertilized with sewage, sewage-polluted recreational waters (like swimming pools, water rides in parks) and contaminated drinking water. These viruses cause a wide variety of illnesses in man like hepatitis A, gastroenteritis and poliomyelitis.

**Worms or helminths** live like parasites in their host which can be an animal or man. Some examples of worms which can cause serious illnesses in man are round worms, tapeworms, hookworms and threadworms. Several worms can get entangled and cause intestinal obstruction, which may need to be surgically removed. Proper cooking of food can destroy the eggs of the worm. Other preventive measures involve maintaining a high standard of hygiene especially when handling food.

**Protozoa** are single-celled organisms. The most important disease-causing protozoan is an amoeba called *Entamoeba histolytica* which causes amoebic dysentery. Faecal contamination of food (especially raw vegetables) and water aids in spreading infection.

Prevention of enteric infections lies in safe disposal of human excreta and simple hygienic practices of washing hands before eating or handling food and after a visit to the toilet. Food handlers whether at home or in the commercial setting like hotels and restaurants,
should be periodically examined for enteric infections and should also be educated about basic practices of personal hygiene.

Sources of food hazards

Waste from our homes, offices and industries (detergents, soaps, pesticides, discarded batteries, effluent of factories, heavy metals, etc.) is disposed daily either into our rivers and seas or buried on land. Smoke from industries as well as exhaust fumes from vehicles and machinery pollute the atmosphere. These toxic chemicals present in the soil, water and air are taken in by the plants and by land and marine animals. Animals feeding on these plants accumulate these harmful chemicals and hence the meat, milk or eggs we get from these animals gets contaminated. Man being on top of the food chain consumes both contaminated plants as well as animals (Figure 2).

![Diagram of the food chain](image)

**Figure 6.2: How the contaminants enter the food chain**

Adverse health effects

Symptoms are usually restricted to the gastrointestinal tract – nausea, vomiting, diarrhoea and abdominal cramps, but may also become systemic if the infection/toxin travels to other parts of the body, sometimes resulting in death (Table 1). Dehydration is a cause of concern especially in small children leading to a lot of deaths.
Table 6.1: Microbes associated with different symptoms of foodborne diseases

<table>
<thead>
<tr>
<th>Symptoms/ Toxic effects</th>
<th>Microbes implicated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhoea</td>
<td>Vibrio cholerae, Campylobacter spp., Bacillus cereus, Cryptosporidium spp., Entamoeba histolytica, E. coli, Giardia spp., Norovirus, Shigella spp., Salmonella spp. (non-typhoidal), Staphylococcus aureus</td>
</tr>
<tr>
<td>Enteric fever</td>
<td>Salmonella enterica Typhi and Paratyphi A</td>
</tr>
<tr>
<td>Septicemia/ sepsis</td>
<td>Listeria monocytogenes, E.coli, Staphylococcus aureus, Vibrio parahaemolyticus, Campylobacter</td>
</tr>
<tr>
<td>Meningitis</td>
<td>Listeria monocytogenes, Salmonella spp, Enterobacter spp.</td>
</tr>
<tr>
<td>Neurological symptoms</td>
<td>Brucella spp., Toxoplasma gondi, Taenia solium</td>
</tr>
<tr>
<td>Hepatitis (inflammation in liver)</td>
<td>Hepatitis A virus</td>
</tr>
</tbody>
</table>

A large number of chemical hazards in food could lead to illness and even death. Table 2 lists some of these chemicals and the possible toxic effects that they could produce. Although short term exposure to a large dose of these chemicals could lead to severe reactions and even death, the larger public health problem lies in effects of chronic toxicity. People are exposed to low levels of these chemicals over an extended period of time resulting in diseases like cancer, neurological disorders, etc.

Table 6.2: Toxic effects of chemical hazards

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pesticide residues</td>
<td>Cancer, birth defects, liver damage, reduced sperm count, sterility, miscarriage and nerve damage</td>
</tr>
<tr>
<td>Veterinary drug residues</td>
<td>Resistance to the antibiotic, allergic reactions, interference with the bacterial cultures which are used to make fermented foods</td>
</tr>
<tr>
<td>Heavy metals</td>
<td>Damage vital organs like brain, liver, kidneys, etc. and seriously affect the nervous system</td>
</tr>
<tr>
<td>Chemicals leaching from containers, equipment (BPA, phthalates, PCBs)</td>
<td>Hormonal disturbances (endocrine-disruption), potentially can cause cancer, reduced mental development and suppressed immune reactions</td>
</tr>
<tr>
<td>Chemicals produced during cooking/processing (AGEs, nitrosamines, acrylamide, etc.)</td>
<td>Increased oxidative stress and inflammation, potentially carcinogenic</td>
</tr>
<tr>
<td>Dioxins</td>
<td>Some of them are known to cause cancer in humans, have also been linked to severe effects on the brain, reproductive and immune systems</td>
</tr>
<tr>
<td>Naturally occurring chemicals</td>
<td>Konzo (paralytic disease from eating cassava), Lathyris (paralytic disease from eating khesari dal), Shellfish poisoning</td>
</tr>
</tbody>
</table>
Measures to reduce exposure

Food needs monitoring right from the level of the primary producer up to the end consumer to ensure safety. This approach is referred to as the 'farm to fork approach'. Most of the diseases are transmitted person to person by the faecal-oral route. Humans are a reservoir of infectious microbes and may be excreting millions of disease-causing bacteria and viruses. Due to improper personal hygiene practices, like not washing hands before handling food, or poor environmental sanitation like open defecation, these microbes excreted by carriers may reach others through food and water.

The principal means of prevention of outbreaks of food poisoning include prevention of contamination of the food. This is achieved by general methods of maintaining hygiene and sanitation.

At the farm level the farmer needs to follow good agricultural practices (GAP) so that food does not become contaminated with pesticides, mycotoxins and heavy metals. The dairy farmer or the animal rearer similarly needs to maintain his livestock/fish/poultry and adopt good veterinary practices (GVP) to avoid residues of drugs and other contaminants in his produce. Good manufacturing practices (GMP) at the secondary level of processing foods in the industry, go a long way in ensuring that food is free from physical, chemical and microbial contaminants. Tamper proof packaging, storage at appropriate temperatures and appropriate handling practices are important.

At the consumer level, personal hygiene plays a major role in the transmission of germs and perhaps is responsible for most of the food poisoning outbreaks. Dirty hands especially have been recognised as one of the most important sources of contamination. Sanitation of not just the kitchen and food storage areas but also surrounding areas is important. This is because pests from these areas can easily enter the kitchen bringing disease causing germs.

Keeping the environment clean is vital. This starts by choosing an appropriate location for the kitchen or food service establishment. The surrounding areas have to be clean with no garbage dumps, open drains or other sources of pollution in close proximity. The kitchen should be constructed in such a way that pests cannot gain entry through the walls, floor, windows or doors. Screens on doors and windows and traps in drains help to keep pests like rodents and insects out. There shouldn’t be any places which can harbour pests inside or outside the kitchen.

Special precautions need to be taken to reduce the exposure to chemical contaminants which will be dealt with in detail in the next chapter. In general purchasing food from trusted sources, thoroughly washing all foods like grains, fruits and vegetables before cooking and consumption, using appropriate utensils, containers for cooking and storing food and using appropriate cooking methods can help reduce different types of physical and chemical contaminants in our food.
Consumer Guidance: Formalin in Fish

Formaldehyde is not permitted to be added to preserve fish. Consuming fish adulterated with formaldehyde can be harmful for health as it may cause abdominal discomfort, vomiting, renal injury etc. Formaldehyde is water soluble and washing the fish thoroughly in water will reduce the content of the chemical. Cooking thoroughly at temperatures above 75°C also decreases the formaldehyde content as it is volatile. Consumers can also test for adulteration with formalin using the rapid detection kit 'CIFTest' developed by ICAR-CIFT. It is advisable to purchase the fish from reliable sources.


Food allergies

Some people show abnormal responses to certain foods ranging from breaking into a rash to breathing difficulties and even death. Let us understand how the same food which others can safely eat, can become a hazard for these individuals.

What is food allergy?

When the body's immune system overreacts to some specific foods it is termed as a food allergy. The substance to which the body reacts is referred to as an allergen. When an allergen is consumed, the body's immune system identifies it as a threat and counters it with release of antibodies. In most cases the allergen is a protein found in the offensive food.

Food allergies affect both adults and children. Prevalence of food allergy in preschool children in developed countries was reported as 10% and that in developing nations like India as 7% in a global survey (Prescott et al., 2013). With a population of more than a billion, such high prevalence rates would mean millions of people being affected and food allergy becoming a huge public health problem. Some estimates suggest up to 3% of Indians (mostly those under the age of 40) may already have food allergies. Around 30,000 emergency hospital treatments and 100 to 200 deaths per year could be attributed to food allergies. Up to 3 million Indians may have peanut allergy alone (Gazzola, 2010).

The allergic reactions can be triggered by ingestion of even minute quantities of allergenic food. The symptoms which may appear can be from mild to severe. Symptoms of food allergy include:

- Itching or swelling in your mouth
- Vomiting, diarrhoea, or abdominal cramps and pain
- Running nose, sneezing and watery eyes.
- Hives or eczema
- Tightening of the throat and trouble breathing
- Chest tightness as in severe asthma
- Hypotension
- Loss of consciousness, confusion, coma

Anaphylaxis - Anaphylaxis is a severe allergic reaction that is rapid in onset and may cause even death. Not all allergic reactions will develop into anaphylaxis. However, early signs of anaphylaxis can resemble a mild allergic reaction. These can quickly progress to life threatening symptoms such as-

- breathing difficulties
- trouble swallowing or speaking
- dizziness or fainting

Food intolerance happens when unpleasant symptoms (usually gastrointestinal) occur after eating a substance, which the body cannot handle because the digestive system does not produce sufficient quantities of an enzyme/chemical, which is needed to break down the food and aid digestion. A common example is that of lactose intolerance in which an individual’s digestive system lacks the enzyme lactase. Symptoms include bloating, diarrhoea and abdominal cramps. Lactose intolerance is distinct from allergy to milk proteins in which individual’s immune system may react to bovine milk proteins. Gluten is a protein found in cereal grains like wheat, rye and barley. People may develop an allergy to gluten and hence wheat.

Common food allergens

The foods that most often trigger allergic reactions include fish, shellfish, peanuts, tree nuts, eggs, milk, soy, and wheat. In infants the cow’s milk may cause allergic symptoms like bloating, diarrhoea etc. Early introduction of other foods in infancy may also be responsible for development of allergic reactions especially if there has been family history of some food allergy.

Lactose Intolerance

Lactose intolerance is common digestive problem where body is unable to digest lactose, or milk sugar found in milk and dairy products. Individuals suffering from lactose intolerance may experience symptoms like diarrhoea, flatulence, abdominal pain and/or abdominal distension. Lactose intolerance can be diagnosed with a breath or blood test. Lactose breath test is the preferred method as it is a non-invasive and simple method. It measures amount of hydrogen and/or methane in end expiratory breath. Patient is asked to breathe into balloon-type container. Then, asked to drink 25g lactose dissolved in 250 ml of water. Samples of breath are collected at set time intervals, hydrogen and methane levels are checked. Normally, very little hydrogen and methane are there in breath. Raised hydrogen and/or methane in breath indicates lactose intolerance. Limiting intake of lactose is the main treatment for lactose intolerance. Curd is usually better tolerated than milk. This is because the bacteria which ferment milk convert the lactose into lactic acid, performing the function of the missing enzyme lactase.
Managing allergies

Near about 40% of food allergies in children subside by the age of five years. As soon as a food allergy is identified foods having the particular allergen should be excluded from diet (elimination diet). Re-challenge (i.e. introducing the allergenic food again into the diet) after one year can be done as most of the allergies abate with time. Nuts, peanuts and seafood allergies are particularly persistent and can be re-challenged at 4 to 8 years interval.

Some allergies like from peanut and sea foods may cause anaphylaxis even on consumption of very small quantities leading to death. Individuals with a history of such allergies should observe caution while eating out and having packaged food. They should carefully check the food labels and ingredient information on the food products to avoid ingestion of food they are allergic to. According to the new regulations it will be mandatory for packaged food products to declare on their labels the presence of any ingredient which can cause food allergies.

Most Indian dishes are a combination of several ingredients. It is very important for people with allergies to be aware of the composition of dishes and avoid foods which contain allergens. They should also inform and alert the staff in restaurants so that the correct selection of dishes can be made. They should keep a note about their allergic condition on their person for medical help during emergencies resulting from inadvertent consumption of the allergenic food. In India many people are not aware about their allergies or food sensitivities. They need to be aware of these as an adverse reaction can be fatal.

Exposure to food antigens in early infancy is likely to lead to hypersensitivity. The risk of food allergy can be reduced by delaying the introduction of solid foods to an infant until after 6 months of age. Up till six months exclusive breastfeeding should be encouraged as mother’s milk is easy to digest and is tailor-made for the infant. Cow’s milk can however cause allergic reactions in sensitive infants.

Food allergy awareness among public, health officials and individuals involved in food processing is an important step towards prevention of adverse reactions. In order to manage allergen risks, manufacturers need to have a thorough knowledge of the allergenic ingredients and possible contaminants in a food product. Proper cleaning of equipment after using potential allergy causing foods should be done as to avoid unintentional contamination of other foods.

In schools, offices and colleges the canteens should clearly mention the ingredients of the dishes prepared. Anti-allergy medication should be kept in medical kits in these institutions to give first aid to individuals who accidently consume an allergen.
Gluten Sensitivity and Celiac Disease

Gluten is a protein found in wheat, rye and barley. Some individuals may show a heightened immune response to gluten. Celiac disease is a chronic inflammatory disorder of the small intestine triggered by consumption of gluten in genetically predisposed individuals. Symptoms include chronic diarrhoea, poor weight gain, growth retardation, irritability and damage to the lining of the small intestine because of which absorption of nutrients is adversely affected. People having this condition need to eat a gluten-free diet. They should read labels carefully and look for products labelled ‘gluten-free’. For any product to be declared gluten-free, it should have less than 20mg of gluten per kg. Hence the ingredient list should be checked before purchase to make sure there are no gluten containing foods. They should also avoid buying flour from local mills as these may have processed wheat at some point in time and there is a high risk of cross-contamination.

Source:

Water and sanitation

As already discussed in the previous sections, contaminated water is one of the most common sources of hazards and foodborne illness. Unclean environments are major contributors to physical, chemical and biological hazards. Inadequate water, sanitation and hygiene cause about 829,000 preventable deaths from diarrhoeal disease per year. Globally, 23% of all deaths could be prevented through healthier environments (WHO, 2019).

Drinking water includes water used for drinking, cooking and personal hygiene. People around the world drink water from a variety of sources. Health of the consumer is at a significant risk of getting affected by intake of water contaminated with microbes and toxic chemicals. Unsafe water is responsible for a large part of the burden of foodborne diseases. Poor sanitary conditions contribute to spread of diseases and add to the overall burden. Sustainable Development Goal 6 (SDG 6) aims to ensure availability and sustainable management of water and sanitation for all, and to eradicate open defaecation by 2030. Achievement of a number of other Sustainable Development Goals is dependent on the state of sanitation in the country and accessibility to safe drinking water.

As per the joint UNICEF-WHO Report (2019), 7 out of 10 people used safely managed drinking water services, 4 out of 10 used safely managed sanitation services and 3 out of 5 had basic handwashing facilities in 2017. There has been a 47% points reduction in open defaecation in India between 2000-2017 and 43% points increase in use of basic sanitation services.

Globally, billions of people live without access to even the most basic sanitation services. Inadequate management of sanitation systems puts billions of people at risk of infections and infestations. Diarrhoea is one of the leading causes of disease and death in the developing world. Part of the reason there is a lot of undernutrition in these countries is also because of communicable diseases which spread because lack of adequate sanitation facilities.
**Potable water**

Water is a scarce resource and an important basic necessity for human survival. The quantity of potable water on earth is limited and its availability per person is reducing day by day due to increase in global population and damage to the environment. In 2017, 90% of the World’s population used at least basic drinking water services, rising from 82% in 2000 (UNICEF/WHO, 2017). However, according to 2016 data, at least 2 billion people in the world drank faecally contaminated water. (WHO, 2019).

Access to safe drinking water was declared as a human right by the United Nations but remains a challenge for India. Depleting ground water, lack of proper rainwater harvesting and rising contamination in the ground water due to sewage and industrial effluent discharge is posing fresh challenges for the Indian cities, especially in low-income or resettlement colonies. While 5% of the total Indian population who are affluent depend on purified water and packaged or bottled water, over 95% of Indians still depend on free sources of water, some of which are unreliable. Lack of safe drinking water poses many health hazards such as diarrhoea, cholera, and typhoid, etc.

Adequate drinking water, sanitation, and hygiene are all essential ingredients to ensure good health. Proper wastewater management is also a basic prerequisite for environmental welfare and protection. Improving upon these services will bring long term economic gains by reducing the prevalence of infections and foodborne illnesses. These issues received attention in 2014 with Prime Minister Narendra Modi focussing on drinking water and sanitation in India and later launching the Swachh Bharat Mission that added further momentum and strength to the implementation of WASH (Water, Sanitation and Hygiene) facilities in the country. There is a move to strengthen implementation of regulations for drinking water, monitoring and surveillance of water quality and minimizing microbial and chemical contamination of drinking water by protecting water resources.

**Open defecation**

Sanitation is defined as ‘access to and use of facilities and services for safe disposal of human urine and faeces.’ However, the problem of open defecation is quite widespread in India. Open defecation refers to the practice whereby people go out in fields, bushes, forests, open bodies of water, or other open spaces rather than using a toilet to defecate.

Open defecation poses a serious threat to health. The lack of safe sanitation systems increases the risk of vector-borne diseases and helminthic infections and their consequences (Table 3). Diarrhoea is a major public health concern and a leading cause of disease and death among children under 5 years of age in low- and middle-income countries. More than 500 children under the age of five die each day from diarrhoea in India alone. UNSANITARY conditions have been linked with stunting which affects almost one quarter of children under-5 globally (UNICEF/World Bank, 2018).

Under the Swachh Bharat Mission there has been a massive drive to build toilets in rural and urban areas and to encourage people to use these. However, there are several reasons why people prefer to defecate in the open rather than use toilets. These include lack of facilities, or poor quality or unclean facilities, convenience, habit, lack of familiarity with toilets, limited awareness of health consequences, lack of water and the belief that a toilet inside the home makes the home impure (WHO, 2018).
Table 6.3: Health Impact of Unsafe Sanitation

<table>
<thead>
<tr>
<th>Direct Impact (Infections)</th>
<th>Indirect Impact (Consequences of infection)</th>
<th>Broader Well-being</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhoea</td>
<td>Stunting/Growth faltering</td>
<td>Poor pregnancy outcome</td>
</tr>
<tr>
<td>Dysentery</td>
<td>Impaired cognitive function</td>
<td>Absence from school due to repeated infections</td>
</tr>
<tr>
<td>Poliomyelitis</td>
<td>Anaemia</td>
<td>Antimicrobial resistance</td>
</tr>
<tr>
<td>Typhoid</td>
<td>Nutritional deficiencies</td>
<td>Decreased economic productivity and consequently poverty</td>
</tr>
<tr>
<td>Helminth infections</td>
<td></td>
<td>Need for privacy and security not met for women</td>
</tr>
<tr>
<td>Insect vector diseases (vectors breeding in faecally-contaminated waters) e.g. filariasis, Trachoma</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Good Practices**

Water treatment before distribution is vital to ensure that only safe drinking water reaches households. Pathogenic bacteria, viruses, protozoa and helminths may be present in drinking water and hence disinfection is essential. Water sources also need protection from chemical contamination and hence regulation of industrial effluents being released into water bodies and wastewater management are important.

Good sanitation is associated with improvements in health, including positive impacts on infectious diseases, nutrition and well-being. Key actions for improving sanitation begin
with preventing open defecation. This can be achieved not only by provision of safe and clean toilets for every household but also by creating a demand for these toilets. A social behavioural change needs to be brought in the community to motivate people to prefer and use toilets over open defecation. A monitoring and evaluation plan should always be a part of the program. Behaviour change programs are most effective when they target the determinants of behaviour. Safe toilets with adequate hand washing facilities also need to be provided in public places, schools and places of work. A safe sanitation system, designed and used to separate human excreta from human contact at all stages of the sanitation service chain from the toilet to final disposal, is needed in communities. In addition, wherever wastewater and excreta are used in agriculture and aquaculture, safe practices need to be ensured. Sanitation and hygiene need to be integrated in all health and nutrition related programs. SDG indicators related to WASH need to be monitored. WHO Guidelines (2018) talk about ensuring universal access to toilets and encouraging the use of toilets. Toilets should safely contain excreta at home, workplaces, schools, health care facilities and public places. Ensuring a safe sanitation service chain is crucial for safe disposal (Figure 3). Either the faeces is treated at source or sent to treatment plants from where it is safely disposed or the end product used in agriculture, etc.

Figure 6. 3: Sanitation Service Chain

Source: WHO, 2018

Safe sanitation is associated with improvements in health of a community. Positive impacts on incidence of infectious diseases, nutrition and wellbeing are the likely benefits of maintaining good sanitation. There is an urgent need to focus on the vulnerable age-groups and those left behind in order to achieve targets of universal access to drinking-water, sanitation and hygiene services. Efforts should be directed towards creating an enabling environment taking care of social, political and economic factors alongside infrastructure and governance.

The Jal Shakti Abhiyan (JSA) was a timebound, mission-mode water conservation campaign. The JSA ran in two Phases: Phase 1 from 1st July to 15th September 2019 for all States and Union Territories; and Phase 2 from 1st October to 30th November 2019 for States and UTs receiving the retreating monsoon (Andhra Pradesh, Karnataka, Puducherry and Tamil Nadu). During the campaign, officers, groundwater experts and scientists from the Government of India worked together with state and district officials in India’s most water-stressed districts for water conservation and water resource management by focusing on accelerated implementation of five target interventions. The JSA aimed at making water conservation a Jan Andolan through asset creation and extensive communication.

Know more about: https://ejalshakti.gov.in/JSA/JSA/Home.aspx
Summary

- Eating safe food is important for good health.
- Foodborne diseases have a major impact on health. Repeated episodes of illness can adversely affect the nutritional status resulting in a state of malnutrition. Foodborne diseases impede socioeconomic development by straining health care systems, and harming national economies, tourism and trade.
- A food-borne hazard is a substance or organism which can increase the risk of illness or adverse health effects when present in a food item. These hazards can be classified as physical, chemical or biological.
- Physical hazards include items like straw, husk, chips of stones, bone, shards of glass, iron filings, etc. anything physically present in food which can cause damage.
- Chemical hazards include a wide variety of chemicals which are either naturally present in plant and animal foods, or produced during processing of food, leaching into food from equipment and storage containers or entering as residues of pesticides, veterinary drugs or heavy metals.
- Biological hazards are microbes (bacteria, fungi, yeasts, protozoa and viruses) and their toxins as well as helminths.
- Food needs monitoring right from the level of the primary producer up to the end consumer to ensure safety. This approach is referred to as the ‘farm to fork approach’.
- Safety of food can be assured by proper handling, preparation, storage and consumption. Importance of personal hygiene and environmental sanitation cannot be overemphasized.
- Food allergens are also hazards which can lead to adverse reactions by the body like itching or swelling in the mouth, vomiting, diarrhoea, abdominal cramps, running nose, sneezing and watery eyes, hives or eczema, tightening of the throat and trouble breathing, drop in blood pressure, collapse, coma and even death (anaphylaxis).
- The foods that most often trigger allergic reactions include fish, shellfish, peanuts, tree nuts, eggs, milk, soy, and wheat.

Did you know?

According to UNICEF, One GRAM of faeces contains:

- 10,000,000 viruses
- 1,000,000 bacteria
- 1,000 parasite cysts

Child faeces contain more germs than adults’
Lactose intolerance is a common digestive problem where the body is unable to digest lactose, or milk sugar found in milk and dairy products.

Food allergies can be managed by affected individuals by avoiding foods likely to have the offending allergen.

Globally, 23% of all deaths could be prevented through healthier environments. Unsafe water is responsible for a large part of the burden of foodborne diseases. Poor sanitary conditions contribute to spread of diseases and add to the overall burden.

Open defecation poses a serious threat to health. The lack of safe sanitation systems increases the risk of vector-borne diseases and helminth infections and their consequences. A social behavioural change needs to be brought in the community to motivate people to prefer and use toilets over open defecation.

A safe sanitation system, designed and used to separate human excreta from human contact at all stages of the sanitation service chain from the toilet to final disposal, is needed in communities.

Key Terms

Anaphylaxis – a serious allergic reaction which is rapid in onset and can cause death

Food allergy – abnormal response to food triggered by the body’s immune response

Food hazard - a substance or organism which can increase the risk of illness or adverse health effects when present in a food item

Food Intolerance – hypersensitive reaction to food primarily due to difficulty in digesting the food

Open defecation - the practice whereby people go out in fields, bushes, forests, open bodies of water, or other open spaces rather than using the toilet to defecate

Potable Water – water that is safe to drink

Sanitation - access to and use of facilities and services for safe disposal of human urine and faeces

Sanitation service chain - includes the capture, storage, transport, treatment and disposal or reuse of human excreta and wastewater

SDG - Sustainable Development Goals are global goals adopted by Member States of the United Nations in 2015 with the aim to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030.

WASH - Water, Sanitation and Hygiene
Exercises

1. List the types of hazards which can be present in foods.

2. What are the different types of biological hazards which cause foodborne disease in humans?

3. Discuss briefly how foodborne diseases affect the economy of a country.

4. Comment on the sources of different chemical contaminants explaining how they enter the food chain.

5. Which foods are considered to be the most allergenic? How should people who are allergic or intolerant to certain foods, manage their diets?

6. Describe measures which can help reduce our exposure to food hazards.

7. What are some of the adverse health effects of consuming chemical contaminants?

8. Why is ensuring good water quality important for preventing food borne diseases?

9. Why is open defecation a problem?

10. What do you understand by ‘Sanitation service chain’. Outline some good practices which will help improve sanitation.

References

1. Food allergy. American Academy of Allergy, Asthma and Immunology


Chapter 7: Safe Food at Primary Production Stage

- **Pesticide residues**
  - Good Agricultural Practices
  - Integrated pest management

- **Veterinary drug residues**
  - Good veterinary practices
  - Monitoring

- **Heavy metals**
  - Bioaccumulation and Biomagnification
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- **Mycotoxins**
  - Types of mycotoxins and crops affected
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- **Feed control**
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  - Foods commonly adulterated
  - Health effects of adulterants
  - Prevention and Control
Chapter 7: Safe Food at Primary Production Stage

In the last chapter you learnt about the different physical, biological and chemical contaminants which may enter the food chain. Primary production of food includes harvesting, slaughtering and milking of animals. Physical contaminants like dust, stones, metal/glass shards, seeds, straw, husk, etc. could enter the food during these processes. Bacteria, viruses, helminths, fungi and mycotoxins could contaminate the food when adequate sanitation is not maintained during the production process or if the growing conditions of food crops favoured microbial contamination. Good hygiene practices are essential for the handling of animals and animal products otherwise it can lead to serious food borne illnesses. Residues of pesticides, drugs administered to animals (veterinary drug residues), heavy metals, and toxic chemicals naturally present in plants and animals are likely to contaminate food at the primary production stage. Contamination can also occur at later stages of production, storage and transport of foods. Contaminant chemicals can leach out of utensils or packaging material in which food has been kept. Some chemicals may get formed during the process of cooking or processing. This chapter describes in detail how these contaminants enter our food, how severe the problem of contamination is, and the good practices needed to keep level of contaminants in check at the production level.

Pesticide residues

Pesticides are chemicals used to protect food from pests, such as insects, rodents, weeds, mold, and bacteria. The use of pesticides has increased several-fold in India over the years. Residues of these pesticides persist in the environment as well as in food. Runoff water from fields can contaminate the water bodies in which it falls or the soil and ground water if it penetrates the surface. Residues of pesticides detected in different foods like cereals, pulses, fruits, vegetables and in drinking water are a result of poor agricultural practices at the farm level.

Use of pesticides which do not dissipate very easily creates further problems. The most persistent pesticides are termed “persistent organic pollutants” (POPs). These tend to accumulate in the food-chain. They can biomagnify (concentrate) in marine and land animals, as well as humans building up chiefly in the adipose tissue, leading to toxic effects in the body. Examples of POPs include mainly organochlorine pesticides, namely, aldrin, endrin, dieldrin, chlordane, DDT, endosulfan, lindane, hexachlorobenzene, etc.

Examples of chronic poisoning effects due to build-up of pesticide residues in the body may include- carcinogenicity (ability to produce cancer), mutagenicity (ability to cause genetic changes), teratogenicity (ability to cause birth defects), oncogenicity (ability to induce tumour growth), liver damage, endocrine disruption resulting in hormonal disorders, reproductive disorders such as reduced sperm count, sterility, and miscarriage, neurotoxicity (nerve damage) or development of allergies to pesticides or chemicals used in formulation of pesticides.
Exposure of either parent to pesticides before conception, or of the mother during pregnancy, has been associated with increased risk of foetal death, spontaneous abortion and early childhood cancers. Exposure within the womb is also associated with increased risk of growth retardation, low birth weight and congenital anomalies.

**Good Agricultural Practices (GAP)**

People applying the pesticide in the field are not aware about concentrations to use, frequency with which to apply, sometimes applying more than needed amounts in the belief that their crops will be better protected. They also lack the knowledge about the safest pesticide to use, and land up purchasing substandard pesticides which they may need to apply more of to get the desired effect. Or, they may purchase the more toxic varieties even though safer and more effective substitutes are readily available. Another reason for high residue levels in foods is the post-harvest treatment of grains, fruits and vegetables, before they are marketed. This is mainly done to prevent spoilage due to insects and microbes. Thus, to ensure good agricultural practices, the farmers and other users of pesticides need to be trained and sensitized to adverse effects of misuse. Every packet of pesticide should carry the relevant information in the local language. In addition, efforts must be made to reduce the use of these chemicals in agriculture.

**Integrated pest management**

Pesticides even in small quantities can prove to be hazardous for us as our body finds it difficult to excrete them. Thus, even if these are judiciously used by the farmers, small amounts tend to accumulate in our bodies and have been known to cause adverse health effects. Research focus is thus on other forms of pest-control. Non-pesticide dependent agriculture and integrated pest management (IPM) is increasingly gaining popularity. The UN’s Food and Agriculture Organisation (FAO) defines IPM as “the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.”

There are eight principles of integrated pest management according to the European Union (Figure 1). The first and foremost is to prevent or suppress pests by various techniques like crop rotation, balanced fertilizer use, adequate drainage and observing hygiene measures. The second principle is to monitor harmful pests using scientific tools. The monitoring data should be able to predict when food becomes vulnerable to pests. The system should have an inbuilt system to warn against pest infestations. The third principle is decision making which the professional needs to do about plant protection measures to apply when he receives a warning from the monitoring system. The fourth principle talks about using biological or physical methods of pest control where possible. The fifth principle states that if pesticides are to be used then the one selected should be the least harmful for the environment, humans and other animals. The sixth principle says that the quantity/frequency of pesticide used should be the minimal required to control the pest.
problem. The seventh principle states that appropriate strategies are needed to ensure that resistance to a pesticide does not develop in the pest. This could be done by using a variety of pesticides with different modes of action. The eighth principle is that the success of plant protection measures should be regularly evaluated. This can be done by monitoring the pests and relating this to the pest control measure used.

Figure 7.1: Principles of integrated pest management

1. Prevention
2. Monitoring
3. Decision making
4. Non-chemical methods
5. Pesticide selection
6. Reduced pesticide use
7. Antiresistance strategies
8. Evaluation

Biopesticides are living things or natural materials like animals, plants, bacteria and certain minerals or biochemicals which can be used for pest management. Biopesticides are less toxic than conventional pesticides. They don’t affect the environment adversely as they don’t persist in the environment and don’t affect other organisms. Microbes like fungi have been used to control weeds and insects. Strains of *Bacillus thuringiensis* (Bt) have been used to control insect larvae. Certain genetically modified plants may have the ability to produce proteins which are pesticidal. Beneficial nematodes have also been used to control insect and slug pests. Animals can also be used as predators to control the population of pests. Such measures can contribute towards reducing contamination of foods and the environment.
National Pesticide Monitoring System

The Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare had started a central sector scheme, "Monitoring of Pesticide Residues at National Level" (MPRNL) in food commodities and environmental samples during 2005-06 with the participation of various laboratories representing Ministry of Agriculture, Indian Council of Agriculture Research, Ministry of Health and Family Welfare, Ministry of Environment and Forest, Council of Scientific and Industrial Research, Ministry of Chemical and Fertilizer, Ministry of Commerce and State Agricultural Universities across the country. The objectives of the scheme include:

- To identify crops and regions having preponderance of pesticide residues in order to focus extension efforts
- To strengthen infrastructure at Quarantine stations to prevent entry of foods which have pesticide residues above maximum residue limit (MRL)
- Testing / Certification of pesticide residues in export / import consignments
- To test pesticide residues and other contaminants in food commodities and environmental samples like soil and water.

Source: http://agricoop.nic.in/sites/default/files/MPRNL%20Guidelines_0.pdf

Veterinary drug residues

Various types of drugs are used while breeding animals, fowl and insects like bees which provide us with food. Some are injected into the animal while some others are given orally-mixed in the feed. Some chemicals may be sprayed or applied on the animals. Residues of these drugs show up in the food derived from these animals like meat, milk, eggs and honey. Acute poisoning outbreaks attributed to veterinary drug residues have been reported in several cases. Those who ate veal liver contaminated with a steroid like drug called clenbuterol developed symptoms of tremor, headaches, abnormally rapid heart rate and dizziness in Lyons, France (Pulce et al, 1991). Similar acute outbreaks were seen in 1996 in Caserta, Italy and in 1992 in Catalonia, Spain which affected 113 people. Hormones have been used by the beef and meat industry for several years to improve growth or milk yield. There have been serious concerns about environmental contamination, particularly of drinking water, from faecal and urinary excretion of hormones by millions of cattle. Hormones in food and water have been linked to endocrine disruption in humans with increased risk of breast cancer and early puberty in girls. Diethyl stilbesterol (DES) which was earlier used to promote growth of cattle, is now banned as it was found to be a potent carcinogen.

Antibiotic residues can be problematic for persons allergic to certain antibiotics. These may also cause a potential build-up of antibiotic resistant organisms in humans. Chloramphenicol has been shown to induce aplastic anaemia in sensitive individuals. Nitrofurans and some sulpha drugs have shown the potential to cause cancer in experiments conducted on laboratory animals. These drugs have been mostly banned for use in food producing animals. When the microflora of our gut is exposed to low doses of antibiotics in the form of residues in the food that we eat (viz. meat, milk and eggs of
contaminated animals), it starts changing. This alteration of gut microflora may lead to
diseases and the development of resistant strains which cause failure of antibiotic therapy
in case of an infection. Anthelmintics (which get rid of worms e.g. tapeworms) and
antifungal medicines also cause a serious ecological problem with their residues being
detected in the soil, besides the meat and milk.

**Good veterinary practices**

Numerous scientific bodies and regulatory agencies have looked at the issue of residues of
hormones coming into the milk and meat meant for human consumption. Most of them
have concluded that if good veterinary practices are followed, then drug residues wouldn’t
pose a significant risk to health. It is important therefore to consult a veterinarian before any
drug is administered to livestock. This ensures that the appropriate drug is prescribed in
the right dosage. The veterinarian can also advise about the appropriate time gap to be
given between administering the drug and milking or slaughtering the animal to avoid high
residue levels in the food products. This time gap is referred to as the withdrawal time or
period during which the drug gets metabolized in the animal’s body and the residues are
excreted from the body so that these do not linger in the meat, milk or eggs of the animal
when slaughtered for consumption. Due to mass production of milk, meat and eggs, use of
drugs has become a necessity. Maintaining good hygiene and sanitary conditions in farms
is of primary importance to reduce the use of these drugs to a minimum.

**Monitoring**

In India, the Food Safety and Standards (Contaminants, Toxins and Residues) Regulations,
which came in to force on 5th August, 2011, deals with compliance to standards set for
various contaminants, toxins (microbial and naturally occurring) and residues (of
pesticides, veterinary drugs and other pharmacologically active substances) in food.
FSSAI specifies the tolerance limits for antibiotic residues in sea foods like shrimps,
prawns, fish and fishery products. The responsibility for residue control is not solely that of
the government. The responsibility should be shared by producers, marketing co-
operatives, veterinarians, scientists and all those involved in the industry. Drug
manufacturers are required to provide tissue residue and depletion rate data for all new
drugs. They also need to provide a method to detect the residues in tissues so that
monitoring can be done effectively.

Concerns over drug residues in food are not limited to public health. They can have serious
economic consequences as well. Antibiotic residues present in milk intended to produce
cheese or other fermented milk products, may interfere with the fermentation process by
adversely affecting the bacterial or yeast cultures. This would result in subsequent
economic losses to the food industry. Every year several consignments of seafood, honey,
meat and meat products, etc. are rejected due to detection of veterinary drug residues by
USA and the European Union. Hence it is in everyone’s interest to address this problem and
work towards a solution.
Heavy metals

Metals contaminate our foods when factories throw their waste products into the seas and rivers or bury their wastes before appropriately treating them. Smoke from industries as well as exhaust fumes from vehicles and machinery pollute the atmosphere with the particulate matter ultimately settling down on plants and soil not only in the vicinity but places further away as well due to widespread dispersion by wind. Food grown in contaminated soil or using contaminated water (especially raw sewage water/sludge), or even in the vicinity of polluting industries tends to be high in heavy metal content. Similarly, fish and other seafood from contaminated water bodies have heavy metals in them. The heavy metals in soil tend to contaminate the ground water as well.

Lead emissions are from road transport, cadmium emissions are mainly from tobacco smoke, fuel combustion and metallurgical operations, and mercury emissions are related to coal consumption. Metals may also enter food from metallic cans and other containers in which the food is cooked, stored or packaged, especially if the food is acidic in nature. Poor quality tin coating or improper tinning of brass vessels can result in tin and copper leaching into the food cooked or stored in the vessel.

Heavy metals like lead, cadmium, mercury and arsenic can cause a lot of damage to human health. Other heavy metals noted for their potential toxicity, include nickel, copper, zinc, silver, tin, and antimony. These metals are not readily excreted from our bodies and so keep getting deposited in different tissues and organs of the body. Concentrations of these heavy metals in blood, hair, nails and urine have been used as biomarkers of exposure. Contamination of drinking water with inorganic arsenic is a major problem in some parts of India especially States like West Bengal. Several surveys in India have detected high levels of lead in different foodstuffs, in drinking water and in seafood. The gastrointestinal uptake of lead from food is high. Also lead can easily cross the blood-brain barrier in children thus leading to neurotoxic effects. There may be a link between heavy metals (like lead, mercury, zinc, copper, arsenic) and autism, and aluminium and Alzheimer’s disease as these heavy metals can be neurotoxic.

Bioaccumulation and Biomagnification

As it is difficult for the body to excrete heavy metals, these tend to over time, accumulate in the body tissues of not just humans but also animals (bioaccumulation). Contamination of fish with methyl mercury is a big problem due to industrial effluents being dumped into rivers, seas and oceans. In fact, fish consumption strongly predicts mercury levels in the body. Large old predators like sharks and pike, or scavengers like halibut, hold the greatest concentrations of mercury as they have fed on several contaminated fish which have in turn fed on contaminated plankton, krill etc. The higher the fish in the food chain, the more mercury it tends to have and this process is referred to as biomagnification (Figure 2). In plants, green leafy vegetables with large leaves tend to accumulate more heavy metals than the ones with smaller leaves. Certain plants tend to bio-accumulate heavy metals from the soil or water more than the others.
Ensuring safe waste disposal

Unlike organic pollutants, heavy metals do not decay and thus pose a different kind of challenge. Extensive research has shown that certain plants or microorganisms can be used to remove some heavy metals such as mercury. These plants can hyper-accumulate the heavy metals from soils by concentrating them in their bio matter.

Use of lead in petrol has decreased over the last few decades, phasing out of the remaining uses of lead additives in motor fuels should be encouraged. Similarly use of lead in paints, food containers, glazing should be banned to reduce exposure to this toxic heavy metal.

Exposure to arsenic is mainly via intake of food and drinking water. According to a study, folic acid (a type of B vitamin) supplementation may reduce the risk of arsenic-related
adverse health outcomes (Gamble et al, 2006). Folic acid helped in the methylation of arsenic and decreased excretion of the inorganic form which has been linked to skin and bladder cancers and peripheral vascular disease. A study in Bangladesh (Freeman, 2009) has indicated that improved nutritional status could constitute a key strategy for reducing the risk of arsenic-related diseases especially in children. Itai Itai disease in which cadmium accumulates in the bones is also seen more in people who in addition to being exposed to excessive cadmium, consume a diet low in calcium and have poor vitamin D status. Thus, having a nutritious diet can protect us from the toxic effects of heavy metals.

Avoiding farm produce grown in contaminated soil, choosing smaller fish to consume and green leafy vegetables with small leaves can also help to reduce our exposure. Utensils made of only good quality alloys should be used. Cheap alloys may leach out more metals when in contact with food materials being stored or cooked in it. Other measures of reducing exposure would include a crackdown on polluting industries, treatment of sewage/sludge to decrease the load of heavy metals, safe and responsible disposal of electronics and batteries, etc. which have heavy metal components and vigilance in monitoring heavy metal levels in the food and water of the population. Contaminated ground water should be treated before consumption. Scientists have been working on low cost technologies to decontaminate water at the household level, especially in rural areas.

FSSAI, the regulatory authority, specifies the maximum amount of heavy metals permissible in food. It is the work of the State Food Safety Departments to monitor levels in foods. For instance, lead in milk should be below 0.02 ppm, whereas in turmeric up to 10 ppm is permissible. Methyl mercury in any food should not be more than 0.25 ppm.

**Mycotoxins**

Fungi growing on food may produce toxins which are harmful to health. These are called mycotoxins. Diseases caused by the growth of fungus on a host are termed as mycoses (like athlete’s foot, ringworm, etc.) while diseases caused due to exposure to toxic fungal metabolites or mycotoxins is called mycotoxicoses.

**Types of mycotoxins and crops affected**

Mold growth is supported by a number of foods and hence mycotoxins have been detected in a variety of foods for human consumption, particularly cereals and nuts. Consumption of mycotoxin contaminated feed by animals can result in tainting of meat, eggs and milk. Some examples of mycotoxins are aflatoxins produced by the fungi *Aspergillus flavus* and *Aspergillus parasiticus*, ergot alkaloids produced by the *Claviceps* sp., Trichothecenes, Fumonisin and Zearalenone produced by the *Fusaria* sp. and Ochratoxin by *Aspergillus ochraceus* and *Penicillium* species. The crops may get contaminated with the fungus while still in the field or after harvest during the storage period. For instance, *Claviceps* affects cereals during the pre-harvest stages; *Fusaria* contamination generally occurs under the field conditions and persists during early storage; and, *Aspergillus* and *Penicillium* are typical storage fungi, infecting agricultural commodities due to improper storage. Infection with *A. flavus* can also occur in the field. Currently there are more than 300 known types of mycotoxins but the attention is usually focussed on the ones which are very toxic to us or those that are carcinogenic.
### Adverse effects

Aflatoxin is one of the most commonly detected mycotoxins in peanuts and products made from peanuts as well as a variety of cereal grains. It is toxic to the liver and has been recognised as a hepatocarcinogen (causing liver cancer). Consumption of cereal grains containing ergot alkaloids leads to symptoms of gangrene and convulsions. Deoxynivalenol and other trichothecenes found in cereal grains and some vegetables and other crops have been shown to inhibit protein synthesis in the body, haemorrhaging in the digestive tract and decreased bone marrow and immune function. In case of skin contact they have also caused dermatitis. Zearalenone has been toxic to the reproductive tract of animals, causing oestrogenic effects in farm animals. Ochratoxin A found in cereals, coffee, spices and dried fruits is a possible carcinogen. It has been shown to be toxic to kidneys. Patulin, found in apples, apple juice, cider, and other fruits, is an irritant to the stomach, causing nausea, vomiting and even ulceration in severe cases. It is genotoxic, neurotoxic, and known to cause reproductive toxicity. These are only some examples of the adverse health effects of mycotoxins.

<table>
<thead>
<tr>
<th>Aflatoxin M1 detected in Milk in India</th>
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<tbody>
<tr>
<td>The National Milk Safety and Quality Survey 2018 conducted by FSSAI revealed Aflatoxin M1 residues beyond permissible limits in 368 (out of 6,432) samples, that is 5.7% of the samples. Aflatoxin M1 comes in the milk through feed and fodder. Amongst the top three States with highest levels of Aflatoxin M1 residues are Tamil Nadu, Delhi and Kerala.</td>
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### Control and prevention

The world over, mycotoxin contamination of foods and feeds has led to significant health and economic impacts - loss of human life, cost of health care and in addition the losses incurred when farm animals or livestock are affected. This is especially a problem in India where farmers can lose their source of livelihood if their cattle or other livestock succumb to the toxic effects of mycotoxin contaminated feeds. High levels of contamination have been seen in certain food crops as well as feed due to poor agricultural and storage practices. In addition, the country has had to deal with huge financial losses due to rejection of shipments of foods by importing nations, due to unacceptable levels of mycotoxins.

As it is not always economically feasible to reject mycotoxin contaminated foods, maximum permissible levels are declared by regulatory authorities of countries. Levels of mycotoxins falling below these are unlikely to cause harm even if consumed for a long period of time. These levels however need to be monitored regularly to ensure that they do not exceed safe levels. Spread of awareness regarding harmful effects of mycotoxins as well as ways to prevent and reduce levels in food and feed is very important. FSSAI in India puts the limit for aflatoxin in different foods for human consumption between 10-15 ppb. For Ochratoxin A the limit is 20 ppb in wheat, rye and barley, 50 ppb for Patulin in apple juice and a 1000 ppb for DON in wheat. The European Union has the strictest maximum acceptable limit in the world (of 4 ppb) for aflatoxins in food for human consumption.

For reducing the amount of the mycotoxin in our food, simple measures like separating visibly mouldy grains, seeds and fruits from healthy ones, as well as washing before
consuming or processing them into food products, can go a long way. Processing and cooking of food seem to lower the level of mycotoxins in food for example, milling and cooking reduces aflatoxin levels in foods. However, processing and pasteurisation of milk does not completely destroy aflatoxin. Filtering unrefined oils also reduces mycotoxin levels especially if passed through adsorbents which bind toxins like aflatoxin. Binding agents like bentonite and aluminosilicate clays are also added to feeds to bind aflatoxin so that it is not available for absorption.

**Good nutrition tackles adverse effects of mycotoxins**

Some nutrients and phytochemicals have shown the potential to reduce the toxic effects of mycotoxins. These include - antioxidants like selenium, vitamins A, E and C, and fructose, phenolic compounds, chlorophyll and coumarins.

However, preventing the growth of the fungi by good agricultural practices and proper storage seems to be the more logical way of reducing the mycotoxin content of foods. Harvesting the crop early is known to protect crop from fungus which is known to attack standing ready crop especially if the weather is unpredictable. Deep ploughing of fields after harvesting and then planting a different crop not susceptible to the same fungus also helps in getting rid of infestations. Sorting, winnowing, washing, crushing combined with de-hulling of grains is effective in reducing mycotoxin levels.

Maintaining absolute cleanliness and sanitation of the storage area and controlling storage conditions go a long way in reducing contamination levels. Maintaining moisture levels below 10%, keeping temperatures low and or maintaining an inert gas environment helps as it discourages fungal growth. Mycotoxin levels could also be kept low by use of chemicals to control growth of fungi and insect infestation. A number of fungicides are used by the agricultural sector, although, there are several concerns with regard to pesticide residues in feeds and food as well as damage to the environment.

**Feed control**

From the discussion above it can be seen that several contaminants may enter the food chain through feed given to animals. Feed contaminants have been detected in the animal products like meat, milk, eggs, etc. Thus, it is important to look at the quality of feed that is given to livestock.

**Sources of contamination**

Environmental, agricultural, industrial, or other sources can contaminate animal feed and feed ingredients, causing serious adverse effects to animal and human health. Contamination can happen at any stage of the animal feed production system – harvest, manufacture, storage, or transportation. Mycotoxins, naturally occurring chemical hazards, heavy metals, pesticides and veterinary drug residues are the different types of contaminants detected in feeds. These may enter as a result of feed of animals being
treated with pesticides, low doses of veterinary drugs being mixed with feed to support growth of animals, feed grown on soil or using water contaminated with heavy metals and, other additives being mixed in feeds. Feed additives are products used in animal nutrition for purposes of improving the quality of feed and the quality of food from animal origin, or to improve the animals’ health. Feed if improperly stored can develop fungal and pest infestation.

Transmissible Spongiform Encephalopathies (TSEs) are a group of progressive degenerative conditions that affect the brain and nervous system of some animals and humans. TSEs are also referred to as prion diseases. Scrapie is a degenerative disease afflicting the nervous system of sheep and goats. In 1986, scientists first learnt that the disease was transmissible to another species. Cattle were being fed offal (intestine and internal organs), meat and bone meal from sheep and goats to increase the amount of protein in their diet. This probably resulted in the transfer of the infective agent causing cattle to develop Bovine spongiform encephalopathy (BSE) or ‘mad cow disease’. The disease was first reported in United Kingdom, and by 2006 the disease spread across international boundaries to more than 24 countries. The export of animal feed products made in UK to other countries had apparently resulted in the spread of the disease.

Quality control

The Feed Hygiene Regulation of the European Commission ensures that feed safety is considered at all stages. This has an impact on feed and food safety, including primary production. The registration of all feed business operators by the competent authority is compulsory. The Regulation tries to ensure that all feed businesses operate in accordance with harmonised hygiene requirements and apply good hygiene practices at all levels of agriculture production and use of feed. Hazard Analysis and Critical Control Point (HACCP) principles are used by feed business operators other than at the level of primary production. There are community and national guidelines for good practices in feed production.

In India, a new Regulation for Animal feed, Feed Additives and Pre-mixtures under FSS Act, 2006, has been formulated. It covers feed standards and hygiene requirements for feed ingredients, medicated feed, feed additives and pre-mixtures as well as specifies sampling and testing methods. Training content under FoSTaC has also been developed for training of feed safety supervisors working in processing establishments and for feed safety officers. Also, there is a module for third party audit of feed business operators.

Other hazards

Some toxins occur naturally in food stuffs. Several may be formed because of the way we process and package the foods during secondary and tertiary processing. Cooking normally destroys or decreases the amount of toxicants in foods. However, in some cases it may introduce new chemicals which are harmful for our health. Some of these have been discussed here highlighting the need to reduce human exposure to these toxic chemicals which can be carcinogenic.
Naturally occurring toxicants

Foods also contain a wide range of natural chemical compounds which may act as toxicants or anti-nutritional factors which interfere with the way our body utilizes nutrients. The harmful effects of consuming these range from mild symptoms of gastric distress to even death. Some examples of naturally occurring toxicants are seafood toxins, biogenic amines, alkaloids and toxic amino acids. Shellfish poisoning (due to toxins present in shellfish), epidemic dropsy (due to consumption of Argemone seeds or oil) and Lathyrism (due to a toxic amino acid in Khesari dal) are some of the disease conditions arising out of consuming foods containing these natural toxins. Some of the chemicals which act as anti-nutritional factors are trypsin inhibitors, phytates, oxalates, tannins and cyanogenic glycosides. They interfere with the absorption or utilization of nutrients by our body.

Produced during processing

A number of toxic chemicals are produced during cooking and processing of foods. Advanced Glycation End Products (AGEs) are produced when animal fats are cooked at high temperatures. They are also produced when plant foods are cooked to the point of browning or crisping. Animal-derived foods that are high in fat and protein are generally AGE-rich. These have been implicated in atherosclerosis as they increase oxidative stress and inflammation, and in aging of the skin (formation of wrinkles). Acrylamide is formed whenever foods that contain the amino acid asparagine and any reactive carbohydrate are heated at temperatures greater than 120 °C. Starch based foods like potato, bread, bakery products and breakfast cereals, cocoa based products and coffee are especially likely to contain acrylamide. Acrylamide causes DNA damage, neurological and reproductive damage, and is a probable carcinogen.

Heterocyclic Amines are formed from pyrolysis of amino acids and proteins at high temperature or when creatine and amino acids present in muscle tissues of animals are heated to high temperatures like during cooking of meat. They may also be formed during the Maillard reaction in which amino acids react with carbohydrates. These are mutagenic and carcinogenic. These may also be formed in plant-based foods when they are browned or charred. Nitrosamines are formed when nitrates or nitrites (preservatives added to processed meat/ fertilizers added to vegetables) combine with amino acids on exposure to high temperatures during cooking (e.g. grilling or frying). These preservatives are used a lot in processed meat products like sausages, bacon, ham, salami, etc. and hence it is undesirable to eat these foods as a part of the regular diet. Nitrosamines have also been detected in alcoholic beverages like beer, cheese, soyabean oil and canned fruit. Drying, kilning, salting, smoking or curing of food also promotes formation of nitrosamines. Nitrosamines have been shown to produce cancer in experimental animals. Polycyclic Aromatic Hydrocarbons (PAHs), are formed during grilling or charring of food especially meats. Food exposed to fumes of cooking oil or to smoke from the fossil fuels (wood, coal and oil) used for cooking may also contain these toxins. Cooking directly in contact with the flame also increases the PAH content.
Packaging and Storage conditions

Toxic chemicals may also migrate from the packaging/holding container to the food. Hence it is very important that the best quality materials be used for cooking, storing and packaging food. Several studies show that storing water and food in plastic results in migration of chemicals. Additives like plasticizers, antioxidants, catalysts, suspension and emulsifying agents, stabilizers and polymerization inhibitors, pigments, fillers, etc. are regularly used in the manufacturer of different types of plastics. These may leach into food and water stored in plastic containers. Bisphenol A (BPA) a component of polycarbonate used to make plastic bottles and also the epoxy-resin lining of metal cans, is a chemical which has been detected even in plain water stored in plastic bottles. BPA is an endocrine disruptor and its use has been banned in many countries especially in baby bottles and cups for children. Phthalates which make plastics more supple and bendable have also been known to leach out into food and beverages in contact with plastics. Food packaging material, tubing and other parts of processing equipment may all have phthalates which can leach out into the food products. Phthalates have also been identified as potential carcinogens and endocrine disruptors.

Tin, aluminium, iron/steel cans and containers may also leach metals into foods stored in them. Acidic foods generally react with metals. Inks used on the packaging for branding, printing the label information and barcoding may also leach out into the food product. Sterilization while food is there in the packaging using gamma radiation, steam, or ethylene oxide treatments, can cause leaching. Gamma radiation can break the carbon-chlorine bonds found in PVC plastics and some additives, forming breakdown products that can then percolate into food. Highly processed foods are likely to contain higher amounts of most of these chemicals. NHANES data from USA indicates that higher the consumption of fast foods by participants, the higher is the concentration of phthalate metabolites in their urine.

Some chemicals are also intentionally added to foods for a technological purpose like to impart colour and flavour to the food, to increase the shelf life of the food or to impart desirable texture to the finished food product. These chemicals are known as food additives and these can turn problematic when they are consumed in large quantities as some additives like preservatives and colouring agents have been associated with allergic reactions in sensitive people. These chemicals may become further problematic and produce other symptoms if misused like adding more than permitted. When additives are added in excess or to foods in which they aren’t permitted, it becomes a case of food adulteration.

Safe Cooking Practices Lower Levels of Contaminants

It is better to reduce consumption of foods cooked at high temperatures (e.g. by frying, grilling, and baking). One should refrain from eating foods that are cooked to a crisp, smoked, charred, or blackened, to reduce exposure to harmful chemical products like AGEs, acrylamide, heterocyclic amines, nitrosamines, and polycyclic aromatic hydrocarbons.

Cooking foods at lower temperatures (boiling, steaming temperatures) or eating some vegetables in the raw form will reduce exposure to most of these chemicals formed at high cooking temperatures.
Food adulteration

Buying food from reliable sources is also an important step towards ensuring that we consume safe food. This reduces the chances of the food being adulterated. Unscrupulous vendors may add inferior quality material or extract valuable ingredients from a food for economic gains. This not only decreases the quality of the food but can lead to serious health consequences if non-edible harmful ingredients are added to food.

According to the Food Safety and Standards Act, 2006 an adulterant is defined as “any material which is or could be employed for making the food unsafe or sub-standard or misbranded or containing extraneous matter”

Foods commonly adulterated

Adulterants have been detected in almost all kinds of foods - food grains and pulses, edible oils and fats, spices, milk and milk products, meat and meat products, beverages (both alcoholic and non-alcoholic), tea, coffee, sweetening agents like sugar, honey, jaggery and items made from these like mithai. Foods which are more likely to be adulterated include:

- Foods which are expensive - like edible oils, spices, etc.
- Foods which sell more like wheat flour, oil, milk etc. are foods consumed daily
- Foods which are perishable like milk and milk products
- Foods sold loose like milk, spices, etc.
- Foods in which it is easy to mix an adulterant like those in the form of powder, paste or mince.

Foods which are in a powder, minced or paste form are also more likely to be adulterated, as it is more difficult for the naked eye to detect adulteration in these foodstuffs. For instance, when buying minced mutton, it is difficult to tell which animal meat is being sold as goat meat, or similarly whether starch dyed yellow has been added to turmeric powder. Adulteration of foods sold loose by the retailer is also more common as compared to packaged foods as labels carry the name and address of the manufacturer or distributor and they can be caught by the regulatory authority if their food stuff is found sub-standard. Consumers should avoid buying foodstuffs sold loose even though these are cheaper.

Selecting Pure Spices

Ground spices are at a high risk of adulteration with coloured starch, straw, chalk powder etc. It is important to keep certain points in mind while purchasing these spices- Do not purchase loosely sold powdered spices as they are at a higher risk of being adulterated. Packets should be sealed properly and carry FSSAI license number and preferably AGMARK logo. Check the best before date. Do not purchase if the spices are too brightly coloured or have an extra shine.

Health effects of adulterants

Adulteration not only lowers the quality but may also lead to adverse health effects. There have been instances of death due to toxic substances added as adulterants to food. Chemicals like urea, sodium carbonate (washing soda, soda), sodium hydroxide (caustic soda), formaldehyde and hydrogen peroxide added to increase the shelf-life of milk, can damage the intestinal lining by irritating it. Use of the Lathyrus pulse to adulterate lentils (masoor) or toor dal or besan, can prove to be harmful. This pulse has a toxic factor, which is a neurotoxin leading to the crippling disease lathyrism. Mustard oil has been found to be adulterated with argemone oil which leads to symptoms of oedema, gastrointestinal disturbances, increased permeability of blood vessels, glaucoma, respiratory symptoms and congestive heart failure. Mineral oil (liquid paraffin) and castor oil, cheap inedible oils used as adulterants, may have a laxative effect with nausea, vomiting and possible damage to the lining of the intestine if consumed in excessive amounts or for a long period of time. Similarly, industrial dyes (like metanil yellow, sudan dyes, auramine, etc.) being used to colour food products have led to food poisoning outbreaks.

Prevention and Control

The Food Safety and Standards Authority of India (FSSAI) has been established for laying down science-based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import to ensure availability of safe and wholesome food for human consumption. FSSAI has also developed a simple, illustrated manual to detect common adulterants at home called DART - Detect Adulterants with Rapid Tests. This manual can be accessed from the weblink provided in the references. The simple tests include physical inspection of food as well as chemical reactions. For instance, artificially coloured pulse grains will leave a colour trail when immersed in a glass of water. Pure silver leaves will crumble to a powder when crushed between fingers whereas aluminium used as an adulterant on mithai (sweetmeats) is not that delicate and will leave shreds. If powdered spices are sprinkled on the water surface, pure spices will not leave any saw dust/powdered bran on the surface of water. In case one finds that any food item is adulterated, one must stop using the food product and report this to the authorities. State Food Authorities in addition regularly pick up samples and analyse them for quality and presence of adulterants. Food vendors selling adulterated food items are prosecuted as per the provisions of the FSS Act.

An efficient monitoring and surveillance system can help in ensuring that all food produced and sold for human consumption is safe from contamination and willful adulteration. Methods for reducing contamination of foods at the primary production stage should be actively used. It is also important to prevent contamination and production of hazardous chemicals in food during secondary and tertiary stages of production.
Summary

- Residues of pesticides, drugs administered to animals (veterinary drug residues), heavy metals, mycotoxins and toxic chemicals naturally present in plants and animals are likely to contaminate food at the primary production stage.

- Residues of pesticides detected in different foods like cereals, pulses, fruits, vegetables and in drinking water are a result of poor agricultural practices at the farm level.

- Pesticides even in small quantities can prove to be hazardous for us as our body finds it difficult to excrete them. Non-pesticide dependent agriculture and integrated pest management (IPM) is thus increasingly gaining popularity. Biopesticides i.e. natural materials like animals, plants, bacteria and certain minerals or biochemicals are being used for pest management.

- Various types of drugs are used for animals, fowl and insects like bees which provide us with food like meat, milk, eggs and honey. Residues of these drugs show up in the food leading to acute food poisoning outbreaks, increased risk of antimicrobial resistance and economic loss to the food industry which uses live cultures for production of fermented products. Hormones in food and water have been linked to endocrine disruption in humans with increased risk of breast cancer and early puberty in girls.

- Good veterinary practices need to be followed and appropriate withdrawal time period given before milking or slaughtering animals for consumption.

- Food grown in contaminated soil or using contaminated water (especially raw sewage water/sludge), or even in the vicinity of polluting industries tends to be high in heavy metal content. Similarly, fish and other seafood from contaminated water bodies have heavy metals in them. Metals may also enter food from metallic cans and other containers in which the food is cooked, stored or packaged, especially if the food is acidic in nature.

- Heavy metals like lead, cadmium, mercury and arsenic can cause a lot of damage to human health as it is difficult for the body to excrete them. Bioaccumulation and biomagnification are a serious issue. Higher the animal in the food chain, greater the heavy metal concentration in body and higher the risk of adverse effects. Safe waste disposal is the key to reducing contamination of air, soil and water.

- Fungi growing on food may produce toxins (mycotoxins) which are harmful to health. Some of these are potential carcinogens. Some examples of mycotoxins are aflatoxins, ergot alkaloids, trichothecenes, fumonisins, zearalenone, patulin and ochratoxin.

- Proper hygienic and controlled storage conditions and certain processing activities can reduce mycotoxin levels in food and feed.
• Environmental, agricultural, industrial, or other sources can contaminate animal feed and feed ingredients, causing serious adverse effects to animal and human health. Contamination can happen at any stage of the animal feed production system – harvest, manufacture, storage, or transportation.

• Transmissible Spongiform Encephalopathies (TSEs) are a group of progressive degenerative conditions that affect the brain and nervous system of some animals and humans. The spread of TSEs has been linked to offal from affected animals being used as feed for other animals. Quality and safety of animal feed hence needs to be monitored.

• Some toxins and anti-nutritional factors occur naturally in food stuffs while others may be formed because of the way we process and package the foods.

• Shellfish poisoning, epidemic dropsy and lathyrism are some conditions which develop as a result of naturally occurring toxic substances in foods. Some of the chemicals which act as anti-nutritional factors interfering with the utilization of nutrients by our body are trypsin inhibitors, phytates, oxalates, tannins and cyanogenic glycosides.

• Advanced Glycation End Products (AGEs), acrylamide, heterocyclic amines, polycyclic aromatic hydrocarbons and nitrosamines are formed when certain foods are cooked at high temperatures. One should refrain from eating foods that are cooked to a crisp, smoked, charred, or blackened, to reduce exposure to harmful chemical products.

• Toxic chemicals (like BPA, phthalates, inks, etc.) and metals may also migrate from the packaging/holding container to the food. Hence it is very important that the best quality materials be used for cooking, storing and packaging food.

• Unscrupulous vendors may add inferior quality material or extract valuable ingredients from a food for economic gains thus not only decreasing the quality of the food but also leading to adverse health consequences especially if non-edible harmful ingredients are used as adulterants.

• Foods which are expensive, have high sale value, are perishable, sold loose or sold in powdered, minced or paste form are more likely to be adulterated. One needs to be vigilant about the quality of food that is procured for consumption.

• The Food Safety and Standards Authority of India (FSSAI) has been established for laying down science-based standards for articles of food and to regulate their manufacture, storage, distribution, sale and import to ensure availability of safe and wholesome food for human consumption.
Key Terms

**Bioaccumulation** – is the gradual accumulation of a substance in the body over time resulting from faster absorption in comparison to the rate of excretion.

**Biomagnification** – also known as bioamplification is the concentration of toxins (like pesticides, heavy metals, etc.) in an organism at successively higher levels in the food chain.

**Biopesticides** - are natural materials like animals, plants, bacteria and certain minerals or biochemicals which can be used for pest management.

**Carcinogenicity** - ability to produce cancer.

**Endocrine disruptors** – are chemicals which interfere with the normal functioning of the hormones of the body producing adverse health effects consequently.

**Mutagenicity** - ability to cause genetic changes.

**Oncogenicity** - ability to induce tumour growth.

**Persistent Organic Pollutants** – are chemicals which are organic in nature and tend to persist in the environment as they do not dissipate easily. They have adverse health consequences.

**Teratogenicity** - ability to cause birth defects.

Exercises

1. Discuss why pesticide residues in food and feed are health hazards.
2. How do veterinary drug residues in food affect us? How will good veterinary practices help to reduce our exposure?
3. What do you understand by bioaccumulation and biomagnification? Discuss with reference to mercury levels in fish.
4. What are mycotoxins? Explain how we can reduce our exposure to mycotoxins.
5. Why is it important to monitor the quality of feed given to animals used for production of food for humans?
6. List some toxic chemicals which are produced during cooking/processing. How can exposure to these be reduced?
7. How can packaging introduce contaminants in our food?
8. What is food adulteration? Which foods are more likely to be adulterated?
Activity

Visit your local market or use the food stuffs in your kitchen for this activity. Download the DART book for testing adulterants in food. Select some basic spices like pepper corns, turmeric and red chilli powder, as well as milk and cooking oil. Perform the simple tests described in the manual to check the purity of the food items.

References

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Chapter 8: Food Safety Law: Safe Food from Farm Gate to Plate

Overview of food safety law and regulations

The Food Safety and Standards Authority of India (FSSAI) is an autonomous body established under the Ministry of Health and Family Welfare. The FSSAI has been established under the Food Safety and Standards (FSS) Act, 2006 which is a consolidating statute related to food safety and regulation in India.

Brief historical perspective - from PFA to FSS Act.

Till 1954, several food laws were in force in different States of the country. There was considerable variance in the standards and rules for food and its trade under these laws leading to interference in the inter-provincial trade. In 1950, the Constitution of India empowered the Central Government for making legislation on food adulteration, as the subject was included in the concurrent list of the Indian Constitution. Thereafter, a Central legislation called the Prevention of Food Adulteration (PFA) Act was enacted by Government of India in 1954 which came into effect in 1955. The Act repealed all laws existing at that time in States concerning food adulteration.

Subsequently, to control the manufacture, sale and distribution of a number of food products including enforcement of sanitary and hygienic practices of the establishments where these products were manufactured, the Government of India promulgated various orders under the Essential Commodities Act, 1955, which included:

- The Vegetable Oil Products (Control) Order, 1947
- The Fruit Products Order, 1955
- The Solvent Extracted Oil, De oiled Meal, and Edible Flour (Control) Order, 1967
- The Meat Food Products Order, 1973
- The Milk and Milk Products Order, 1992
- The Edible Oils Packaging (Regulation) Order, 1998

These orders were administered by different Ministries of Government of India and over a period of time, this led to a state of multiplicity of food standards (often overlapping and sometimes contradictory to one another) and enforcement agencies. This created confusion among food businesses, consumers, traders, manufacturers and investors and hampered the growth of a modern food processing sector in the country as well as fixation of safety standards. Realizing how inadequate these Acts and Orders were proving, the Prime Minister’s Council of Trade and Industry in 1998 recommended enactment of a comprehensive legislation of food subsuming all the present food laws to modernize the food sector and ensure safety of food. In 2004, the Joint Parliamentary Committee (JPC) emphasized that all the present food laws should be converged and there should be just one regulatory body for the whole of India. The Food Standards and Safety Bill, 2005 was passed by both the Houses of Parliament after extensive discussions, consultations with stakeholders and forging a consensus on contentious issues and received assent of the
President of India on 23rd August 2006. It was thereafter published in the Gazette of India (Extraordinary) Part I, Section 1 dated 24th August, 2006. The Food Safety and Standards (FSS) Act, 2006 repealed the PFA Act and all the six Orders stated above.

Objectives, Mandate and Scope of FSS Act and Authority

The objective of the FSS Act, 2006 is to make available safe and wholesome food to the public, in keeping with changing needs and requirements. The Act also aimed to establish Food Safety and Standards Authority of India (FSSAI), as the single reference point for all matters relating to FSS Act, Regulations and enforcement, by moving from multi- level, multi- departmental control to a single line of command.

The major areas of departure of FSS Act from PFA act are:

a. Food safety is the primary responsibility of the Food Business Operator (FBO) as he knows best how the food is manufactured and how safety can be compromised.

b. Risk assessment must form the basis of standard setting. The regulator needs to monitor the latest scientific development in the food sector, emerging safety issues across the world and anticipate safety risks before they actually hit.

c. FBOs at various stages in the food chain need to adhere to applicable safety and hygienic practices as contamination can occur at any point in the food chain. Certification of food safety processes or safety audits become important to ensure food safety.

d. Transparency in setting standards wherein stakeholders are provided with reasonable time to give suggestions on proposed regulations as well as sufficient time to FBOs to make necessary changes in their processes to adopt the new regulations.

e. FBOs have a clear means of contesting the findings of government food laboratories by appealing to accredited referral laboratories.

Two years later, FSSAI was established under the administrative control of Ministry of Health and Family. The mandate assigned to FSSAI is a) to develop science based standards for food and b) to regulate and monitor the manufacture, processing, storage, distribution, sale and import of food, so as to ensure the availability of safe and wholesome food for human consumption. The Food Safety and Standards Rules, 2011 were notified vide Gazette Notifications dated 5th May, 2011. Six principal regulations were notified and came into force on 1st August 2011 - Food product standards and food additives, Contaminants, toxins & residues, Packaging and labelling, Licensing and registration of FBOs, Prohibition and restriction on sales, Laboratory and sample analysis.

All kinds of food whether unprocessed/semi-processed/processed foods are covered under the scope of the FSS Act. It also includes all kinds of substances and water that is used in the preparation of food. It is important to mention that, the Act considers live animals or products of agriculture, horticulture or animal husbandry as food only when it has already passed on from the hands of a farmer. Thus, all activities throughout the food value chain, after primary production through distribution to retail and catering are under
the ambit of the Act. The Act does not discriminate between a small hawker or a huge FBO and makes it mandatory for everyone handling food to keep it safe and fit for human consumption. Therefore, this Act is applicable to every person who is in the food business.

**Organizational structure with Roles and Responsibilities**

Food Authority is the apex body under FSS Act, and a single reference point related to food safety and standards in the country. It comprises of a Chairperson and 22 members, of which at least one-third are women representing various relevant Ministries and Departments such as Agriculture, Commerce, Consumer Affairs, Food Processing, Health, Legislative Affairs and other stakeholders representing farmers, scientists & technologists, small scale enterprises and consumer bodies. The Food Authority is assisted by Scientific Committee and various Scientific Panels in setting standards of food products and by the Central Advisory Committee (CAC) in coordinating with enforcement agencies. State/District level steering committees assist, aid or advise on any matter concerning food safety in a State/UT.

The Chairperson and Chief Executive Officer of FSSAI are appointed by the Central Government. The CEO is responsible for the day to day administration of the Food Authority and draws up work programme of the Authority in consultation with CAC and is responsible for implementing the work programme and decisions of the food authority. The CEO exercises the power of Commissioner of Food safety while dealing with matters relating to food safety of such articles.

The governing structure of FSSAI is depicted in Figure 1.
The role of the Food Authority as prescribed under FSS Act is as under:

a. To specify food quality and safety standards and guidelines for food articles

b. To specify food labelling standards including claims on health, nutrition, special dietary uses and food category systems

c. To specify appropriate system of enforcement

d. To lay down methods of sampling, analysis and exchange of information among enforcement bodies

e. To lay down mechanisms and guidelines for recognition of accredited certification bodies engaged in FSMS auditing/certification.

f. To ensure quality control of imported food.

g. To provide scientific advice and technical support to central / state governments in matters of framing the policy and rules in areas relating to food safety and nutrition, in implementation of food safety crises management procedures, for improving cooperation with international organisations

h. To create an information network across the country to disseminate reliable and objective information on food safety and issues of concern including introduction of rapid alert system to all its stakeholders

i. To provide training programs in food safety and standards for persons who intend to become involved in businesses

j. Contribute and promote co-ordination of work on food standards undertaken by international governmental and non-governmental organisations.

Decentralized regulatory delivery (Centre vs State role)

India is a vast country with a population of over 1.3 billion and the sheer magnitude of food safety enforcement is a challenging task. The Food Authority and the State Food Authorities jointly share this responsibility. While the Food Authority provides policy intervention through notification of various food safety regulations and direction and coordination at National level, States/UTs conduct enforcement at the field level to verify compliance by FBOs to food standards. FSSAI provides support in the form of imparting training and capacity building of the enforcement staff of States/UTs. The Food Safety Authority in States/UTs is headed by the Commissioners of Food Safety for efficient implementation of FSS Act, Rules and Regulations made thereunder. All Commissioners of Food Safety are members of CAC. The CAC ensures close cooperation between Food Authority and State enforcement agencies. The CAC advises the Food Authority on its work programme, prioritization of work, identifying potential risks and pooling of knowledge. The organisational structure at the State level is described in Figure 2. Details about the testing labs and offices at the regional levels is given in Figure 3.
Figure 8.2: Organizational Structure at the State Level

Figure 8.3: Regional Laboratories and Offices
Other regulatory bodies dealing with food

**Bureau of Indian Standards (BIS)** is the National Standards Body of India, functioning under the aegis of Ministry of Consumer Affairs, Government of India for harmonious development of the activities of standardization, conformity assessment and quality assurance of goods, articles, processes, systems and services.

BIS has its Headquarters at New Delhi and 5 Regional Offices (ROs) which are at Kolkata (Eastern), Chennai (Southern), Mumbai (Western), Chandigarh (Northern) and Delhi (Central). There are 22 branch offices under the Regional Offices which offer certification services to the industry and serve as effective link between State Governments, industries, technical institutions, consumer organizations etc. of the respective region.

BIS is engaged in formulating Indian Standards in various technology areas and service sectors under the Bureau of Indian Standards Act, 2016 by a process of consultation involving Government and regulatory bodies, consumers, manufacturers, technologists, scientists and testing laboratories, through duly constituted technical committees comprising of Sectional Committees, Subcommittees and Panels which deal with specific group of subjects. In the Food and Agriculture sector, BIS has formulated over 2150 Indian standards covering food product and equipment specifications, test methods and hygiene codes covering the entire feed and food chain from farm to fork.

BIS does not make Technical Regulations. However, there are technical regulations which make compliance to BIS standards mandatory. Technical regulations are issued by various Departments/Ministries of Government of India.

BIS also operates a product certification scheme by which it grants licenses to manufacturers covering practically every industrial discipline. Though the BIS product certification scheme is essentially voluntary in nature, Government of India, in public interest (for example public health and safety, security, infrastructure requirements, mass consumption) has enforced mandatory BIS certification on various products through various Quality Control Orders or under Regulations issued from time to time under various Acts. In the food sector, FSSAI through the FSS (Prohibition and Restriction of Sales) Regulations, 2011, has made BIS certification mandatory for manufacture, sale and distribution of twelve food products for human consumption covering packaged waters, infant foods, milk powders and condensed milk.

The **Export Inspection Council (EIC)** is the official export–certification body of India which ensures quality and safety of products exported from India. The Export Inspection Council (EIC) functions under the Ministry of Commerce and has a mandate to ensure that products notified under the Export (Quality Control and Inspection) Act, 1963 meet the requirements of the importing countries in respect of their quality and safety.

This assurance is provided through certification of export commodities either by a consignment-wise inspection or quality assurance systems (in process quality control and self-certification) in the exporting units or through installation of food safety management in the food processing units. EIC has its 5 field offices ‘Export Inspection Agencies (EIAs)’ and a network of 30 sub offices backed by NABL accredited laboratories at various places. EIC provides mandatory certification for various food items namely fish and fishery products, dairy product, honey, egg products, meat and meat products, poultry meat.
products and meat by-products, feed additives and pre-mixtures, while other food and non-food products are certified on voluntary basis.

Agricultural and Processed Food Products Export Development Authority (APEDA) and Marine Products Export Development Authority (MPEDA) also function under Ministry of Commerce, Government of India. The main work of these Authorities is to promote the export, assure the quality of the product as per international standards, formulate the standards for export, etc.

APEDA is mandated with the responsibility of export promotion and market development of agricultural commodities and processed foods. The products under the purview of APEDA includes fresh fruits and vegetables, floriculture, processed foods, meat, poultry, milk and other livestock products, food grain, cereals, seeds and allied products. In addition, it has the responsibility to monitor the import of sugar.

APEDA has its Headquarters at New Delhi and 5 Regional Offices and 13 virtual offices which perform the functions of APEDA, make registration and financial assistance schemes etc. available to entrepreneurs / prospective exporters.

MPEDA regulates exports and market promotion of marine products outside India. It is mandated to take all measures required for ensuring sustained, quality seafood exports from the country including carrying out inspection of marine products, implementation of financial assistance schemes for infrastructure development for better preservation and modernized processing, fixing standards, specifications, and imparting trainings to fishermen, fish processing workers, aquaculture farmers and other stakeholders in the respective fields related to fisheries. MPEDA has its Headquarters at Kochi, Kerala and has 11 Regional Offices and 14 sub-regional divisions.

The Directorate of Marketing and Inspection (DMI) is an attached Office of the Department of Agriculture, Cooperation and Farmers Welfare under Ministry of Agriculture & Farmers Welfare. It was set up in 1935 to implement the agricultural marketing policies and programmes in the country with a view to safeguard the interests of farmers as well as the consumers. It implements the provisions of the Agricultural Produce (Grading & Marking) Act, 1937. Standards notified as per the provisions of the Act are popularly called AGMARK Standards. These standards differentiate between quality and 2-3 grades are prescribed for each commodity. Grades help farmers to get prices for agricultural commodities as per the quality produced by them and consumers get the desired quality. The DMI is implementing the scheme of certification of agricultural commodities for domestic trade and export. The Scheme is voluntary. For blended edible vegetable oils and fat spreads, certification under AGMARK is mandatory as per provisions in The Food Safety and Standards Act and regulations, 2006.
Risk Analysis

Risk Analysis is an internationally accepted and systematic approach to examine and assess public health and safety risks associated with food and to formulate, implement and communicate risk management decisions. Risk analysis is comprised of three interrelated components—risk assessment, risk management and risk communication.

It is widely recognized that risk analysis must form the basis for a food regulator in developing new food standards, evaluating proposed changes to existing food standards, for monitoring and surveillance activities, assessing new food processing practices, considering emerging food safety issues and ultimately help in taking necessary action.

Risk Assessment

Risk assessment – is the scientific evaluation of known or potential adverse health effects resulting from human exposure to food-borne hazards. The evaluation must be based on data which is of high quality, is credible and objective (e.g. toxicological studies, relevant human studies, laboratory-based studies, exposure studies, surveillance studies etc.). The process consists of the following steps:

Step 1 - Hazard identification: “Could this food or anything in it be harmful?” Risk assessors collect and review scientific data and identify biological or chemical hazards in food.

Step 2 - Hazard characterization: “What effects do the hazards cause?” Risk assessors evaluate scientific data to determine whether evidence is strong enough to demonstrate that a substance has the potential to cause harm and the nature of the harm.

Step 3 - Exposure assessment: “Who may be harmed and what level of exposure may be harmful?” Experts estimate how much of the food or ingredient consumers in general, population groups (e.g. infants, children, adults) or sub-populations (e.g. vegetarians, vegans) are likely to be exposed to under real-life conditions, where both dose and duration are considered. The exposure must be evaluated to determine if a hazard presents an actual risk (step 4). With increased exposure, the risk also increases.

Step 4 - Risk characterization: “How likely is it that people will be exposed at a level that can cause harm in real life?” The level of exposure that can cause harm is compared to the actual level of exposure that someone would experience in real life. If the exposure level is higher than that which causes harm, there may be a safety concern for consumers in general or for specific groups.

Risk Management

Risk management – is the process of weighing policy alternatives in consultation with all interested parties, considering risk assessment and other factors relevant for the health protection of consumers, and, if needed, selecting appropriate prevention and control measures.
A range of risk management options are available to FSSAI as risk managers for preventing or reducing health risks associated with food. These options can be regulatory i.e. those specified in the Regulations, such as end product standards or outcome-based standards or non-regulatory, such as industry codes of practice, guidelines or information campaigns. While taking such measures, the social and economic aspects are also considered in addition to the scientific risk assessment.

**Risk Communication**

Risk communication – FSSAI is responsible for risk communication, which is a two-way process and involves sharing the information internally with risk analysis team and with external stakeholders including general public in an open and transparent way including the explanation of risk assessment findings and the basis of risk management decisions. Risk communication is also important to help bridge the gap which sometimes exists between the scientific assessment and consumers’ perceptions of risk.

As per the Food Safety and Standards (Food Recall Procedure) Regulations, 2017, the Food Authority may publicise the recall when it is of the opinion that the public needs to be alerted about a health hazard or that clarification of the situation needs to be made to allay public worries. In cases of public health emergencies, the Food Authority may, depending on the available evidence, alert the public before a decision on recall has been reached.

The Food Authority is planning to establish a web-based facility titled ‘Food Recall portal’ on its website with a unique identification number assigned to each recall for monitoring and to provide information to the consumers about such recall.

FSSAI established a **Food Safety Knowledge Assimilation Network (FSKAN)** portal in 2017 for building a scientific community for collation of knowledge and expertise at one place and to provide an electronic forum for scientific consultation as well as exchange of scientific information and coordination of research activities across the country. These serve as a resource for FSSAI when required to be consulted for particular purpose related to food safety.

FSKAN has provided a platform for wider exposure of identified concern areas/ issues across various food sectors leading to a more synchronized and targeted research in the country, avoided duplication in research and also in formulation and execution of joint projects in areas where gaps or uncertainty in risk assessment for food safety exist. FSKAN has helped FSSAI in strengthening its capacity to manage food safety risks and ensuring rapid access to information during food safety events.

**Food standards – Ingredients and Additives**

The basic purpose of establishing food standards is protection of public health and risk, promoting fair trade in food, prevent misleading or deceptive products and enable
consumers to make informed choices by providing adequate information. It is important that such standards should be uniform nationally so that FBOs in all parts of the country have only one set of requirements to be complied with and hence a level playing field.

**Standard setting process**

The entire process of standard setting is carried out in a transparent manner involving all stakeholders. FSSAI has constituted scientific bodies, namely the Scientific Committee and subject specific Scientific Panels comprising of eminent independent subject experts/scientists. The Scientific Committee comprises of Chairpersons of all Scientific Panels and six independent experts, responsible for providing consistent opinion to Food Authority while harmonizing working methods of Scientific Panels. The Committee provides opinions on cross industry and sectoral issues and covers areas that are unique and not covered under the competence of the Scientific Panels.

The scientific risk assessment and setting of standards is carried out on the basis of latest developments in food science along with various factors like emergence of new additives, changes in processing technology, identification of new risks associated with metallic contaminants, residues of veterinary drugs, microbiological contaminants, nutritional aspects, advances in analytical methods etc.

Formulation of standards of any article of food involves several stages (Figure 4). After recommendation by the Scientific Panel and validation by the Scientific Committee, a standard is approved by the Food Authority and by Ministry of Health and Family Welfare. Thereafter, a draft notification is issued for inviting public comments for a period of 60 days. The comments received are then considered by the relevant Scientific Panel and after approvals of the Scientific Committee, Food Authority and the Ministry, the standard is finally notified as either an amendment to an existing regulation or a new/revised regulation.

![Figure 8. 4: Stages for Formulation of Food Standards](image-url)
Types of Standards

Food Standards can be broadly categorized into –

Horizontal Standards- Horizontal Standards cut across food categories and primarily relate to food safety covering limits for various contaminants (chemical and biological), toxins in food and also requirements for packaging, labelling and claims. These are covered under FSS (Contaminants, Toxins and Residues) Regulations, 2011, under Appendix B of FSS (Food Product Standards and Food Additives) Regulations, 2011 and FSS (Packaging and Labelling) Regulations, 2011.

Vertical Standards- Vertical Standards mainly include identity and compositional standards of specific food products and are covered under FSS (Food Product Standards and Food Additives) Regulations, 2011 and under FSS (Health Supplements, Nutraceuticals, Foods for Special Dietary Use, Foods for Special Medical Purpose, Functional food and Novel food) Regulations, 2016.

Harmonization

Harmonization of Indian food standards with global standards is one of the principles mandated under the FSS Act. Standards set by FSSAI are based on international best practices and all efforts are made to harmonize with Codex to promote international trade and higher levels of food safety. Wherever, suitable and appropriate, codex standards are considered for adoption with or without modifications provided they are in line with domestic industry and consumer practices.

Food Safety by Kind of Business

FSSAI recognizes that the responsibility for the supply of food that is safe, healthy and nutritious is shared along the entire food chain - by all involved with the production, processing, trade and consumption of food, as food can be contaminated at any step in the food chain unless effective controls are not put in place. This approach encompasses the whole food chain from primary production to final consumption and the stakeholders include farmers, food processors, transport operators, distributors (wholesale and retail) and consumers. One weak link can make the whole food chain collapse. This necessitates the adoption of practices in food production, post-harvest treatment, processing and handling that reduce the risk of microbiological, chemical and physical hazards from entering the food chain (or controlling at source, if feasible). There are some cases in which the hazard simply cannot be removed from foodstuffs, for example, those hazards involving chemical contaminants. The adoption of sound practices along the food chain – based on the principles defined in Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP) – are the keys to discharging this responsibility along the food chain.

Keeping this in view, FSSAI has laid down detailed sanitary and hygienic practices that should be followed by FBOs irrespective of their position in the food chain in order to ensure food safety. These practices are commonly called as Schedule 4 requirements (provided under Schedule 4 of FSS (Licensing and Registration of Food Business) Regulations, 2011). Compliance to these practices must be ensured by FBOs in the same way as compliance to standards of end product.
Schedule IV requirements and its significance

To provide assurance of food safety, FBOs should strive to implement an effective Food Safety Management System (FSMS) based on Hazard Analysis and Critical Control Point (HACCP) and suitable pre-requisite programmes by actively controlling hazards throughout the food chain starting from food production till final consumption.

Every licensed FBO must have a documented Food Safety Management System (FSMS) plan and is required to comply with Schedule 4 of FSS (Licensing and Registration of Food Business) Regulation, 2011. Schedule 4 introduces the concept of FSMS based on implementation of Good Manufacturing Practices (GMP) and Good Hygiene Practices (GHP) by food businesses and is divided into five parts as given in Table 1.

Table 8. 1: General Requirements under Schedule

<table>
<thead>
<tr>
<th>Schedule 4</th>
<th>General Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 1</td>
<td>General hygienic and sanitary practices to be followed by food business operators applying for registration - Petty food operators and Street food vendors</td>
</tr>
<tr>
<td>Part 2</td>
<td>General hygienic and sanitary practices to be followed by food business operators applying for license - Manufacturing/ processing/ packaging/ storage/distribution</td>
</tr>
<tr>
<td>Part 3</td>
<td>General hygienic and sanitary practices to be followed by food business operators applying for license - Milk and milk products</td>
</tr>
<tr>
<td>Part 4</td>
<td>General hygienic and sanitary practices to be followed by food business operators applying for license - Slaughter house and meat processing</td>
</tr>
<tr>
<td>Part 5</td>
<td>General hygienic and sanitary practices to be followed by food business operators applying for license - Catering</td>
</tr>
</tbody>
</table>

Recently, FSSAI has introduced a web-based real time inspection platform for FSOs called Food Safety Compliance through Regular Inspection & Sampling (FoSCoRIS). Based on the risk score of the food business the frequency of inspections is decided, and the inspections are allotted to FSOs by Designated Officers (DOs) through this application, making the application transparent and efficient. This platform enables verification of physical inspection taking place with features like geotagging, time-stamping and real time data collection. It can be used via hand-held devices and FSOs can upload the findings of the inspection of FBOs on the application which in turn helps to digitize inspection reports. This system is envisaged to ease sample collection and forwarding, traceability and, control the quality of compliances.

FSMS Guidance Documents

A series of sector specific Food Safety Management System (FSMS) Guidance Documents have been developed with the help of domain experts with the intent to provide implementation guidance to food businesses (especially the small and medium
businesses) involved in manufacturing, packing, storage and transportation to ensure that critical food safety related aspects are addressed throughout the supply chain.

These documents are primarily based on Schedule 4 of FSSs (Licensing & Registration of Food Businesses) Regulation, 2011. The documents are recommendatory in nature and provide the basic knowledge and criteria for implementation of Hazard Analysis and Critical Control Point (HACCP) system by the food businesses. Inspection checklists for FBOs to audit their facility and operations are also included in these documents. The FBOs can evaluate themselves based on the indicative scoring. Also, these documents provide important templates and forms to facilitate the FBOs to maintain the records. These include mandatory forms as prescribed by FSSAI and templates for maintaining records of processes critical for food safety.

**Third party auditing**

To strengthen the food safety surveillance system, FSSAI has developed a framework for conduct of food safety audits of FBOs to ensure compliance to sanitary and hygienic requirements, through Recognized Auditing Agencies as per FSS (Food Safety Auditing) Regulations, 2018. It is envisaged to use food safety audits as an alternate to regulatory inspections by Central or State FSOs thereby leading to less frequent regulatory inspections except for regulatory sampling. This will strengthen food safety surveillance system and encourage self-compliance while at the same time assuring safe food to the consumers.

**Hygiene rating and Right Place to Eat Scheme**

Hygiene Rating and Right Place to Eat Scheme has been initiated by FSSAI recently under Project Serve Safe, with the intent of ensuring that consumers make informed choices while eating out and encouraging food businesses to showcase and improve their food hygiene standards.

Hygiene Rating reflects the standards of food hygiene found on the date of inspection by the local authority or recognized third party audit agency. This is a voluntary scheme applicable to food businesses supplying food directly to consumers either on or off the premises and food businesses are rated based on food hygiene and safety conditions found at the time of inspection.

Right Place to Eat is a distinguishing mark granted to Food Businesses with hygiene rating of 4 or more, to encourage FBOs in promoting nutrition, and to bring about behavioral change in consumers by making them aware of healthy choices and giving them access to such options.
FoSTaC

Food Safety Training & Certification (FoSTaC) is a large scale training and capacity development programme initiated by FSSAI for training of food handlers working in the food businesses at supervisor level, to ensure that the establishments in which food is being handled, processed, manufactured, stored, distributed, conform to the food safety requirements. Once trained the food handlers are certified as “Food Safety Supervisor”. There are 16 FOSTAC courses in three levels, Basic, Advanced and Special covering all sectors of the food business. This initiative was started with the aim to enhance the availability of skilled manpower in order to ensure better implementation and self-compliance to FSS Regulations.

The training is imparted through empanelled training partners and master trainers. FoSTaC began in 2017 and has turned into a nationwide training ecosystem for food business operators. FSSAI has been successful in empanelling several institutes as training partners. FSSAI has mandated that all food businesses having Central Licences or State Licences should have at least one trained and certified food safety supervisor for every 25 food-handlers on all their premises.

Domestic compliance

Licensing and Registration

As per FSS Act, every FBO in the country is required to be licensed/ registered under FSSAI. The licensing and registration procedure and requirements are regulated by FSS (Licensing and Registration of Food Business) Regulations, 2011. Food Licensing and Registration system (FLRS) is an online system to facilitate FBOs in India to apply for License/ Registration certificate and for tracking their applications during processing.

Registration is meant for petty food manufacturers that includes petty retailer, hawker, itinerant vendor or a temporary stall holder or small or cottage scale industry having annual turnover up to 12 lacs. All food businesses having income more than this limit are required to take a license. The process of registration has been outlined in figure 5.
The eligibility criteria for Licensing is according to whether one wants a State or Central License:

**State License**-
- Food Businesses with Annual Turnover between 12 lakhs and 20 crores.
- All grain, cereal and pulses milling units irrespective of turnover.

**Central License**-
- Food Businesses with Annual Turnover more than 20 crores.
- Operating business in two or more States.
- Food business covered under Schedule 1 of FSS (Licensing and Registration of Food Businesses) Regulations, 2011.
The process of licensing is outlined in figure 6.

**State level regulatory structure**

The Food Safety Authority in States/UTs is headed by the Commissioners of Food Safety for efficient implementation of FSS Act, rules and regulations made thereunder. The framework for food safety enforcement machinery in the State as provided under the FSS Act primarily comprises of Designated Officer, Food Safety Officer, Adjudicating officer and Food Analyst (Figure 7).
Commissioners of Food Safety are responsible for ensuring an effective implementation of standards and other requirements under the FSS Act, conduct surveys of industrial units to ascertain compliance of such units to standards under the Act, sanction prosecution for offences, prohibit in the interest of public health, the manufacture, storage, distribution and sale of any article of food and also organize training for officials under the State Food Authority.

Designated Officers (DO) are appointed by Commissioner of Food Safety for every district of a State and are in-charge of food safety administration for that district. Designated Officer is the Licensing Authority who can issue or cancel the License of Food Business Operator (FBO). They have the power to prohibit the sale of any article of food, recommend to the Commissioner of Food Safety for sanction to launch prosecutions, maintain record of all inspections made by FSO and action taken by them in the performance of their duties and to investigate any complaint.

Food Safety Officers (FSO) are the representatives of the Food Authority at the ground level and interact directly with the FBOs and thus are the backbone of the entire food safety compliance structure. They are required to inspect all licensed units as frequently as may be prescribed by the DO, to verify/satisfy that conditions of licenses are being complied, report to the DO, procure sample, send for analysis in case of contravention, surveillance, investigate any complaint and to recommend issue of improvement notices to FBOs based on the results of inspections.

Adjudicating officer (AO) plays a crucial role in enforcement of the Food Law. They have the powers of a civil court for the purposes of the Act and all the proceedings before him are deemed to be judicial proceedings. The AO can issue direction to person found guilty of an offence, for taking corrective action to rectify the mistake or destruction of such article of food. He can also direct the offender to pay compensation to victim or representative of victim in case of injury or death of consumer. He can order for cancellation of license, re-call of food from market as well as forfeiture of establishment and property.
Active and Passive Surveillance

Food Safety Surveillance is a system that collects data regarding all types of contaminants with the purpose of timely identification of food safety hazards that are significant. It can provide relevant data for risk assessment and standards setting. The objective of food safety surveillance is to ensure that the food supplied in the market is safe. Without an effective surveillance system, the consumer can be exposed to a variety of hazards including contaminants, toxins and residues in food. In absence of data, it is not possible to assess the present state and magnitude of the problem. The reports received from surveillance activities are compiled and if any surveillance sample fails due to non-conformity then enforcement sampling may be executed and action for prosecution may be initiated.

Two types of surveillance activities are carried out by FSSAI – Active Surveillance and Passive Surveillance. **Active surveillance** comprises of food safety surveys conducted by FSSAI or the State Food Authorities. It provides the most accurate and timely data on food safety parameters. Such type of surveillance includes National level surveillance, State specific surveillance, Seasonal surveillance, Special surveillance during festivals, Commodity specific surveillance etc.

**Passive surveillance** is a system by which FSSAI receives reports from FBOs or other sources (hospitals, medical care practitioners, research institutions) on contaminants in food products. It is a relatively inexpensive strategy to cover large areas and provides critical information for monitoring community health.

Food imports regulations

FSSAI has the mandate to regulate import of food into the country and ensure that it is safe and wholesome for human consumption. The import procedure and requirements are governed primarily by the FSS (Import) Regulations, 2017. No imports of food article are permitted in India without a valid import license from the Central Licensing Authority of FSSAI.

The major food commodities being imported in India are oil and fats, pulses, fruits and nuts, vegetables, cereals, sugars and sugar confectionery, coffee, tea, spices and beverages. Top exporting countries exporting food commodities to India are Australia, Indonesia, Ukraine, USA, Canada, Brazil and Myanmar.

Import clearance process

FSSAI has its presence at six locations through its own Authorised Officers at Chennai, Kolkata, Mumbai, Delhi, Cochin and Tuticorin covering 20 points of entry. Further, at other Point of Entries throughout the country, FSSAI has notified Customs officials as Authorised Officers for the purpose of regulating food imports. FSSAI has in place an online Food Import Clearance System (FICS), integrated with the customs ICE-GATE (Indian Customs Electronic Commerce/Electronic Data interchange Gateway) under SWIFT (Single Window Interface for Facilitating Trade). The consignment of food articles is referred to FSSAI for clearance by Customs Authorities through FICS.
Thereafter, the food consignments are subject to scrutiny of documents, visual inspection, sampling and testing in FSSAI notified laboratories in order to determine whether they conform to the safety and quality standards laid down under various FSS Regulations.

To expedite the clearance process of imports, Risk Management System (RMS) has been introduced under SWIFT which scrutinizes the application and if the sampling is required; the BOE is referred to FSSAI through FICS or else cleared through green channel. FSSAI has mapped a total of 1470 ITC-HS Codes pertaining to articles of food or food additives with the Customs-ICEGATE. These HS Codes have been subdivided into High Risk or Low-Risk food items based on safety. Further, dual use items have also been identified and if end use is food then the dual use items are referred to FSSAI for clearance.

**Testing facilities**

A laboratory is required under Import regulations to complete the analysis and upload the test report in FICS within five days of receipt of the sample with conclusive opinion about the product tested as conforming or non-conforming. For testing of food import consignments through a transparent and expeditious process, NABL accredited laboratories have been notified by FSSAI throughout the country.

If the samples are found conforming, then a No Objection Certificate (NOC) is generated and if not conforming then Non-Conforming Report (NCR) is generated rejecting the clearance of food consignments. The same is communicated to Customs-ICEGATE through FICS. A system of sending the sample to referral labs exists as in the case of domestic compliance when the sample fails in the notified laboratory. FSSAI has also notified Referral labs for re-testing of appeal samples of the Importers. Animal Quarantine and Plant Quarantine Departments under the Ministry of Agriculture also take samples separately in case of certain food items marked by Customs for their NOC.

Special dispensation for rectification of labels is provided for imported packaged food consignments under Import Regulations, 2017. The Import Regulations also provides for issuance of Provisional NOC in respect of consignments of fresh fruits and vegetables which are perishable in nature with shelf life of less than 7 days or consignments of food which require special storage conditions (refrigerated conditions like frozen or chilled food products) or consignment of pre-packaged retail food products, subject to satisfactory visual inspection and without waiting for the result of testing from the notified laboratory. The consignment can thereafter be moved to the warehouse of the importer. However, the products cannot be released into the domestic market without issuance of NOC which is based on the analysis report. In the event of a non-conformance report, the importer is responsible for moving the consignment back to customs jurisdiction and comply with the requirement of re-export or destruction as decided by AO.
Food traceability

Meaning of Food recall

Food Recall means an action to remove food products from market at any stage of the food chain, including that possessed by consumer, which may pose a threat to the public health or food that violates the FSS Act. Recall of food product is in the common interest of the industry, the government and the consumer. A food recall may be initiated as a result of a report or complaint from a variety of sources – manufacturers, wholesalers, retailers, government agencies and consumers.

Food recall regulations and implementation

The FBOs are strictly liable for any article of food which is unsafe under the FSS Act. The FSS (Food Recall) Regulations provides guidance to the FBOs for food recall procedures whereby an FBO is required to immediately inform the competent authorities and co-operate with them, if the food which he has placed in the market is unsafe for the consumers. The regulations also mandate the FBO to establish an effective and efficient follow-up action/ post-recall report system.

A traceability system is an effective tool with which FBOs can trace food throughout the food chain. The FBO is required to have as a minimum a documented one-step-back/one-step forward traceability approach. Small FBOs with limited distribution may not be required to have a fully documented traceability system in place and may rely solely on their purchasing and sale records to act as their traceability record. In the context of a food recall, the objectives of traceability are to:

a. Identify uniquely a lot/batch/consignment of food in a way that allows tracing of the physical flow of the food forwards through the food chain to the immediate customer and tracing of the physical flow of raw materials backwards to the immediate supplier.

b. Create and maintain accurate traceability records that can be provided within a short time period when needed for recall or at the request of the competent authorities.

Summary

- The Food Safety and Standards (FSS) Act, 2006 repealed the PFA Act and all the six Orders under Essential Commodities Act, 1955.

- The mandate assigned to FSSAI is a) to develop science based standards for food and b) to regulate and monitor the manufacture, processing, storage, distribution, sale and import of food, so as to ensure the availability of safe and wholesome food for human consumption.
• The FSS Rules came into effect on 5 August 2011 with the notification of six principal regulations on Food product standards, Contaminant, toxins & residues, Packaging and labelling of food, Licensing and registration of FBOs, Prohibition and restriction of sales, Laboratory and sampling.

• Food Authority provides policy intervention through notification of various food safety regulations, provides direction and coordination at National level, States/UTs conduct enforcement at the field level to verify compliance by FBOs to food standards.

• The Food Safety Authority in States/UTs is headed by the Commissioners of Food Safety for efficient implementation of FSS Act, rules and regulations made thereunder.

• Other regulatory bodies dealing with food include BIS, EIC, APEDA, MPEDA and DMI.

• FSSAI assess risks through its Scientific Panel, Scientific Committee and FSKAN. After scientific risk assessment, FSSAI manages risk and take measures which are regulatory (i.e., provisions in the regulations, end products standards), or non-regulatory (such as industry codes of practice, guidelines or information campaigns). While taking such measures, the social and economic aspects are also considered in addition to the scientific risk assessment. FSSAI communicates risks through issuing advisories, social media channels at both central and state level.

• The basic purpose of establishing food standards is protection of public health and risk, promoting fair trade in food, prevent misleading or deceptive products and enable consumers to make informed choices by providing adequate information. Food standards can be broadly classified as Horizontal and Vertical Standards. These need to be harmonized with International standards.

• FSSAI has laid down detailed sanitary and hygienic practices that should be followed by FBOs irrespective of their position in the food chain in order to ensure food safety. These practices are commonly called as Schedule 4 requirements (provided under Schedule 4 of FSS (Licensing and Registration of Food Business) Regulations, 2011).

• Hygiene Rating and Right Place to Eat Scheme has been initiated by FSSAI recently under Project Serve Safe, with the intent of ensuring that consumers make informed choices while eating out and encouraging food businesses to showcase and improve their food hygiene standards.

• Food Safety Training & Certification (FoSTaC) is a large scale training and capacity development programme initiated by FSSAI for training of food handlers working in the food businesses at supervisor level, to ensure that the establishments in which food is being handled, processed, manufactured, stored, distribute conform to the food safety requirements.

• As per FSS Act, every FBO in the country is required to be licensed/registered under FSSAI. Registration is meant for petty food manufacturers that includes petty retailer, hawker, itinerant vendor or a temporary stall holder or small or cottage
scale industry having annual turnover up to 12 lacs. All food businesses having income more than this limit are required to take a license.

- Every licensed FBO must have a documented Food Safety Management System (FSMS) plan and is required to comply with Schedule 4 of FSS (Licensing and Registration of Food Business) Regulation, 2011.

- FSSAI has the mandate to regulate import of food into the country and ensure that it is safe and wholesome for human consumption. No imports of food article are permitted in India without a valid import license from the Central Licensing Authority of FSSAI. It is done through an online Food Import Clearance System (FICS).

- Food Recall means an action to remove food products from market at any stage of the food chain, including that possessed by consumer, which may pose a threat to the public health or food that violates the FSS Act.

Keywords

**Quality Standards:** The standards framed, based upon the intrinsic properties of Agricultural or Food Commodities

**Mandatory:** Such provisions which are compulsory or binding to comply.

**FoSTaC:** Food Safety Training and Certification, a large-scale training and capacity building programme for food handlers

**FOSCORIS:** Food Safety compliance through Regular Inspections and Sampling, a web-based system to verify compliance to food safety and hygiene standards by food businesses as per regulatory requirements.

**FLRS:** Food Licensing and Registration System, an online system to facilitate FBOs in India to apply for License/ Registration certificate and for tracking their applications during processing.

**FICS:** Food Imports Clearance System, an online system of FSSAI for imported food clearance

**FSKAN:** Food Safety Knowledge Assimilation Network, a scientific community for collation of knowledge and expertise and for coordination of research activities across the country.

Exercises

1. What is the objective and mandate of FSSAI?
2. Describe the structure and roles of Food Authority.
3. How does FSSAI ensure food safety at central and state level?
4. Describe the bodies/organisation other than FSSAI responsible for food safety.
5. Explain the process of standards setting.
6. Explain the eligibility criteria for State and Central License.

7. Give a brief note about FoSTaC.

8. How does FSSAI ensure the safety of imported Foods?

9. What are the salient features of FOSCORIS?

References


Chapter 9: Safe Food Everywhere

- Food safety practices at home
  - Personal Hygiene
  - Selecting safe and good quality foods
  - Food handling
  - Waste disposal

- Food safety practices outside home
  - Major concerns in food service sector
  - Food hygiene and safety practices

- Tools to ensure food safety
  - Hygiene rating
  - Food safety training and certification
  - Consumer complaint handling
Chapter 9: Safe Food Everywhere

Unsafe food and poor diets create a vicious cycle of disease and malnutrition particularly affecting infants, young children, elderly and the sick. The ‘food ecosystem’, includes not only food business operators (FBOs) but also the consumers. While food businesses may adopt a casual approach in maintaining food safety and hygiene standards, consumers tend to make wrong food choices (figure 1).

![Figure 9.1: Food Ecosystem – FBO and Consumer](image)

Trap of malpractices can be broken by adequate food safety education. This chapter gives simple tips on food safety to empower consumers as well as FBOs. If we look into the food safety ecosystem closely, it can clearly be seen that, any individual eats either at home or out of home. Hence, accordingly the chapter will look at safety issues at home as well as when the individual eats out whether in restaurants, workplace, school or even at a place of worship.

Food Safety Practices at home

Culture of food safety practices should start at home. If we inculcate these habits within ourselves, we spontaneously will expect the same practices by the food service industry. This will drive the food service industry to adopt the best practices. Food safety can be ensured at the household level by being mindful of personal hygiene, selection of right food, proper food handling and waste disposal.

Personal Hygiene

We ourselves can be the biggest source of contamination. The following precautions need to be taken by all people handling food so that it does not become contaminated:

- Wash hands every time you handle food, go to the washroom or touch surfaces likely to be contaminated like doorknobs, walls, hair, skin, etc.
- Wear clean clothes and preferably an apron to keep street clothes away from food.
• Keep hair short or tied up and covered to prevent strands from falling into food.
• Keep nails short and clean.
• Avoid wearing rings and other pieces of jewellery from which stones, etc can fall into the food.
• Wear gloves while handling food which will not be cooked or reheated like salads.
• Cover all wounds and cuts on your hands properly and preferably wear gloves so that neither the wound nor the bandage comes in contact with the food.
• Do not bring street shoes into the kitchen.
• Avoid cooking if unwell especially with diarrhoea or vomiting as you could be a carrier of a foodborne illness.

Selecting safe and good quality foods

Healthy and safe eating begins with choosing the right kind of foods. It is important that we select safe and wholesome ingredients to prepare our food. Unless contamination is visible in the form of dirt, mold growth, decay, signs of insect or pest infestation (eggs, body parts, hair, excreta, etc.), it is not simple to detect if the food item is safe. One needs to look out for some cues which point to the product being unfit for consumption or at least being on the verge of spoilage.

Food adulteration, as discussed in an earlier chapter, is another menace one needs to be aware of. What can help is the knowledge about the common adulterants, foods which are likely to be adulterated and simple tests for detection of adulteration which can be done at the household level. It is also helpful to know what to look out for in packaged foods. The label of these foods can help the consumer to identify foods which are more nutritious. The sections which follow include some pointers to help consumers select both safe and nutritious foods.

Consumers need to look for certain features before buying different types of foods. Figure 2 illustrates what to look for while shopping for different food groups.
Here are some tips on what to keep in mind while purchasing food from the market:

- **Buy fresh, seasonal and locally available vegetables and fruits at the right stage of maturity.**

- **For packed items, look for FSSAI License, expiry date/best before date along with MRP. Read nutritional content, choose the food items depending on the body type and nutritional need.**

- **Spices and condiments should be closely inspected before purchase, especially powdered spices. Always buy packaged powdered spices and look for quality marks like ISI or AGMARK.**
• Buying food which is at the right temperature is also important. Certain high-risk foods are sold either chilled or frozen. Frozen foods should be frozen solid at the time of purchase. Make sure these are purchased at the end of the shopping trip so that they can be brought home as soon as possible and put in the freezer until use. Maintaining the cold chain is important for foods like meat and meat products, milk and its products as microbes tend to multiply very fast in such foods at ambient temperatures.

• Buying food from reliable sources is also an important step towards ensuring safe food. This reduces the chances of the food being adulterated.

Food handling

Once procured, foods also need to be processed, stored and handled with care to ensure that they stay safe. WHO has outlined five keys to keeping food safe (figure 3). The first is cleanliness. We need to ensure that our hands are clean before handling food. Raw food also needs to be washed and cleaned thoroughly to get rid of visible dirt. It is also important to keep all food contact surfaces clean like kitchen equipment, knives, storage containers, etc. The kitchen and storage areas need to be protected from pests as well as environmental contaminants. The second key is to separate the raw and the cooked foods as there are chances of cross-contamination. Raw food may be contaminated with dust, pesticide residues, microbes which may be passed on to cooked food if both are kept in close contact or if same utensils, knives, spoons are used for both. Raw meat, fish and poultry have a very high microbial load and the same chopping board and knives should not be used for cutting vegetables unless they have been thoroughly sanitized.
Food needs to be cooked thoroughly to destroy any disease-causing microbes which may have been present in the food even after washing and cleaning. The core temperature of the food should reach beyond 70°C, preferably 75°C in tropical climates to ensure that all pathogens have been destroyed. Previously cooked food which had been refrigerated needs to be reheated to this temperature before consumption. All food should be stored at appropriate temperatures. The danger zone between which microbes are known to multiply rapidly is 5–65°C. Hence foods which need to be kept cool should be refrigerated and kept below 5°C. Raw flesh foods are best kept frozen at below -18°C. When it is time to cook or consume frozen food, thawing should either be done in a microwave or under running tap water. Never leave the frozen food at room temperature to thaw. This encourages the growth of microbes. Once thawed the food should not be refrozen again because the microbial load has now increased, probably to dangerous levels. Hence it is advisable to freeze foods in packets or containers which contain amounts which are likely to be consumed by the family in one sitting. Cooked foods should not be left at room temperature for more than 2 hours. If the food is to be served hot after a few hours, it can also be kept hot (like in a bain-marie) above 65°C.

To begin with, it is important to procure good quality raw ingredients from reliable sources. Packaged food products need to be checked for their best before/expiry dates. Storage
instructions by manufacturers mentioned on food labels should be read and followed. Potable water should be used to clean the fruits, vegetables, flesh foods before consumption, cooking or storage.

Waste disposal

Households generate waste which needs to be disposed of responsibly. It is important to segregate waste so that it can be sent further for appropriate disposal (figure 4). For instance, food scraps, peels, inedible portions of fruits and vegetables, eggshells, bones, and such other organic matter can be used in homes or colonies itself for making compost. It can also be safely sent to landfills. Other waste like packaging material - paper, cardboard, plastic, tin, etc. needs to be recycled and reused. Waste bins in the kitchen should have tight fitting lids. There should be separate waste bins for biodegradable waste (vegetable matter, paper so that it may be composted later) and recyclable waste (polythene, cardboard, glass, etc.). These bins should be emptied daily and kept thoroughly clean and covered so that they don’t attract pests. They would also need to be disinfected regularly and the area kept odour free by not letting garbage spill or accumulate for long. Avoid throwing solid waste into drains as they tend to get choked and result in backflows. Keep sinks and drains clean. Drains should have traps or covers which do not permit entry of pests like cockroaches or rats.

Figure 9.4: Waste Segregation for Better Disposal
Food Safety Practices Outside Home

Changing lifestyles and eating patterns coupled with increase in purchasing power have led to an increase in the number of people eating outside home. Meals prepared in restaurants, fast food outlets and street food are gaining popularity. This has led to mushrooming of several small and large-scale catering units. This has raised the concern related to food hygiene and safety.

Major concerns in food service sector

Food safety lapses can have disastrous consequences resulting in food poisoning outbreaks and monetary losses for the FBO as well as the consumer. For the FBO it may be loss of business and getting stuck in legal proceedings against them, but for the consumer it leads to loss of wages due to absence from work coupled with medical expenses. In each type of FBO there may be different concerns regarding food safety (Table 1). Irrespective of the size of the operations of any food business, the basic principles of ensuring safe food remain the same. The Codex has outlined the essential principles of food hygiene applicable throughout the food chain and has indicated how these principles should be implemented to ensure safety of food from the ‘farm to the table’. FSSAI has also developed Food Safety Management System (FSMS) Guidance Documents which have been described in the previous chapter.

To ensure food safety in an establishment, one needs to consider various features - starting with the selection of site where the unit will be set up, to the design of the premises. In the premises, the design of the kitchen is of primary importance - the layout of the kitchen, i.e. area where the food will be stored, prepared and served, the drainage and waste disposal facility, and provisions for protection from pests.

Food service establishments can be temporary/mobile units or those which are fixed and so more or less permanent. A mobile food service establishment like a van, pushcart or even a movable stand, is a self-contained food unit which prepares and serves food to consumers. Street food vendors come under this category. A fixed food service establishment on the other hand operates at a specific location and probably has all the basic facilities like water supply, electricity, waste disposal system, etc. In contrast, these facilities are mostly not available in mobile units. Fixed establishments include canteens, restaurants, cafes, as well as food served in institutions like hostels, hospitals, schools, etc. A temporary food service establishment is usually one which sets up operation for a fixed number of days at a location- usually at a fair, or gathering for a festival, exhibition, or any other celebration/event. These units may be supplied with the basic amenities (water, electricity, waste disposal) during the event organized so that they can function smoothly.

With a surge in people travelling for business or pleasure, there is a focus on providing them with safe food during their long journeys by bus or train (wheels), airlines (wings) and ships (waves). Some of these journeys may last for a few days. Contaminated food can lead to serious food poisoning affecting several people at the same time. For railway and airplane journeys the food is generally prepared in advance. Care needs to be taken that this preparation is not too much in advance. Food should be fresh when loaded on trains or airplanes. Sometimes the food is served within a few hours of the journey, however in some long-distance flights, the food may be served 10-12 hours later. And if, trains or flights are delayed, the freshness of the food is further compromised. To ensure that the food remains...
safe, adequate cool and hot storage facilities should be available on board. The food should be kept safely packaged and unexposed to contaminants and pests. Only safe packaging material should be used which does not introduce chemical contaminants into the food. Also, safe potable water should be served. Maximum care must be taken for the quality of ice, which should be prepared using potable water and handled carefully.

Journeys on ships may last much longer – a few days to a few weeks. It is not possible for all food to be cooked in advance; hence ships have proper fully functional kitchens like any other hotel or restaurant. They need to follow the same principles of hygiene and sanitation as other food service establishments with proper storage facilities, food processing areas, cleaning areas and well-trained personnel.

Table 9.1: Concerns regarding food safety in different types of FBOs

<table>
<thead>
<tr>
<th>FBO Type</th>
<th>Concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td>School Meals and Canteens</td>
<td>Children are the vulnerable population. It is essential that food prepared is safe and hygienic. The common issues in school meal service are:</td>
</tr>
<tr>
<td></td>
<td>- Lack of knowledge about food hygiene and safety.</td>
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<tr>
<td></td>
<td>- Lack of food grade equipment, utensils and cutlery</td>
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<tr>
<td></td>
<td>- Use of artificial colours and flavours to make food attractive.</td>
</tr>
<tr>
<td>Restaurants, Cafeteria</td>
<td>Restaurants and cafeteria are most common places to eat nowadays. It is essential that the food hygiene and safety practices are followed. Some issues in restaurants and cafeteria are:</td>
</tr>
<tr>
<td></td>
<td>- Inadequate space for food preparation area</td>
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<tr>
<td></td>
<td>- Lack of food hygiene and safety knowledge</td>
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<tr>
<td></td>
<td>- Improper handling of food</td>
</tr>
<tr>
<td></td>
<td>- Temperature abuse</td>
</tr>
<tr>
<td>Dhabas, Street Food, Food Trucks, etc.</td>
<td>These are majorly part of unorganised sector. There is complete lack of awareness about food hygiene and safety. The key issues in such businesses are:</td>
</tr>
<tr>
<td></td>
<td>- Do not have FSSAI registration</td>
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<tr>
<td></td>
<td>- Can be exposed to environmental pollution</td>
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<tr>
<td></td>
<td>- Lack adequate structures, fitting and designs</td>
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<tr>
<td></td>
<td>- Use of non-food grade equipment, dirty dusters, etc.</td>
</tr>
<tr>
<td></td>
<td>- Lack of food hygiene and safety knowledge</td>
</tr>
<tr>
<td></td>
<td>- Improper handling of food</td>
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<tr>
<td></td>
<td>- Temperature abuse</td>
</tr>
<tr>
<td></td>
<td>- No access to clean potable water</td>
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</tbody>
</table>
Food hygiene and safety practices

It is essential that food prepared is safe and hygienic for consumption. Essential food hygiene and safety practices have been briefly described below:

1. **Location and Surrounding:** The food premise should be located away from the sources of environmental contamination. If that is not possible then suitable measures must be adopted to protect food service establishments from the source of contamination.

2. **Layout:** The food preparation area, stores, service area, waste disposal area, employee facilities, etc. should be designed in such a way that food prepared is protected from contamination.

3. **Structures and Fittings** such as floors, walls, ceilings, doors and windows should be made of impervious, non-toxic, and easy to clean material. There should be no cracks or crevices, gaps and flaking of paints. Windows should be covered with mesh. There should be adequate lighting (shatter proof lights), ventilation in the food preparation area.

4. **Food Procurement and Storage:** Food should be procured from FSSAI licensed vendor. Food should be received at the right temperature - frozen foods should be at -18°C while foods to be kept in refrigeration should be received chilled at temperatures below 5°C. They should be stored in clean, food grade containers at the required temperatures. There should be adequate space, ventilation, lighting and temperature control facilities in the storage area. Food and non-food items, vegetarian and non-vegetarian food products should be segregated during storage.

5. **Food Preparation:** There should be separate food grade equipment for food preparation of vegetarian and non-vegetarian foods. There should be adequate supply of clean potable water for washing food and equipment and, for food preparation. Food should be thoroughly cooked/reheated above 75°C (core temperature) before serving.

6. **Service and Display:** Clean, food grade utensils and cutlery should be used for food service and display. Hot food should be held at 60°C or above while cold food should be held at 5°C or below.

7. **Packaging and Transportation:** Food grade packaging material and containers should be used while food packaging and transportation. Transport or delivery vehicle should be clean and sanitized. It is preferable that food is held at adequate temperature i.e. hot food at 60°C or above and cold food at 5°C or below.

8. **Personal Hygiene:** Food handlers should go for annual medical check-ups and should be vaccinated for enteric diseases. They must maintain high level of hygiene standards which include bathing regularly, keeping hair, beard and nails trimmed, avoid wearing nail varnish, wear clean clothes/apron, cap and gloves (wherever necessary), wash hands after use of toilets, touching/scratching self, sneezing, coughing, etc. There should be adequate supply of hot and cold water, soap, clean towels and sanitizers. Food handlers should have separate changing area and toilets facilities.
9. **Cleaning and Maintenance:** The food premise (floors, drains, walls, fittings), equipment and cutlery should be thoroughly cleaned after use or end of food processing. There should be adequate facility for hot and cold potable water. The waste should also be disposed regularly from the food premise.

**Tools to ensure food safety**

Food safety can be ensured only when every stakeholder plays their respective role responsibly. For example, an FBO must be self-compliant and make available safe food for the consumers. At the same time, consumer should be aware about what to look for in an FBO and how to select safe food. Consumer organizations need to undertake drives to educate the consumer as well as FBOs about food hygiene and keeping the consumer safe.

FSSAI has devised three major initiatives, which can be used by the FBO and consumer as a powerful tool to ensure food safety. You were introduced to these in the previous chapter. Let us learn about these in greater detail.

**Hygiene rating**

It is an online, transparent rating process aimed at empowering consumers to make an informed choice when they eat out and encourage businesses to ensure hygiene standards.

It is a user-friendly, technology-driven scheme where food service establishments are given a score (between five to one) as per their hygiene and food safety compliance. The businesses can display that they are a Right Place to Eat through stickers and thus promote their business. The consumer can judge whether it is a safe place to eat by looking at the rating of the food service establishment.

Following steps are involved in obtaining a Hygiene Rating:

1. **Self-Assessment by FBO** – The FBO should log-in to Serve Safe Portal with (FLRS) Login ID and password. After the login, self-assess food safety compliance on parameters mentioned on the Hygiene Rating Checklist.

2. **Verification Process** – The FBO will have an option to choose from the empaneled Hygiene Rating Auditing Agency (HRAA)/ Food Safety Department, which will then visit and inspect the premises for food safety compliance. The Food Safety Officer (FSO)/Auditor will submit the report on Serve Safe Portal.

3. **Generation and Display of Hygiene Rating** – Once verification process is complete, FBO can download the Hygiene Rating Certificate and display where it is visible to the consumers.

4. **Overall monitoring by regulatory staff** – The regulatory staff from State or Central authority will be responsible to ensure that the Hygiene Rating of a food service establishment is done in an ethical manner.
Food safety training and certification

In terms of section 16(3) h of the Food Safety and Standards Act 2006, the Food Safety and Standards Authority of India (FSSAI) has to ensure training of persons who are or intend to become involved in food businesses, whether as food business operators or employees or otherwise. It is accordingly desired that -

a. All food businesses having central licences or state licenses should have at least one trained and certified food safety supervisor for every 25 food-handlers or part thereof on all their premises.

b. These supervisors should in turn carry out periodic onsite training of all food handlers, at least on quarterly basis and maintain record thereof for food safety audit and inspections.

c. Food handlers in all petty food businesses that are registered should be trained and certified.

Following training courses have been designed for the purpose –

**Level 1: Basic:** (5 Courses of 4 to 6 hours duration over 1 or 2 days) - (1) Street Food Vending, (2) Catering, (3) Manufacturing / Processing, (4) Storage & Transport, and (5) Retail & Distribution

**Level 2: Advanced:** (4 Courses of 8 hours duration over 1 or 2 days) - (1) Catering (2) Manufacturing / Processing, (3) Storage & Transport, and (4) Retail & Distribution


FoSTaC Plus: (2 Courses of 8 hours duration on 1 day or 2 days)- (1) Start-Ups, (2) Organic Food Business.

Additional training courses including customised courses could be introduced in due course as the need arises. Currently, courses are being offered on face to face mode, while this would be continued, but subject to availability of credible training partners, some of the courses could be allowed through online mode as well.

FSSAI has created training content for the above courses. The same is currently available in English and is being translated in Hindi and 10 regional languages.

FSSAI has taken on partners who are providing training. Training partners include -

1. Big food businesses (central licensees and big state licensees)
2. Academic and Vocational Institutions
3. National Skill Development Corporation (NSDC), Sector Skill Councils (SSCs) and State Skill Development Missions.
4. Training agencies approved under other government schemes
5. Industry Associations, Scientific and Technology Associations
6. Civil Society Organisations

It is desired that big food businesses, particularly all with central licenses and bigger ones with state licenses should take responsibility of training and certification of food safety supervisors and food handlers in their own premises and of the suppliers, distributors, retailers and transporters in their entire food value chain.

Each State/UT would identify resource persons, master trainers and trainers from food businesses, food technology, home science and nutrition colleges / universities, industry associations, consumer organisations and individual experts and professionals.

FSSAI has established the FoSTaC platform (available at https://fostac.fssai.gov.in/) to manage the entire food safety training and certification system.

**Consumer complaint handling**

Food Safety Connect is an initiative of FSSAI to develop a credible and robust information and feedback mechanism across various channels to create a responsive ecosystem to bring each citizen on-board to share their concerns regarding food safety violations.

This “Food Safety Connect” initiative allows a consumer to share their concerns, know their rights and track Food Business Operators license/registration certificate authenticity. The main objective of this initiative is to ensure satisfactory and timely redressal of concern and to create a robust ecosystem of ensuring food safety in the country.

If a consumer has a food concern/complaint and is looking for the right person to contact, the following steps need to be followed:

- **STEP 1:** Identify type of food and the problem observed
- **STEP 2:** Identify the recommended practices not followed under the premises
- **STEP 3:** Identify the Outlet or Product Brand Name and provide address of the Seller/Outlet of the product

Once all the details are provided, the concern will be shared with the nearest Food Safety Officer for further follow up.

Thus, in order to ensure safe food for consumers, food hygiene must be maintained at home as well as at all food service establishments. It is important to know how safe and good quality foods should be selected. It is also important to handle food safely and ensure safe disposal of waste. Lack of adequate infrastructure and knowledge of safe food handling practices among food service establishments, especially the small-scale food businesses and street food vendors, raises special concerns. Hygiene rating, training and certification of food handlers and safety supervisors, and a consumer connect mechanism are some of the initiatives introduced by the Food Regulatory Authority of India to improve the food safety scenario of the country.
Summary

- Unsafe food and poor diet create a vicious cycle of disease and malnutrition. All stakeholders of a food ecosystem need to be aware about keeping food safe.

- Food safety can be ensured at the household level by being mindful of personal hygiene, selection of right food, proper food handling and waste disposal.

- Food adulteration is a menace and one needs to be aware of the common adulterants added to our foods, foods which are likely to be adulterated and simple tests for detection of adulteration which can be done at the household level.

- Consumers need to look for certain features before buying different types of foods. Labels must be examined carefully for best before/expiry date, quality marks (ISI, AGMARK), storage instructions and ingredients.

- Once procured, foods also need to be processed, stored and handled with care to ensure that they stay safe. WHO has outlined five keys to keeping food safe – keep clean, separate raw and cooked foods, cook thoroughly, keep food at safe temperatures and use safe water and raw materials.

- It is important to segregate waste (wet, dry and recyclable waste) so that it can be sent further for appropriate disposal.

- With the mushrooming of large and small scale food service establishments including street food vending, there is a serious concern regarding safety of the food served.

- It is important to ensure that the location and infrastructure of the food preparation area is suitable. The kitchen layout and design should also ensure smooth flow of operations with minimum chances of contamination. Drainage and waste disposal facility should also be as per norms laid in the Food Safety Management System (FSMS) Guidance Documents.

- There should be separate food grade equipment for preparation of vegetarian and non-vegetarian foods. There should be an adequate supply of clean potable water for washing food and equipment and, for food preparation.

- Clean, food grade utensils and cutlery should be used for food service and display. Hot food should be held at 60°C or above while cold food should be held at 5°C or below.

- Cleaning and sanitization of premises and maintenance of good personal hygiene levels is also vital.

- Consumer organizations need to undertake drives to educate the consumer as well as FBOs about food hygiene and keeping the consumer safe.

- Hygiene ratings will help consumers make appropriate food choices.

- Food safety training and certification (FoSTaC) of FBOs will help in empowering the FBOs in serving safe food.
• Basic, Advanced and Special training courses are offered by FSSAI through Training Partners suitable for different kinds of FBOs.

• The consumer has been further empowered to raise grievances against FBOs who are selling unsafe food.

Key Words

• Ecosystem - the set of elements, living and non-living, that interact, over time, within a defined locale.

• FLRS: Food Licensing and Registration System, an online system to facilitate FBOs in India to apply for License/ Registration certificate and for tracking their applications during processing.

• Food Safety Connect - an initiative of FSSAI to develop a credible and robust information and feedback mechanism and to bring each citizen on-board to share their concerns regarding food safety violations.

• FoSTaC - Food Safety Training and Certification, a large-scale training and capacity building programme for food handlers.

• HRAA - Hygiene Rating Auditing Agency.

• Hygiene rating – an online, transparent rating process aimed at empowering consumers to make an informed choice when they eat out and encourage businesses to ensure hygiene standards.

Exercises

1. Explain why food safety education is important for both the consumers and FBOs.

2. Discuss the points to be kept in mind by individuals to ensure that they don’t become a source of contamination for food cooked at home (Hint: Maintain personal hygiene).

3. Describe how you will select safe and wholesome ingredients for cooking meals at home.

4. What are the five keys to keeping food safe? Discuss with reference to the guidelines given by WHO.

5. Why is waste segregation and proper disposal important?

6. What are the major concerns regarding food safety in the food service sector?

7. List some essential food hygiene and safety practices for FBOs.

8. Discuss some tools for ensuring supply of safe food by FBOs.
References


Chapter 10: Food Safety Risk by Food Categories

- Food categorization
- Dairy Products and Analogues
- Cereals, Pulses, Millets and their products
- Fruits and Vegetables
- Spices and Condiments
- Edible Oils and Fats
- Meat, Poultry, Fish and Eggs
- Other food products
  - Organic foods
  - Irradiated foods
Chapter 10: Food Safety Risk by Food Categories

Food is essential for human existence. It provides energy and other resources for normal human physiological functions. Food availability at affordable prices is an important parameter of food security. Besides availability, food should also be free from potential health risks. It is therefore implied that to qualify as food, it should be safe and wholesome for human consumption. Thus, food security and food safety go hand in hand. As per the Food Safety and Standards Act, 2006 “Food” means any substance, whether processed, partially processed or unprocessed, which is intended for human consumption and includes primary food, or food containing such ingredients, infant food, packaged drinking water, alcoholic drink, chewing gum, and any substance, including water which is added to the food during its manufacture, preparation or treatment but does not include any animal feed, live animals unless they are prepared or processed for placing on the market for human consumption, plants prior to harvesting, drugs and medicinal products, cosmetics, narcotic or psychotropic substances. “Food safety” means assurance that food is acceptable for human consumption according to its intended use. Since there are a number of food commodities, foods have been categorized into food categories, and subcategories for easy identification and regulatory compliance.

Food categorisation

Foods have been categorized into 16 major categories by Codex. These categories have been further divided into subcategories comprising of similar products. This categorization allows easy implementation and enforcement of standards by regulatory bodies. For example, certain food additives and processing aids may be allowed to be used in some foods to achieve certain desired technological functions. Major food categories are listed below.

1. Dairy products and analogues: This category includes all types of dairy products that are derived from the milk of healthy milch animal(s).
2. Fats and oils, and fat emulsions: Includes all fat-based products that are derived from vegetable, animal or marine sources, or their mixtures.
3. Edible ices, including sherbet and sorbet: This category includes water-based frozen desserts, confections and novelties, such as fruit sorbet, and flavoured ice.
4. Fruits and vegetables (including mushrooms and fungi, roots and tubers, pulses and legumes, and aloe vera), seaweeds, and nuts and seeds.
5. Confectionery: Includes all cocoa and chocolate products, other confectionery products that may or may not contain cocoa, chewing gum, and decorations and icings, or foods produced solely with any combination of foods conforming to these sub-categories.
6. Cereals and cereal products derived from cereal grains, roots and tubers, pulses, legumes and pith or soft core of palm tree: Includes unprocessed and various processed forms of cereal and cereal-based products.
7. Bakery wares: Includes categories for bread and ordinary bakery wares and for sweet, salty and savoury fine bakery wares.
8. Meat and meat products, including poultry: This category includes all types of meat and poultry products, in pieces and cuts or comminutes fresh and processed.

9. Fish and fish products, including molluscs, crustaceans, and echinoderms: This broad category is divided into categories for fresh fish and various processed fish products. This category includes aquatic vertebrates (e.g. fish) and aquatic invertebrates (e.g. jellyfish), as well as molluscs (e.g. clams, snails), crustaceans (e.g. shrimp, crab, lobster), and echinoderms (e.g. sea urchins, sea cucumbers).

10. Eggs and egg products: Includes fresh in-shell eggs, products that may substitute for fresh eggs and other egg products.

11. Sweeteners, including honey: Includes all standardized sugars, non-standardized products, and natural sweeteners.

12. Salts, spices, soups, sauces, salads, protein products: This is a broad category that includes substances added to food to enhance its aroma and taste including salt and salt substitutes; herbs, spices, seasonings and condiments, certain prepared foods like soups and broths; sauces and like products; and salads and sandwich spreads, and products derived from soybeans.

13. Foodstuffs intended for particular nutritional uses: Includes Infant formulae, follow-up formulae, and formulae for special medical purposes for infants, complementary foods for infants and young children, dietetic foods and food supplements.

14. Beverages, excluding dairy products: Includes all types of non-alcoholic and alcoholic beverages.

15. Ready-to-eat savouries: Includes all types of savoury snack foods.

16. Prepared foods: These foods are not included in the other food categories (1-15) and shall be considered on a case-by-case basis. Prepared foods are mixtures of multiple components (e.g. meat, sauce, grain, cheese, vegetables); the components are included in other food categories.

Each type of food is associated with different hazards according to the nature of the food, storage and processing conditions. Thus, it is important to understand what can be done to protect different kinds of foods from becoming unsafe. This chapter describes the hazards that may be found in some of the food categories, measures to keep the foods safe and pointers for selection of safe and quality food products.

**Dairy products and analogues**

Milk is an extensively consumed food product in the diet of humans of all age groups. Milk provides almost all the essential nutrients required by the body for its growth, development and maintenance of healthy bones especially for children, women and the elderly. These include protein, carbohydrate, fats, vitamins and minerals. India is the largest producer of milk in the world.

However, milk and milk products are perishable and hence tend to spoil fast if appropriate storage temperatures are not maintained. They are also at a high risk for adulteration being
expensive commodities which are in high demand. Let us learn how milk can become unsafe for consumption.

**Spoilage and Contamination**

Milk being an excellent growth medium for many microorganisms is regarded a high-risk food product and is a highly perishable commodity. Spoiled products may cause food poisoning and/or adverse health effects on unsuspecting consumers. The contamination may occur in milk at the farm level, during manufacture of products or during transit.

Milk contains few bacteria during secretion from the udder of the healthy animals. During milking, milk may get contaminated by the exterior of the udder. There are chances of contamination from the milk contact surfaces such as dairy utensils, milk pails and milking machines. Milk can also get contaminated by the hands of dairy workers and surrounding environment. Hence, immense care needs to be taken on farm while milking animals.

Approximately, 64 per cent of the milk is sold by the unorganized sector in loose form by local farmers or traditional milk suppliers who are unaware about the regulatory requirements and the ill-effects of adding chemicals in milk.

Lack of good agricultural and good veterinary practices may lead to higher levels of residues of pesticides, antibiotics, hormones, heavy metal contaminants and mycotoxins in milk. Poor handling and storage of milk also increase the risk of pathogens in milk. Milk has a long and complex supply chain which involves collection of milk from dairy farmers, collection in chilling centres and then transportation to milk cooperatives and dairy companies for further processing and final distribution. It is necessary to maintain the temperature of milk below 4°C to protect milk quality through the supply chain.

**Adulteration of milk**

A gap in demand and supply tempts vendors to adulterate milk. It may also be adulterated to increase its shelf-life. Previously, addition of water was the most common practice but now a plethora of chemical substances are being detected in milk, which have been added to increase shelf life (like formalin, hydrogen peroxide, neutralisers, etc.) or to mask the dilution (by adding starch, urea, etc. to increase density or melamine to increase nitrogen content). Addition of water to milk may seem to be just an economic offence. However, the dilution brings down the nutritional quality of the milk. Also, if unsafe water is used for dilution, it may introduce hazardous microbes. Apart from adulteration, other practices like mislabelling (wrongly labelled for instance, claiming on the label that the product is free of antibiotic residues whereas it is not), misleading (leading the people to believe that the product has certain attributes/health benefits which it actually doesn’t have), counterfeiting (e.g. fat spread made with vegetable oil being sold as butter), are also prevalent.
Keeping it safe

Consumers have the right to expect that the milk they buy is safe and of the expected quality. Food Safety and Standards Authority of India (FSSAI) works to ensure that safe and good quality food products are available for consumers. FSSAI has the following approaches:

- FSSAI has established standards for the quality of milk and milk products. All food businesses need to comply with these standards in order to provide safe and quality products to the consumers.

- FSSAI has been conducting surveys based on sampling and quality analysis. A National Milk Safety and Quality Survey is conducted. Based on the survey report FSSAI takes necessary measures and identifies action areas to address the issues of quality and safety of milk in India.

- In order to cultivate and foster growth of compliance culture, FSSAI has notified Food Safety and Standards (Food Safety Auditing) Regulations, 2018, which also enables compliance of high-risk foods including milk, through private recognized auditing agencies.

Selection

- Milk and milk products (like curd, paneer, khoa, etc.) in loose or packaged form should be purchased from reliable and known sources.

- Since dairy products are stored at low temperature, milk and other dairy products should be bought at the end of grocery shopping. This will ensure that the products do not spoil, and consumers take them home in a fresh state. Dairy products stocked in stores at room temperature should not be purchased except otherwise indicated on the package label.

- Consumers should check the details on label properly such as FSSAI License, best before date/ manufacturing and packaging date, manufacturer’s details etc.

- To address growing concern of micronutrient deficiencies, fortification of milk with Vitamin A and Vitamin D is encouraged. Consumers should look for +F logo on the label while purchasing milk.

Cereals, pulses, millets and their products

Cereals and pulses are important sources of carbohydrates and proteins, vitamins and minerals in the daily diet of people. Many commodities in this category are staple foods in Indian diets. Selecting good quality cereal grains, pulses, and their products in daily diet is therefore important. These foods are also susceptible to certain food hazards.
Spoilage and Contamination

The spoilage of grains mainly occurs due to moisture absorption during storage. This leads to fungal growth mainly under conditions of high temperature and humidity. Cereals are often contaminated before harvest by fungal spores which may germinate and produce mycotoxins. Signs of spoilage are:

- Musty odour and off flavour
- Presence of weevils, beetles, moths and worms
- Clumping and caking

In addition, poor agricultural practices may lead to grains being contaminated with pesticides and heavy metals. Excessive spraying of crops with pesticides or mixing pesticides with harvested grains to prevent pest damage may result in high residues which are harmful to health. Growing crops in contaminated soils close to industries or using contaminated water for irrigation could lead to build up of heavy metals in the crops.

Grain allergy

Food allergy is a condition in which certain foods trigger an abnormal immune response. The symptoms of the allergic reaction may range from mild to severe, and may include itchiness, swelling of the tongue, vomiting, diarrhea, hives, trouble breathing, or low blood pressure.

Gluten is the main protein found in wheat and certain other cereal grains including rye, barley, and triticale. Gluten causes damage to the intestines of people with celiac disease or gluten intolerant patients. Patients with celiac disease or wheat intolerance should buy foods that are labelled ‘gluten-free’.

Soy allergy is one of the most common food allergies. Symptoms include stomach cramps, indigestion, diarrhea, etc. People allergic to soy should strictly avoid soy and soy products in their diet.

Keeping it safe

Grains should be stored in a cool and dry place. The drums or silos used for storage of grain and grain products should be airtight and insect proof. Grains and grain products are normally disinfested using permitted fumigants or using ionizing radiation. Before use, grains should be washed thoroughly to reduce pesticides residues and dirt and grime.

Selection

- Whole grains are healthier than the refined ones. In whole grain all three main parts bran, germ and endosperm are intact. Shelf life of some whole grains like brown rice may be less than white polished rice because of the higher fat content.
• The grain may be chewed to check the texture and flavour. Hollow, soft fibrous texture indicates poor quality.

• Sour taste or rancid flavour and odour indicate spoilage during storage.

• Grains should be free from colouring matter, molds, insects, obnoxious substances, discolouration, poisonous seeds, and foreign matter.

• Clumping in grains and grain products is an indication of insect infestation.

**Fake news: Plastic Snacks**

Media reported that some of the snacks made of cereals/ millets/pulses in the market were made of plastic. There were videos of snacks such as *namkeens* and potato chips being set aflame to prove the same. These are mainly made of cereals/millets/pulses (rich in starch), spices and oil. Starch and fats have a natural characteristic of burning when exposed to fire. The effect seen was not because they were made of plastic!

**Fruits and Vegetables**

Fruits and vegetables are called protective foods as they protect us from diseases. Therefore, it is important to consume fresh fruits and vegetables for good health. Fruits and vegetables also serve as vehicle for certain food borne contaminants and should be selected with great care.

**Spoilage and Contamination**

The spoilage of raw fruits and vegetables may result from physical injury, action of natural enzymes, microbial action, or a combination of factors. The presence of high humidity, and high temperature as extrinsic factors during storage of fruits and vegetables increase the chances of microbial growth and spoilage. Microbial spoilage results in significant economic loss throughout the distribution chain. Storage in contaminated containers, contact with decayed products, unhygienic handling, fruit fly infestation also aggravate spoilage. Fungal growth may be accompanied by formation of mycotoxins which cause serious health consequences. In addition, they may also be contaminated with pesticides and heavy metals due to poor agricultural practices.

**Keeping it safe**

Implementing Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs) are important steps to reduce food safety risks:

• Fruits should be stored under low temperature and controlled humidity conditions. In large scale storage units, the storage atmosphere can be modified by decreasing
the oxygen and increasing the amount of carbon dioxide to prolong shelf life by decreasing the respiration rate.

- The outer leaves of leafy vegetables such as lettuce and cabbage should be discarded to minimize the hazards of pesticide residues as well as microbes.
- Cut fruits and vegetables should be consumed or cooked within 1-2 hours or they should be chilled or refrigerated for longer storage.
- Fruits and vegetables should be properly washed or scrubbed under running water.
- Contact surfaces such as cutting boards, dishes, utensils should also be washed with hot water and safe detergent
- Fruits and vegetables should be stored separate from raw meat, poultry, and seafood to prevent cross-contamination.
- Chopping boards and utensils used for cutting meat, poultry and seafood should not be used for cutting fruits and vegetables.
- Fruits and vegetables infected by molds should be discarded.

Selection

- For direct consumption the selected fruits and vegetables should be free of any physical damage, mold growth, necrosis or other abnormalities.
- Fruits ripened by ethylene gas should be used. Ethylene is a natural hormone produced within the fruits and does not pose any health hazard to consumers.
- Fruits and vegetables with artificial colours should be avoided. Artificial colours on fresh fruits and vegetables may be detected by rubbing water or cotton soaked in vegetable oil on the surface. If colour appears on cotton, it indicates coating of colour on produce.
- Juice of bitter bottle gourd or lauki contains a toxic compound called cucurbitacin. Hence it should be tasted for bitterness before juicing. Do not consume the gourd even if slightly bitter. This toxic compound is also found in bitter cucumbers.
- Fruits coated with natural waxes such as bees wax at safe levels are not harmful. Coating of fresh fruits with natural waxes is done to protect moisture loss from fruits and to increase their shelf life. However, coating with non-edible waxes can be a problem.
- Unhygienic openly stored pre-cut fruits and vegetables for direct consumption should be avoided. Choose only those which are properly stored under refrigerated or low temperature conditions.
Spices and condiments

Spices and condiments are important components of our meals. These ingredients increase the palatability and appeal of the prepared food. Dry spices have longer shelf life than herbs and condiments. Even though these are consumed in small quantities they may carry potentially harmful contaminants.

Spoilage and Contamination

Buy spices in small quantities to prevent its spoilage due to insect infestation. Contaminants such as heavy metals, mycotoxins or pesticide residues are often detected in spices. High levels of microbial contamination in spices and herbs is also often reported. Studies suggest that poor conditions during postharvest handling, storage, and processing are responsible for this.

High value spices are common target for economic adulteration. Ground spices are often substituted with fillers, less expensive/low quality spices, flour, corn starch, sawdust etc. Sometimes toxic and potentially carcinogenic dyes are also added to older stocks to enhance their appearance and hide the presence of fillers. Some of the common adulterations in spices are:

- Addition of low-priced cassia in cinnamon
- Addition of papaya seeds in black pepper
- Use of sudan dye to enhance the appearance of low-quality chilli powder
- Addition of foreign resin in asafoetida.
- Addition of coloured gelatin fibres, maize cobs fibre and parts of flower other than the stigma and style in saffron.
- Exhausted spices mixed with fresh ones in small quantities to confuse the consumer.

Artificially Ripened Fruits

To avoid spoilage of fruit during transport and storage, traders generally harvest raw fruits and then artificially ripen them near the point of sale. Artificial ripening is the process by which ripening is controlled to achieve desired characteristics intended for better consumer acceptance and improving sales. It is generally done for climacteric fruits such as mango, papaya, banana, etc. to achieve faster and uniform ripening characteristics. There is no harm in consuming fruits artificially ripened with ethylene gas as it is also naturally produced by fruits during the process of ripening. However, use of calcium carbide is not permitted for ripening fruit as it can leave traces of arsenic on the fruit which can be very harmful if consumed. Its use is banned in India.

Keeping it safe

Spices should be stored in cool and dry place preferably in airtight containers to prevent loss of aroma and microbial spoilage. Storing spices for long duration should be avoided at home. During long term storage, spices and condiments are prone to insect and microbial contamination. This may be controlled by using fumigants or physical processes such as irradiation on a large scale. The problem of microbial and chemical contaminants is best mitigated though the use of good agricultural practices in the field as well as post-harvest drying, processing and storage.

Selection

- While buying whole or ground spices from the market it is better to avoid spices with extra shine and bright colour as they are more likely to be adulterated.
- Do not buy spices having lump formation or unpleasant odor.
- Do not buy spices having visible mold growth or insects.
- Always read the best before date, manufacturing date, manufacturer details and other labelling claims before buying the spices.
- Always check FSSAI organic logo (Jaivik Bharat) before buying organic spices.
- Cumin seeds are sometimes adulterated with grass seeds coloured with charcoal dust by the fraudsters. Rub small amount of cumin seeds on palm and if palm turns black it indicates the adulteration with coloured grass seed.
- Cassia is often mislabelled and marketed as Cinnamon due to similarity in appearance and characteristics. Bark of cinnamon is thin and can be rolled up in multiple layers to form compact stick, whereas, cassia bark is thick and looks like hollow tube on rolling.
- Exhausted whole spices (volatile oil extracted) mainly cloves, cardamom etc. should be checked before buying. Exhausted spices are light in weight and if put in water will float while genuine spices tend to settle at the bottom.
- Do not buy powdered spices available in loose form. Sale of powdered spices in loose form is not permitted by FSSAI due to high possibility of adulteration.
- Always buy powdered spices in packaged condition from trusted brands only. Check the FSSAI license number and AGMARK logo on packed spices.
Edible Oils and Fats

Edible oils and fats are an essential part of a healthy diet and are a major source of energy. Edible oils and fats also add to the taste and palatability of the product. However, a high intake of fat is associated with increased incidence of non-communicable diseases such as obesity, diabetes, hypertension and cardiovascular diseases. It is important therefore to limit their intake and select the type of oils to be used in order to maintain good health.

Sources of oils or fats are both plant and animal based. Milk fats such as ghee and butter are rich in SFA, whereas, plant sources (vegetable oils) are predominantly rich in MUFA and PUFA, except coconut oil and palm oil. Of all the fatty acids, omega-3 and omega-6 are considered as essential fatty acids since these cannot be synthesized in the body.

Spoilage and Contamination

The oils and fats are mostly spoiled due to rancidity. Rancid oils have characteristic unpleasant odour and flavour. The oils may go rancid due to oxidation or hydrolysis when exposed to air, light, moisture, enzymes or by bacterial action. In refined oils, spoilage due to flavour reversion is generally observed i.e. the development of objectionable flavours before the onset of rancidity when exposed to UV light, visible light or heating.

Oils and fats like ghee being expensive are also susceptible to adulteration with cheaper oils and fats. Unrefined oils like groundnut oil may be contaminated with Aflatoxin if fungal infested groundnuts are used for oil extraction. Mustard oil may be contaminated with Argemone oil as the Argemone plant often grows wild next to the mustard crop and their seeds are similar in appearance.

Keeping it safe

- Store in an airtight container.
- Do not store in plastic container. Store in stainless steel or glass container.
- Do not store at warm places such as near the stove etc.
- Do not reuse frying oil to avoid the formation of polar compounds and other harmful breakdown products which have detrimental effects on health. Its best to use the oil left after frying for making other preparations provided it is clear, has not got discoloured or become viscous.
Selection

It is best to buy cooking oils and fats from reliable sources. Buy only packaged oils and check all the essential details on the label viz. FSSAI license number, best before/expiry date, type of oil, etc. The packaging should be opaque to prevent light from causing oxidative damage to the oil. Consume a variety of oils, rotating them every month or using different kinds of oils and fats for preparing different dishes. This is because no one oil is perfect. Having a variety will give you all the nutritional benefits. Avoid using fats which are rich in trans fats like vanaspati, margarine, partially hydrogenated fats or products made from these.

<table>
<thead>
<tr>
<th>Safe Use of Cooking Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeated use of cooking oil for frying should be avoided as it leads to the production of polar compounds which are harmful for health. Fresh oil should never be mixed with old used oil and stored as it can also get spoiled. Used cooking oil should be filtered before storage and used within a day or two. It can be used for preparing some other dish also. You should discard the oil if it darkens, starts foaming or becomes viscous.</td>
</tr>
</tbody>
</table>

Meat, Poultry, Fish and Eggs

Meat and other flesh foods are considered a good source of protein and certain vitamins. Fish is a good source of essential fatty acids. However, these foods are highly perishable. Flesh foods are also a potential source of microbial pathogens, hence, require special attention while handling.

Spoilage and Contamination

Flesh foods and eggs may be contaminated with veterinary drug residues like hormones, antibiotics, etc which were administered to the animal or bird. Contaminated feed can also transfer chemical contaminants like pesticide residues to the meat and eggs. Meat is one of the highly perishable commodities owing to its composition and high moisture content. Spoilage of meat and meat products occur due to the contaminating microorganisms (bacteria or fungi) and enzymatic activity. Meat spoilage may show the following signs:

- Surface slime: Growth of bacteria on the surface of the meat leads to formation of slime.
- Changes in colour of meat pigments: The red colour of meat, called its “bloom,” may be changed to shades of green, brown, or grey.
- Black spots or red spots or green patches on the surface: Due to fungal growth.
- Rancidity: The oxidation of unsaturated fats leads to rancidity (off-odours and off-flavours)
• **Souring**: It results due to lactic acid activity and enzymatic action.

• **Phosphorescence (photoluminescence)**: This defect is caused by phosphorescent or luminous bacteria, e.g., *Photobacterium* spp., growing on the surface of the meat. Such meat will show luminous (shining) areas on its surface.

**Fish** is also highly perishable and source of microbial pathogens. It may also contain naturally occurring toxicants. Many people may be allergic to fish and other seafood. Fish are also likely to contaminated with heavy metals like mercury.

The spoilage of fish begins as soon as fish dies, which results in the undesirable change in the colour, texture, flavour, odour, and appearance. Spoilage of fish is also referred to as “putrefaction”. In raw fish, spoilage takes place mainly due to three reasons mentioned below:

• **Enzymatic (autolytic) action**: This results in flavor changes in fish, belly bursting and color changes in the fish (Black/blue discoloration, yellowing of fish flesh, brown discoloration),

• **Microbial action**: Bacteria are present on the skin, gills and intestine of fish. In dead fish bacteria begin to invade the tissues causing spoilage and production of undesirable compound. This may result in the foul smell due to the formation of ammonia, trimethylamine and indole production. Microbial spoilage of fish also produces the toxin, histamine in certain fishes.

• **Chemical action (oxidation of fats)**: Fat oxidation (breakdown of fat) gives rise to rancidity such as rancid flavour and odor as well as discoloration.

**Specific fish hazards**

• **Biotoxins**: Biotoxins gets accumulated in fish/shellfish which include brevetoxins, okadaic acid, saxitoxins, ciguatoxin and domoic acid.

• **Allergens**: Hypersensitivity to an allergen present in fish can happen, which may result in an overreaction of the immune system and lead to severe physical symptoms.

• **Mercury and other toxic metals**: Fish products have been shown to contain varying amounts of toxic metals. Organometallic forms such as dimethyl mercury and tetraethyl lead can be extremely toxic.

Persistent organic pollutants: If fish and shellfish inhabit polluted waters, they can accumulate toxic chemicals, particularly fat-soluble pollutants containing chlorine or bromine, dioxins.
Parasites: Parasites in fish are a natural occurrence and common. Though not a health concern in thoroughly cooked fish, parasites are a concern when consumers eat raw or lightly preserved fish.

Formalin: Formaldehyde is naturally present in fishes. Formalin (formaldehyde in water) is also a common adulterant used in fish by the traders and suppliers to extend the storage life of fresh or chilled fish and artificially improve the sensory attributes. Ingesting large amounts of formaldehyde can cause health problems like abdominal pain, vomiting, coma, and renal injury.

Freshly laid eggs are sterile. Shells soon become contaminated by faecal matter of hen, cage or nest, water used for cleaning and washing of eggs, handling and packaging materials. In general, more spoilage is caused by bacteria than molds. Three main types of spoilage are green rot, colourless rot and black rot. The other two types of spoilage are pink rot and red rot.

### Types of Bacterial Spoilage in Eggs

- Green rot is caused by *Pseudomonas fluorescens*
- Colourless rot is caused by *Pseudomonas, Acinetobacter and Alcaligenes.*
- Black rot is most commonly caused by *Proteus sp.* *Pseudomonas* and *Aeromonas* can also cause black rot.
- Pink rot is caused less often by strains of *Pseudomonas.*
- Red rot caused by *Serratia* occurs quite rarely

Molds that cause spoilage of eggs include species of *Penicillium, Cladosporium, Sporotrichum, Mucor, Alternaria and Botrytis.*

Development of off-flavours or mustiness may be caused in eggs by bacteria. The growth of *Streptomyces* near the egg may produce earthy or musty flavours that are absorbed by the egg. A hay odour is caused by *Enterobacter cloacae.* Fishy flavours are produced by certain strains of *E. coli.*

**Keeping it safe**

Following steps should be adopted while handling flesh foods and their products to keep them safe:

- Wash hands and surfaces often.
- Fish should be thoroughly washed with running tap water to remove the formaldehyde present in the fish, especially marine fish.
- Don't cross-contaminate. Keep raw and cooked meat separately. Store meat in sealed, moisture proof carry bags to avoid any contamination or dripping into other foods. Wrap the cooked meat tightly while storing.
• Cook to the right temperature. In general, all flesh foods should be cooked to achieve minimum core temperature of 75 °C or higher.

• Store at right temperature. Meat must be stored in a chiller (4 °C) for short term storage (up to 4 days) or in the freezer (-18 °C or lower) if it needs to be stored longer. To avoid any health risk, the chilled meat shall be consumed within 2 to 4 days and the frozen meat shall be consumed within 10 -12 months.

• Fish may be chilled in refrigerator (4 °C) or may be covered with layers of ice for short term storage or in the freezer (-18 °C or lower) if it needs to be stored longer.

• Wet or dry salting can be done to increase its shelf life.

• The fish or fish product can be dehydrated to improve its storage life.

• Frozen products should be thawed slowly, in the refrigerator.

• Always wash hands thoroughly with soap and water after handling flesh foods and even eggs.

• Take out only as many eggs as needed for immediate use. Do not stack egg (trays) near the grill or stove.

• Use only clean, uncracked eggs.

• Avoid washing eggs. However, in case of dirty/soiled eggs, it is advised to clean it using a piece of sandpaper.

• Never mix the shell with internal contents of the egg.

• Do not reuse a container (blender, bowl and mixer) after using raw egg in it. Clean and sanitize the container thoroughly before using again.

• Never leave egg dishes at room temperature for more than one hour (including preparation and service time).

• Refrigeration keeps eggs fresh for longer duration as compared to room temperature, and also minimises the risk of any bacterial growth.

• Store eggs away from foods with strong odours (such as fish, cabbage or onions).

• Rotate egg use – Follow the First in/First out (FIFO) principle.

• Good veterinary practices will prevent contamination of flesh foods and eggs with drug residues.

• Control of quality of feed given to animals will help in ensuring that other contaminants like residues of pesticides are not transferred to the flesh foods and eggs.
Selection

The following points should be taken into consideration while selecting any meat or poultry products for consumption:

- Meat should have a uniform colour throughout the cut and should have no slime formation on the surface. Avoid meat that has discolouration.
- Meat should have a normal smell. Any rancid or strange smelling meat should be avoided.
- Always make sure the meat is firm to the touch. It can be tested by poking it. Meat that doesn’t come back to the original shape or is too tight to poke should be avoided.
- Do not procure meat from places having unhygienic conditions.
- Avoid buying meat from retail shops who hang the carcasses in open. Prefer to buy packaged and chilled/frozen meat.
- Never buy meat that is wrapped in newspaper or coloured plastic bags.
- For packaged meat or poultry products, always closely examine the labelling with respect to its ingredients, use by date or expiry date.
- Do not select meat or poultry in packaging that is torn or leaking.

Following parameters of fish should be examined while selecting it for human consumption:

- Clear eyes: The eyes of the fish should be crystal-clear, plump, wet, and shiny, with no sunken features. Once the fish begins to deteriorate, the eyes dry out, become cloudy, and sink in or shrivel away.
- Healthy tail and fins: The tail and dorsal fins of the fish should be healthy-looking, wet, and intact. A fish that has been mishandled will have torn or ragged fins, while an older fish’s fins will be dry and brittle.
- Firmness: It can be done by poking the fish. Fish that has lost its firm shape is no longer fresh.
- Colour of gills: The brighter the colour, the fresher the fish. When first caught, a fish’s gills appear bright red, and slowly darken over time becoming dark brown or even black in colour. The gills will become slimy and sticky if spoiled.
- Touch the scales: The scales should be shiny and firm. Less-fresh/spoiled fish will often shed scales when touched, and they may appear dry and flaky.
- Look for cracks and breaks in fillets: Look for cracks in the fillet that run between the muscles and collagen sheath (the white lines running through the fish). Breaks in the muscle itself tend to indicate mishandling. Natural separation of the muscles along the collagen sheaths indicates that the fish is not very fresh.

- Fish flesh: For white fish, such as cod or halibut, the meat should look fairly translucent. If it is very opaque and extremely white, it's a sign that the flesh is not fresh. For darker meat, like tuna or salmon, the flesh should be bright and very saturated in color. For all fish, make sure the flesh is wet and glossy. Fish that is sticky, dry, or chalky has likely been handled improperly (held at warm temperatures), frozen and thawed several times, or is old.

- Packaged fish or fish products: Always closely examine the labelling with respect to its ingredients, use by date or expiry date (whichever is mentioned) and the quality of packaging material.

The following points should be considered while selecting the eggs:

- Visual inspection (exterior): While the egg is in shell, check that the shell is not cracked, slimy or powdery. Sliminess or cracks can indicate the presence of bacteria, while a powdery appearance on the shell may indicate mold.

- Visual inspection (interior): Fresh eggs will have milky or clear whites and a bright yellow or orange yolk. If the egg is rotten, the whites will be thin and watery or may look pink and the yolk will flatten out.

- Smell: Uncooked fresh eggs should have a neutral odour and should not smell sulphuric or sour. If the egg smells bad before or after you crack it, it is rotten.

- Read the use-by date on the carton. Eggs can usually last up to 3 weeks if stored in the refrigerator. The use by date on the carton is usually a good indication of whether the eggs are still fresh.

- Perform float test: If the egg sinks to the bottom, it is still fresh. If the egg sinks but stands upright on the bottom of the container, the egg is slightly old. If the egg floats in water, it should be avoided as such eggs might be stale or rotten.

**Myth Buster: Plastic Eggs**

Plastic eggs or artificial eggs are a myth mainly because there is no technology available to manufacture an egg which perfectly resembles the natural egg. Eggs stored at high storage temperatures tend to spoil faster with the whites becoming watery and the membrane around the yolk rupturing resulting in mixing of the egg yolk and white. Depending on the variety of hen and also freshness of the egg, the egg membrane may sometimes be thick also. It is best to store eggs in a refrigerator and consume within a few days.

Other Products

Organic Foods

Section 22 of the Food safety and Standards Act 2006 provides for establishment of regulations for organic foods. Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. It combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved (IFOAM).

Consumers are interested in buying foods which are free from pesticides and other contaminants. The country’s organic food market is transforming into the world’s fastest growing segment. Consumer’s decision to buy organic foods is typically affected by the variables such as price, health consciousness, certification and labeling, availability, and environmental concerns.

Organic foods are produced from various crops in accordance with the organic production standards where the commodities are grown under a system of agriculture without the use of chemical fertilizers and pesticides with an environmentally and socially responsible approach and processed as per the prescribed standards.

Selection of organic products and regulatory mechanism

To ensure consumer’s trust, there is need of establishing genuineness and authenticity of foods claimed as ‘Organic’. To ensure this, a regulatory mechanism backed by a robust certification system is required.

Section 22 of the Food Safety and Standards Act, 2006 (FSS Act, 2006) gives mandate to Food Safety and Standards Authority of India to regulate manufacture, distribute, sell or import organic foods. Food Safety and Standards (Organic Foods) Regulations, 2017 have been notified.

The organic foods should comply with provisions of any one of the following certification system:

- National Programme for Organic Production (NPOP) notified by Directorate General of Foreign Trade (DGFT) under the Foreign Trade (Development & Regulations) Act, 1992. It is a quality assurance initiative by the Government of India under the Ministry of Commerce and Industry. The NPOP not only provides the institutional framework for accreditation of certification agencies and operationalization of certification programme through its accredited certification agencies but also ensures that the system effectively works and is monitored on regular basis.

- Participatory Guarantee System for India (PGS-India) implemented by Department of Agriculture, Cooperation and Farmer’s Welfare through National Centre of Organic Farming (NCOF)- PGS-India certify producers based on active
participation of stakeholders and are built on a foundation of trust, social networks and knowledge exchange. People in similar situations (small holder producers) assess, inspect and verify the production practices of each other and take decision on organic certification. National Advisory Committee is the apex policy making body for PGS India Programme and National Centre of Organic Farming is the Secretariat of the PGS programme.

Organic food needs to comply with the requirements of Food Safety and Standards (Labelling) regulations in addition to that of NPOP or PGS-India. Additionally, organic food products shall carry Food Safety and Standard Authority of India’s organic logo and may carry certification or quality assurance mark of NPOP/PGS-India.

Traceability should be established through one of the above mentioned systems. Both NPOP and PGS-India have well established traceability system for products.

Sales by small original producer or producer organisation directly to the end consumer are exempted from provisions of any of the above mentioned two systems.

All organic food need to comply with the requirements of product standards as provided in the Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011 Regulations and contaminants, toxins as provided in the Food Safety and Standards (Contaminants, Toxins and Residues) Regulations, 2011 except for residues of insecticides for which the maximum limits shall be 5% of the maximum limits prescribed or Level of Quantification (LoQ) whichever is higher.

Organic food imports under bilateral or multilateral agreements on the basis of equivalence of standards between NPOP and the organic standards of the respective exporting countries shall not be required to be re-certified on import to India. India had equivalence agreements with EU, Switzerland and with USA for conformity assessment (as per information available till December 2019).

Consumers are reluctant to buy organic food from the market because they are not sure about its genuineness. FSSAI’s ‘Jaivik Bharat Logo’ enables consumers to distinguish organic foods as authentic organic foods available on the shelves. Additionally, FSSAI has also developed “Indian Organic Integrity Database Portal” which is a repository of Organic Food Business Operators certified under NPOP and PGS-India. This would help consumers verify the authenticity of organic foods. Through this portal, consumers can access all information with respect to the producer, the certification system and the availability of certified organic products in specific markets.
**Irradiated Foods**

Section 22 of the Food safety and Standards Act 2006 provides for establishment of regulations for irradiated foods. Radiation processing of food or food irradiation is a physical process in which food commodities, bulk or pre-packaged are exposed to controlled doses of energy of ionizing radiation such as gamma rays or X-rays to achieve different technological objectives. These technological objectives include extension of shelf life, destruction of storage and quarantine insect pests, and killing of parasites, pathogens and spoilage microorganism. Radiation processing can thus be used for enhancing food safety, food security and international trade.

**Salient features of the technology**

Radiation processing of food involves the controlled application of energy from ionizing radiations such as gamma rays, electrons and X-rays for food preservation.

- Ionizing radiations are short wavelength radiations of the electromagnetic spectrum. X-rays and gamma rays are examples of ionizing radiations.

- Radiation processing of food is carried out inside a radiation shielded chamber. Food either pre-packed or in bulk placed in suitable containers is sent into it with the help of an automatic conveyor.

- The absorbed dose is determined by the residence time of the carrier or tote box in irradiation position. Absorbed dose is checked by placing dosimeters at various positions in a tote box or carrier.

- Advantage of radiation processing of food is that it does not leave any harmful toxic residues in food and is more effective.

- The irradiation process does not make the food radioactive, the food itself never comes in contact with the radioactive material.

- Extensive scientific studies have shown that irradiation has a very little effect on the main nutrients in food. Very little change in vitamin content is observed in food exposed to low doses.
Safety and wholesomeness of irradiated foods

Foods processed by radiation have been subjected to a thorough assessment of safety in national and international laboratories. These studies show that food irradiation presented no toxicological, nutritional or microbiological problems. The food products that can be irradiated are:

- Fresh fruits and vegetables including bulbs, stem and root tubers and rhizomes
- Cereals and their milled products, pulses and their milled products, nuts, oil seeds, dried fruits and their products
- Fish, aquaculture, seafood and their products (fresh or frozen) and crustaceans
- Meat and meat products including poultry (fresh and frozen) and eggs
- Dry vegetables, seasonings, spices, condiments, dry herbs and their products, tea, coffee, cocoa and plant products
- Dried foods of animal origin and their products
- Ethnic foods, military rations, space foods, ready to eat, ready to cook/minimally processed foods
- Food additives
- Health foods, dietary supplements and nutraceuticals

How safe are Irradiated Foods?

Food irradiation is a physical process in which food is exposed to controlled doses of ionizing radiation (gamma rays or X rays) to extend the shelf life of food. The radiation destroys pests and microbes without harming the food constituents. No harmful effects on human health have been reported.


Regulatory framework

Regulations on radiation processing have been notified under the Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011, as per these Regulations, all packages of radiation processed food shall bear the Radura logo in green colour and following declaration, namely:
**Table 10.1: Some hazards associated with different food categories**

<table>
<thead>
<tr>
<th>Food</th>
<th>Physical hazard</th>
<th>Chemical hazards</th>
<th>Biological/Microbiological hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy products</td>
<td>Glass, chipped pieces from equipment, metal shavings from cans and foils, plastic pieces, lint and threads, hair, finger nails</td>
<td>Detergents, sanitizers and disinfectants, urea, hydrogen peroxide, other preservatives, neutralizers, pesticides, antibiotic and veterinary drug residue, hormones, metal contaminants, residues from packaging materials</td>
<td>Mycotoxins (Aflatoxin), Salmonella, Escherichia coli, Listeria monocytogenes, Staphylococcus aureus, Yersinia enterocolitica, Bacillus cereus, Clostridium botulinum, Mycobacterium bovis, Brucella abortus, Brucella melitensis</td>
</tr>
<tr>
<td>Cereals and pulses</td>
<td>Glass, nail chipping, hair, stones, grit, dirt, pest droppings, metal pieces plant parts, debris, weeds, seeds</td>
<td>Pesticide residues, metal contaminants, naturally occurring toxic substances (Lathyrus or Khesari dal with neurotoxin BOAA - beta-oxalyl aminoalanine; Trypsin inhibitors, Haemagglutinins, Cyanogenic glycosides), metal contaminants</td>
<td>Mycotoxins (Aflatoxin) Bacillus cereus</td>
</tr>
<tr>
<td>Fruits &amp; Vegetables</td>
<td>Dirt, weeds</td>
<td>Pesticide residues, heavy metals, naturally occurring toxic substances (cucurbitacins, goitrogens, solanine, etc.)</td>
<td>Insect larvae, mycotoxins Escherichia coli O157:H7, Salmonella spp., Listeria monocytogenes.</td>
</tr>
<tr>
<td>Spices and condiments</td>
<td>Dirt, weeds, foreign seeds, straw</td>
<td>Pesticide residues, heavy metals, artificial colors</td>
<td>Mycotoxins, Salmonella spp.</td>
</tr>
</tbody>
</table>
### Summary

- Foods have been categorized into 16 major categories. These categories have been further divided into subcategories comprising of similar products.

- Milk and milk products are regarded as high risk foods, highly perishable and susceptible to adulteration. In addition, they may be contaminated with pesticide residues, heavy metals and mycotoxins the source of which might be the contaminated feed given to milch animals. They may also have residues of veterinary drugs administered to the animals.

- FSSAI has established standards for the quality of milk and milk products. All food businesses need to comply with these standards in order to provide safe and quality products to the consumers.

- Cereals, pulses, millets and their products are prone to fungal and pest infestation. In addition, poor agricultural practices may lead to grains being contaminated with pesticides and heavy metals. A few people may be allergic to the wheat protein – gluten and to soyabean.

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<table>
<thead>
<tr>
<th>Food</th>
<th>Physical hazard</th>
<th>Chemical hazards</th>
<th>Biological/Microbiological hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat</td>
<td>Dirt, shards of bone</td>
<td>Pesticide residues, heavy metals, naturally occurring toxic substances, veterinary drug residues</td>
<td>Salmonella, Campylobacter, Listeria, E. Coli, Pseudomonas spp.</td>
</tr>
<tr>
<td>Fish and seafoods</td>
<td>Dirt, microplastics, pieces of bone</td>
<td>heavy metals, naturally occurring toxic substances (Biotoxins: brevetoxins, okadaic acid, saxitoxins, ciguatoxin, domoic acid), veterinary drug residues</td>
<td>Salmonella, Shigella, E. coli, S. aureus, Clostridium botulinum, Vibrio sp., Aeromonas sp.</td>
</tr>
<tr>
<td>Eggs</td>
<td>Dirt, bird droppings</td>
<td>Pesticide residues, heavy metals, veterinary drug residues</td>
<td>Salmonella, Pseudomonas, Streptococcus, Alcaligenes, Staphylococcus, Bacillus, Flavobacterium, Proteus, Serratia, Arthrobacter and Micrococcus spp</td>
</tr>
<tr>
<td>Fats and oils</td>
<td>-</td>
<td>Polar Compounds, adulterants like mineral oils, paraffin, argemone oil</td>
<td>Mycotoxins</td>
</tr>
</tbody>
</table>
• Fruits and vegetables are highly perishable foods and spoil on keeping due to natural enzyme action or microbial action. They may also be contaminated with mycotoxins, pesticides and heavy metals due to poor agricultural practices.

• Appropriate selection, processing and cooking methods can be used to decrease the exposure to contaminants.

• Spices and condiments are susceptible to insect infestation. Contaminants such as heavy metals, microbes, mycotoxins or pesticide residues are often detected in spices. High value spices are common target for economic adulteration.

• The oils and fats are mostly spoiled due to rancidity. The oils may go rancid due to oxidation or hydrolysis when exposed to air, light, moisture, enzymes or by bacterial action. Oils and fats like ghee being expensive are also susceptible to adulteration with cheaper oils and fats.

• Meat, poultry, fish and eggs have a high microbial load and be contaminated with disease causing germs. They need to be handled very carefully. These may also be contaminated with veterinary drug residues or pesticide residues.

• It is important to select these foods with great care.

• Organic foods are produced without the use of chemical fertilizers and pesticides with an environmentally and socially responsible approach. Section 22 of the Food safety and Standards Act 2006 provides for establishment of regulations for organic foods.

• The organic foods should comply with provisions of either National Programme for Organic Production (NPOP) or Participatory Guarantee System for India (PGS-India).

• FSSAI’s ‘Jaivik Bharat Logo’ enables consumers to distinguish organic foods as authentic organic foods available on the shelves. Additionally, FSSAI has also developed “Indian Organic Integrity Database Portal” which is a repository of Organic Food Business Operators certified under NPOP and PGS-India.

• Radiation processing of food or food irradiation is a physical process in which food commodities, bulk or pre-packaged are exposed to controlled doses of energy of ionizing radiation such as gamma rays or X-rays to achieve different technological objectives.

• Regulations on radiation processing are notified under Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011. As per these Regulations, all packages of radiation processed food shall bear the Radura logo in green colour along with a declaration.
Key Words

**Jaivik Bharat Logo** – symbol to identify authentic organic foods

**Irradiated food** - involves the controlled application of energy from ionizing radiations such as gamma rays, electrons and X-rays for food preservation.

**Organic food** – foods produced without the use of chemical fertilizers and pesticides with an environmentally and socially responsible approach

**Radura logo** – symbol to identify food processed by radiation

Exercises

1. Briefly explain the purpose of classifying food into different categories.

2. List the different types of contaminants and adulterants which may be found in milk and milk products.

3. What points should be kept in mind while selecting the following foods:
   a. Grains
   b. Vegetables
   c. Fish
   d. Eggs
   e. Spices

4. Describe the kinds of spoilage seen in:
   a. Meat
   b. Grains
   c. Fruits
   d. Oils

5. What are the kinds of adulterants that have been seen in spices?

6. What are the special types of hazards found in fish?

7. What are organic foods? How is their sale regulated in India?

8. Explain the technology of food irradiation in simple terms. Give examples of foods which are irradiated in India.
References


Chapter 11: Regulatory Food Testing Ecosystem

- Types of food testing laboratories in India
  - Role of Food laboratories

- Accreditation of laboratories

- Strengthening the food testing ecosystem
  - Capacity building of Food laboratories
  - Significance of competent staff in food laboratories
  - Significance of Rapid Test methods
  - Connecting with Consumers
Chapter 11: Regulatory Food Testing Ecosystem

In any effective regulatory food system, a food testing ecosystem is critical to evaluate the quality and safety of foods, their compliance to set standards and also identify any emerging risks from farm to fork or plate to palate. This would, directly or indirectly, help various stake holders in eliminating unsafe food from the supply chain or avoid their consumption. Simultaneous development of infrastructure, qualified technical manpower and time-tested harmonized methods are needed to make any food testing ecosystem a robust and efficient one.

Establishment of a robust regulatory food testing ecosystem involves following vital components:

- Food testing laboratories at state and national levels with advanced facility and equipment.
- Pool of Competent Staff
- Efficient capacity building system
- System to oversee the competence of testing in these laboratories through accreditation and certification.

Food testing laboratories ensure an effective food safety mechanism in the country. They play an important role in ensuring safety and quality of food through testing of foods/food products for adulterants/contaminants and for assessment of product quality and nutritive value.

Types of food testing laboratories in India

As per FSS Act, 2006 “food laboratory means any food laboratory or institute established by the Central or a State Government or any other agency and accredited by National Accreditation Board for Testing and Calibration Laboratories or an equivalent accreditation agency and recognised by the Food Authority under section 43”. The section 43 of FSS Act 2006 empowers FSSAI

- to notify food laboratories and research institutions accredited by National Accreditation Board for Testing and Calibration Laboratories or any other accreditation agency for the purposes of carrying out analysis of samples.
- to establish or recognise by notification, one or more referral food laboratory or laboratories
- to frame regulations specifying the functions of food laboratory and referral food laboratory, procedure for submission of food samples for analysis, forms of the laboratory’s reports, analysis fee and other matters to carry out its functions effectively.
FSSAI has formulated FSS (Laboratory and Sample Analysis) Regulations, 2011 to specify the functions of Referral laboratories, sampling procedure and formats for sample submission and analysis report. Further, FSS (Recognition and Notification of Laboratories) Regulations, 2018, was framed for recognition and notification of laboratories to improve and streamline the process of notification of food laboratories. These regulations not only provide a legal foundation for the operation of the laboratory system that already exists under the ambit of FSS Act 2006, but also usher transparency by defining the procedural requirements for the recognition and notification of food testing laboratories. The categorizations of laboratories notified by FSSAI are shown in Figure 1.

The roles and responsibilities of all laboratories notified by FSSAI are given below:

**National Reference Laboratories (NRL’s):** FSSAI has recognized around 15 of its primary and referral laboratories as NRLs, for the purpose of developing/verifying/validating methods of testing, assessing proficiency of notified food labs, providing training to the laboratory personnel and develop repository of information in a designated product/analyte category. These NRLs would set up a country wide standard for routine procedures, reliable testing methods and validation of such standard procedure/testing methods, development of new methods and ensuring proficiency in testing across the food laboratories with special reference to the risks or food categories. Once operationalized, all the NRLs would be brought into a single umbrella called the Network of NRLs (NNRLs) forming another subset of higher tier laboratories.

**Referral Food Laboratories (RFL’s):** FSSAI has notified around 19 referral laboratories which include state government labs, research Institutes and private NABL labs. These referral labs are responsible for the analysis of food samples submitted by food safety inspectors and providing the certificate of analysis. RFLs are also responsible for investigation for the purpose of fixation of standard of any article of food, capacity building, collaboration with state labs and food analyst, maintaining high standards of accuracy, reliability and credibility in the analysis, ensuring competency of the laboratories.

**Primary Laboratories:** Any laboratory accredited against ISO/IEC 17025 by the National Accreditation Board for Testing and Calibration Laboratories or other equivalent accreditation agency and having adequate capability and competence for testing of food safety and quality parameters as per FSS Act can apply online to be notified by FSSAI. Several such laboratories have been notified for the purpose of carrying out analysis of food samples taken under the Food Safety and Standards Act 2006 and Rules and Regulations made thereunder.
**Mobile labs**: Availability of testing facilities in remote areas is a greater challenge which needs to be addressed on a priority basis in order to assure safe food to citizens in those parts of the country. To address this issue of lack of food testing infrastructure in the remote areas and to cater to the basic analytical needs of consumers, FSSAI has also established mobile food testing laboratories referred to as Food Safety on Wheels (FSW). Apart, from conducting simple tests for common adulterants in milk, water, edible oil and other items of food of daily consumption, the FSW would also be used for awareness building around food safety, hygiene and promoting healthy eating habits in citizens at large. Apart from testing and training, the FSWs would also help regulatory staff or the field functionaries in the states to enhance their outreach; and, also help in conducting surveillance activities even in far-flung areas.

**Role of Food laboratories**

Food analysis laboratories play crucial role in enforcement of food regulations including monitoring and surveillance activities of food safety. They don’t just monitor foods produced in the country but also help in regulating imported foods and their safety. The sample taken by the food safety officer as per FSS Act is analysed by a FSSAI notified lab to test its compliance against set standards and its authenticity. The risk-based analysis of imported products for its compliance against FSS quality and safety parameters and clearance is also done by FSSAI notified labs. In addition to this, food laboratories are integral component of all monitoring and surveillance activities done by FSSAI. The INFOlNET (See Box 1) provides back-end integration with existing core IT solutions like Food Licensing & Registration system (FLRS) and Food Import Clearance System (FICS) for the ease of doing business.

**Box 1: Digitization and networking of food laboratories in India**

FSSAI has developed an information technology solution for benefit of food testing laboratories in the country called the Indian food laboratory network or INFOlNET. In this, all the laboratories in the network will be connected to a centralized system. The INFOlNET also integrates with FSSAI’s core IT system such as licence, registration, imports, surveillance etc. INFOlNET allows the laboratories to centrally digitise information related to their activities such as, their testing facility, manpower details, infrastructure details, sample management & tracking and publishing test reports. They are also provided interface to share laboratory test reports on a real time basis with stakeholders. These are hoped to result in better handling of samples and surveillance activity apart from creating a transparent system that would build stakeholder confidence in food testing. A new online feature called Surveillance Regulatory Compliance has been introduced in this network. In this, states can plan and initiate their surveillance with the advantage of having lab information at common place under the preview of FSSAI HQ.
Accreditation of laboratories

Laboratory accreditation is a procedure by which an authoritative body gives formal recognition of technical competence for specific tests/measurements. It is based on third party assessment and follows international standards. This formal recognition of competence of a laboratory creates confidence in testing reports issued by the laboratory. It also provides feedback to the labs on their quality assurance system and technical competence for further improvement.

In India, National Accreditation Board for Testing and Calibration Laboratories (NABL), a Constituent Board of Quality Council of India is the nodal agency for the accreditation of food testing laboratories. NABL has been established with the objective to provide Government, Industry Associations and Industry in general with a scheme for third party assessment of the quality and technical competence of testing and calibration laboratories against ISO/IEC 17025. ISO/IEC 17025 is an international standard which enables laboratories to demonstrate that they operate competently and generate valid results, thereby promoting confidence in their work both nationally and around the world.

Strengthening the food testing ecosystem

Certain critical inputs are required to strengthen the food safety ecosystem. Building the capacity of laboratories and training and developing competence of food analysts are important. In addition, there is need for innovative initiatives which can strengthen the role of laboratories in enforcement, monitoring and surveillance as well as empower consumers.

Capacity building of Food laboratories

Capacity building is as a process aimed at strengthening the skills of individuals as well as of food labs to cope with new trends and the emerging changes. FSSAI through its various initiatives and collaborations with Government institutions, International bodies and Private laboratories ensures continuous upgradation of technical skills of Food Analysts and other laboratory staff with the aim to acquaint them with latest analytical techniques and methods. State of art training facilities are critical in providing classroom training and hands on training on new and advanced analytical techniques. One such facility is being created at Mumbai in association with EIC and GFSP. This facility would also help in creation of a mechanism to share information and best practices among a network of scientific peers on continuous basis.

Significance of competent staff in food laboratories

Competency of staff is one of the important components of any food laboratory apart from its infrastructure and testing facility. In order to create a pool of competent staff, FSSAI regularly conducts Food Analyst examination through a rigorous selection process as per the FSS Act, 2006. The objective is to identify and encourage qualified technical manpower for the food testing laboratories. These certified food analysts are responsible for analysis of food samples submitted by food safety officers for enforcement or
surveillance purpose. ISO 17025 also prescribes requirements and technical qualifications for the personnel involved in the food analysis of samples. Inefficient staff may generate erroneous analytical results adversely impacting the process of prosecution of food vendors.

**Significance of Rapid Test methods**

The incidence of foodborne diseases has increased over the years and resulted in major public health problems globally. Generally, foodborne diseases are caused by the consumption of food or water contaminated with microbial or chemical contaminants. To provide safe food to the consumers and to minimize the occurrence of foodborne diseases it is essential to analyse the food for the presence of foodborne pathogens or chemical contaminants. From simple visual inspections and chemical analyses to microbial assays and culturing techniques, food quality assurance has come a long way. These conventional methods are time-consuming and multi-step processes, with prolonged incubation periods, amplifying opportunities for human error.

In recent years, different rapid methods with high sensitivity and specificity have been developed to overcome the limitations of conventional methods. Furthermore, researchers are still developing novel methods with improvements in terms of rapidity, sensitivity, specificity and suitability for analysis of food samples. Generally, rapid detection methods are categorized into nucleic acid-based, biosensor-based and immunological-based methods. Rapid methods are more time-efficient, labour-saving and able to reduce human errors. In addition, the equipment are also space saving and do not require a complex setup and advance trainings. They can be installed in mobile labs for food analysis and creating awareness. These devices can be easily operated, and data can be stored by connecting them electronically.

**Connecting with Consumers**

Section 40 of the FSS Act 2006 empowers the purchaser to get analysed any article of food from the food laboratories on submitting the requisite fees. In case the sample is found unsafe the fee submitted by the purchaser is refunded. While most of the food testing requires sophisticated equipment and highly trained manpower, there are some common adulterants and contaminants that can be tested by citizens themselves. In order to enable the citizens to ascertain the safety of their food themselves, FSSAI has compiled some of the common tests - which can be performed at home without any equipment or chemicals - in the form of a booklet titled Detecting Adulterants with Rapid Testing (DART). In addition, FSSAI has also developed a magic box, which can be used by the consumers to detect adulteration with a few simple tests at home. These magic boxes can also be used as a tool for creating awareness among citizens. The mobile labs of FSSAI i.e. ‘Food safety on wheels’ also help in creating consumer awareness on food adulteration through simple and rapid test methods.

Thus, we have seen how a food testing ecosystem is critical in assessing the quality and safety of foods and identifying emerging risks. Capacity building of laboratories notified by FSSAI as well as training of food analysts in the latest techniques of analysis is important to strengthen the food testing. Developing information technology solutions and accreditation of the laboratories will further strengthen the ecosystem. Empowering the consumer is also important for the ecosystem.
Summary

- In any effective regulatory food system, a food testing ecosystem is critical to evaluate the quality and safety of foods, their compliance to set standards and also identify any emerging risks from farm to fork or plate to palate.
- FSSAI has formulated FSS (Laboratory and Sample Analysis) Regulations, 2011 to specify the functions of Referral laboratories, sampling procedure and formats for sample submission and analysis report.
- FSS (Recognition and Notification of Laboratories) Regulations, 2018, was framed for recognition and notification of laboratories to improve and streamline the process of notification of food laboratories.
- Laboratories notified by FSSAI are categorized as National Reference Labs, Referral Labs, Primary Labs and Mobile labs.
- Food analysis laboratories play crucial role in enforcement of food regulations including monitoring and surveillance activities of food safety.
- FSSAI has developed an information technology solution for benefit of food testing laboratories in the country called the Indian food laboratory network or INFoLNET.
- Laboratory accreditation is a procedure by which an authoritative body gives formal recognition of technical competence for specific tests/measurements. It is based on third party assessment and follows international standards.
- In India, National Accreditation Board for Testing and Calibration Laboratories (NABL), a Constituent Board of Quality Council of India is the nodal agency for the accreditation of food testing laboratories.
- Capacity building is as a process aimed at strengthening the skills of individuals as well as of food labs to cope with new trends and the emerging changes.
- Competency of staff is one of the important components of any food laboratory apart from its infrastructure and testing facility.
- Different rapid methods with high sensitivity and specificity have been developed to overcome the limitations of conventional testing methods.
- The DART book, the Magic Box and Mobile labs are some consumer connect initiatives which not only spread awareness but also empower consumers.
Key Words

**DART** - Detecting Adulterants with Rapid Testing

**FICS** – Food Import Clearance System

**FLRS** - Food Licensing & Registration System

**FSW**- Food Safety on Wheels

**INFoLNET** - Indian Food Laboratory Network

**ISO/IEC 17025** - an international standard which enables laboratories to demonstrate that they operate competently and generate valid results, thereby promoting confidence in their work both nationally and around the world.

**NNRL** – Network of National Reference Laboratories

Exercises

1. What are the different categories of labs certified by FSSAI? Describe the mandate of each kind of lab.

2. What is the INFoLNET? How does it benefit the food testing laboratories?

3. Which nodal agency in India is designated for accreditation of food testing laboratories?

4. Discuss how capacity building of food laboratories and food analysts will help strengthen the food testing ecosystem.

5. What are the benefits of using rapid tests for analysis of food?

6. List the consumer connect initiatives of FSSAI which are meant for creating awareness about food testing as well as empowering the consumers to test the food themselves.

References

1. FSSAI. Food Safety And Standards (Laboratory And Sample Analysis) Regulations, 2011. Available at
    https://www.fssai.gov.in/upload/uploadfiles/files/Lab_Sample_Regulations.pdf

2. FSSAI. Food Safety and Standards (Recognition and Notification of Laboratories) Regulations, 2017. Available at
5. FSSAI. Food Safety & Standards Act, 2006 Available at https://www.fssai.gov.in/cms/act-2006.php#


16. FSSAI INFoLNET. Indian Food Laboratory Network. Available at https://infolnet.fssai.gov.in/#/
Section 3: Eat Healthy

12. Poor Diets and its Consequences
13. Healthy Diets for All
14. Healthy Diets Everywhere
15. Lifecycle Approach to Healthy Diets
16. Influence of Taste and Other Sensory Perceptions on Food Choices
17. Social and Behavioural Change for Improving Health Outcomes
Chapter 12: Poor Diet and its Consequences

• Relationship between agriculture, nutrition and health
• Epidemiological shift from communicable to non-communicable diseases
• Undernutrition and micronutrient deficiencies
• Overnutrition and associated consequences
• Economics of malnutrition
• Initiatives for tackling malnutrition
Chapter 12: Poor Diet and its Consequences

‘Anam Aham’ or ‘I am what I eat’ is a realisation we have had since ancient Vedic times. This is because the food, along with all the nutrients and other bioactive substances present in food which we eat, literally governs our health and nutritional status. Food is also known to affect our moods, our cognitive abilities and our intelligence quotient. Nutrients and the other bioactive substances play a big role in preventing communicable and non-communicable diseases. Even if a single nutrient is missing from our diet it can lead to adverse health symptoms. If we eat too much of a nutrient it can result in an imbalance in the body with a negative impact on health. Hence the focus is always on a balanced diet. This chapter explains the relationship between the food we eat, the nutrition it provides to our body and the effect on health and disease. It examines the effect of under and overnutrition on health as well as the economy. Initiatives to tackle the problem of malnutrition, that have been and need to be intensified, are discussed.

Relationship between agriculture, nutrition and health

The definition of ‘health’ as adopted by the World Health Organization in 1948 is as follows:

‘A state of complete physical, mental and social well-being and not merely the absence of disease and infirmity’

Unhealthy diets are closely linked with poor health status. In turn, dietary patterns and food choices are determined by a multitude of factors such as availability of foods, pricing, knowledge and awareness, taste preferences, social and cultural norms amongst others. Food, therefore, becomes a common point between agriculture, nutrition and health. It serves as the output of agricultural activities and subsequently plays a major role as a carrier of nutrients thereby resulting in either positive or negative health outcomes depending on how it is consumed.

Food is more than a sum of its nutrients or individual components. Synergism and interaction between different food components often requires a balancing act. This forms the rationale behind the concept of a ‘balanced diet’ as prescribed by the National Institute of Nutrition, Indian Council of Medical Research (ICMR) Dietary Guidelines for Indians. A balanced diet should provide around 50-60% calories from carbohydrates, preferably from complex carbohydrates, about 10-15% energy from proteins and 20-30% from both visible and invisible fats.

Absolute quantity of food components is equally important as the quality as well as relative proportions. For example, over the years, focus has shifted from total fat intake to intake of unhealthier fat fractions such as saturated fats. Likewise, carbohydrates are a major affordable energy source in Indian diets. Carbohydrates get preferentially used by the body for energy and thus have a protein sparing action, allowing the human body to utilize proteins for their critical role of tissue synthesis and maintenance. At the same time, in the absence of physical activity, excess carbohydrates in the diet may lead to weight gain and obesity. Qualitatively, complex carbohydrates such as those present in pulses, millets and whole grains (minimally processed with outer bran layer intact) are known for their positive attributes such as low glycemic index, satiety, cholesterol lowering properties etc.
The nutrition we derive from foods is deeply rooted in traditional practices of cooking, preserving and consuming seasonal foods as well as the ancient wisdom of some foods with medicinal benefits. For e.g., fruits and vegetables are known to be rich sources of vitamins, minerals, fibre as well as many non-nutritive yet protective substances such as flavonoids, antioxidants, etc. Including fruits and vegetables in the daily diet may reduce the risk of some non-communicable diseases and certain types of cancers. Swapping (exchanging) an unhealthy snack with a seasonal fruit is also a way to prevent weight gain and eventually reduce the risk of obesity. Some fruits and vegetables are known to boost the immune system. For e.g., Indian gooseberries (*amla*), oranges and other citrus fruits.

A diet consisting of foods from various food groups typically provides most of the daily requirement of nutrients. Food groups can be broadly classified as follows:

- Cereals and Millets
- Pulses
- Milk and animal derived foods such as meat, fish & poultry
- Fruits and Vegetables
- Nuts, oilseeds, Oils, Fats, and Sugars

Based on the degree of processing and/or cooking, intake quantity, degree and nature of interaction with other food components, the above-mentioned food groups provide us with the following nutrients:

- Macronutrients such as Carbohydrates, Proteins & Fats
- Micronutrients such as Vitamins and Minerals

The right food choices practiced consistently over a period of time lead to achievement of health goals specific to different stages of life. Age appropriate dietary guidelines as well as nutrient requirement values serve as guidance for nutrient intake at population level. For example, during the early years of life, optimal growth & development require sufficient proteins to support bone and tissue development. Similarly, adolescents in the age group of 10-15 years demand adequate protein-carbohydrates to sustain the second growth spurt. Physiological conditions such as pregnancy and lactation have higher requirements for most macro and micronutrients such as iron, folic acid and calcium. Whereas, as one grows older, energy requirements are reduced owing to a predominantly sedentary lifestyle with limited physical activity. However, vitamins, minerals and proteins remain critical to ensure healthy ageing.

Poor or unhealthy diets often lead to negative health outcomes:

- Undernutrition leads to physical and cognitive impairment, and increases susceptibility to infectious diseases.
- Micronutrient deficiencies or in other words possible insufficient intake of iron, iodine, vitamin A, folate etc. can cause severe illnesses and physical impairments, such as anaemia, mental retardation, visual impairment or birth defects respectively.
- Overweight and obesity increase the risk of non-communicable diseases (NCDs) such as type 2 diabetes, hypertension, heart disease, stroke and certain cancers.
Epidemiological shift from communicable to non-communicable diseases

India is in the middle of an epidemiological transition and is simultaneously battling the coexistence of undernutrition, overnutrition, and micronutrient deficiencies. While earlier the majority of deaths were due to communicable, infectious diseases, the death rates are now higher for diet related non-communicable diseases. The many facets of this transition include:

**Agricultural transformation:** With the advent of the green revolution in the late 1960s, India has moved from being food insecure to self-sufficient in grains. The focus has been on cereal grains especially staple crops such as wheat, rice and maize with relatively less attention towards other nutritious crops such as pulses, millets, coarse grains. This supply-demand equation has affected the share of plate in a typical Indian meal which tends to be cereal (carbohydrate) heavy.

**Urbanization:** Urbanization including migration to cities in search of work, has led to a change in dietary/consumption patterns. With more women entering the workforce, there’s less time to cook meals and hence a reliance on convenience foods and out-of-home consumption. Increase in disposable incomes is another factor resulting in changing consumer habits and preferences.

**Food environments/ecosystem:** The external as well as personal food environment/ecosystem has experienced a transformation with availability through formal/informal markets, price volatility, online delivery, promotion and marketing campaigns, regulatory ecosystem etc.

**Physical activity:** Factors such as rise of sedentary job profiles, time spent on gadgets/electronic devices, changing patterns of transportation, modern innovations that have automated some of the household tasks, cultural and safety considerations have led to a decrease in physical activity. As per a WHO statistic, globally, about 25% of adults and more than 80% of adolescents were insufficiently physically active in 2010. Physical inactivity is a leading risk factor for various non-communicable diseases, injuries and premature deaths worldwide.

**Healthcare infrastructure:** The revamped National Health Mission with a focus on disease control, prevention and surveillance has made a huge impact on healthcare system. Life expectancy at birth in India has risen to 69 years during 2013-17.

Undernutrition and micronutrient deficiencies

Human nutrition describes the processes whereby the body obtains and uses necessary substances obtained from foods (nutrients) to maintain structural and functional integrity. Optimum nutrition refers to an adequate intake of nutrients. Malnutrition is an imbalanced nutritional status resulting from deficiencies, excesses or imbalances in a person’s intake of nutrients.

The term malnutrition covers 2 broad groups of conditions. One is ‘undernutrition’—which includes stunting, wasting, underweight and micronutrient deficiencies. The other is
‘overnutrition’ which results from excessive intake of nutrients leading to overweight and obesity when there is excess intake of calories, or other symptoms of toxicity of excess intake of micronutrients.

As per the conceptual framework developed by UNICEF in 1990, the causes of malnutrition can be broadly classified as immediate; underlying and basic (Figure 1). Immediate causes act at individual levels. They include inappropriate diet and disease status. Inappropriate diet may be the result of unavailability of food, inappropriate dietary intake, poor feeding practices and personal food preferences. Diseases, particularly infectious ones such as diarrhoea, intestinal worms, respiratory infections, can both be a cause or result of undernutrition. Dietary transition, inadequate physical activity and lifestyle choices may be contributing factors to overnutrition.

Underlying causes act at a household and community level. These are primarily household food insecurity i.e. poor availability or access to food, inadequate health care, and unhealthy household environments. Family size and composition, gender inequalities and household income also affect household food security. Basic causes act at a national and international level. These include social, economic and political structures as well as environmental factors. Political instability, availability of health and social services, population size and growth rate, urban migration, natural resources, agricultural output, natural disasters, climate change, humanitarian crisis, international trade agreements and global food prices all affect the nutritional status of the population as a whole.

From the perspective of access, availability and affordability, some of the main causes of malnutrition include:

- Limited access to food and its affordability
- Limited access to adequate health care facilities
- Inadequate social environment at home and local community, especially for women and children
- Geographical segregation and poor accessibility to markets due to lack of roads
The indicators used to measure nutritional imbalance in undernutrition are defined as follows:

- **Underweight or low weight for age**
  
  Weight for age is a term used to describe weight appropriate for a particular age. In case the weight of a child is less than -2 standard deviations from the WHO child growth standards median, the child can be categorized as underweight. However, underweight is a composite indicator as it can reflect wasting, indicating acute weight loss, as well as stunting (long term or chronic growth failure). As per the Comprehensive National Nutrition Survey (CNNS 2016-18), 33% of children under five are underweight. The survey also indicates 10% school going children are underweight.

- **Wasting or low weight for height**
  
  Wasting is an acute form of malnutrition usually due to frequent and prolonged infections where the child loses weight resulting in low weight for height. Wasting may also result from sudden shock (food deficits) such as lack of food due to drought/famine and/or severe and sudden illness. This type of malnutrition is reversible if proper measures are taken to feed the child frequently with nutrient dense foods. As per the Comprehensive National Nutrition Survey (2016-18), 17% of children under five are wasted. The survey also indicates 23% school going children
are thin (BMI for age is less than -2 SD). Body mass index (BMI) is an indicator of weight status and is used to identify thin, overweight/obese individuals.

- **Stunting or low height for age**

  This is associated with long term (chronic) growth failure. In India, stunting is a major issue and is often linked to lack of timely nutritional interventions, caring practices, illness and chronic deficits in food intake. Stunted children not only have reduced physical growth, they also lag behind in academics, which may have negative consequences for their future. As per the Comprehensive National Nutrition Survey (2016-18), 35% of children under five are stunted. The survey also indicates 22% school going children are stunted.

  All anthropometric indices are compared to the WHO Child Growth Standards (2006).

- **Micronutrient deficiencies**

  Also known as hidden hunger, it is a consequence of inadequate intake of essential micronutrients like iron, vitamin A, vitamin B12, iodine and zinc in the diet. Micronutrient deficiencies in children are usually not seen in isolation. Children tend to have multiple micronutrient deficiencies due to low intake of food and lack of diversity in diets.

Other assessment criteria include anthropometric measurements like MUAC (Mid-Upper Arm Circumference), presence of clinical signs and symptoms like oedema (swelling), skin changes (pallour, dryness, dermatitis, etc.), hair changes, night blindness, deformity of bones, etc.

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**The Poshan (Prime Minister’s Overarching Scheme for Holistic Nutrition) Abhiyaan** was launched by the Prime Minister on 8 March 2018. It is India’s flagship program of the Ministry of Women and Child Development to improve nutritional outcomes for children, adolescents, pregnant and lactating mothers by leveraging technology, a targeted approach and convergence.

For implementation of POSHAN Abhiyaan the four-point strategy/pillars of the mission are:

- Inter-sectoral convergence for better service delivery
- Use of technology (ICT) for real time growth monitoring and tracking of women and children
- Intensified health and nutrition services for the first 1000 days
- Jan Andolan

Read more about at:

http://poshanabhiyaan.gov.in#/  
https://icds-wcd.nic.in/nmm/home.htm  
https://niti.gov.in/poshan-abhiyaan
Overnutrition and associated consequences

Over nutrition is a state where the nutritional intake exceeds the nutritional needs and then manifests itself as overweight and obesity in case of excess intake of energy. Overweight is a condition which is characterized by excess body fat. Obesity is a consequence of long-term positive energy balance i.e. having more calories than actually required. Based on the WHO guidelines for Asia Pacific (2004), Body Mass Index (BMI) between 23 to 24.9 kg/m² is a determinant of overweight whereas obesity is marked with a BMI of 25 or more (Table 1).

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.5</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5 to 22.9</td>
</tr>
<tr>
<td>Overweight</td>
<td>&gt;23</td>
</tr>
<tr>
<td>At risk</td>
<td>23 to 24.9</td>
</tr>
<tr>
<td>Obese I</td>
<td>25 to 29.9</td>
</tr>
<tr>
<td>Obese II</td>
<td>&gt;30</td>
</tr>
</tbody>
</table>

Source: Mishra, 2009

India ranks third, after US and China, in terms of obesity prevalence. As per the National Family Health Survey (NFHS-4) data, obesity amongst Indian adults has nearly doubled in the last decade. By 2030, 290 million Indians will be overweight while 52 million would be obese.

Globally, prevalence of childhood and adolescent obesity has increased tenfold in the last four decades. As per the Comprehensive National Nutrition Survey (2016-18), about 4% school going children (5-9 yrs. old) and 5% adolescents (10-19 yrs. old) are overweight or obese.

Let us examine the factors which can increase the risk of being overweight or obese:

**Birth weight:** Low birth weight is defined as weight (at birth) less than 2500g. Both low birth weight and high birth weight is linked to obesity in adult years. Infants born preterm or those small for gestational age are at risk of larger waist circumference and a higher BMI as adults. This is due to change in gene programming while the baby is still in the womb.

**Genetics and familial causes:** Genetics affects hormones involved in fat regulation and if both parents are obese the likelihood of obesity is more in children. Familial history can also be linked to the family’s eating pattern and parents’ own eating behaviours and child-feeding practices.

**Socio economic status:** Obesity was known to be common in prosperous countries and people from higher socio-economic status of developing countries, owing to the higher
accessibility and availability of food. Financial security may lead to indulgence in calorie dense fast foods and a lifestyle involving less of physical activity, use of labour-saving gadgets and increased screen time. However, recent evidence suggests that obesity prevalence cuts across socio-economic status and is gradually on the rise.

**Dietary pattern:** Over the past few decades, the food and the home environments have changed tremendously. Our modern eating environment has had an effect on the way the people eat. Fast food outlets and conveniently available food has led to availability of foods high in fats, sugar and energy. The portion sizes have increased, and people are making unhealthy food choices.

**Sleep:** Insufficient sleep is now linked to metabolic disorders. It has been observed that short sleepers may be obese and short sleeping adults/children may suffer from obesity related disorders (Horne, 2008).

**Physical inactivity:** Besides changes in the nutritional habits, daily physical activities and recreational activities have also changed dramatically over the past two generations. The ubiquity of modern technology and motorization in our life has greatly contributed to a decrease in physical activity and significantly reduced energy expenditure (Corzilius, 2007). Growing urbanization and use of personalized transportation have resulted in children going to school in automated means of transportation. Schoolwork and academic competitiveness have led to reduced physical activity and participation in sports is negligible.

Obesity is associated with diet-related non-communicable diseases (NCDs). Disease conditions like insulin resistance (impaired response of body to insulin), diabetes, dyslipidemias (abnormal amounts of lipids in blood), hypertension (high blood pressure), cardiovascular diseases and certain types of cancer are higher in obese individuals.

**Economics of malnutrition**

The adverse effect of malnutrition is poor health consequences for individuals - impairment of growth and development in children, poor cognitive development and as a result reduced chances of succeeding in life. Poor education usually results in poor job prospects and reduced earning capacity, thus perpetuating the vicious cycle of poverty and malnutrition. Let us discuss the economic impact of malnutrition in greater detail.

**Impact on individuals: Impaired physical growth and cognitive development**

Early-life undernutrition and its effects often persist life-long, leaving the individual susceptible to infectious diseases, impaired physical growth, impaired cognitive development, delayed maturation, lower muscle strength and reduced bone density. Many children are born undernourished because their mothers have poor nutritional status prior to and/or during pregnancy. The nutritional status of women and girls is poor due to limited availability and access to food, traditional and cultural practices - women eat the last and least, early marriage, repeated pregnancies and frequent infections along with poor access to health care and sanitation. This phenomenon is known as the ‘Inter-generational’ cycle of malnutrition.
Impaired physical growth reduces work capacity, labour productivity and increases absenteeism from work. This results in lower income levels, lower standards of living and an overall poorer quality of life. Poor educational performance leads to loss of employment opportunities. This in turn prevents reduction of poverty levels. Loss of productivity due to malnutrition is estimated to be more than 10% of an individual’s lifetime earnings.

**Impact at a household, community and country level**

Morbidity due to malnutrition has an economic impact at the household and national level. Cost of medical care and hospitalization as well as the resultant loss of earnings can be catastrophic for families living below poverty line. There is also a huge fiscal cost for the government. In terms of medical and social care needed, increased morbidities put a strain on national health care and welfare systems.

A study found that stunting resulting in 1% loss in adult height is associated with a 1.4% loss in productivity. The loss in adult income from being stunted may be up to 22%. Malnourished and weak adults have lower manual productivity particularly in the agricultural and other manual or labor-intensive sectors. Another study observed that elimination of anemia can lead to 5-17% increase in adult productivity.

According to another report by Save the Children (Crosby et al, 2013), economic cost of micro-nutrient malnutrition for India is between 0.8 per cent and 2.5 per cent of its GDP, which is equivalent to $15–46 billion.

India faces the human and economic threat posed by NCDs. NCDs account for about 40% of all hospital stays and roughly 35% of all recorded outpatient visits. NCDs not only affect health, but also productivity and economic growth. The probability of dying during the most productive years (ages 30–70) from one of the four main NCDs is a staggering 26%. India stands to lose $4.58 trillion before 2030 due to NCDs and mental health conditions. Cardiovascular diseases, accounting for $2.17 trillion, and mental health conditions ($1.03 trillion), will lead the way in economic loss (Bloom et al., 2014).

**Initiatives for tackling malnutrition**

Nutrition is a multisectoral problem. Solving the issue of malnutrition is a challenging but not insurmountable feat as the causative factors are interactive and complex.

In 2012, the World Health Assembly identified six global nutrition targets- reducing stunting and wasting in children under 5 years, halting the obesity epidemic, reducing anemia in reproductive age women, reducing low birth weight and increasing exclusive breastfeeding rates. In 2015, world leaders adopted the Sustainable Development Goals which included the goals to eradicate hunger and end all forms of malnutrition by 2030.

India has implemented several food security programs such as the Mid-Day Meal Program, Annapurna Scheme, Integrated Child Development Services scheme, Public Distribution System, National Food Security Act, National Horticultural Mission etc. However, despite a decline in rates of undernutrition, malnutrition continues to be a persistent problem in India. Hence a multisectoral solution is required. A holistic approach that allows for physical,
economic, social and ecological access to a macro and micronutrient replete diet is required. This approach should include a partnership between all stakeholders i.e. governments, UN agencies, NGOs, food industries, researchers, farmers and civil society. Malnutrition should be tackled at the farm, processing and consumption stages.

Social safety net schemes have an important role to play in promoting the ‘Eat Healthy’ philosophy. Table 2 outlines the beneficiaries and the provisions of three large scale food security programs.

Table 12. 2: Food Security Programs and Schemes in India

(A) INTEGRATED CHILD DEVELOPMENT SERVICES (ICDS): WHAT IS IT?

- Flagship programme for early childhood care and development
- Launched on 2nd October 1975
- Now governed by provisions of National Food Security Act (2013)
- Target beneficiaries: Children between 6 months to 6 years, Pregnant women & Lactating mothers
- Number of beneficiaries as of 31st March 2019:
  a) Operational Anganwadi centres: 13,72,872 (13.72 lakhs)
  b) Number of children between 6 months to 3 years: 39,58,4766
  c) Number of children between 3 years to 6 years: 30,78,9356
  d) Number of children between 6 months to 6 years: 70,37,4122
  e) Number of Pregnant women and Lactating mothers: 17186549
  f) Total beneficiaries: 87,56,0671

INTEGRATED CHILD DEVELOPMENT SERVICES (ICDS): WHY IS IT IMPORTANT

- ICDS scheme offers a package of six services including supplementary nutrition and nutrition and health education
- The scheme is jointly administered by Ministry of Women and Child Development (three services) and the Ministry of Health & Family Welfare (three services)
- Under the National Food Security Act (2013), the supplementary nutrition provisions are entitled for every pregnant woman and lactating mother till six months after child birth; and for every child in the age group of 6 months to 6 years (including those suffering from malnutrition) for three hundred days in a year
- Supplementary nutrition categories:

<table>
<thead>
<tr>
<th>Beneficiary</th>
<th>Type of meal/supplementary nutrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children between 6 months to 3 years</td>
<td>Take Home Rations (THR) with 500 calories and 12-15g protein</td>
</tr>
<tr>
<td>Malnourished children between 6 months to 3 years</td>
<td>THR with 800 calories and 20-25g protein</td>
</tr>
<tr>
<td>Children between 3 years to 6 years</td>
<td>Morning snacks and hot cooked meals in conformity with ICDS norms</td>
</tr>
<tr>
<td>Malnourished children between 3 years to 6 years</td>
<td>Additional 300 calories of energy and 8-10g of protein in addition to the meal/food provided to the children of this age group</td>
</tr>
<tr>
<td>Pregnant women and Lactating mothers</td>
<td>THR with 600 calories and 18-20g protein</td>
</tr>
</tbody>
</table>
INTEGRATED CHILD DEVELOPMENT SERVICES (ICDS): TELL ME MORE

• The ICDS scheme addresses inter-generational cycle of malnutrition by improving nutritional and health status of pregnant women and lactating mothers. It also reduces the risk of malnutrition associated/linked morbidity and mortality amongst children between 6 months and 6 years of age.
• Nutrition education to promote the use of healthy balanced diets through dietary diversification is an important component of different Government programmes such as POSHAN Abhiyaan and Anganwadi Services.
• Ministry of Women and Child Development has advised all the States/UTs to ensure use of relevant fortified food articles (wherever supplied) in the administration of the Supplementary Nutrition Programme.
• Use of iodized salt is mandatory for cooking the food under supplementary nutrition programme.

(B)  MID-DAY Meal (MDM) Scheme: WHAT IS IT?

• Largest school feeding programme launched with a view to enhance enrolment, retention, attendance and simultaneously improve nutrition levels amongst school going children.
• Launched as centrally sponsored scheme (National Programme of Nutritional Support to Primary Education) on 15th August 1995.
• Now governed by provisions of National Food Security Act (2013).
• Target beneficiaries: 9.12 crore primary and upper primary school children in the age group of 6-14 years.

MDI-DAY Meal (MDM) Scheme: WHY IS IT IMPORTANT?

• The scheme is administered by Ministry of Human Resource Development.
• Food norms under the scheme are as follows:

<table>
<thead>
<tr>
<th>Primary students (class I to V)</th>
<th>Upper primary students (class VI to VIII)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100g food grains</td>
<td>150g food grains</td>
</tr>
<tr>
<td>20g Pulses</td>
<td>30g Pulses</td>
</tr>
<tr>
<td>50g Vegetables</td>
<td>75g Vegetables</td>
</tr>
<tr>
<td>5g Oil and Fat</td>
<td>7.5g Oil &amp; Fat</td>
</tr>
<tr>
<td>Salt &amp; Condiments (As needed)</td>
<td></td>
</tr>
</tbody>
</table>

• The MDM guidelines are designed in such a manner that children get sufficient amount of carbohydrates, proteins and micronutrients such as iron and folic acid.
• The primary school children are provided with 450 calories and 12g protein while children in upper primary classes get 700 calories with 20g protein.
• MDM scheme addresses the issue of hunger and protein-energy malnutrition amongst the age group of 6-14 years thereby positively impacting learning outcomes in school.
• Vegetables (sourced locally by schools) can be a good source of vitamins, minerals, phytochemicals and fiber in the meal. Vegetables with high Vitamin C content can also alleviate iron deficiency by boosting the absorption of iron from the meal.
• After infancy, children in school going age experience the second growth spurt up to late adolescence i.e. 19 years. This is a crucial phase for nutrition intervention to correct height deficits.
The school health programme administered by National Health Mission (Ministry of Health and Family Welfare) compliments the MDM scheme through services such as Immunization, Micronutrient supplementation, De-worming, Health promotion, Capacity building of school teachers.

**MID-DAY Meal (MDM) Scheme: TELL ME MORE**

- Rice constitutes ~85% of the food grains consumed through MDM. Fortification of food items in a systematic manner through Food Corporation of India (FCI) (starting with rice) has been approved for MDM. Kitchen gardens are also being promoted in each school.
- As per guidelines on food safety and hygiene for school kitchens in MDM scheme issued by Ministry of Human Resource Development dated 13th Feb 2015, the States/UTs must consider engaging CSIR institutes/NABL accredited laboratories and FSSAI notified laboratories for testing of MDM food samples for microbiological and chemical parameters
- The testing charges for protein and calories have been fixed as INR 1200 (excluding taxes) for MDM meals vide order number 15022/01/2019-QA dated 8th April 2019

**C) PUBLIC DISTRIBUTION SYSTEM (PDS): WHAT IS IT?**

- Launched as ‘Targeted’ public distribution system (TPDS) scheme in June 1997
- Operated under the joint responsibility of Central government and State/Union Territory governments
- Now governed by provisions of National Food Security Act (July 2013)
- Target beneficiaries: 75% rural and 50% urban population; coverage of almost two-thirds (80.5 Crore persons) of the total population at an all India level under two categories: Antodaya Anna Yojana (AAY) and Priority Households (PHH)

**PUBLIC DISTRIBUTION SYSTEM (PDS): WHY IS IT IMPORTANT?**

- TPDS is administered by Department of Food & Public Distribution (Ministry of consumer affairs, food and public distribution) with a vision to ensure food security for the citizens
- Subsidized food grains are provided to identified eligible households as per the following entitlement norms:

<table>
<thead>
<tr>
<th>Category of beneficiary</th>
<th>Number of Households</th>
<th>Foodgrains entitlement (per month)</th>
<th>Issue price (per kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rice</td>
</tr>
<tr>
<td>AAY</td>
<td>2.5 crores</td>
<td>35kg per family</td>
<td>Rs 3</td>
</tr>
<tr>
<td>Priority households</td>
<td>16.1 crores (approx.)</td>
<td>5kg per person</td>
<td>Rs 3</td>
</tr>
</tbody>
</table>

- In 2018, India ranked 103 (of the 119 countries) on the Global Hunger Index. The index includes measurement of ‘inadequate’ food supply which is an important indicator of hunger.

**PUBLIC DISTRIBUTION SYSTEM (PDS): TELL ME MORE**

- Rice forms >50% of the food grains distributed through PDS. Government of India has approved the centrally sponsored pilot scheme on ‘Fortification of Rice and distribution under Public Distribution System’ on 14th February 2019. The rice would be fortified with Iron, Folic acid and Vit B12. The pilot scheme has been approved for an initial period of three years beginning 2019-20 with a focus on 15 districts to begin with.
Policy level reforms

**Poverty reduction:** Increased purchasing power will allow people to consume a more diversified diet that incorporates foods rich in fruits, vegetables and protein. Effective implementation of employment programs such as the National Rural Employment Guarantee Act (NREGA) and increased investment in skill development programs will help reduce rates of unemployment and consequently lead to a reduction in household food insecurity.

Let us discuss how the existing programs can be implemented more effectively, the food environment improved as well as other efforts needed to tackle the problem of malnutrition in India.

**Restructuring of existing programs:** More effective implementation and monitoring of existing programs, particularly the Public Distribution System, is required. Decentralization of programs, increasing the diversity of foods provided by subsidy programs, increased funding, scaling up of successful pilot programs, and enabling vulnerable individuals to access their benefits is required. Existing health and nutrition programmes need to be reoriented to also target the challenges of rise in NCDs. Prevention and early detection of NCDs will help in more effective management. The infection-malnutrition cycle can be prevented by improving health infrastructure and sanitation services.

**Agricultural reforms:** India was able to attain self-sufficiency in food production by land reforms, irrigation programs, subsidies and incorporation of new technologies. While ensuring food production continues to keep pace, new issues like climate change, low crop diversity, indiscriminate use of chemical fertilisers and pesticides, improper use of available water, unavailability of water, loss of soil quality, fluctuating crop prices, and financial struggles of farmers, need to be addressed. Improving processing and storage methods to reduce wastage at the farm gate and investment in new farming technologies are other areas that need attention.

**Education:** Consumer behaviour patterns need to be modified. Educating the consumer about an adequate diversified diet, cooking and processing techniques to improve nutrient retention, infant child feeding practices, lifestyle, and sanitation is required. This can be provided by family counselling, local community campaigns, mass media campaigns and school-based interventions. Panchayats, NGOs and Self-Help Groups do play an important role in dissemination of information. In addition, people should also be educated regarding health and nutrition programs that they are eligible for to ensure proper utilization of the available schemes.

**Supplementation programs:** Supplementation programs such as the Mid-Day Meal (MDM) program and Integrated Child Development Services (ICDS) in vulnerable populations such as children, pregnant women, lactating women, and the elderly may help reduce nutrient gaps. Provision of fortified foods or food supplements such as fortified complementary foods, multiple micronutrient powders, iron fortified cereals, and lipid based nutrient supplements can be useful in combating micronutrient deficiencies such as iron deficiency anaemia. In recent years, the Food Safety and Standards Authority of India (FSSAI) has nudged various stakeholders to increase the development and use of fortified staples such as oil, salt, milk, wheat flour and rice. Fortified foods have now been incorporated into the Public Distribution System, MDM, and ICDS schemes by various state governments.
**Intersectoral coordination:** The nutritional policies and programs currently available often fall under the aegis of multiple government agencies such as Health and Family Welfare, Women and Child Welfare, Human Resource Development etc. Policies are formulated centrally but implementation is at the state level. Collaborations with environment, forests, agriculture, and public works sectors will help to appropriately tailor programs to the specific region. Such efforts have already been initiated. FSSAI has introduced initiatives such as the Eat Right movement which involves collaborations between Civil Society Organizations, Industry and Professional Associations, NGOs, national and international agencies, academia and corporates. Food safety and nutrition resources are being integrated into existing central and state programs.

India currently faces the triple burden of malnutrition. Access to an adequate, safe, and nutritious diet is a basic human right. Food security is vital to ensure optimal growth and development, maintenance of health, improved productivity and sustainable development of the nation. Malnutrition is a multifaceted problem which can only be combated by an integrated multi sectoral approach.

India contributes to 18% of the world population and is projected to surpass China as the world’s most populous country by 2027. Several strides have been made but there are miles to traverse and further actions are required to ensure that India and the global community meets the commitment to Sustainable Development Goals.

**Summary**

- Food is a common point between agriculture, nutrition and health. It serves as the output of agricultural activities and subsequently plays a major role as a carrier of nutrients thereby resulting in either positive or negative health outcomes depending on how it is consumed.

- A diet consisting of foods from various food groups (cereals, millets and pulses, fruits and vegetables, milk, egg and flesh foods, fats and sugars) typically provides most of the daily requirement of nutrients (carbohydrates, fats, protein, minerals and vitamins).

- The right food choices practiced consistently over a period of time lead to achievement of health goals specific to different stages of life.

- Poor or unhealthy diets often lead to negative health outcomes - undernutrition, overnutrition and micronutrient deficiencies.

- There has been an epidemiological shift in causes of mortality and morbidity - from communicable (infectious) diseases to non-communicable diseases. Diet-related non-communicable diseases include type 2 diabetes, hypertension, heart disease, stroke and certain cancers.

- The shift has been related to agricultural transformation, urbanization, changes in the food environment, physical activity levels and health care infrastructure.

- There are several causes of malnutrition.
• Indicators of undernutrition include underweight, stunting and wasting/thinness. BMI is a useful indicator of weight status.

• Malnutrition impairs physical growth and cognitive development in individuals.

• Morbidity due to malnutrition has an economic impact at the household and national level. Cost of medical care and hospitalization as well as the resultant loss of earnings can be catastrophic for families living below poverty line. There is also a huge fiscal cost for the government.

• In terms of medical and social care needed, increased morbidities put a strain on national health care and welfare systems.

• India has implemented several food security programs such as the Mid-Day Meal Program, Annapurna Scheme, Integrated Child Development Services scheme, Public Distribution System, National Food Security Act, National Horticultural Mission etc.

• Several measures are needed to transform the food ecosystem and existing programs to intensify the fight against malnutrition. These involve restructuring of existing programs, agricultural reforms, behaviour change communication, focussing on micronutrient malnutrition in the food supplementation programs and intersectoral coordination.

Key Words

**Anthropometry** – study of measurements of the human body

**BMI** – Body Mass Index, an indicator of weight status of the body

**Dyslipidemias** - elevated total or low-density lipoprotein (LDL) cholesterol levels, or low levels of high-density lipoprotein (HDL) cholesterol

**GDP** – Gross Domestic Product which measures the value of economic activity within a country

**Hypertension** - condition in which the blood pressure in the arteries is persistently elevated.

**Insulin resistance** - impaired response of body to insulin

**Low birth weight** – birth weight less than 2500g

**Morbidity** – the rate of disease in a population

**Mortality** - death

**NCD** - non-communicable diseases like cardiovascular diseases, diabetes, cancer, etc.

**Stunting** – low height for age

**Wasting** – low weight for height
Exercises

1. Describe the relationship between the food you eat and the status of your health.

2. Give reasons why we see a shift in causes of mortality and morbidity from communicable to non-communicable diseases.

3. Discuss the basic, underlying and immediate causes of undernutrition.

4. What are the best anthropometric indicators to study the prevalence of undernutrition among children in a community?

5. Discuss the economic cost of malnutrition on the individual and the nation.

6. Who are the beneficiaries and what are the provisions of the following food security schemes of the government?
   a. ICDS
   b. MDM
   c. TPDS

7. Discuss measures to intensify the efforts to reduce the prevalence of malnutrition in India.

References


16. WHO. Fact Sheets on Physical Activity. Available at https://www.who.int/news-room/fact-sheets/detail/physical-activity
Chapter 13: Healthy Diets for All

- Basic concept of food and nutrition
  - Nutrients, Food groups and Balanced diets
  - Food Based Dietary Guidelines
  - Nutrient Requirements

- Macronutrients
  - Water
  - Carbohydrate
  - Protein
  - Fat

- Micronutrients
  - Water soluble
  - Fat Soluble
  - Minerals

- Other bioactive substances

- Enhancing the quality of diets
  - Short term intervention - Supplementation
  - Medium term intervention - Food Fortification
  - Long term intervention - Dietary Diversification
  - Others
Chapter 13: Healthy Diets for All

Food is necessary for survival. All organisms consume food for the energy and nutrients it provides. However, the basic biology underlying food intake is also closely linked to pleasure. Hence, we continue to eat food even when satiated knowing well that most of the highly palatable foods may not be the most wholesome. Our desire to eat these foods is also dependent on several influences in our modern food environment, like cost, availability, convenience and social influences.

It is known that even though food is essential for survival, not all foods are created equal. An appropriate knowledge related to food and its constituent nutrients is necessary to ensure good health. Nutrients are those constituents of food that give nourishment essential for the maintenance of life, growth and development. Most foods contain nearly all nutrients, some being in higher proportions and some lesser. Some nutrients are needed in larger amounts by the body and are hence called macronutrients; while some, though being essential, are needed in smaller amounts, these are called micronutrients. It is important to obtain the right proportion of nutrients from the foods consumed. The following discussion will highlight the different nutrients and their role in health and well-being. This chapter will also help in understanding different concepts that could be used to enrich our diets.

Basic concept of food and nutrition

It is well known that for survival, the human organism needs to take in oxygen, water, and food. We can survive only about three minutes without air, three days without water, and three weeks without food (Towell, 2011). Food is the source of nutrients which are essential for growth, reproduction and good health.

Nutrients, Food groups and Balanced diets

Nutrients are the constituents of food that is required by the body in appropriate amounts. Broadly, nutrients can be classified as:

- Macronutrients – These are required by our body in large quantities (measured in grams) and include proteins, carbohydrates, fats and water.
- Micronutrients – These include vitamins and minerals and are required by our bodies in relatively smaller quantities (measured in milli or micrograms) but are essential for various body processes.

The requirement of these nutrients varies throughout the lifecycle depending on the need and nutritional status of an individual. Nutritional status is the condition of health which is influenced by the utilization of nutrients. The key to achieve a good nutritional status is to consume a balanced diet. A balanced diet is one that contains all types of food in such quantity and proportion that meets all needs of the body adequately. The quantities of foods needed to meet the nutrient requirements vary with age, gender, physiological status and physical activity. A balanced diet should provide around 55-60% of total calories from
carbohydrates, preferably from complex carbohydrates, about 10-15% from proteins and 20-30% from fat.

In addition, a balanced diet should provide other non-nutrients such as dietary fibre, antioxidants and phytochemicals which bestow positive health benefits. Antioxidants such as vitamins C and E, beta-carotene, riboflavin and selenium protect the human body from free radical damage. Other phytochemicals such as polyphenols, flavones, etc., also afford protection against oxidative damage. Spices like turmeric, ginger, garlic, cumin and cloves are rich in antioxidants. Foods are conventionally grouped as:

1. Cereals and Millets
2. Pulses
3. Milk and milk products, Egg, Meat and Fish
4. Vegetables and Fruits
5. Oils and Fats, Nuts and Oilseeds, and Sugars

However, foods may also be classified according to their functions - energy giving, body building and protective foods. Energy giving foods mainly include cereals, fats and sugars; body building food groups are pulses, milk and milk products, meat, fish, poultry and eggs; and, protective foods include mostly fruits and vegetables, though other food groups also contribute vitamins and minerals to the diet.

The relationship between food and health is complex. Everyone needs food to live, but too little food, too much food, or the wrong type of food has negative consequences for health. Improving eating habits is not just for an individual but for the whole population. ICMR-NIN has introduced the concept of ‘My Plate for the Day’ (figure 1) to fight hidden hunger. The plate is half filled with fruits and vegetables. A major portion of the remaining half is cereals, millets and pulses. Small amounts of fats, oils, nuts and oilseeds are also included along with one glass/cup of milk/curd.
While planning a diet the dietary goal should focus on maintenance of a state of positive health and optimal performance. It should ensure adequate nutritional status by achieving adequacy in all nutrients, prevention of deficiency diseases, prevention of chronic diet-related disorders and increasing the life expectancy.

**Food Based Dietary Guidelines**

Right nutritional behaviour and dietary choices are needed to achieve dietary goals. The following 15 dietary guidelines provide a broad framework for appropriate action (ICMR/NIN 2011):

1. Eat variety of foods to ensure a balanced diet.
2. Ensure provision of extra food and healthcare to pregnant and lactating women.
3. Promote exclusive breastfeeding for six months and encourage breastfeeding till two years or as long as one can.
4. Feed home based semi-solid foods to the infant after six months.
5. Ensure adequate and appropriate diets for children and adolescents, both in health and sickness.
6. Eat plenty of vegetables and fruits.
7. Ensure moderate use of edible oils and animal foods and very less use of ghee/butter/vanaspati.
8. Avoid overeating to prevent overweight and obesity.
9. Exercise regularly and be physically active to maintain ideal body weight.
10. Restrict salt intake to minimum.
11. Ensure the use of safe and clean foods.
12. Adopt right pre-cooking processes and appropriate cooking methods.
13. Drink plenty of water and take beverages in moderation.
14. Minimize the use of processed foods rich in salt, sugar and fats.
15. Include micronutrient-rich foods in the diets of elderly people to enable them to be fit and active.

Nutrient Requirements

Requirements are the quantities of nutrients that healthy individuals must obtain from food to meet their physiological needs. These have been defined at different levels - the Estimated Average Requirements (EAR), the Recommended Dietary Allowances (RDAs) and the Tolerable Upper Intake Levels (TUL).

**Terms used in the framework of nutrient requirements (ICMR-NIN, 2020)**

**Estimated Average Requirement (EAR)** refers to the average daily nutrient intake level estimated to meet the requirements of half of the healthy individuals in a particular life stage and gender group.

**Recommended Dietary Allowances (RDAs)** refer to the daily dietary nutrient intake level that is sufficient to meet the nutrient requirements of nearly all (97–98 percent) healthy individuals in a particular life stage and gender group.

**Tolerable Upper Level (TUL)** refers to the highest average daily nutrient intake level that is likely to pose no risk of adverse health effects to almost all individuals in the general population. As intake increases above the TUL, the risk of adverse effects will increase.
Macronutrients

The macronutrients needed by our body in larger quantities and these include carbohydrates, protein and fats. In addition, water is also considered to be an important nutrient.

Water

Water is the largest component of the human body making up 50 to 70 % of body weight, depending on age and body composition. Water is the medium in which all metabolic processes of our body take place. Water itself participates in several metabolic reactions. It serves as a solvent for vitamins, minerals, amino acids, glucose and many other substances so that they can participate in reactions. It is the medium of all cell fluids, digestive juices, lymph, blood, urine and perspiration, and hence important for the process of digestion, absorption, transport and excretion of nutrients and waste products. Water helps in the regulation of normal body temperature.

Besides plain water, beverages like fruit and vegetable juices, milk, soft drinks and soups also contribute to the total water intake. Water is also present in fruits and vegetables making up most of their weight. Fruits which are juicy have higher water content like watermelon, muskmelon, oranges, etc. Vegetables with a high percentage of water by weight include cucumber, bottle gourd (ghia), green leafy vegetables, etc. Water needs vary with factors such as body size, physical activity and environmental conditions. Adults need at least 2 to 3 litres (8-12 glasses) of fluids per day to replace daily losses. This amount includes pure water and water present in foods and beverages.

Carbohydrates

Carbohydrates are essential for the body as they are a source of readily available energy for the body. These are organic compounds that consist of carbon, hydrogen and oxygen.

Classification

Carbohydrates are of two types - simple and complex. Simple carbohydrates are sugars, such as the ones found in candy, fruits and baked goods. They are called simple sugars because they are made up of one (mono) or two (di) units of sugars (saccharides).

Monosaccharides (simple sugar): These contain one sugar molecule. Glucose – which is needed by the body for immediate energy is a simple sugar. It is also known as dextrose, grape sugar, and corn sugar. It is about half as sweet as table sugar. Other examples for monosaccharides are fructose (found in fruits and honey) and galactose.

Disaccharides (simple sugar): Disaccharides contain two sugar molecules. Table sugar, or sucrose is a disaccharide, as it consists of glucose and fructose. Other examples are lactose or milk sugar, composed of galactose and glucose; and Maltose made of two glucose molecules.
Cane sugar or sugar and other sweeteners like honey and jaggery are 95 per cent to 100 per cent carbohydrate. Although both honey and sugar provide the same amount of calories, unlike table sugar, honey contains a small amount of vitamins and minerals.

**Complex Carbohydrates** are the ones found in fruits and vegetables, whole grains and pulses. They are basically long chains of several (poly) sugar (saccharide) molecules attached together. Hence, they are called polysaccharides. Examples of complex carbohydrates are starch, glycogen and dietary fibre (pectin, gums, mucilages, cellulose, hemicellulose). **Starch** is a complex carbohydrate and is the storage form of carbohydrate found in plants. It is an important source of energy for animals and humans. Cereal and cereal products, pulses and legumes, roots and tubers are the main source of carbohydrate for Indians. It acts as an excellent source of fuel (energy) for the body. **Glycogen** is the form of carbohydrate stored in the body in animals.

**Dietary fibres** are complex carbohydrates that cannot be digested by human enzymes. Cellulose is the main structural component of plant cell walls and is referred to as insoluble dietary fibre. Pectin is also a complex carbohydrate found in ripe fruit and vegetables and is referred to as soluble dietary fibre. It helps to set jams and jellies. Both soluble and insoluble dietary fibre help in regulating many body processes, including body weight, bowel movement, blood sugar, blood pressure and blood cholesterol.

So, it can be said that carbohydrates are important components of the diet. While simple sugars and many refined foods like flour provide readily available energy/calories, many of these foods lack vitamins, minerals, and fibre. These "empty calories" and can lead to weight gain. In 2015, the World Health Organization (WHO) set upper limits by recommending that the intake of free sugars be less than 10% of the total energy intake (strong recommendation) and a further reduction to less than 5% of total energy intake (conditional recommendation) throughout the lifespan for preventing both dental caries and obesity. Thus, it is healthiest to get carbohydrates from as natural a form as possible -- for example, from fruit instead of table sugar, or from whole wheat flour instead of maida.

**Functions**

Some of the important functions of carbohydrates are listed below:

- The main function of the carbohydrate is to provide energy. One gram of carbohydrate yields 4 kcal (17 kJ) of energy. Some amount of carbohydrate is stored as glycogen in the liver and muscles for immediate conversion to glucose/energy. Brain and the central nervous system use only glucose as their source of energy.

- Fibre, or complex carbohydrates, can absorb water, prevent constipation and other bowel disorders, provide a feeling of fullness and control hunger. Fibre plays a role in prevention of diseases like cancer of colon i.e. the large intestine, diabetes (by
lowering blood glucose levels) and heart disease (by lowering blood triglyceride and cholesterol levels).

- If taken in sufficient quantity, carbohydrates are preferentially used as a source of energy thus sparing proteins for their function of growth and maintenance.

**Food sources**

Milk, yogurt, and other milk products are a source of lactose; fruits, some vegetables and their juices are a source of fructose, glucose and sucrose; bread, rice, wheat and other cereals, legumes and pulses, starchy vegetables are a source of starch and fibre; processed food items like sweets, cookies, sweetened beverages and other desserts are a rich source of sucrose.

Carbohydrates are thus an important component of our diet and we must ensure that 55 to 60% of our daily calories are provided from an intake of healthy carbohydrates.

**Proteins**

The English word protein originated from the Greek word “proteios”, meaning prime or primary. This term is very appropriate in nutrition, because proteins are the primary structural and functional component of every living cell. Like carbohydrates, they are organic compounds, but are distinct from carbohydrates as they have nitrogen along with carbon, hydrogen and oxygen in their structure. A protein molecule is made up of tiny units called amino acids. Amino acids are linked together in chains by linkages called peptide linkages. All proteins are built up of just 20 kinds of amino acids.

The biological value of proteins is dependent upon combinations of amino acids that build up any particular protein. There are nine amino acids that are essential to human health and nutrition. They are essential because they cannot be synthesised in the body and must be supplied by the protein in the diet. The nine essential amino acids are: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. Thus, the content, digestibility coefficients, and relative proportions of amino acids in dietary protein are the determinants of its nutritional value.

**Classification**

The proteins can be classified on the basis of their amino acid content as:

**Complete protein:** Any food that has all the essential amino acids in the right proportions is called a complete protein food. These are high quality proteins which promote growth and maintain life. Animal proteins, such as eggs, cheese, milk, meat, and fish, are considered high-quality, or complete proteins because they provide sufficient amounts of the essential amino acids and hence are superior to plant protein foods. The protein content of soybean is exceptionally high.
**Partially complete protein:** Plant proteins are of lower-quality, or partially complete proteins because many plant proteins lack one or more of the essential amino acids. Partially complete proteins can, however, be combined with other foods to provide all the essential amino acids. For example, cereals and pulses are deficient in lysine and methionine, respectively. Rice and pulse when taken together improves the quality of protein by supplying these two amino acids and making up for the deficiency. This is called **mutual supplementation.**

**Incomplete protein:** They are completely lacking in one or more of essential amino acids and can neither promote growth nor maintain life, e.g. gelatin (found in bones, cartilage and collagen) and zein (found in corn). Nitrogen liberated by the breakdown of these proteins can be utilized for synthesis of other amino acids in the body.

**Functions**
- Proteins are vital to basic cellular and body functions, including cell regeneration and repair, tissue maintenance and regulation.
- Hormone and enzymes, which are vital for the regulation of metabolism, are protein in nature.
- Even antibodies which protect the body from illness are also proteins.
- Proteins like hemoglobin, lipoproteins perform important body functions.
- Protein can also provide energy if sufficient carbohydrate and fat are not supplied by the diet. Each gram of protein yields about 4 Kcal.

Deficiency of proteins leads to serious illnesses such as impaired mental health, oedema, shrinkage of muscle tissues, as well as weak immune system. Deficiency of both energy and proteins results in protein-energy malnutrition (PEM). It is characterized by a group of related disorders that include marasmus, kwashiorkor and intermediate states of marasmic-kwashiorkor.

Children with kwashiorkor have nutritional oedema, skin and hair changes, metabolic disturbances, including hypoalbuminemia (low protein in the blood) whereas marasmus is characterized by severe wasting.
Food sources

Protein is found in foods from both animal and plant sources. Good sources of protein include meat, poultry, fish, milk, egg, and cheese, as well as legumes and pulses. Protein content of some foods is given in Table 1.

Table 1: Protein content of some foods (g/100 g of foodstuff)

<table>
<thead>
<tr>
<th>Food from animal sources</th>
<th>Protein (g)</th>
<th>Food from plant sources</th>
<th>Protein (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken, leg</td>
<td>19.44</td>
<td>Peas (dry)</td>
<td>20.43</td>
</tr>
<tr>
<td>Goat chops</td>
<td>20.39</td>
<td>Lentils</td>
<td>24.35</td>
</tr>
<tr>
<td>Fish (Hilsa)</td>
<td>21.8</td>
<td>Cowpea</td>
<td>21.25</td>
</tr>
<tr>
<td>Eggs</td>
<td>13.28</td>
<td>Cashew Nut</td>
<td>18.78</td>
</tr>
<tr>
<td>Paneer</td>
<td>18.86</td>
<td>Groundnuts</td>
<td>23.65</td>
</tr>
<tr>
<td>Milk</td>
<td>3.26</td>
<td>Soybean</td>
<td>37.8</td>
</tr>
<tr>
<td>Peas (dry)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lentils</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cowpea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cashew Nut</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Groundnuts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soybean</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Fats or Lipids

Fats are organic compounds that are made up of carbon, hydrogen, and oxygen. A typical fat molecule is made up of one molecule of glycerol and three molecules of fatty acids. It is also called triglyceride or triacylglycerol.

Classification

Fats or the fatty acids they are made of can be classified as:

- Essential and non-essential fatty acids
- Saturated and unsaturated fats
- Visible and invisible fats

Some fatty acids are called essential as they cannot be synthesised in our body and must be an essential part of our diet. Examples are linoleic acid (omega 6) and linolenic acid (omega 3); whereas fatty acids which can be synthesised in the body are termed as non-essential fatty acids like stearic acid, palmitic acid, etc.

Saturated fats have single bonds between their molecules and are "saturated" with hydrogen molecules. They tend to be solids at room temperature, such as ghee, butter, coconut oil.

Unsaturated fat: Unsaturated fats contain one or more double or triple bonds between the molecules. Most of these are found in vegetable oils. These fats are liquid at room temperature. They are also found in certain foods. This group is further classified into two
categories called monounsaturated fats (having one double bond) and polyunsaturated fats (having two or more double bonds).

Fat naturally present in foods and our body exists as the cis isomer. During the process of hydrogenation trans fats are formed. Hence partially hydrogenated oil (e.g. vanaspati, margarine, bakery fat) would have some trans fats. Some meats and dairy products contain small amounts of trans fats which have been formed due to microbial conversion, but mostly they are usually found in processed foods. Examples of food products that may contain trans fats include bakery products like cookies, doughnuts, and fried foods like namkeens, samosas etc. Trans fats should be completely avoided in the diet as they are harmful for health.

Fat is also present in almost all food stuffs. Cereals, pulses, nuts and oilseeds, meat, fish, poultry have fat in them. They are called invisible fats as we cannot see the fat. Visible fats are fats which are added to foods like butter, cooking oil, ghee, etc. and can be seen.

**Functions**

- Fat is a concentrated source of energy. Each gram of fat provides approximately 9 kcal.
- Fats provide satiety and palatability to the diet.
- Fat serves as a carrier of fat-soluble vitamins in the body and also helps in their absorption.
- Fat is stored under the skin and thus it checks the loss of heat from the body and keeps the body warm.
- It is also present around the vital organs of the body such as kidney and the heart and thus protects them from external injury.
- Fat serves as a source of essential fatty acids which have important functions in our body.

It is recommended that not more than 30% of a person's daily calories should come from fat; and less than 10% from saturated fats. Dietary cholesterol comes exclusively from animal sources. It is an important component of cell membranes and a precursor of bile acids, steroid hormones and vitamin D. A mix of different vegetable oils should be consumed to attain a good fatty acid profile. High fat diets lead to obesity and associated non-communicable diseases like cardiovascular diseases, diabetes and certain cancer.
Food Sources

Rich Sources of different types of fats are given in Table 2:

Table 13. 2: Food Sources of Different Types of Fats

<table>
<thead>
<tr>
<th>Type of Fat</th>
<th>Food Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saturated fat</td>
<td>Animal sources include meat and dairy products, such as: cheese, butter, cream, high-fat cuts of meat. Plant sources include coconut oil, palm oil.</td>
</tr>
<tr>
<td>Monounsaturated fat</td>
<td>Red palm, palmolein, groundnut, sesame, olive, ricebran and cottonseed oil</td>
</tr>
<tr>
<td>Polyunsaturated fat</td>
<td>All vegetable oils except for coconut oil, especially corn oil, safflower and sunflower oils, fish oil</td>
</tr>
<tr>
<td>Omega 3 fatty acids</td>
<td>Fatty cold water fish (salmon, tuna, sardines, mackerel) and fish oils, invisible fat of legumes like rajmah, cowpea, soyabean, black gram, cereals like wheat and bajra, mustard and fenugreek leaves and seeds, green leafy vegetables, canola, mustard and soyabean oils, flaxseed, walnuts.</td>
</tr>
<tr>
<td>Trans fat</td>
<td>Hydrogenated or partially hydrogenated vegetable oil, vanaspati, margarine, bakery shortening/fat</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>Egg yolk, organ meats (liver, kidney, brain, etc), milk fat, red meat, shrimp, prawn</td>
</tr>
</tbody>
</table>

Source: Ross et al, 2014; Mudambi and Rajagopal, 2012; Chadha and Mathur, 2015; Roday, 2018

Micronutrients

Nutrients which are required by the body in relatively lesser amounts are called micronutrients. Vitamins and minerals fall under this category. The requirements in terms of amounts may be small, but most vitamins and minerals have very important roles to play in health and well-being.

Vitamins

Vitamins are organic nutrients that are essential for carrying out several regulatory functions in the body. Vitamins are classified as water soluble and fat – soluble vitamins, based on their solubility in water and fats respectively.

Fat soluble vitamins: Vitamins which are soluble in fats are called fat soluble vitamins. There are four fat soluble vitamins – vitamin A, vitamin D, vitamin E and vitamin K. These vitamins can be stored in the body, hence excessive intake could be toxic. Table 3 gives in brief the main functions of each of these fat-soluble vitamins along with some examples of their food sources and deficiency signs and symptoms.
<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Function</th>
<th>Sources</th>
<th>Deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>- Normal vision in dim light.</td>
<td>Retinol (animal sources: fortified milk, cheese, cream, butter, eggs, liver, fish oil Betacarotene (plant sources): Dark green leafy vegetables; yellow-orange fruits (apricots, papaya, mango) and vegetables (carrots, sweet potatoes, pumpkin)</td>
<td>- Xerophthalmia: Night blindness Conjunctival xerosis (dryness of the conjunctiva), Bitots spots (foamy spots on the conjunctiva) and keratomalacia which may lead to blindness. - Keratomalacia: degeneration and keratinization of the epithelium. - Follicular Hyperkeratosis: Skin changes, skin becomes rough, dry and scaly.</td>
</tr>
<tr>
<td></td>
<td>- Maintains a healthy epithelium, especially the membranes that line the eyes, mouth, the gastrointestinal, respiratory and genitourinary tracts. This resists bacterial invasion and thus vitamin A gives protection against infection. - Essential for normal skeletal and tooth development. - Keeps the skin healthy. - Essential for the normal development of foetus.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin D</td>
<td>- Regulates the absorption and utilization of calcium and phosphorus from the intestinal tract. - Along with calcium and phosphorus forms bones and teeth makes them healthy and strong. - It regulates the amount of calcium and phosphorus in blood and promotes reabsorption of calcium and phosphorus in kidney.</td>
<td>Egg yolks, liver, fatty fish, fortified milk, fortified margarine. When exposed to sunlight, the skin can make vitamin D.</td>
<td>Rickets in Children: a condition in which the level of calcium and phosphorus is low causing knock knees, bow shaped legs and rachitic rosary (swelling or expansion of ends of ribs). Softening of the skull, and delayed closing of the fontanelles. Tetany: Low serum calcium level, causes trembling in hands and sometimes cramps and convulsions in children. Osteomalacia, in adults: bones become soft, fragile and susceptible to fracture. There is bone pain and difficulty in walking and climbing stairs.</td>
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<td></td>
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</tr>
</tbody>
</table>
Vitamin E  
- Antioxidant: it combines with free oxygen radicals, protects the integrity of the cell membranes.  
- It reduces the risk of cancer, heart disease by protecting cells, DNA, lipids from oxidative damage.  
- It has an important role to play in maintaining reproductive health  
- Vitamin E also maintains health of muscles  
Polyunsaturated plant oils (soybean, corn, cottonseed, safflower); leafy green vegetables; wheat germ; whole-grain products; liver; egg yolks; nuts, legumes and seeds  
Vitamin E deficiency is very rare.  
- Increased haemolysis (breakdown) of the red blood cells leading to anaemia.  
- Repetitive abortions or premature births.  
- Weakening of muscles due to the excessive oxidation of fats.  

| Vitamin K | Needed for proper blood clotting. It is also called an Anti-Haemorrhage vitamin. | Leafy green vegetables such as spinach; green vegetables such as broccoli, brussels sprouts, and asparagus; also produced in intestinal tract by bacteria | Usually seen in premature infants, but otherwise rare. May lead to excessive bleeding due to non-formation of blood clot |

**Source:** Ross et al, 2014; Mudambi and Rajagopal, 2012; Chadha and Mathur, 2015; Roday, 2018

**Water soluble vitamins:** These vitamins are soluble in water. They cannot be stored in the body and excess are excreted mainly in urine. Vitamin B–complex and Vitamin C are examples of water-soluble vitamins.

**Vitamins of B complex group** include Thiamine, Riboflavin, Niacin, Pantothenic acid, Pyridoxine, Biotin, Folic acid, Folic acid, Cobalamin (B₁₂). Table 4 gives, in brief, the main functions of important water-soluble vitamins along with some examples of their food sources and deficiency signs and symptoms.
### Table 13. 4: Water-soluble Vitamins- Functions, Sources and Deficiency

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Function</th>
<th>Sources</th>
<th>Deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamine</td>
<td>- Acts as a co-enzyme for an enzyme carboxylase, needed for energy metabolism; - important for nerve function</td>
<td>Found in all foods in moderate amounts: whole-grain legumes, nuts and seeds, dried yeast, pork, liver.</td>
<td>Beriberi (dry beriberi mainly the nervous and muscular systems are affected and wet beriberi affects the neurological and the cardiovascular systems and it is characterised by oedema)</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>- Part of an enzyme needed for energy metabolism; - important for vitamin and mineral metabolism as well - Some riboflavin dependent enzymes have an antioxidant role in the body</td>
<td>Dried yeast, milk, liver, meat eggs, kidney and green leafy vegetables.</td>
<td>Ariboflavinosis (inflammation of the tongue, scaling and cracks at the corners of the mouth, scaly lesions on the skin)</td>
</tr>
<tr>
<td>Niacin</td>
<td>- Part of an enzyme needed for energy (carbohydrate and fat) metabolism - essential for protein metabolism</td>
<td>Yeast, poultry, meat, liver, fish, peanuts, whole grains, legumes and some green leafy vegetable - Milk is deficient in niacin but rich in Tryptophan which is a precursor of niacin.</td>
<td>Pellagra characterized by diarrhoea, dementia, dermatitis and ultimately death if condition is left untreated. The dermatitis is bilateral and worsens on exposure to sunlight.</td>
</tr>
<tr>
<td>Pantothenic acid</td>
<td>- Part of an enzyme needed for energy metabolism - It participates in several reactions of synthesis of lipids, neurotransmitters, steroid hormones</td>
<td>Widespread in foods - Common sources include milk, meat and vegetables, peanuts, egg yolk, mushroom, potatoes, tomatoes, broccoli, yeast.</td>
<td>Irritability, anorexia, postural hypotension (low blood pressure in standing position), impaired muscle coordination, numbness and tingling of hands and feet</td>
</tr>
<tr>
<td>Biotin</td>
<td>- Part of an enzyme needed for energy metabolism - role in regulating gene expression</td>
<td>Widespread in foods like egg, liver, green leafy vegetables and nuts; also produced in intestinal tract by bacteria</td>
<td>Hair loss, dermatitis (redness and soreness of skin), conjunctivitis, lethargy, depression, hallucinations, prickling or tingling sensation of extremities in adults and decreases tone of muscles.</td>
</tr>
<tr>
<td>Nutrient</td>
<td>Function</td>
<td>Sources</td>
<td>Deficiency</td>
</tr>
<tr>
<td>------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Pyridoxine (vitamin B6)</td>
<td>-Part of an enzyme needed for amino acid metabolism; - Works with vitamin B12 and folic acid to lower homocysteine -Essential for the synthesis of heme, white blood cells and neurotransmitters.</td>
<td>Meat, fish, poultry, nuts, pulses and whole grains, some vegetables, fruits</td>
<td>Inflammation of nerves, anaemia, neurological disorders</td>
</tr>
<tr>
<td>Folic acid</td>
<td>-essential for maturation of RBCs -formation of neurotransmitters. -required for the synthesis of DNA. -metabolism of amino acids</td>
<td>Organ meat (liver, kidney), deep green leafy vegetables, yeast, eggs, muscle meats and fish are good sources of this vitamin. Wheat and cereals provide a fair amount.</td>
<td>-megaloblastic anaemia (large, immature RBCs) -Deficiency during pregnancy may cause neural tube defects in infants</td>
</tr>
<tr>
<td>Cobalamin (vitamin B12)</td>
<td>Present only in the foods of animal origin. Liver, organ meat, muscle meat, fish, poultry, and milk and its products are good sources. It is not found in the foods of plant origin.</td>
<td>-It helps in metabolizing fats. -essential for the maturation of red blood cells in bone marrow. -important for nerve health</td>
<td>pernicious anaemia -is associated with nerve degeneration that can result in eventual paralysis and death, megaloblastic anaemia (large, immature RBCs)</td>
</tr>
<tr>
<td>Ascorbic acid (vitamin C)</td>
<td>-Formation and maintenance of collagen the cementing material that holds the cells of the body together. -Healing of wounds -Absorption of iron by the reduction of ferric iron to ferrous ion which is assimilated easily in the body. -Acts as an antioxidant -Provides Immunity -Formation of RBC’s in bone marrow. -It is helpful in the formation of hormones</td>
<td>Citrus fruits (oranges, grapes, fruits, lemons and limes) berries, melons, pineapples, guavas, pears, banana, apple, leafy vegetables, capsicum, gooseberry, tomatoes are good source of ascorbic acid. Germination enhances the Vitamin C content of legumes.</td>
<td>Fleeting joint pains, irritability, retardation of growth in infants and children, anaemia, poor healing of wounds and increased susceptibility to infections Gross deficiency results in Scurvy (spongy bleeding gums)</td>
</tr>
</tbody>
</table>

Source: Chadha and Mathur, 2015; Ross et al, 2014; Mudambi and Rajagopal, 2012; Bamji et al, 2009; Srilakshmi, 2007; Roday, 2018
Minerals

Minerals are inorganic substances required by the body in small amounts and perform a variety of functions. Mainly, minerals are essential components of enzyme systems needed for several body functions. Some minerals are called **macrominerals** as they are needed in larger amounts than others, e.g. calcium, phosphorus, magnesium, sodium, potassium and chloride. Others are required in smaller quantities and are sometimes called **trace minerals**, e.g. iron, zinc, iodine, fluoride, selenium and copper. Despite being required in smaller amounts, trace minerals are no less important than other minerals. These minerals may be needed in very small quantities but having too much or too little can upset a delicate balance in the body. Table 5 and 6 list the functions and sources of important minerals in the body.

**Table 13.5: Macrominerals: Function and sources**

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Function</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>Maintains proper fluid balance, nerve transmission, and muscle contraction</td>
<td>Table salt, sauces, pickles, papads, chutneys, processed foods; small amounts in milk, breads, vegetables</td>
</tr>
<tr>
<td>Chloride</td>
<td>Maintains proper fluid balance</td>
<td>Table salt, sauces, pickles, papads, chutneys, processed foods; small amounts in milk, breads, vegetables</td>
</tr>
<tr>
<td>Potassium</td>
<td>Maintains fluid balance, muscle contractions and nerve signals, help reduce blood pressure and water retention</td>
<td>Bananas, oranges, grapefruit, prunes, raisins, and dates, broccoli, spinach, Potatoes, Sweet potatoes, Mushrooms, Peas, Cucumbers.</td>
</tr>
<tr>
<td>Calcium</td>
<td>Important for healthy bones and teeth; helps muscles relax and contract; important in nerve functioning, blood clotting, blood pressure regulation. Deficiency causes osteoporosis</td>
<td>Milk and milk products; green leafy vegetables, legumes, sesame seeds</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Important for healthy bones and teeth; phospholipids help in the transport of fat and are part of the cell membrane, constituent of nucleic acids, involved in energy production</td>
<td>Meat, fish, poultry, eggs, milk, beans, lentil, nuts, whole grains</td>
</tr>
<tr>
<td>Magnesium</td>
<td>It is a cofactor in more than 300 enzyme systems, regulates protein synthesis, energy production, muscle and nerve function, blood glucose control, and blood pressure regulation, good for bone health, immunity</td>
<td>Nuts and seeds; legumes; leafy green vegetables; seafood; bananas, apricots, cashew</td>
</tr>
</tbody>
</table>

*Source: Chadha and Mathur, 2015; Ross et al, 2014; Mudambi and Rajagopal, 2012; Nix, 2009; Wardlaw et al, 2004*
<table>
<thead>
<tr>
<th>Mineral</th>
<th>Function</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>Haemoglobin (iron containing compound) transports oxygen and carbon dioxide; myoglobin (iron containing compound in muscle) provides oxygen for muscle contraction; vital component of certain enzymes involved in metabolism of carbohydrates, fats and protein; helps in preventing infections, improves cognitive ability. Deficiency causes anaemia</td>
<td>Organ meats; red meats; fish; poultry; egg yolks; legumes; dried fruits; dark, leafy greens; and fortified cereals</td>
</tr>
<tr>
<td>Zinc</td>
<td>It is a constituent of many enzymes present in the body; is a cofactor in the synthesis of DNA and RNA, and thus proteins; immune reactions, insulin synthesis, taste perception, wound healing, the making of sperm, and the normal development of the fetus. Deficiency leads to delayed growth and sexual development</td>
<td>Meats, fish, poultry, nuts, whole grains, legumes</td>
</tr>
<tr>
<td>Iodine</td>
<td>Found in thyroid hormone, which helps regulate growth, development, and metabolism; needed for foetal brain development Deficiency leads to goitre (swelling of thyroid gland), cretinism in infants born to deficient mothers, poor cognitive development in children</td>
<td>Seafood, foods grown in iodine-rich soil, iodized salt</td>
</tr>
<tr>
<td>Selenium</td>
<td>Proper functioning of thyroid gland, as an antioxidant, improves immunity</td>
<td>Meats, organ meats, seafood, grains</td>
</tr>
<tr>
<td>Copper</td>
<td>Part of many enzymes for energy metabolism, regulation of neurotransmitters and connective tissue formation; needed for iron metabolism</td>
<td>Legumes, nuts and seeds, whole grains, organ meats, seafoods, drinking water (where pipes are made of copper)</td>
</tr>
<tr>
<td>Manganese</td>
<td>Part of many enzymes especially in carbohydrate and lipid metabolism, formation of connective and skeletal tissues, part of the antioxidant defence system</td>
<td>Widespread in foods, especially plant foods - whole grain cereals (wheat, barley, rice bran), legumes, green leafy vegetables, nuts and tea, fruits and vegetables</td>
</tr>
<tr>
<td>Fluoride</td>
<td>Involved in formation of bones and teeth; helps prevent tooth decay Excess can lead to fluorosis with mottling of teeth, joint pains, arthritis, stiffness of spine</td>
<td>Drinking water (either fluoridated or naturally containing fluoride), seafood, and most teas</td>
</tr>
</tbody>
</table>

*Source: Chadha and Mathur, 2015; Ross et al, 2014; Mudambi and Rajagopal, 2012; Nix, 2009; Wardlaw et al, 2004*
Other Bioactive Substances

Besides nutrients, there are a few other constituents of food which one should be familiar with. These substances with are bioactive are referred to as **phytochemicals** (plant chemicals) or **zoochemicals** (chemical substances obtained from animal sources e.g. omega-3 fatty acids obtained from fatty fish, probiotics obtained from fermented dairy products). They have numerous health benefits. There are several ways in which these chemicals exert their beneficial effect in the body. Some act as antioxidants and help to neutralize the damage-causing free radicals in the body. Others exert their influence by modulating the activity of enzymes which control metabolic processes. They may activate, deactivate, block or suppress certain enzymes or hormones. Some others work by reducing the inflammation levels in the body. An inflammatory condition has been linked to increased risk of cardiovascular diseases. Some phytochemicals work by improving immunity. They may have antibacterial and antiviral properties. Certain others may help to maintain DNA stability and ensure repair. Alteration of lipid and lipoprotein metabolism, regulation of blood sugar levels and blood pressure are some of the beneficial effects attributable to other phytochemicals. Fruits, vegetables, spices and condiments are a storehouse of different types of phytochemicals.

**Antioxidants:** They are natural compounds found in some foods that help in neutralising free radicals in our body. Fruits and vegetables are good source of antioxidants. Besides vitamins like β carotene, E, C and minerals like selenium, other phytochemicals like lycopene (present in tomatoes and watermelon), carotenoids (present in Green/yellow/orange fruits and vegetables), catechins (in tea), allium sulphur compounds (present in garlic, onion), anthocyanins (present in berries, beetroot), etc. act as antioxidants.

**Anti-inflammatory:** Some foods are rich in phytochemicals which reduce inflammation in the body. Curcumin present in turmeric is a powerful anti-inflammatory substance. Fatty fish are rich in omega 3 fatty acids which also reduce inflammation. Berries, broccoli, green tea, peppers, mushrooms, dark chocolate, cherries, tomatoes, etc. are considered as anti-inflammatory foods.

The role of antioxidants and other phytochemicals in health is increasingly becoming important, owing to our immense exposure to toxins, pollutants, pesticides and other harmful substances.

**Pre and Probiotics.** In recent years probiotic bacteria have increasingly been incorporated into foods and are ‘live microorganisms which when administered in adequate amounts confer a health benefit on the host’ (FAO/WHO 2002). In today’s fast pace life there are factors that negatively influence the interaction between intestinal microorganisms such as stress and diet, which lead to detrimental effects on health. Increasing evidence indicates that consumption of ‘probiotic’ microorganisms can help maintain a favourable microbiome which results in several therapeutic benefits. Commonly used bacterial probiotics include various species of *Lactobacillus*, *Bifidobacterium* and *Streptococcus* as well as *Lactococcus lactis* and some *Enterococcus* species. Currently, the only probiotic yeast used is the non-pathogenic *Saccharomyces boulardii*.

The term prebiotic was coined by Gibson and Roberfroid in 1995. Dietary fibres which resist digestion by the human enzymes but are digestible by the gut microbes are referred to as prebiotics. These encourage the growth of good bacteria in our gut.
Oligosaccharides, which are relatively short chain carbohydrates, have now been acknowledged to have prebiotic properties. Various type of oligosaccharides are found in natural foods available abundantly in the Indian diets like fruits (watermelon, pomegranate, dates, figs), vegetables (onion, beetroot, green peas, sweet corn, garlic), legumes (chickpea, lentils, soyabeans) cereals (wheat, bran), milk and honey.

It can thus be concluded that almost all the nutrients and other substances which we derive from the diet have some essential role to play in the body. The lack or excess of any may prove to be harmful to the body. Eating a diversified, balanced diet with wholesome meals would meet the requirements of most of the nutrients. Awareness regarding the correct proportions of food and nutrients required, based on the physiologic needs, would help in promoting health.

**Enriching the quality of our diet**

‘Hidden Hunger’ or micronutrient deficiencies are majorly impacting the nutritional status of the Indian population. According to the CNNS Survey, nearly 80% of the adolescent population suffers from at least one micronutrient deficiency in India. Poor diet quality and faulty dietary patterns coupled with lack of nutrition awareness is the main cause of malnutrition. Enriching the diets of at-risk population through micronutrient fortification, supplementation and encouraging dietary diversification is the most cost-effective and sustainable method to tackle deficiencies. Strategies to combat malnutrition at a national level need to be cost-effective and feasible enough to reach remote areas. Enriching diets of masses with specific micronutrients and not focusing simply on caloric intake is a solution adopted by several nations around the globe. In India, various policies and programs have been implemented to ensure adequate supply of micronutrients. These include increasing content of protein and micronutrients contained in the Midday Meal Scheme and Integrated Child Development Scheme, development of efficient public distribution schemes and food fortification. It is not enough to just provide adequate amounts and quality of food, but also to improve awareness about nutrition and eating right.
Figure 13. 2: Three main interventions to prevent and tackle malnutrition

Figure 1 depicts the short, medium and long term solutions to the problem of micronutrient malnutrition. These can be used either individually or in combination. These interventions are complementary rather than mutually exclusive and a multi-sectoral approach involving health, food security and agriculture is, therefore, of prime importance. Micronutrient supplementation provides the fastest improvement in the micronutrient status of targeted population, fortification has lesser but a wider and sustainable impact; increasing dietary diversity and utilizing local food resources takes the longest to create an impact, however, it is the most desirable and sustainable solution. The choice would depend on (1) level of nutritional deficiency (2) public health issues (3) existing government policies (4) availability of resources (5) awareness amongst populations and (6) cost-effectiveness.

**Short term intervention: Supplementation**

**What is supplementation?**

Supplementation is the term used to describe the provision of relatively large doses of micronutrients, usually in the form of pills, capsules or syrups.

**What is the need for supplementation?**

Timely supplementation of micronutrients in the correct doses can be lifesaving. Ensuring that women of reproductive age, pregnant women and children have sufficient essential micronutrients improves the health of expectant mothers, the growth and development of unborn children, and the survival and physical and mental development of children up to five years old.
Micronutrient insufficiency is a direct cause of child mortality. Even very small doses of micronutrients such as iron, vitamin A, iodine and folic acid can be life saving for young children and pregnant women.

The intake of foods rich in vitamin A, iron and zinc is low in India.

In cases of severe deficiency, food-based approaches alone are not as effective, and supplementation is required to be implemented.

The bioavailability of many micronutrients is low and require an ideal environment for absorption. For example, the rate of conversion of carotene to retinol is less than desired, limiting the use of dietary diversification as a strategy to combat vitamin A deficiency. (Retinol is the active form of vitamin A. Vegetarian sources such as yellow-orange fruits and green vegetables contain a precursor of retinol i.e. β carotene). Additionally, the absorption of iron from vegetarian food sources (also known as non-heme iron) is lower as compared to iron from meat, poultry and fish (also known as heme iron) due to the presence of anti-nutrient factors such as oxalates and phytates. This makes it difficult to raise levels through diet alone even after increasing food intake in case of a public health crisis.

Certain medical conditions such as severe diarrhea in children and acute respiratory illness, pneumonia can prove to be life-threatening. Micronutrients such as zinc play a vital role in reducing the morbidity associated with the same.

The requirements of micronutrients are altered throughout the life cycle. For example, demands of micronutrients such as iron, folic acid, vitamin B6 and vitamin B12 is increased during pregnancy. Supplementation of these during pregnancy has proven to reduce postnatal complications such as neural tube defects, low birth weight babies and anemia during pregnancy.

Who is the target group for supplementation?
- Women in reproductive age
- Pregnant women
- Lactating women
- Children under the age of 5

How is it done?
Supplementation is often done through government intervention programs.

For how long is it done?
Periodic supplementation should be combined with programs focussing on food fortification and dietary diversification. Supplementation should only be used as a short-term intervention in order to avoid risks of high dosages.
Which micronutrients are targeted?

Micronutrients that are identified to pose a public health challenge through intervention studies in a target population are often used for supplementation in at-risk population. These include vitamin A, iron, folic acid

What are the current programs in India?

National Vitamin A prophylaxis program

Deficiency of vitamin A is recognised as a public health problem. Dietary surveys indicate that intake of vitamin A is lower than Recommended Daily Allowance in young children, adolescent girls and pregnant women. Clinical and subclinical deficiency is highest in India. In the fifties and sixties many states reported blindness in children below five years of age due to vitamin A deficiency. A five-year long trial by National Institute of Nutrition indicated that mega doses of vitamin A once in six months in children aged one to three years can prevent xerophthalmia. These results suggested the need to administer massive doses of vitamin A in at-risk population groups.

The National Prophylaxis Program Against Nutritional Blindness was started in 1970, for children up to 3 years of age. In 2006, the age group was changed to children from 6 months to 5 years after reconsidering recommendations of the WHO, UNICEF and Ministry of Women and Child Development. The prophylaxis program has long term as well as short term strategies. The short-term strategy focuses on administration of mega doses on periodic bases, the long-term strategy focuses on the improvement of dietary quality.

National Iron Plus Initiative

Anaemia is one of the most challenging public health problems with more than 50% prevalence among the vulnerable groups such as pregnant women, infants, young children and adolescents. The most common causes of anaemia are nutritional with Iron Deficiency Anaemia (IDA) being the most prevalent nutritional cause of anaemia. Anaemia is known to have serious health outcomes and affects physical and cognitive health during all life stages. It is thus important that measures must be taken to prevent the onset of anaemia in vulnerable population groups.

The National Iron Plus Initiative (NIPI) is an attempt to look at the Iron Deficiency Anaemia comprehensively across all life stages including adolescents and women in reproductive age group who are not pregnant or lactating. The National Iron+ Initiative guidelines have been developed by the Adolescent Division of the Ministry of Health and Family Welfare (MoHFW), Government of India. The guidelines build on past and continuing work on the prevention and control of anaemia in India and have been developed in the context of the existing policies and strategies of the health, nutrition and population sectors. Under an Intensified NIPI, the Anemia Mukt Bharat Campaign has been launched in 2018 to reduce the prevalence of anemia.
Calcium Supplementation during pregnancy and lactation

Eclampsia and pre-eclampsia during pregnancy is highly preventable with timely care and healthcare provision. WHO recommendations and global evidence suggests that provision of calcium supplementation during pregnancy and lactation, can prevent the onset of hypertensive disorders. This program has now been included in the Government of India’s ante-natal care (ANC) and post-natal care (PNC) package. For prevention of pre-eclampsia, WHO 2013 guidelines recommend inclusion of routine prenatal calcium supplementation in high doses (>1 gm/day), especially in areas where dietary calcium intake is low.

Protocol: Oral swallow able calcium tablets to be taken twice a day (total 1g calcium/day) starting from 14 weeks of pregnancy up to six months post-partum. It is not advisable to take both calcium tablets together as more than 800 mg calcium interferes with iron absorption. Calcium tablets should not be taken empty stomach since it causes gastritis. Calcium and Iron Folic Acid (IFA) tablets should not be taken together since calcium inhibits iron absorption. IFA tablets should be taken preferably two hours after a meal. Along with this, women are also counselled with regards to supplementation and calcium intake.

What are some challenges for supplementation programs?

A lack of supplies and poor compliance are consistently reported by many Supplementation programme managers as being the main barriers to success. Iron supplements are not well tolerated by some as they produce symptoms of gastric distress.

Anemia Mukt Bharat

Anemia affects a large part of our population, all age groups and income categories. It affects physical growth, mental development and work capacity. Anemia Mukt Bharat campaign by the Ministry of Health and Family Welfare targets to reduce the prevalence of anemia by 3 percentage points per annum. It has a 6x6x6 strategy – 6 types of beneficiaries, 6 interventions and 6 institutional mechanisms. It specifically targets iron deficiency and folic acid deficiency related anemia by prophylactic supplementation. In addition, there is provision for biannual deworming as intestinal worm infestation has been identified as one of the causes of anemia. Besides testing and treating people for anemia, the important component of behaviour change communication has also been incorporated in the strategy for demand generation of supplements, to improve intake of iron rich foods as well as other measures.

Read more about it at: https://anemiamuktbharat.info/
Medium Term Intervention: Food Fortification

What is food fortification?

Food Fortification is the practice of deliberately increasing the content of an essential micronutrient, i.e. vitamins and minerals (including trace elements) in a food, so as to improve the nutritional quality of the food supply and provide a public health benefit with minimal risk to health. Food fortification can take several forms. It can either be for the general population or for a targeted population group; it can be mandated by the Government or can be a voluntary decision of manufacturers.

What is the need for fortification?

As mentioned earlier, the problem of hidden hunger is a serious concern in India which needs to be addressed in order to improve the health status of the nation. Often, there is considerable loss of nutrients during the processing of food as well. One of the food-based strategies to address this problem is fortification of food. This method complements other ways to improve nutrition such as diversification of diet and supplementation of food.

When did food fortification start in India?

Food fortification has been practiced in India since the 1950s and continues to be a part of policy programs to prevent several micronutrient deficiencies till date.

What are some key considerations for fortification?

The fortified food must be consumed in adequate amounts by a large proportion of the targeted population. It is also important that the targeted population has access to the foods which are going to be fortified. The form in which the nutrient (fortificant) is to be added, should be absorbed well by the body. The fortificant should not affect the sensory properties (taste, colour, appearance, texture) of the food to which it is added.

The general principles underlying the conditions for any fortification program given by the Food Safety and Standards Authority of India (Fortification of Food) Regulations, 2016 include the following:

Essential nutrients may be added to food for the purpose of contributing to any of the following:

I. Prevention or reduction of demonstrated deficiency of one or more micronutrients.
II. Reduction of the risk or correction of inadequate nutrition status of one or more essential nutrients
III. Meeting daily requirements of one or more essential nutrients
IV. Maintaining or improving health
V. Maintaining or improving nutritional quality of foods.
What are the health benefits seen with fortification?

The nutrients used in fortification of staple foods can prevent deficiencies, and hence improve immunity, productivity and cognitive development. Fortifying food with iodine, iron, vitamin A, and vitamin D has reduced the cases of iron deficiency anemia, night blindness and goiter. Evidence pertaining to fortifying staple foods with essential micronutrients is vast and thus the Government of India and FSSAI have set standards and regulations for fortification.

Which foods are used as staple vehicles for fortification in India and which micronutrients are targeted?

Single micronutrient or a combination may be used in order to fortify foods. Some processed foods are fortified. The Food Authority has drafted the standards for fortification of processed foods. The standards include fortification of cereal and cereal products like breakfast cereals, pasta and noodles, and bakery wares like bread, biscuits, rusks, buns with added iron, folic acid, and vitamin B 12 (in addition they may be fortified with zinc, vitamin A, riboflavin, niacin, and pyridoxine). In addition to these fruit juices shall be fortified with vitamin C. Fortification of processed foods will help in increasing the nutritional quality of these products as well as help in improving the nutritional status of the population at large.

How are allowances for fortification decided?

Generally, the extent of food fortification depends on the level of public health issues and those nutritional deficiencies that are most seen must be given priority. The level of micronutrient/s recommended for fortification of staple foods is country specific. It largely depends on the habitual diet of the population in a region. A database of micronutrient compositions of various foods and information on bioavailability are powerful tools to facilitate the process of arriving at the quantity of micronutrients required for fortification. It is also necessary to keep in mind the nutrient requirements and recommended dietary allowances of micronutrients for Indians.

How can a fortified food product be identified?

A logo (+F logo) has been notified for fortified food products as shown in figure 2.

Figure 13.3: The Logo to indicate whether the food is fortified
Food fortification provides a medium-term food-based intervention and its benefits outweigh the limitations. Fortification must be encouraged, and nutrition awareness must be created regarding the use of fortified staples.

The intent of Food Fortification rests on micronutrient deficiencies which are a public health concern. Today we have iron deficiency, iodine deficiency and vitamin A and vitamin D deficiencies which are causing a serious concern in the population. The amount of the nutrient fortified is country and population specific and thus it is based on scientific recommendations made by expert bodies at national level. The quantities of nutrients fortified are safeguarded towards any toxicity as the dosages are in line with the normal recommendations needed by the population. The foods which are selected for fortification are the vehicles which are used by major section of the population on daily basis like wheat, rice, salt, oil. This is to cover the adequacy of these specific nutrients due to lack of diet diversity especially in the lower and middle socio-economic strata.

**Long term intervention: Dietary Diversification**

Increasing dietary diversity means increasing both the quantity and the variety of foods consumed (including a variety of food groups and a range of micronutrient-rich foods from each of the food groups). In practice, this requires the implementation of programs that improve the availability and consumption of, and access to, different types of micronutrient-rich foods (such as animal products, fruits and vegetables) in adequate quantities, especially among those who are at risk for, or vulnerable to micronutrient deficiencies.

Increasing dietary diversity is the preferred way of improving the nutrition of a population because it has the potential to improve the intake of many food constituents – not just micronutrients – simultaneously. Micronutrient-rich foods also provide a range of antioxidants and prebiotic substances that are important for protection against non-communicable diseases and for enhancing immune function.

However, as a strategy for combating micronutrient malnutrition, increasing dietary diversity is not without its limitations, the main one being the need for behaviour change and for education about how certain foods provide essential micronutrients and other nutritive substances. A lack of resources for producing and purchasing higher quality foods can sometimes present a barrier to achieving greater dietary diversity, especially in the case of poorer populations. The importance of foods from animal sources for increasingly dietary quality is being recognized, and innovative approaches to increase their production and consumption in poorer regions of the world are currently being explored. Efforts are also underway to help poorer communities identify, domesticate and cultivate traditional and wild micronutrient-rich foods as a simple and affordable means of satisfying requirements.

For infants, ensuring a diet of breast milk is an effective way of preventing micronutrient deficiencies. In much of the developing world, breast milk is the main source of micronutrients during the first year of life (with the exception of iron). Exclusive breastfeeding for the first 6 months of life and continuation into the second year should thus be promoted. Moreover, all lactating women should be encouraged to consume a healthful and varied diet so that adequate levels of micronutrients are secreted in their milk. After the age of 6 months, it is important that the complementary foods provided to breast-fed infants are as diverse and as rich in micronutrients as possible.
Others

Some of the other techniques that could be used easily at home scale are fermentation, germination and biofortification. **Fermented foods** are those foods that have been subjected to the action of microorganisms. Fermented foods have many advantages, besides enhancing the nutritional quality of food by increasing the bioavailability of certain vitamins and minerals; it also acts as nutraceutical agents to impart beneficial health effects. **Germination** refers to the process by which grains are sprouted. This is an effective processing method for improving nutritional quality, reducing anti-nutritive compounds, boosting the level and digestibility of free amino acids and available carbohydrates, increasing mineral bioavailability, increasing vitamins and improving the functional properties of cereal and pulses.

A very important aspect in enriching diet is communication and awareness. This is one of the most important issues if the message of nutrition has to spread to all sections of the society including, policy makers and planners, bureaucrats, professionals from the fields of agriculture, health and medicine, social sciences, education and others besides the community. For health and nutrition security there has to be awareness, and access to balanced diet at an affordable cost. Knowledge of right feeding practices, clean environment and safe drinking water, and health care outreach- primary and curative is important. Education, particularly of women is important for optimum utilisation of the available services and creating demand.

It is ironical that both ends of the spectrum of malnutrition have inherent hidden hunger which is related to the quality of food intake by the population. High intake of HFSS foods across all socioeconomic strata of Indian population adds to the baggage of malnutrition. In addition, a low diet diversity is an added aspect contributing to micronutrient malnutrition. Thus, a judicious combination of strategies- Food Fortification, Diet Diversification and Supplementation is the way forward to enrich the diets of the Indian population.

Summary

- Nutrients are those constituents of food that are essential for the maintenance of life, growth and development.

- Nutrients can be classified as macronutrients and micronutrients based on the requirement. They can also be classified as energy giving, body building and protective foods based on their functions.

- Macronutrients are nutrients required in larger quantities and include proteins, carbohydrates, lipids and also water.

- Micronutrients are nutrients required in small quantities and include all the vitamins and minerals.

- All nutrients have important functions to perform in our body. A deficiency of any of the nutrients results in clinical signs and symptoms.
 Phytochemicals and zoochemicals are bioactive substances present in plant and animal foods respectively. They confer us with health benefits.

My plate of the day given by ICMR/NIN (2018) gives a good example of a balanced meal providing 2000kcal a day.

The quantities of foods needed to meet the nutrient requirements vary with age, gender, physiological status and physical activity.

To overcome malnutrition various simple techniques could be used to enrich our diet such as diet diversification, food fortification, food supplementation, fermentation and germination.

Key Words

Hidden hunger – another term for micronutrient deficiencies

Macronutrients – These are required in large quantities (in grams) and include proteins, carbohydrates, fats and water.

Micronutrients – These include vitamins and minerals – are required in relatively smaller quantities, but are essential for various body processes.

Prebiotics – substances (like oligosaccharides, fibre) which encourage the growth of good bacteria in our gut

Probiotics - live microorganisms which when administered in adequate amounts confer a health benefit on the host

Exercises

1. List the dietary guidelines for the Indian adult.
2. Why is water important for our body?
3. What are the different types of carbohydrates? Explain by giving examples.
4. What are the different types of fats found in our diet? Give at least two food sources for each.
5. Define the following terms briefly (2-3lines):
   a. Pellagra
   b. Balanced Diet
   c. Essential Amino acids
5. Describe the functions of the following nutrients:
   a. Lipids
   b. Vitamin C
7. Explain the different methods which can be used at the household level for enriching our diet. Supplement your answer with suitable examples.

8. Discuss the merits and limitations of food fortification as a strategy to address micronutrient malnutrition.

References
Chapter 14: Healthy Diets Everywhere

- Healthy Diets at School
  - Nutrient requirements
  - Eating behaviour
  - Eating disorders
  - Promoting healthy eating habits
  - Healthy food at school
  - Promoting good hygiene practices in childhood

- Healthy diets at Home
  - Nutrient requirements
  - Meal Planning
  - Improving nutrient availability

- Healthy diets at workplace
  - Faulty eating habits at workplace
  - Steps to promote healthy eating behaviour

- Healthy diets when eating out
  - Buying ready-to-eat packaged food
  - Healthy food choices when eating out
Chapter 14: Healthy Diets Everywhere

The rapidly increasing prevalence of diet related non-communicable diseases (NCDs) in Indians has been largely linked to changes in lifestyle and dietary patterns. Rapid urbanization, hectic work schedules and high economic growth have resulted in greater access to commercially available processed and packaged foods. Scientific evidence indicates that regular consumption of foods high in simple carbohydrates (sugar), salt, fats, and industrial trans fats is one of the prime reasons for sudden increase in overweight/obesity and NCDs in India. It is therefore important to follow a healthy diet and lifestyle to lead a healthy life. Choosing foods wisely whether you eat at home or outside becomes important while trying to eat healthy.

In the previous chapters you learnt about the concept of ‘healthy diets’, macro and micronutrients, their requirements, and about ways of enriching the diet. In this chapter you would learn about how you can select and eat healthy meals whether you are at home, in school, in your workplace and even while eating out in a restaurant or any other food outlet. This chapter would also elaborate upon the concept of meal planning and other associated aspects including portion sizes and food exchanges, choosing wisely from the various food groups, impact of cooking on specific nutrients, household measures of improving diet quality, food labels and menu labelling.

A healthy diet is a solution to many of our health-care problems. It’s the most important solution.

~John Mackey

A healthy diet can be described as a diet that helps to maintain or improve the overall health. It is one of the basic and most essential elements for maintaining good health, to prevent chronic diseases, and to provide an overall sense of wellbeing and vitality. It provides the body with essential nutrition: macronutrients, micronutrients, adequate calories and water. A healthy diet should maximize the consumption of whole grains, vegetables, fruit, and legumes and limit the consumption of red meats as well as refined and ultra-processed foods.

In the upcoming sections you would learn about the essentials of a healthy diet at home, at school, at workplace and when eating out.

Healthy diets at school

School is an educational institution which is designed to provide a learning space and environment to the students. In India a child remains in a formal schooling system for fourteen years. Apart from providing formal education, schools also nurture the overall development of the child including inculcation of good dietary and lifestyle habits. Healthy eating in childhood and adolescence is crucial for proper growth and development and to prevent various adverse health conditions. Poor dietary habits and nutrient inadequacy
during childhood and adolescence can delay growth and increase the risk of chronic diseases in adulthood.

**Nutrient requirements**

The school age includes a wide age group, from pre-schooler (3 to 4 years) to adolescence (17 years) spanning nearly 1.5 decades. During the school age the body grows, thus requirements of all the nutrients are high, however the specific requirement for each age group varies widely. As the child becomes older, peer influence and acceptance may become more important than family values thereby creating period of conflict between children and parents. Nutritional requirements vary among males and females after the age of 10 because of variations in growth rate, body composition, and physical activity level.

Micronutrient needs of youth are elevated during adolescence to support physical growth and development. Because of accelerated muscular, skeletal, and endocrine development calcium needs are greater during puberty and adolescence than during childhood or adult years. Iron requirements are increased during adolescence for the deposition of lean body mass, increase in red blood cell volume, and to support iron lost during menses among females. Other important nutrients are calcium, zinc and of course all vitamins during this period.

**Eating behaviour**

Eating behaviours evolve during the first few years of life. Most of the eating problems are behavioural in nature. Some of the most common eating issues include children being picky eaters, not eating enough or eating too much, eating the wrong foods, refusing to eat certain foods, or having erratic mealtimes. Most eating problems do not last long enough to interfere with a child's growth and development. However, difficult eating issues among children and adolescents may lead to serious changes in eating habits that can lead to health problems.

Food habits that are seen more frequently among adolescents than other age-groups include irregular consumption of meals, excessive snacking, eating away from home (especially fast-food venues), dieting, and meal skipping. Meal skipping increases throughout adolescence as they try to lose weight through calorie restriction, and as their lives become busier in general due to academic pressure. Breakfast is the most commonly skipped meal, especially among adolescent females. Adolescents who skip meals often snack in response to hunger instead of eating a meal. Snack foods consumed are often high in fats, sugar and sodium. Sugar containing aerated beverages are commonly consumed, accounting for high daily caloric intake. Many factors contribute to these behaviours, including decreasing influence of family and increasing influence of peers on food and health choices, increasing exposure to media, and increase in time spent outside home.

Most adolescents are aware of the importance of nutrition and the components of a healthy diet; however, there are many barriers to choosing healthy foods and beverage. They cite taste, time, and convenience as the key factors that affect their food and beverage choices. Many adolescents lack the ability to associate current eating habits with future disease risk and show little concern for their future health.
Eating disorders

Avoidant/restrictive food intake disorder (ARFID) is an eating disorder characterized by eating very little food or avoiding eating certain foods. It is a common eating disorder experienced by young children. Children with this disorder experience a disturbance in their eating which can include a lack of interest in food or a sensory aversion to certain foods. ARFID usually presents in infancy or during childhood and may persist into adulthood. It may initially resemble the picky eating that's common during childhood. For example, a child might become averse to the texture of foods they once enjoyed. They might also fear experiencing abdominal pain or vomiting after consuming a certain food. These aversions and restrictions can lead to weight loss and nutritional deficiency among young children. Pica is a type of condition where a child might have the urge to eat non-food or non-nutritional substances like, soap, chalk, sand, ice, and hair.

High-risk dieting practices are used by many adolescents which may lead to risk of poor nutritional status and increased risk for eating disorders. Let us look at some of the eating disorders:

- Anorexia nervosa (AN) a disorder characterized by (1) refusal to maintain a normal body weight, (2) intense fear of gaining weight, (3) body image distortion. It may be one of two sub types restricting or binge eating/purging binge. A binge eating episode is marked by three particular features: (1) the amount of food eaten is larger than most persons would eat under similar circumstances (2) the excessive eating occurs in a discrete period, usually less than 2 hours; and (3) the eating is accompanied by a subjective sense of loss of control.

- Binge eating disorder (BED) is characterized by the occurrence of binge eating episodes at least twice a week for a 6-month period.

- Bulimia nervosa (BN) is characterized by repeated episodes of binge eating followed by inappropriate compensatory methods such as purging including self-induced vomiting or misuse of laxatives, diuretics, enemas, or non-purging, including fasting or engaging in excessive exercise.

Promoting healthy eating habits

School years shape the future of a child. Healthy eating habits during this phase help the child in imbibing them in their lifestyle. Children follow what they see, thus adults need to demonstrate the healthy eating habits themselves and be role models. This can help children maintain a healthy weight and normal growth. Some of the simple practices are listed here:

- Guide the family’s choices rather than dictate foods. Make a wide variety of healthful foods available in the house. This practice will help children learn how to make healthy food choices. Leave the unhealthy choices like chips, soda, and juice at the grocery store. Serve water with meals.
• Encourage children to chew the food properly and eat slowly. A child can detect hunger and fullness better when they eat slowly. Suggest the child to chew properly, this aids in digestion and gives time to the brain to register fullness.

• Eat meals together as a family as often as possible. Try to make mealtimes pleasant with conversation and sharing, not a time for scolding or arguing. If mealtimes are unpleasant, children may try to eat faster to leave the table as soon as possible. They then may learn to associate eating with stress.

• Involve children in food shopping and preparing meals. These activities can help parents understand children's food preferences and provides an opportunity to teach children about nutrition. In addition, children may be more willing to eat or try foods that they help prepare.

• Plan for snacks. Continuous snacking may lead to overeating, but snacks that are planned at specific times during the day can be part of a nutritious diet, without spoiling a child's appetite at mealtimes. Snacks should be as nutritious as possible and should be within reach and at eye level of the child.

• Discourage eating meals or snacks while watching television. Try to eat only in designated areas of home, such as the dining room or kitchen. Eating in front of the television may make it difficult to pay attention to feelings of fullness and may lead to overeating.

• Encourage children to drink more water and stay hydrated. Over consumption of sweetened drinks and sodas has been linked to increased rates of obesity in children.

• Try not to use food to punish or reward children. Withholding food as a punishment may lead children to worry that they will not get enough food. For example, sending children to bed without any dinner may cause them to worry that they will go hungry. As a result, children may try to eat whenever they get a chance. Similarly, when foods, such as sweets, are used as a reward, children may assume that these foods are better or more valuable than other foods. For example, telling children that they will get dessert if they eat all their vegetables sends the wrong message about vegetables.

• Make sure that children's meals outside the home are balanced. Also, select healthier items when dining at restaurants.

• Make sure that the child does not skip meals. Don't let the child skip or delay meals and ensure to schedule the snacks on time. Skipping or delaying meals can lead to eating too much or choosing an unhealthy snack.

• Pay attention to portion size and ingredients. Read food labels and limit foods with trans-fat, high fat, salt and/or sugar.
Nutrition education and counselling for children and adolescents should focus on short-term benefits, such as improving school performance, looking good, and having more energy. Messages should be positive, developmentally appropriate, and concrete, emphasizing skills to help them make healthy choices. Because snacking is prevalent among adolescents and snacks are often consumed in place of meals, teens should be encouraged to make healthy choices when choosing snack foods and beverages rather than to avoid snacking.

To prevent eating disorders, healthy eating habits should be developed and promoted from early childhood. To inculcate the habit of eating healthy foods among children and adolescents, it is important to change the food environment. Healthy food must be readily available to the children and access to unhealthy options should be limited.

**Healthy food at school**

Healthy food makes children feel better, grow better and learn better and right eating habits can be engrained in them from a young age. According to the United States (US) Centres for Disease Control and Prevention (CDC), children learn better eating habits when schools provide healthy foods. In India some private schools provide school meals to the younger children while in government schools mid-day meal service is provided. Schools need to promote healthy eating behaviour. Schools should also ensure that the food available in the school cafeteria is healthy and hygienically prepared. With the aim to ensure safe and wholesome food for School children FSSAI has notified a regulation on Food Safety and Standards (Safe Food and Balanced Diets for Children in School) Regulations, 2020 (Box 1).

**Box 1: Ten-point Charter of healthy diets for School Children**

<table>
<thead>
<tr>
<th>S. No</th>
<th>Charter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The School Authority itself/FBOs contracted by School Authority selling or catering school meals and FBOs contracted by Department of School Education for operation of the Mid-Day Meal scheme must obtain a registration or license as applicable and comply with the requirements of sanitary and hygienic practices to the food service establishments as specified under schedule 4 of the Food Safety and Standards (Licensing and Registration of Food Businesses) regulations, 2011.</td>
</tr>
<tr>
<td>2</td>
<td>Foods which are referred to as foods high in fat, salt and sugar (HFSS) cannot be sold to school children in school canteens/ mess premises/ hostel kitchens or within 50 meters of the school campus.</td>
</tr>
<tr>
<td>3</td>
<td>Encourage schools to adopt a comprehensive program for promoting Safe food and Healthy diets amongst school children, and to convert school campus into Eat Right School focusing safe and healthy food, local and seasonal food and no food waste as per the specified benchmarks.</td>
</tr>
<tr>
<td>4</td>
<td>Encourage School Authority to promote consumption of a safe and balanced diet in the school as per the guidelines issued by the National Institute of Nutrition (NIN)</td>
</tr>
<tr>
<td>5</td>
<td>The School Authority shall ensure that FBOs supplying prepared meals in the premises are on the basis of general guidance provided in the regulation and as per the direction issued by the Food Authority or the Commissioners of Food safety.</td>
</tr>
<tr>
<td>S. No</td>
<td>Charter</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
</tr>
<tr>
<td>6</td>
<td>Nutritionists, dieticians may be engaged by the School authority to assist in the preparation of menu for the children, periodically.</td>
</tr>
<tr>
<td>7</td>
<td>FBOs manufacturing HFSS food products barred from advertising such foods to children in school premises or within 50 meters of the school campus.</td>
</tr>
<tr>
<td>8</td>
<td>FBOs to support healthy eating in schools and not market, sell, or give away low nutrition foods anywhere on school campus, including through logos, brand names, posters, textbook covers etc.</td>
</tr>
<tr>
<td>9</td>
<td>Regular inspection of premises to ensure that safe, healthy and hygienic food is served to students</td>
</tr>
<tr>
<td>10</td>
<td>Creating a sub-committee by the State Level Advisory Committee to monitor the implementation of this regulations and to ensure availability of safe and wholesome food to school children.</td>
</tr>
</tbody>
</table>

It is also important for the parents and caregivers to understand the importance of providing healthy food in the tiffin. Box 2 presents some points to keep in mind to plan a healthy tiffin meal. Including all three food groups helps provide a balanced and healthy meal (Cereals for energy, pulses/flesh foods/eggs/milk products for body building and vegetables/fruits as protective foods).

**Box 2: Healthy tips for school tiffin**

<table>
<thead>
<tr>
<th>S. No</th>
<th>Healthy tips for school tiffin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Choose healthy and wholesome recipes for tiffin. For example, roti wraps, rice preparations, stuffed parathas, steamed foods (idli, dhokla), and sandwiches stay best in tiffin lunch.</td>
</tr>
<tr>
<td>2</td>
<td>Include some protein (egg, paneer, pulses, sprouts, yoghurt) in the meal to keep your child satiated.</td>
</tr>
<tr>
<td>3</td>
<td>Pack vegetables or fruit with the school tiffin.</td>
</tr>
<tr>
<td>4</td>
<td>Do not fill up the meal box with creamy, cheesy, fatty or fried food.</td>
</tr>
<tr>
<td>5</td>
<td>Avoid using too much white sugar, biscuits or jams in the school meal.</td>
</tr>
<tr>
<td>6</td>
<td>Pack the meal box once the food has completely cooled. This helps keep the food fresh for longer periods.</td>
</tr>
<tr>
<td>7</td>
<td>Squeeze lemon over cut fruit (apple, pear, papaya, guava) to prevent discolouration and keep them fresh.</td>
</tr>
</tbody>
</table>

**Promoting good hygiene practices in childhood**

It is important to maintain personal hygiene to keep away food borne illness and stay healthy. Repeated illness during childhood adversely affects the growth of children. It is important to build these habits in the child’s growing years. Some of these have been highlighted in box 3.
Box 3: Personal habits for maintaining good hygiene

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Hygienic habits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Brushing teeth twice a day</td>
</tr>
<tr>
<td>2</td>
<td>Having regular baths and thoroughly cleansing the body during a bath</td>
</tr>
<tr>
<td>3</td>
<td>Regularly washing hair and trimming nails</td>
</tr>
<tr>
<td>4</td>
<td>Washing hands before and after eating, after using toilet</td>
</tr>
<tr>
<td>5</td>
<td>Washing hands after handling a pet or touching something that isn’t “clean”</td>
</tr>
<tr>
<td>6</td>
<td>Covering the mouth and nose with a tissue while sneezing/coughing</td>
</tr>
<tr>
<td>7</td>
<td>Changing into clean clothes after getting dirty</td>
</tr>
</tbody>
</table>

Healthy diets at home

What family members consume at home largely depends on the home food environment. What are the kinds of foods that are readily available at home? When hungry, do family members easily reach out to chips, savouries, biscuits, etc. or to fresh fruits, nuts, or other healthy preparations? It is also important to consider the composition of the family and keep in mind the nutrient requirements of each age group.

Nutrient requirements

The children in the family need good quality protein in every meal to supply essential amino acids for tissue synthesis all day long. Good quality protein sources include flesh foods (meat, poultry, fish), eggs, milk and milk products, or a combination of cereals and pulses. Pregnant and lactating women also need to have good quality proteins in every meal as they support the growth of the foetus and infant respectively. In another chapter you have learnt how requirements of nutrients increase at certain age groups and physiological stages of the lifecycle. As the individual ages, the energy needs decrease in response to decrease in activity levels. Adulthood is a critical period of life when any excess weight may predispose an individual to non-communicable diseases like diabetes, hypertension or heart disease.

Every member of the family may have different nutrient requirements however the principles of what constitutes a healthy, well balanced diet remain same for all age groups. Variations in texture and digestibility may have to be accounted for infants and elderly. These can easily be made in what is being cooked for the family. For example, a portion can be taken out for little children before putting in chillies, or a separated food portion can be mashed for infants and elderly having trouble chewing. It is important to keep the special nutritional needs of all family members in mind while planning and preparing meals for the family.

Meal Planning

Eating a well-planned meal becomes important in today’s time when the population is struggling from the triple burden of malnutrition. Choosing a healthy diet for our own self and for others starts with comprehensive planning of each meal. With more people moving out for work, meal planning becomes critical in providing a combination of nutrition, taste and satisfying food preferences.
Meal planning may be defined as the science of when and how much to eat. It involves selection of each food group in adequate amounts to meet the nutritional need of the individual.

Meal planning comprises planning of balanced meals which are wholesome, nutritious, palatable, appetizing and well within the economic means of the family. It involves what, and how much to eat during each meal. The meals planned should not only ensure that nutrient requirements are adequately met but also be flexible enough to accommodate easily available seasonal foods. Further, it should also take care of the individual and family’s food preferences. A balanced diet should provide all nutrients in the amount and proportion required by the body according to individual’s age, gender and activity. Since adequate nutrition is important for physical, mental and emotional development of an individual, it therefore becomes essential that sufficient emphasis is laid on planning of proper meals. Main steps in meal planning include:

- Understanding the nutritional requirements
- Assessing acceptability of meals
- Procurement and storage of food

**Some points to remember**
- Have regular family meals.
- Serve a variety of healthy foods and snacks.
- Be a role model by eating healthy yourself.
- Involve your child in meal planning and preparation.
- Keep mealtime calm and pleasant.

Acceptability of meals is an important aspect of meal planning. To make the meals acceptable consideration needs to be given to likes and dislikes of the family members, including variety in the meals, taking care of the food habits, seasonal food availability and palatability. Preference should be given to regional and seasonal foods as they are economical, nutritious add diversity to the diet and such diets are sustainable. It is important to plan meals in advance and procure them in advance to save time and resources.

**Improving nutrient availability**

Cooking food improves digestion and increases the absorption of many nutrients, for example, the protein in cooked dals is more digestible and β-carotene is better absorbed from cooked vegetables. However, some cooking methods reduce several key nutrients like vitamins B and C which are heat labile. The most common methods of cooking are sautéing, roasting, boiling, frying and steaming.

Water-soluble vitamins like vitamin C and the B vitamins namely — thiamine, riboflavin, niacin, pantothenic acid, pyridoxine (B6), folic acid, and cobalamin (B12); and water soluble forms of minerals are easily lost if soaking or cooking water is discarded and not consumed. Exposing food to high heat or prolonged cooking time also destroys heat labile vitamins. B
vitamins also get destroyed in alkaline medium when cooking soda is used for cooking pulses etc. Leaving cut fruits and vegetables exposed to air may also destroy vitamins. Additionally, vitamins like A and E may get destroyed by oxidation, if food is left exposed to air and light.

Loss of nutrients in vegetables begins from preparation onward and is greater during the cooking process.

1. When fruits and vegetables are peeled the vitamins present under the skin may be lost.
2. Nutrients are also lost when the edible leaves of carrot, beetroot and outer leaves of cabbage are discarded.
3. Vitamin B complex and Vitamin C are water soluble and are lost when the water in which vegetables are cooked is discarded. Sodium, potassium and chlorine are also lost when cooking water is discarded.
4. Vitamin C is lost by oxidation due to exposure of air.
5. During dehydration ascorbic acid and carotene are lost.
6. Addition of soda results in heavy loss of B – Vitamins during cooking.

When fruits and vegetables such as apple, banana, potato and brinjal are cut, there is a development of brown colour on the surface due to action of enzymes. This is known as enzymatic browning. When the tissue is injured or cut and the cut surface is exposed to air, phenol oxidase enzymes are released at the surface. These act with the polyphenols present in the fruits and oxidise them to orthoquinones, which gives the brown colour to cut tissues. Browning can be prevented by squeezing lemon on cut surfaces of fruits or keeping the cut vegetables soaked in water. However, it is best to use the cut vegetables soon after cutting to reduce nutrient losses.

Minimizing the nutrient loss during cooking

- When cooking vegetables, keep skins on when possible
- Do not wash vegetables after chopping/peeling
- Avoid repeated reheating of food
- Use a minimal amount of cooking liquid
- Choose steaming over boiling
- When boiling, retain the cooking liquid for a future use (like soups and stocks)
- Use a pressure cooker when possible to reduce cooking time
- Avoid using baking soda to hasten cooking or retain colour
- Cut vegetables into large chunks to reduce surface area and hence loss of nutrients
Healthy diets at workplace

A workplace is a place of employment or any location where an individual or group of individuals work. Such a place can range from a home office to a large office building or factory. The workplace is one of the most important social spaces other than the home. A working individual spends substantial part of each day at his/her workplace. It is therefore important that the meal/snacks consumed at workplace are healthy. The worksite is a central venue for influencing dietary behaviour.

Faulty eating habits at workplace

Faulty eating habits in the workplace contribute to poor health, reduced productivity and a negative working environment. Employees who have trouble in concentrating, suffer from irritability and lethargy may be making poor food choices. Talking to employees about bad eating habits is a delicate task best handled by addressing the workforce rather than targeting individuals. Small business owners should take a proactive and fun approach that encourages employees to make wise food choices. Some of the poor food habits include consuming too much of tea/coffee, untimely snacks, unhealthy (high fat, sugar and salt) snacks during team meetings, poor meal timings, etc.

### Benefits of healthy eating in the workplace

- Increased energy
- Increased productivity
- Decreased absenteeism
- Lower rates of chronic diseases
- Decreased medical claims, disability and insurance costs related to nutrition related chronic conditions

### Steps to promote healthy eating behaviour

The dietary patterns of the employees/workers are also likely to be influenced by other factors in the work environment. Research studies have shown that workplace dietary interventions are generally effective, especially fruit and vegetable interventions. The following steps may help in improving eating behaviour of employees:

- Develop workplace policies that promote healthy eating
- Create an accessible area where information can be posted (such as a bulletin board), regarding healthy eating, nutritional information, and other resources
- Send out information regarding healthy eating and nutrition via emails or through workplace newsletters
- Organize health fairs that promote healthy eating, that include dietitians/ health and wellness experts to answer questions and provide consultations
• Provide access to a Registered Dietitian who can help counsel and provide support to those wishing to change their eating habits
• If selling food in the cafeteria, ensure that nutritional information is available
• Offer healthy foods in the cafeteria, vending machines, and during meetings
• Provide self-assessment tools for employees to assess their eating habits
• Offer workshops on topics such as preparing healthy meals, reading food labels etc.
• Provide a kitchenette, microwave, and refrigerator for employees to prepare, reheat and/or store healthy meals.

Table 1 provides suggestions for healthy workplace snacks and meals.

Table 14.1: Healthy eating choices at workplace

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Meeting/ Cafeteria</th>
<th>Healthy food/ snack options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Meeting snacks</td>
<td>Roasted, unsalted chana, nuts, puffed rice, fox nuts, dates, steamed corns and peas, sprouts, steamed dhokla, fruits, low-fat sandwiches with whole wheat bread and vegetables, etc.</td>
</tr>
<tr>
<td></td>
<td>Beverage options</td>
<td>Unsweetened lemonade and butter milk, green tea, coconut water, unsweetened juice with pulp</td>
</tr>
<tr>
<td>2</td>
<td>Cafeteria Meals</td>
<td>Wholesome meals containing roti made from whole wheat or multigrain, millets, roti wraps, steamed idli, rice, freshly cooked pulses and legumes, dairy products such as plain yogurt/curd, buttermilk and milk, fresh vegetables especially green leafy vegetables, fresh and seasonal fruits and vegetables as salads</td>
</tr>
</tbody>
</table>

In addition to awareness about healthy diets, worksites should put in effort to reduce work-related stress and provide avenues for increasing physical activity especially among employees engaged in desk work.

Healthy diets when eating out

There has been a notable shift in the global eating culture in the past 40 years. Consumption of commercially available food/snacks outside the home has become an integral part of the busy modern lives. With fewer meals being consumed at home, the overall quantity of calories has increased while nutritional quality has declined. This has further contributed to the burden of diet related non-communicable diseases. It is therefore important that due care is given to the type and amount of food consumed outside home. Commercially available food/snacks can be either packaged or unpackaged, ready to consume.
Buying ready-to-eat packaged foods

When buying packaged foods, it is important to read the nutrition labelling properly. “Labelling includes any written, printed or graphic matter that is present on the label, accompanies the food or is displayed near the food, including that for the purpose of promoting its sale or disposal.” Nutrition labelling is a combination of various mandatory (Nutrition Facts Panel (NFP) and ingredients) and voluntary information (symbols and logos, nutrient claims, health claims, allergen declaration) on food labels.

The Food Safety and Standards Act, (2006), and Food Safety and Standards (Packaging and Labelling) Regulations, 2011 have laid down the requirements for labelling of pre-packaged foods. It is mandatory that every package of food should carry a label that bears all the information required under the Act. Mandatory information is compulsory to be printed on food labels while voluntary information declaration is optional for the manufacturers. However, if any voluntary claim is being made then it should be substantiated by NFP. For example, nutrient claim “sugar free” should be substantiated by reporting the sugar value as zero-nil on NFP.

The label should not carry a false, misleading or deceptive description or presentation of the pre-packaged food and the labelling should not create a misleading impression regarding the character of food. To begin with, understanding of nutrition labelling is a must to make healthy food choices by the consumers. Nutrition labelling is the first and the most important source of information regarding the nutritional content of food purchased by the consumer. It is a tool for nutrition education and information about essential components of the food which has public health implications in preventing nutrition and diet related conditions such as obesity, cardiovascular disease and diabetes. Without nutrition labelling it is difficult for the consumers to identify the nutritional content of packaged food. Packaged foods which are usually high in fat, trans fat, sodium and sugar should be consumed judiciously.

To ensure that one is making healthy food choices, one should know how to read nutrition labels. One should be able to recognise foods which are high in fat, trans fat, sodium and sugar and consume these foods occasionally. Nutrition labelling is found on Front of Pack and Back of Pack. Usually the front of the label information is short and precise, in the form of nutrient and health claims while the back of the pack includes more detailed presentation of nutrients in the form of Ingredients list and Nutrition Facts Panel.

**Nutrient Claims:** Nutrient claim is usually related to the function, presence or absence of a nutrient in a food. For e.g. nutrient claims like "low in fat", "good source of calcium", "high in dietary fibre", "zero cholesterol", etc. Nutrient claims are not mandatory but if it is declared on the label then it becomes inevitable to have the nutrition value declared. For e.g. when a claim "rich in iron" is made on the label then it is mandatory to have iron values as percentage/mg on the panel and this is called substantiation of a claim.

**Health Claims:** “Health claim means any representation that states, suggests or implies that a relationship exists between a food or a constituent of that food and health and include nutrition claims which describe the physiological role of the nutrient in growth, development and normal functions of the body”. Other functional claims can concern specific beneficial effect of the consumption of food or its constituents, in the context of the total diet, on normal functions or biological activities of the body. Such claims can relate to a positive contribution to health or to the improvement of function or to modifying or
preserving health or disease. Risk reduction claim relates to the consumption of a food or food constituents, in the context of the total diet, to the reduced risk of developing a disease or health related condition.

**Nutrition Facts Panel:** Nutrition Facts Panel (figure 1) is a tabular presentation or declaration of the nutrients contained in a food package. Nutrition information is usually given as, “per 100g” or “per serving” or “% DV” or combination of “per 100g and per serving” or combination of “per serving and % DV” or combination of per 100g, per serving and % DV.” “%DV” stands for ‘Percent Daily Value’ which is the amount of nutrient needed by a person based on a 2000 Kcal diet. An individual’s Daily Value may be higher or lower depending on the calorie needs. A food is considered a rich source of a nutrient if 20% or more of the DV is present in that food; 10 – 19% is considered a good source and 5% or lower is considered a poor source.

This declaration should compulsorily comprise of the following information-

- Energy value in kcal
- Protein, fat and carbohydrate along with sugar quantity in grams
- Amount of any other nutrient for which a nutrition / health claim is made.
- The amount of vitamins and minerals should be in metric units.
- For nutrition declaration made per serving, the amount in one serving in grams or milliliter should be mentioned for reference beside the serving measure.
- When a claim is made on the amount or type of fatty acid or the amount of cholesterol, the amount of saturated fatty acids, monounsaturated fatty acids and polyunsaturated fatty acids in grams and cholesterol in milligrams should be declared. Along with this, the amount of trans fatty acids in grams should also be stated.

So, while selecting packaged foods for their nutritional value, the following can be kept in mind:

- Nutrients which are good for you include vitamins, minerals, fibre, protein and omega 3 fatty acids and it is a good idea to select foods rich in these nutrients.
- Select foods which have more than 15% DV of vitamins and minerals.
- Foods rich in fibre should have at least 6g fibre per 100g of food.
- There should be zero trans fat in the food as trans fats are bad for cardiovascular health.
- Healthy foods are low in total fat, saturated fat, sugar and salt/sodium.
- Low fat foods have no more than 3g fat/100g of food or 1.5 g fat/100 ml of beverage.
- Prefer foods with no added sugar.
- Foods with no more than 0.12 g of sodium or 0.3 g salt/100g are considered to be low in sodium/salt.

![Nutrition Facts Panel](Source: Pink Book, FSSAI)
The Food Safety and Standards Act, (2006), and Food Safety and Standards (Packaging and Labeling) Regulations, 2011 have laid down the requirements for labeling of pre-packaged foods. It is mandatory that every package of food should carry a label that bears all the information required under the Act. At the same time, it is also important that the label should not carry a false, misleading or deceptive description or presentation of the pre-packaged food and the labeling should not create a misleading impression regarding the character of food in any respect. Table 2 presents clarifications about certain claims which are seen on food packages or advertisements for food products. Box 4 lists the mandatory information each food label should have. In addition, there are certain mandatory declarations which manufacturers have to make on the label. These include:

- Addition of certain food additives like food colours, artificial sweeteners, Class II (chemical) preservatives, flavouring agents, monosodium glutamate, etc.
- For edible oils the kind of oil, names and proportions of oils in case of blends, and the declaration that the oil is not to be sold loose and that it is free of Argemone oil (an adulterant).
- For infant foods, it is mandatory to declare on the label that breast milk is the best for the baby.
- Presence of allergens in food.
A complete label gives the assurance that the food item has been manufactured by a reliable firm which is not trying to hide facts. In addition to checking whether the packets are well sealed and labelled and within the best before date, the list of ingredients should be checked for the presence of allergens. Products are also supposed to declare allergy information in case any of the known allergens like cereals with gluten, crustacean, peanut, tree nuts, egg, milk, fish, soy and sulphite in concentrations of 10 mg/kg or more have been used in the formulation of the product or the product has been processed in a plant where these ingredients are also processed.

Healthy food choices when eating out

In today's fast paced lifestyle, eating out has become inevitable. It is mainly due to lack of time, increased mobility of younger generation, more opportunities for social activities, and availability of a variety of regional and international cuisine. Hence it has become increasingly imperative to ensure that hygienic and healthy eating options are available to consumers of all income brackets. FSSAI is trying to improve the safety of street foods through its ‘Clean Street Food Hub’ initiative. Street foods provide cheap, nutritious and
traditional meals to a sizeable population in urban areas of our country. Maintaining hygiene is an integral part of keeping food borne diseases away. Food outlet and kitchens should maintain proper hygiene. Before selecting a food outlet, one should check the hygiene rating of the food outlet, if available.

**Menu labelling** refers to providing and displaying the calories and/or other nutritional information for each food item available at a food outlet. It is aimed at helping people make informed – and ideally healthier – food choices when eating out. To facilitate informed consumer choices, regulations on advertising and claims and mandatory menu labelling has been notified. FSSAI has issued draft packaging and labelling regulations making it mandatory for restaurant chains to declare on the menu cards, the calorie content of all the dishes served at their outlets. It also intends to bring online food-delivery platforms and food aggregators under the ambit of these regulations. Apart from menu labelling there are some other points to be considered when eating out for healthful and mindful eating, these have been outlined below:

- Avoid eating out when you are overly hungry. Eat a small healthy snack, such as carrots or a small apple, just before going out.
- Check the menu online so you can make healthy choices ahead of time.
- The portion sizes at many restaurants are very large. The temptation for overeating can be hard to resist at these places. Think and plan ahead and order for smaller portion sizes or share your food.
- When ordering, ask about food items cooked in a healthier manner such as baked or steamed instead of fried.
- Prefer salads and other vegetable side dishes. Order salads or uncooked food items only if you are sure of the hygienic standards of the outlet.
- Prefer foods that are broiled, grilled, steamed, poached, roasted, or baked.
- Avoid anything creamy, fried, crispy, breaded, battered, or au gratin.
- Avoid sauces or soups with lots of butter, cream, or cheese.
- Avoid thick or creamy salad dressings.
- Limit fried foods, creamy curry sauces, cream sauces such as *Korma* or *Makhani*, and foods made with clarified butter or *ghee*.
- Prefer water or low-fat milk over beverages that have empty calories, such as sodas.
- Avoid ordering the value or combo meal unless the restaurant offers healthy sides such as salad.

Thus, whether we eat at home or at school, in the workplace or any food outlet, keeping some of these pointers in mind will help us select healthier food options which will increase the overall healthfulness of our diets.
Summary

- Eating a healthy diet is the basic step towards good health. Following a healthy diet at home, in school, at workplace and while eating out is possible and achievable.

- Healthy eating in childhood and adolescence is crucial for proper growth and development and to prevent various health conditions.

- Adequate nutrition is crucial during the school age, however there are several hindrances in achieving it, one such factor is ‘eating behaviour’ during the school age.

- Nutritional requirements vary greatly among males and females because of variations in growth rate, body composition, and physical activity level.

- It is also important for the parents and caregivers to understand the importance of providing healthy food in the tiffin. Choose healthy and wholesome recipes for tiffin. For example, roti wraps, rice preparations, stuffed parathas, steamed foods (idi, dhokla) etc. Combination of a cereal with pulse along with some vegetables/fruits provides a wholesome meal.

- How healthy the family diet is, is partly dependent upon the home food environment. It is therefore essential that healthy, well balanced meals are prepared, which cater to all family members of different age groups at home.

- Meal planning comprises planning of balanced meals which are wholesome, nutritious, palatable, appetizing and well within the economic means of families.

- Faulty eating habits in the workplace contribute to poor health, reduced productivity and a negative working environment. Employees who have trouble concentrating, irritability and lethargy may be making poor food choices. The workplace food environment should encourage and improve availability of healthy food options.

- Consumption of commercially available food/snacks outside the home has become an integral part of the busy modern lives. With fewer meals being consumed at home, the overall quantity of calories has increased while nutritional quality has declined.

- When buying packaged foods, it is difficult to check the food quality by looking at the food. In these cases, reading the food label helps in selecting more nutritious options of food.

- Before selecting a food outlet, one should check the hygiene rating of the food outlet, if available.
Key Words

Health claim - means any representation that states, suggests or implies that a relationship exists between a food or a constituent of that food and health

Nutrition claim - is usually related to the function, presence or absence of a nutrient in a food.

Nutrition Facts Panel - is a tabular presentation or declaration of the nutrients contained in a food package.

Nutrition labelling - information on the label of packaged food regarding ingredients and nutrients present in food.

Percent Daily Value - which is the amount of nutrient needed by a person based on a 2000 Kcal diet.

Exercises

1. Discuss the things to be considered and the healthy food options when eating out.
2. Explain why meal planning is important.
3. What are some concerns regarding eating behaviour of children and adolescents?
4. Explain the things to be kept in mind when buying packed foods. Discuss importance of reading food labels.
5. What can be the best options for healthy tiffin?
6. Why is it important for employers to improve the food environment at the workplace? Discuss giving suggestions on how meals and snacks offered at workplaces can be improved.

Activity

1. Visit a college/school canteen or observe the service of a mid-day meal being served in a school. Make a note of the menu. Critically evaluate the nutritional quality of the meals served. (Hint: Look at the food groups included. Are any of the dishes high in fat, sugar or salt?)
2. Visit an office and check out the meals served in the cafeteria. How would you rate the healthfulness of the dishes? Use a nutrient profiling model to evaluate.
References

1. Food Safety and Standards (Safe Food and Balanced Diets for Children in School) Regulations, 2020 Available at: https://fssai.gov.in/eatrightschool/school-regulations.php


Chapter 15: Lifecycle Approach to Healthy Diets

- Importance of the first 1000 days
  - Nutritional care during pregnancy
  - Nutritional care during lactation
  - Nutritional care during infancy

- Childhood - the growing years
  - Importance of nutrition
  - Factors affecting dietary pattern
  - Inculcating healthy eating practices

- Adolescence – a critical period of development
  - Nutritional needs during Adolescence
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- Adulthood and Healthy Ageing
  - Dietary needs and nutritional concerns
  - Healthy lifestyle
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Chapter 15: Lifecycle Approach to Healthy Diets

Good nutrition is essential for survival, physical growth, mental development, performance, productivity, health and well-being across the entire life span: right from fetal development up to birth, childhood, adulthood and aging. Nutritional needs and concerns vary during different stages of life. Nutritional needs should be met at every stage of the life cycle because nutritional status at one stage influences health status at a later stage.

This chapter focuses on how the individual’s nutrient needs change through the lifecycle. If these needs are not met, they can adversely affect growth and development. For instance, iron deficiency experienced by young children can decrease intellectual capacity, and adequate vitamin D status during adolescence and early adulthood decreases the risk of breast cancer in older women. A focus is needed on meeting nutritional and other health needs of individuals during every stage of the life cycle in order to prevent diseases and promote good health.

Healthy individuals require the same nutrients throughout life, but amounts of nutrients needed vary based on age, growth, and development. Nutrient needs during each stage of the life cycle can be met through a variety of foods. There is no one best diet for everyone. Traditional diets defined by diverse cultures and regions provide the foundation for meeting individuals’ nutritional needs.

<table>
<thead>
<tr>
<th>The amount of nutrients needed by individuals vary depending on:</th>
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<tr>
<td>• Age</td>
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<td>• Illness</td>
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<td>• Body size</td>
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<td>• Lifestyle habits (e.g. smoking, alcohol intake)</td>
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<td>• Physical Activity</td>
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<td>• Medication use</td>
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<td>• Growth</td>
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<td>• Pregnancy and lactation</td>
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Importance of first thousand days

The “First 1000 days” begin from the day a woman conceives and continues till the child turns two years of age (Figure 1).
The first 1,000 days is a unique period of opportunity when the foundation of child’s optimum growth and development across the life span is established. This critical period of growth and development is largely affected by maternal and child nutrition. It is a period of great opportunity to provide adequate nutrition for the child without which the child becomes vulnerable to various birth defects and health problems. Inadequate nutrition before and during pregnancy may lead to low birth weight, poor mental development, greater chances of diseases such as overweight/obesity, diabetes, high blood pressure, heart diseases in later life and even death of the child. Therefore, it becomes critical to provide appropriate nutrition during the first 1,000 days of life. Let us now understand the entire 1,000 days in three stages with the focus on nutrition.

**STAGE 1**: Period between conception to birth of the child i.e. first 270 days.

**STAGE 2**: Period from birth of the child to 1 year i.e. 365 days.

a. Stage 2a: Birth to 6 months.

b. Stage 2b: Six months to 12 months.

**STAGE 3**: Period between 12 months to 24 months of child’s age.

The World Health Organisation identifies early childhood as the most important developmental phase throughout the lifespan, with lasting impacts that will affect the individual and the community. Essential nutrients are important for brain development, healthy growth and a strong immune system. Major public health problems such as obesity, diabetes, heart disease, cancer and mental health problems which were once regarded as adult issues, are largely shaped by how the baby is nourished in the womb and during the first 1,000 days’ period. Experiences in early childhood are also related to criminal behaviour, literacy level and employability.

**Alarming Facts**

Almost 21% of children under the age of 5 are stunted, as a result of chronic malnutrition. The effects of stunting last for the lifetime, beginning with lower IQ, weakened immune system and greater risk of diseases in later life. Children who are stunted, frequently earn up to 20 percent lower than average adults. (UNICEF/WHO/World Bank, 2020; UNICEF, 2012)
Nutritional care during pregnancy

The effects of poor nutrition in early life impact not only the child’s health but also that of the child’s offspring. In this way, the damaging effects caused by poor nutrition in early life have the potential to cascade down through generations. It is critical to break this cycle of malnutrition; otherwise undernourished girls will become undernourished women who give birth to low birth weight infants.

India has made groundbreaking progress in recent years in reducing maternal deaths during pregnancy. These have been possible because of the following schemes, initiatives and programs:

1. Institutional deliveries – Women are encouraged to deliver in hospitals and health care centres rather than at home. India has made a concerted push to increase access to quality maternal health services and hospital deliveries now stand at 79%.

2. State-subsidized schemes like the Janani Shishu Suraksha Karyakram – which allows all pregnant women delivering in public health institutions to free transport and no-expense delivery, including caesarian section.

3. Pradhan Mantri Surakshit Matritva Abhiyan, which allows women access to antenatal check-ups, gynecologists and to track high-risk pregnancies – exactly what is needed for healthier pregnancy outcomes.

Importance of healthy diet

During pregnancy, the quality of a mother’s diet and the rate of weight gain are two of the most crucial factors that influence a child’s future health. An inadequate diet will place the baby at risk for developmental delays, birth defects and poor brain development. When a woman lacks sufficient folic acid before becoming pregnant and in the early weeks of her pregnancy, it can lead to birth defects of the brain and spine (neural tube defects) that can cause death or lifelong disability. According to NFHS 4 data, more than half of the women in the reproductive age are anaemic. Although the pregnant woman needs to consume a balanced diet and the requirement for all nutrients increases, nutrients which are critical during pregnancy include:

According to UNICEF (2012), children who get the right nutrition during this time
- are 10 times more likely to overcome most of life threatening childhood diseases
- complete 4.6 more grades at school
- go on to earn 21% more in wages as adults
- are more likely as adults to have healthier families
- **Iodine** for foetal brain development and growth
- **Folic acid** to prevent birth defects and for better fetal development
- **Iron** to help in foetal brain development, expansion in blood volume and growth.
- **Vitamin B12** to prevent anemia and for nerve health.
- **Vitamin D** for calcium absorption and bone development.

In addition, the pregnant woman needs to take care about her meal timings and frequency, fluid intake, exercise and monitor weight gain. She should eat small and frequent meals as she will be unable to eat enough at a single meal. Foods rich in fats and spices should be avoided to prevent heartburn. She should avoid the foods or factors which trigger nausea such as smell of certain foods during initial months. Plenty of fluids should be taken to avoid dehydration and constipation. Gestational diabetes or hypertension need to be treated and appropriate medical nutrition therapy provided.

**How does mother’s weight gain affect the baby?**

The weight gained by the woman during her pregnancy has a powerful influence on her child’s lifelong health. Mothers’ nutritional status also affects the birth outcome. Underweight and overweight mothers both have an adverse effect on the growth of foetus. Obesity in pregnancy poses a threat to a baby’s future health. For example, it puts women at risk for gestational diabetes—a condition in which women exhibit high glucose levels during pregnancy. Gestational diabetes negatively impacts the baby’s development in the womb and makes him more susceptible to obesity and type 2 diabetes later in life. Excessive weight gain during pregnancy significantly increases the risk of childhood obesity. Moreover, women who are already overweight, before they become pregnant, will have children who are more likely to have problems maintaining a healthy weight later in their life.

**Nutritional care during lactation**

In order to support breast feeding, the mother’s body undergoes a number of physiological changes. Lactation is a period which puts great demands on maternal tissues as her breast milk has to meet the needs of a fully developed and rapidly growing infant. Adequate nutrition is very important to ensure good health of both mother and child. The effects of any nutritional inadequacies during this period can adversely affect the total quantity of milk produced. The nutrient content of the milk is usually maintained at the cost of maternal tissues, however the levels of certain nutrients in mother’s milk can reduce if the mother is severely under nourished.

Lactation therefore is an important period and care needs to be taken to ensure good maternal nutritional status. The energy and protein requirement of the nursing mother increases along with several micronutrients. The additional micronutrients which the nursing mother needs to include in her daily diet include:
• **Calcium**: to replenish calcium secreted in the milk and ensure good bone health for mother and child.

• **Vitamin A**: secreted in breast milk, important for growth and development of baby, immunity and its role in vision

• **Vitamin C**: secreted in breast milk, important for collagen synthesis, immunity

• **Folic acid**: prevents anemia, important for growth and development

• **Vitamin B12**: prevents anemia, important for growth, development, and nerve health

Successful lactation requires adequate nutrition and rest, in addition to family support and encouragement. The nursing mother should take a lot of fluids to support the secretion of nearly 800 ml of milk during the initial 6 months. Small and frequent meals are better accepted as the mother needs to consume additional food to meet the increased energy needs of the body. There are no food restrictions during lactation except strongly flavoured and spicy foods, smoking, alcohol and drug abuse as they may pass into breast milk. Also, any medications if required should be taken under strict medical supervision only as they may also pass into breast milk.

**Nutritional care during Infancy**

A child’s birth weight and whether the baby was born full-term or not are important markers of future health and development. Low birth weight is a leading cause of infant deaths in India. A baby is considered to be low birth weight when she weighs less than 2.5 kgs at birth. Intrauterine growth restriction due to poor maternal health and nutritional status may lead to low birth weight. **Premature babies** — that is babies born before 37 weeks of pregnancy also require additional care.

**Why exclusive breast feeding is very important for babies?**

• From birth through the first year, breastfeeding provides the healthiest start to the newborn. For the first 6 months the babies should be exclusively breast fed i.e. they shouldn’t be given any other fluid or food including water. Giving infants water, other liquids or other foods before six months, reduces the breast milk consumed, and may introduce germs leading to disease and malnutrition.

• It is very important that newborns get colostrum, the first thick yellowish milk from the breast which is the child’s ‘first vaccine’ and the best protection that she can have against illness, disease and death.
  a. Breastfeeding within one hour of life protects the child from infections and reduces the risk of death by nearly 22% in the first month of life. Every mother should start breastfeeding within one hour of life to take advantage of the newborn’s intense suckling reflex and alert state to stimulate breast milk production.
b. Starting breastfeeding within one hour of life and learning to breastfeed properly (positioning and attachment), helps the mother produce more milk for her child.

- Skin-to-skin contact with the mother through breastfeeding keeps the child warm and fosters mother-infant bonding.
- Breastfeeding on demand should be encouraged.

Children who are exclusively breast fed are 14 times more likely to survive the first six months of life than non-breastfed children. Mother’s milk is all they need for survival and for optimal growth and development.

- Babies who are breastfed continue to be exposed to a wide range of flavours from their mothers’ diet through her breast milk. This plays a key role in determining what foods are familiar to and thus preferred by the baby.
- Breastfeeding is a natural birth control measure as it helps to increase the time between pregnancies, which naturally help to space births.
- Exclusive breastfeeding is also financially advantageous as families do not need to spend money on expensive infant foods.
- It is not just the babies who benefit from breastfeeding. A longer duration of breastfeeding is associated with lower risk of overweight, obesity, type 2 diabetes, ovarian cancer, breast cancer and heart disease for the mother.

Thus breastfeeding-friendly workplaces and public spaces should be created to improve support for mothers to breastfeed. Organisations should provide paid parental leave and family-friendly workplace policies to support parents to give their children the strongest start.

How long should breastfeeding be continued and when should the baby be weaned?

Babies should be exclusively fed on breast milk for the first 6 months of their lives. All the possible support should be given to the young mother to pursue breastfeeding for the first six months. This should be followed by continued breastfeeding for up to 2 years, alongside the appropriate introduction of complementary foods at 6 months.

If mothers must return to work within first year, they should be encouraged to express and store breast milk, which can be given to the baby while the mother is at work. The reasons why women avoid or stop breastfeeding vary, but women who want to breastfeed need stronger support from their families, communities, healthcare providers and employers.

By the end of sixth month, breast milk alone is not enough to meet an infant’s nutrient requirements. Therefore, complementary feeding should begin at the seventh month. Babies who begin to eat solid foods before the age of 6 months are at greater risk for food
allergies. Age-appropriate complementary feeding adequate in quality, quantity and frequency should be available for children from 6-24 months. Young children have a very small stomach thus small frequent feeds are recommended. Infants should be fed slowly and patiently. Children should be presented with a variety of nutrient-dense foods to fuel their growth and development. A varied diet will also help shape their taste preferences for adulthood. Cow’s milk as a drink should be avoided for the first 12 months (as babies can become allergic to it), though it can be used in the preparation of a dish such as porridge. Six monthly vitamin A supplementation is recommended.

Salt and sugar should not be introduced in the child’s diet in the first year. Use natural fruits and vegetables to impart flavour. Mild flavours are preferred by infants. The temperature of the dishes should be neither hot nor cold. In fact, infancy is a golden window of opportunity to influence a child’s preference for healthy foods. New foods should be introduced one at a time in small quantities, and tolerance to the food evaluated before presenting a larger serving to the infant. Introducing new foods at a time when the infant is hungry ensures better acceptance. The texture and consistency of the food also changes as the infant grows from strained gruels of flowing consistency to a semi-solid dish like mashed *khicheri*. By the age of one year the infant is ready to start the family meals albeit with less spices (texture to remain soft and mashed till teeth erupt for effective chewing).

**What precautions should be taken during the weaning stage?**

Infants aged 6 to 12 months old are more likely to suffer from diarrhoea than any other age group as this is the time period when they start eating complementary foods. If these foods are not handled in a safe and clean manner, it can lead to diarrhoea, illness and malnutrition. The following precautions need to be taken while preparing meals for infants:

- Boiled water should be given to infants and used for making their foods.
- Safe handling of foods and hygienic cooking and feeding practices are extremely important, as food contamination and subsequent diarrhoea contributes to 25% of undernutrition in infancy.
- Washing parents’ and children’s hands with soap before preparing and eating foods is one of the most important ways of preventing germs from getting into food and avoiding diarrhoea in young children. Hand washing with soap alone prevents up to 50% of childhood diarrhoea.
- Food served immediately after cooking and stored safely, reduces the risk of germs getting into food.
- Using clean utensils and crockery will stop germs from getting into food.
- Feeding bottles, which are difficult to keep clean, should be completely avoided. Instead cups and spoons should be used.
• Improper disposal of stools and subsequent unclean hands lead to germs entering the body of young children, causing diarrhoea, other infections and leading to growth failure and poor development.

Childhood - the growing years

“A child’s body needs nutrition, not just food”

- Julie Webb Kelley

Growth and development are a continuous process whereby each year builds upon the preceding one. In the pre-school age, the child grows more in height. The body fat decreases but as the child enters middle childhood years, there is an adiposity rebound. The child gains about 5-7cms in height and about 2-3kg weight every year. In middle childhood along with gross muscles, fine muscles develop rapidly. By tracking the growth, children with growth deficiencies such as stunting, wasting or underweight or overweight/obesity can be identified at an early stage and intervened. So, before we start to offer nutrition counseling, nutritional assessment is of topmost priority.

Importance of nutrition

Good nutrition improves the child's physical well-being as well as cognitive development, leading to better growth and academic performance. Counselling of care givers on nutrition and healthy eating for children is important. Both quality and quantity of food intake from each food group needs to be focused on.

Nutrient requirements are high during the growing years. Dietary energy must be sufficient to ensure growth and spare protein to be used for tissue synthesis. At the same time care has to be taken to not allow excess weight gain and obesity. As the child grows the energy requirements also tend to increase during periods of rapid growth. The brain needs energy to function properly and hence the supply of glucose is relevant and critical. Cognitively demanding tasks, such as schoolwork, require regular supplies of glucose to the brain in order to enhance cognitive functioning and improves memory and mood. The major sources for energy are fats and carbohydrates.

Carbohydrates is the main source of energy for school-age children. The recommended intake of carbohydrates is approximately 60% of the total energy intake. Complex carbohydrate sources such as whole grains, fruits, vegetables and legumes should be chosen instead of refined carbohydrates like refined grains (Maida, corn flour etc.), fruit juices with added sugars or other foods with high sugar content. Foods with high fat, sugar and/or salt such as chocolates, cookies, puffs, patties, samosa, burger, pizza, carbonated beverages should also be avoided as these may lead to obesity and associated health problems.

Suggested intake of fat is not more than 30% of total energy being contributed by fat, mainly from mono- and polyunsaturated fats. Sources of these healthy fats include vegetable oils, peanut butter, nuts and seeds. Essential fatty acids especially omega-3 fatty acids, are important for the child's cognitive development. Food sources high in omega-3
fatty acids include green leafy vegetables, whole grains, fatty fish, walnuts, soybeans, flaxseeds and pumpkin seeds.

As proteins are essential for muscle strengthening, body growth, maintenance, and to enhance immunity, protein requirements gradually increase as the child grows. High-quality protein foods include eggs, dairy products, meat and seafoods. The other protein rich sources include processed soy products, legumes, nuts and oil seeds. Vitamins and minerals are an integral part of healthy nutrition since they perform several functions in body. Children of school age are more prone to developing micronutrient deficiencies that can have adverse influence on their overall performances. Some nutrients of concern are listed below:

- **Vitamin A** deficiency in children may lead to night blindness.
- **Vitamin D** is required for bone growth and calcium metabolism. Lack of vitamin D (Sunshine Vitamin) leads to Rickets in especially children not exposed to sunlight.
- **Calcium** is important to support bone growth
- **Iron** deficiency anemia can affect the cognitive performance of children
- **Vitamin C** enhances the absorption of iron from meals besides providing other benefits.

**Factors affecting dietary pattern**

Most young children need some structure and routine to their day. Generally, they prefer meals and snacks at regular times, as governed by the family’s lifestyle. They have a preference for simply prepared, mild tasting foods that they can easily handle. At this age children also tend to develop negative and positive associations with food. For example, sweets and chocolates which are given by parents as rewards for good behavior may be associated with positive emotions. On the other hand, foods which parents sometimes force their children to have like milk may get associated with negative emotions. It is important to know that early impressions associated with various uses of food, affect food-related attitudes and practices throughout life. When they grow up, they will be averse to consuming foods which evoke negative emotions. Food preferences can be influenced by parents and friends; as well as media advertisements may influence the child to select certain foods over others.

In contrast to the pre-school age where familial influence is higher, in the school-age, children are more influenced by their peer group. The food habits of school-age children are more scheduled due to specific school timings. However, many external influences may affect the child’s food choices. It is estimated that children are spending more time in front of a screen (television, computer and mobile) rather than in outdoor recreation. Ill effects of this include decreased physical activity and hence loss of appetite. Studies have shown that television advertising influences children’s food preferences and purchasing requests resulting in inclusion of unhealthy foods which increase the risk for obesity, dental caries, deficiency of micronutrients etc. Social events and parties often promote unhealthy eating habits.
The food served in school canteens or school lunch programs (Mid day meal programme in India) also influences the food choices of children. Availability of junk foods in or around the school acts as an enticement, and children land up making poor food choices. Hence it is very important to control the sale/service of unhealthy foods in the vicinity of schools. The Food Safety and Standards (Safe Food and Balanced Diets for Children in School) Regulation (2020) will regulate the sale of HFSS foods in schools and ensure that only healthy meals are served in schools.

**Inculcating healthy eating practices**

It is common among school children to skip breakfast. This makes the child feel inattentive and tired during class hours. Skipping breakfast affects both the nutritional status as well as the school performance of the students. Empirical evidence from research on the effects of breakfast on cognition shows that particularly for younger children, skipping breakfast can have adverse effects on both general energy levels and cognition of school children. The reason for skipping breakfast has to be identified and addressed.

As long as a child is at home the whole day, the mother can feed him meals. However, as soon as children enter school, they need to start eating a meal or two on their own. While packing tiffins the mothers need to make sure that it should be an item which is easy for the child to eat. The meal must be simple yet nutritious. For example, a vegetable-stuffed chapati or mixed vegetable rice or dal chawal cooked with vegetables can be chosen instead of too many items like chapati/rice, dal and sabzi separately.

Classroom lessons must include a subject on healthy eating habits. For small children the teacher may need to supervise the lunch ensuring that children inculcate good eating manners and finish their lunch.

Special effort needs to go into feeding a fussy eater. Active feeding rather than forced feeding should be done so that mealtimes do not become unpleasant for the child. Healthy foods of their choice must be packed, and variations must be considered. In a few cases, getting an attractive lunch box will also help to motivate the child into eating. For these children, mothers should involve them in the cooking process and teach them the benefits of each food. Family pot eating and family mealtime is important. Having meals together helps the child understand the importance of each meal. The whole family needs to eat healthy to inculcate healthy habits in the child.

Children who are underweight may need special care and attention. Children who are obese need to cut down unhealthy snacking especially on non-nutritive energy dense food. A study shows that for children of school going age, snacks may contribute up to one-third of the total calorie intake for the day. This is generally after-school snacks which are majorly influenced by peer pressure. Regular consumption of outside food increases the body weight and results in obesity. Children frequently consuming sweet foods such as sweets, chocolates, jellies, pastries, sugar sweetened beverages followed by poor oral hygiene tend to develop dental caries. Hence good oral hygiene is important.

Anaemia reduces the attention capacity of the child and brings down the academic performance. It may hinder the growth and development of the child. It is important to take care that iron rich foods are included in daily meals along with vitamin C rich foods for better
absorption of iron. Inhibitors of iron absorption (e.g. tannin, oxalate, phytate and calcium) which reduce the bioavailability of iron from the food should not be consumed along with meals rich in iron. Tea, coffee, tamarind, cocoa are few beverages and foods which have these inhibitors.

Adolescence – a critical period of development

Adolescence is the period of transition from childhood to adulthood and a period of rapid growth and maturity both physiologically and psychologically. Adolescence has been referred to as a window of opportunity to prepare for a healthy productive and reproductive life and prevent the onset of nutrition related chronic disease in adult life. The three dimensions of growth during adolescence are physical growth, mental and emotional blooming and sexual development. Inadequate intake of nutrients can result in slow growth and delayed sexual maturation.

WHO (2010) defines adolescence as the segment of life between the ages of 10-19 years. Considering the major physical, cognitive and emotional changes that take place, this age group is further divided into 3 stages:

- Early Adolescence: Ages 10-15 years
- Middle Adolescence: 14-17 years
- Late Adolescence: 16-19 years

Nutritional needs during Adolescence

During adolescence, the linear growth of childhood is suddenly altered by an increase in the velocity of growth. Almost 80% of adolescent growth is completed during early adolescence. Post-puberty, the growth spurt decreases. Growth spurt in adolescence is associated with cognitive, emotional and hormonal changes. Nutritional needs vary during adolescence. They are different for males and females. This is mainly due to differences in growth spurts and sexual maturation. Puberty hits females between the age group 10-14, whereas for males it occurs between 12-16 years of age. Differences are seen not just in caloric and macronutrient requirements, but also in the requirements of micronutrients. Iron requirements are generally higher in females due to increased physiological demands and menstrual losses. It must also be noted that there are differences in body composition. Boys have greater muscle mass as compared to females. Approximately 45% of the skeletal mass is added during adolescence. Girls on the other hand tend to accumulate more fat than muscle tissues.

Energy and Protein requirements: The considerable increase in energy and protein requirements is attributed to the gain in weight and height along with increase in muscle mass in boys and fat mass in girls. Increment in requirements correlates with growth patterns, with the peak in requirements occurring at the peak growth period of adolescence. While considering protein requirements, it is important to consider the quality of proteins and not just quantity. Good quality protein should be provided daily by including
sources of good quality protein viz. milk and milk products, eggs, meat, fish and/or by using ideal food combinations of cereal and pulse (e.g. Dal-Roti/rice, khichdi, etc.). Most Indian diets lack protein and thus efforts must be made to include a serving of good quality protein in every meal of an adolescent.

**Minerals and Vitamins:** Minerals and vitamins play a critical role in the growth and development. The role of these micronutrients is considered to be very crucial due to the peak in growth velocity, increase in body size, body density and puberty changes. Micronutrients are involved in various physiological processes in the form of catalytic enzymes, hormones, structural components and protective agents. Thus, it is necessary to ensure the provision of a diet that supplies all essential micronutrients in required amounts. Iron and calcium are two minerals for which the requirement increases as the blood volume as well as skeletal mass is increasing. If adolescents in the age group of 13-17 years fail to meet calcium requirements they may not achieve their peak bone mass, thus increasing the risk of developing osteoporosis at a later age. Adolescent girls are at increased risk of anaemia due to rapid growth and development in adolescence and menstruation which increases the demand for iron. Zinc is important for growth and sexual maturation in adolescent.

**Nutritional Issues and Dietary Challenges**

Adolescent growth and development are linked to the quality of the diet they receive during childhood and adolescence. Adequate nutrition of any individual is determined by two factors: (1) adequate availability of food in terms of quantity as well as quality, which depends on socioeconomic status, food practices, cultural traditions, and intra-family allocation of the food, (2) the ability to digest, absorb, and utilize the food. This ability can be hampered by infection and metabolic disorders.

Food choices made by adolescents is a major factor that impacts the nutritional status and thus the health status of this age group. Factors that influence food choices of adolescents are:

- Taste
- Peer influence, food trends and fads
- Mood
- Body image
- Food habits as influenced by family, culture, religion
- Influence of media, celebrity endorsements, Influencers
- Convenience foods

Mass media as well as social media play a big role in influencing adolescents. Use of social media has now become an addiction to many and it greatly affects self-perception and body image. Besides the physical ill-effects of increased screen time, social media has a greater impact that influences choices, behaviour patterns, and mental health and lifestyle habits. This powerful form of media should be used in a positive manner to provide authentic health and nutritional messages.
Adolescent health problems include sexual health issues, teenage pregnancy, problems related to menstruation, drugs, tobacco and alcohol abuse, anaemia, eating disorders, obesity, behavioural problems and oral health. Many teens may describe themselves as being overweight despite being of normal weight, signifying a distorted body image. This leads to eating disorders like Anorexia Nervosa, Bulimia Nervosa and Binge eating. **Anorexia nervosa** is characterized by failure to maintain an adequate body weight, body image disturbance, and excessive dietary restriction and it may be accompanied by periodic binge eating and purging (e.g., self-induced vomiting, laxative use). The symptoms include muscle wasting, growth retardation, dry brittle hair, dry skin, and amenorrhea (absence of menses).

**Bulimia Nervosa** is characterized by recurrent binge eating (consuming large amounts of food while feeling out of control) accompanied by compensatory behaviors to prevent weight gain, and body image disturbances. Compensatory behaviors may be purging (self-induced vomiting, laxative, diuretic, or enema use) or non-purging (excessive exercise, fasting). Salivary gland enlargement, dental problems, heartburn, bloating and irregular menstrual periods are some common problems associated with bulimia nervosa.

Tendency to rely exclusively on junk food like potato chips or fries, burgers, pizzas, chocolates, etc. and consuming carbonated and, sweetened beverages on regular basis is on the rise among this age group. These snacks are easily available, convenient to be carried and inexpensive. Though most of these are energy dense due to their high fat/carbohydrate contents, they are devoid of important nutrients.

Skipping of meals is a common practice in this age group and this is more common in girls than boys. Girls generally miss meals in an effort to lose/maintain weight. Generally, breakfast, which is the most important meal of the day, is not consumed. When adolescents skip meals they tend to consume more snacks and fast foods which tend to be energy dense and low in other essential nutrients. Adolescent obesity is emerging as a major health problem, especially in urban populations. The reason is increased consumption of calorie dense foods and at the same time decreased physical activity. Obesity increases the risk for diabetes, heart disease, hypertension and polycystic ovary syndrome (PCOS) in girls.

Thus, it is important to promote not just good eating habits but also a good lifestyle which includes regular physical activity/exercise. Well-nourished adolescents ensure a healthier future of the nation.

**Healthy diet during adolescence**

Although dietary tips on food choices remain similar throughout the lifecycle, Figure 2 puts together foods to be encouraged and discouraged for the adolescents.
Besides these, it is also advisable to involve children in selecting and preparing foods. The home and the school food environment should be conducive for them to make healthy food choices. Poor food choices are often linked to non-availability of healthier food alternatives at home or in and around school.
Counseling related to excessive energy intakes among adolescents should focus on intake of discretionary calories, especially those from added sugars consumed through soft drinks and from solid fats consumed through snack foods and fried food. Tips should be provided for selecting nutrient-dense foods and beverages at all locations where teens spend their time. An ideal meal pattern for an adolescent age group is a three-meal pattern with two in between snacks – required to meet the multi nutrient requirements.

**Adulthood and Healthy Ageing**

Adulthood marks a long period which begins with the cessation of active growth. Population above 65 years is regarded as the geriatric age group. Aging is a normal process that begins at conception and ends at death. Once the body reaches physiologic maturity, the rate of catabolic or degenerative change may become greater than the anabolic regeneration. The resultant loss of cells can lead to varying degrees of decreased efficiency and impaired function. Lifestyle factors that seem to influence physiologic age are adequacy and regularity of sleep, frequency of consumption of well-balanced meals, sufficiency of physical activity, smoking status, extent of alcohol consumption, and body weight. Disease and disability are not always inevitable consequences of aging. The use of preventive service, elimination of risk factors, and adoption of healthy lifestyle behaviours are some of the major determinants of how well a person ages.

**Dietary needs and nutritional concerns**

Dietary needs of adults change with age due to the physiological changes which accompany aging. Some of these changes raise nutritional concerns and have to be managed by appropriate dietary interventions:

- The sense of taste, smell, sight, hearing, and touch often diminish at individual rates in the older adult. A reduction in taste and smell reduces appetite and hence overall food intake putting them at a risk of undernutrition. Impaired vision, and loss of functional abilities may prevent older adults from cooking and eating on their own. Improving the flavour of food by using a variety of spices and herbs may help increase appetite.

- **Xerostomia** (dry mouth) can cause difficulty with chewing and swallowing, which can result in the avoidance of certain foods. In such cases every meal needs to have a curry item to facilitate swallowing of the dry items. People who have missing teeth or who wear dentures often chew less efficiently, which can cause them to eat less hard-to-chew foods such as fruits, and raw vegetables. Modifications of food texture or consistency may make some foods easier to eat and therefore improve a person’s over all nutrient intake.

- **Dysphagia**, a weakening of the gag reflex that causes swallowing difficulties, can affect a person’s ability to safely consume foods. A person with dysphagia may need modifications in the texture or consistency of food, method of eating, or both.
- **Gastric atrophy**, alterations in gastric acidity, delayed gastric emptying, changes in bowel motility rates, decreased lactase activity, and medication usage can affect intake and availability of nutrients. These conditions can affect the bioavailability of nutrients, overall nutritional status, and the risk for developing chronic diseases such as osteoporosis.

- **Constipation**, which makes it difficult to pass stools or causes incomplete or infrequent passage of stools, is one of the most common digestive complaints in older adults. It can be caused by insufficient fluid intake, inadequate dietary fibre intake, limitations in mobility or activity, psychological factors, and medications. Constipation can often be resolved by increasing intake of dietary fibre, fluid, and increasing physical activity.

- During the aging process, blood vessels become less elastic and total peripheral resistance increases, leading to an increased risk for and prevalence of **hypertension** and **cardiovascular** diseases. Salt needs to be controlled in the diet as well as fats and simple carbohydrates, in order to keep blood pressure and lipid levels in check.

- **Renal function** and the glomerular filtration rate can diminish as much as 60% between the ages of 30 and 80 years, primarily because of a reduction in the number of nephrons, the functional unit of urine formation in the kidney, resulting in reduced blood flow. Consequently, older adults are often less able to respond to changes in fluid status and challenges to the acid-base balance. Excessive amounts of protein waste products and electrolytes may become increasingly difficult to metabolize, so dietary modifications may be needed.

- As people age, bone resorption becomes more than bone formation. The cause of **osteoporosis** may be age related changes such as decreased estrogen production associated with menopause. Decreased intestinal absorption of calcium and production of vitamin D, reduced physical activity and increased parathyroid hormone secretion may also cause osteoporosis. Many avoidable risk actors like sedentary lifestyle, emotional stress, inappropriate diet may contribute to osteoporosis.

- Every second woman of the reproductive age group in India is **anaemic**. Nearly one fourth of the men are also anaemic. Iron inadequacy can be caused by low dietary intake, impaired absorption possibly resulting from lack of heme iron or vitamin C or blood loss. Treatment may involve using iron supplements together with a diet providing iron sources of high bioavailability and vitamin C to enhance absorption.

- Both forms of **malnutrition** - undernutrition and overnutrition may plague both the adults and elderly.
Nutrition plays an important role in delaying the ageing process. While planning diets for adults and elderly the physiological conditions as well as any existing pathology should be kept in mind. Elderly may require food with special modifications in texture and consistency.

To maintain a healthy life, one should keep in mind quantity of nutrients of concern like saturated fat, trans fat, sodium and added sugar in the diet. Excess consumption of these may increase the risk of obesity, metabolic syndrome, Type-2 diabetes, hypertension and other cardiovascular diseases and, certain cancers. Saturated fat and simple sugars intake should each provide less than 10% of energy. For further risk reduction less than 5% energy from simple/free sugars is recommended. Salt intake should be less than 5g (1 teaspoon) in a day and trans fat intake should be less than 1 energy%.

**Healthy lifestyle**

As we have discussed in earlier chapters, healthy eating is the key for healthy living. Besides our diet, we need to focus on other aspects also which would lead to a healthy life. These factors include physical activity, stress, consumption of tobacco, alcohol etc.

WHO defines a healthy lifestyle as a way of living that lowers the risk of being seriously ill - a way of living that helps you enjoy more aspects of your life. Health is not just about avoiding a disease or illness. It is about physical, mental and social well-being too. When adults adopt a healthy lifestyle, they become a more positive role model for other members of their family, particularly children.

**Healthy Eating – Eat Right Logo of FSSAI**

The logo (figure 3) represents a healthy *thali* or plate to ensure a balanced and wholesome diet comprising all food groups in right quantity for a healthy life. Each colour in the logo represents different food groups. The size of the colour depicts the quantity of the food to be consumed.
Physical activity and exercise is a major contributor to a healthy lifestyle. Physical activity is necessary to stimulate the body’s own natural maintenance and repair system. It is vital for the health of bones, joints, muscles, lungs and heart. Physical inactivity increases the risk of several diseases - coronary heart disease, stroke, high blood pressure, osteoporosis, etc. and in addition can contribute to poor posture, overweight, breathlessness, flabby body, low energy levels and stiff joints. Regular exercise can prevent and reverse age-related changes like decreases in muscle mass and strength, improve balance, flexibility, and endurance, and decrease the risk of falls in the elderly. Regular exercise can help prevent coronary heart disease, stroke, diabetes, obesity, and high blood pressure. Regular, weight-bearing exercise can also help prevent osteoporosis by building bone strength. It can help chronic arthritis sufferers improve their capacity to perform daily activities such as driving, climbing stairs etc. It also increases self-esteem and self-confidence, decreases stress and anxiety, enhances mood, and improves general mental health. Regular exercise can help control weight gain and, in some people, cause loss of fat. Box 1 outlines an action plan for increasing the physical activity level while Box 2 talks about the amount of sleep needed for different age-groups.
Smoking can cause respiratory illness, coronary heart disease and cancer. Use of tobacco causes cancers of the lung, mouth, lip, tongue, oesophagus, kidney, and bladder. It also further increases the risk of bladder cancer. Tobacco can cause atherosclerotic arterial disease (hardening and narrowing of the arteries) that can lead to heart attacks, strokes, and lack of blood flow to the lower extremities.

Drinking small amounts of alcohol may not be harmful for health however for many people it becomes difficult to draw the line. Raised blood pressure, which increases the risk of stroke; stomach disorders; depression and emotional disorders; cancers, particularly of the mouth, throat and gullet; hepatitis and cirrhosis of the liver; malnutrition; accidents at home, at work and on the roads; and suicides are some of the problems associated with alcohol consumption.

It is easy to become addicted to both tobacco and alcohol. Support and understanding from family members are often critical for sustained recovery. Medication can be useful for the prevention of relapses and for withdrawal symptoms.

Box 1: Action Plan for Increasing Physical Activity

1. If you are not physically active identify when you could be more physically active and how (e.g. put more physical effort into housework; walk briskly, get off the bus or tram one stop earlier; choose to climb the stairs even if there is a lift, play sports).
2. Start slowly – don’t do too much too soon. Listen to your body: if you experience dizziness, nausea, pain and extreme tiredness you are doing too much too soon.
3. If you are comfortable with what you are doing increase the amount of exercise and build it up gradually.
4. Aim at half an hour of moderately intense physical activity five or more days a week. Exercise can be broken up into smaller 10-minute sessions.

Almost any type of exercise (resistance, water aerobics, walking, swimming, weights, yoga, and many others) is helpful for everybody.

Box 2: Get enough sleep daily

It is recommended that newborns (0-3 months) get at least 14 to 17 hours of sleep, infants (4-11 months of age) need 12 to 15 hours, Toddlers (1-2 years of age) need 11-14 hours, Preschoolers (3-5 years of age) need 10-13 hours, school age children (6-13 years) need 9 to 11 hours, and teenagers (14-17 years) need 8-10 hours and those 18 years and above need 7-9 hours of sleep. Older adults (65+ years) need about 7-8 hours but do not sleep as deeply and may awaken at night or wake early, so naps allow them to make up the total of seven to nine hours of sleep.

Eating Mindfully

Nutrition researchers and practitioners have recently adopted the concept of “mindfulness” to better understand and modify dietary behaviour. Mindful eating, includes making conscious food choices, developing awareness of physical as opposed to psychological hunger, satiety cues, and eating healthfully in response to those cues. Mindfulness, even without specific training in mindful eating, may encourage people to better control portion sizes and choose less calorie-dense foods. Some simple tips which could be followed to ensure mindfulness while eating are:

- Stop eating when you are about 80% full even when eating something you love.
- Always judge the portion size before consuming any meal. When portion size of a dish is too large, share your dish.
- When you eat at “all you can eat” buffets, choose carefully and avoid tasting everything.
- Even if there are dishes on the menu that you love, don’t take a second helping (especially when you are full).
- Avoid getting the larger size food or drink regardless of how hungry you are and how cost effective it is.
- Don’t get attracted to food advertisements and freebies (buy one get one offers or free gifts)- stop, judge and think about the benefits or harmful effects of eating that product.
- Don’t eat if not hungry.
- Avoid eating in front of a screen like television, mobile phone, tablet, computer etc. as the person does not realise what and how much they have eaten.
- Avoid any distractions while eating. Concentrate on your food and what you are eating at every meal.
- Avoid binge eating as an emotional response to when you are sad or stressed.

Summary

- Balanced diet is important during all stages of life with special attention required during pregnancy, lactation and infancy.
- During the first 1,000 days, the brain grows more quickly than at any other time in a person’s life. While a newborn’s brain is only one-quarter of the size of an adult’s, it grows to about 80% by 2 years of age. During this time in particular, protein, iron, zinc and iodine are essential to the toddler’s rapidly developing brain.
• Iron plays a very important role throughout the first 1,000 days and the damage done by iron deficiency in pregnancy and the first 2 years of a child’s life can be irreversible. Iron deficiency in infants and toddlers can lead to impaired learning and social-emotional behaviour, including less alertness, increased irritability, less interest in play, contributing to poorer developmental outcomes. Early iron deficiency is also associated with higher levels of anxiety and depression later in life.

• Iron supplementation and deworming protect children from anaemia. Worms in children’s intestine result in loss of nutrients including iron, therefore regular deworming is very important.

• On the other end of the spectrum, rapid weight gain throughout the first two years of life is associated with childhood obesity and other serious negative health outcomes throughout life.

• Adolescence is a period of change from childhood to adulthood. This is the time for the second growth spurt and hence good nutrition is very important.

• Adults should ensure a balanced diet along with a moderate level of physical activity. This would prevent the occurrence of diet related non communicable diseases.

• Nutritional needs of elderly should be modified based on any specific conditions they are facing. Special attention should be given as they are vulnerable to both under and over-nutrition.

• Mindful eating is a habit that needs to be inculcated from childhood itself. Knowledge about right food choices will help an individual to train their mind towards healthy eating.

Important Terms

• **Gestational diabetes:** Diabetes which develops during pregnancy

• **Anorexia nervosa:** Eating disorder characterised by a failure to maintain adequate body weight, body image disturbance and excessive dietary restrictions.

• **Bulimia Nervosa:** Eating disorder characterised by recurrent binge eating accompanied by compensatory behaviours to prevent weight gain and body image disturbances.

• **Low birth weight:** Birth weight less than 2.5 kg.

• **Premature:** Born before 37 weeks of gestation.

• **Colostrum:** The milk secreted after childbirth for the first few days. It is yellowish in colour and rich in nutrients.

• **Physical Activity:** The state of being active or in energetic action or movement.
- **Malnutrition**: Refers to the under/over-nutrition or imbalances in the intake of energy, protein and/or other nutrients.

### Exercises

1. What are the factors determining nutritional needs during the lifecycle?
2. List important vitamins and minerals required in increased quantity during pregnancy.
3. Why is it important for a pregnant woman to gain adequate weight during pregnancy?
4. What is colostrum? Why is exclusive breastfeeding important for the baby?
5. What is complementary feeding and explain the factors to be kept in mind during its initiation?
6. Explain the nutritional concerns of a school going child.
7. Why is adolescence considered to be a critical period of development?
8. What are the common conditions that impact the nutritional status in elderly?
9. Discuss how lifestyle changes can help ensure healthy ageing in adults.
10. What do you understand by ‘mindful eating’?

### References


Chapter 16: Influence of Taste and Other Sensory Perceptions on Food Choices

- Factors affecting food choices
- Role of senses in making food choices
  - Vision
  - Smell
  - Texture
  - Flavour = Taste + Aroma
- Taste Sensitivity: driving our food choices
Chapter 16: Influence of Taste and Other Sensory Perceptions on Food Choices

How do we choose what we eat? Our food choices are dependent on various intrinsic and extrinsic factors. The choice we make between a pack of chips or a fruit is not only based on our liking but there are several other factors involved. These factors include intrinsic properties of food like aroma and taste compounds, texture, colour, appearance, and temperature. Psychosocial and cognitive factors such as culture, education, mood, or conditioning also influence food choices. Understanding sensory perception of food is important for food producers. Food brings pleasure and conviviality to our lives and triggers multitude of emotions. The most nutritious food will not be willingly accepted and regularly consumed if it has poor sensory properties. The challenge to the food industry is to fit what consumers want with what they need, delivering nutritional value and health through products they prefer. This chapter addresses the questions- why we eat what we eat and how can we improve the choices we make?

Factors affecting food choices

The key driver for eating is of course hunger but what we choose to eat is not determined solely by physiological or nutritional needs. Some of the other factors that influence food choices include:

- Biological determinants such as hunger, appetite, and taste
- Economic determinants such as cost, income, availability
- Physical determinants such as access, education, skills (e.g. cooking) and time
- Social determinants such as culture, family, peers and meal patterns
- Psychological determinants such as mood, stress and guilt
- Attitudes, beliefs and knowledge about food

The complexity of making food choices is obvious from the list above, which is in itself not exhaustive. Factors affecting food choices also vary according to life stage and the power of one factor will vary from one individual or group of people to the next. Thus, one type of intervention to modify food choice behaviour will not suit all population groups. Rather, interventions need to be geared towards different groups of the population with consideration to the many factors influencing their decisions on choosing food. In this chapter we would focus on biological determinants of food choices.

Hunger and satiety: Our physiological needs provide the basic determinants of food choice. Humans need energy and nutrients in order to survive and will respond to the feelings of hunger and satiety (satisfaction of appetite). The central nervous system is involved in controlling the balance between hunger, appetite stimulation and food intake. The sensitivity of all basic tastes increases during hunger and declines post meal for about one hour. It has been observed to be the greatest at mid-morning. Depletion of body salt
content increases the sensitivity to salt without affecting the other taste thresholds. No significant influence of fasting has been observed in the sensitivity of various taste qualities.

The macro-nutrients i.e. carbohydrates, proteins and fats generate satiety signals of varying strengths. The balance of evidence suggests that fat has the lowest satiating power, carbohydrates have an intermediate effect and protein has been found to be the most satiating. The energy density of diets has been shown to exert potent effects on satiety; low energy density diets generate greater satiety than high energy density diets. The high energy density of high-fat and/or high-sugar foods can also lead to 'passive overconsumption', where excess energy is ingested unintentionally and without the consumption of additional bulk. An important satiety signal may be the volume of food or portion size consumed. Many people are unaware of what constitutes appropriate portion sizes and thus inadvertently consume excess energy.

**Palatability** is proportional to the pleasure someone experiences when eating a particular food. It is dependent on the sensory properties of the food such as taste, smell, texture and appearance. Sweet tasting and fat-rich foods have a greater sensory appeal. It is not surprising then that food is not solely regarded as a source of nourishment but is often consumed for the pleasure value it imparts.

The influence of palatability on appetite and food intake in humans has been investigated in several studies. There is an increase in food intake as palatability increases, but the effect of palatability on appetite in the period following consumption is unclear. Increasing food variety can also increase food and energy intake and in the short term alter energy balance. However, effects on long-term energy regulation are unknown.

**Sensory aspects**: ‘Taste’ is consistently reported as a major influence on food behaviour. ‘Taste’ is the sum of all sensory stimulation that is produced by the ingestion of a food. This includes not only taste per se but also smell (flavour), appearance and texture of food. These sensory aspects are thought to influence spontaneous food choice.

From an early age, taste and familiarity influence behaviour towards food. A liking for sweetness and a dislike for bitterness are considered innate human traits, present from birth. Taste preferences and food aversions develop through experiences and are influenced by our attitudes, beliefs and expectations. We still remember the foods which we consumed as children – special seasonal dishes like pickles, chutney and the traditional dishes grandma made. We search for that taste only.

Now we know that the process by which we accept or reject food is of a multi-dimensional nature. In complex food matrices, it is not always easy to establish relationships between the body’s response, physiological perception, and consumer reaction. Individual’s responses to food are not only based on the sensory characteristics of the product and on their physiological status but they are also related to other factors, such as previous information acquired about the product, their past experience, and their attitudes and beliefs.

Though there are several factors involved but sensory quality should be considered as a key factor in food acceptance because consumers seek food with certain sensory characteristics. The acceptance of a food will depend on whether it responds to consumer needs and on the degree of satisfaction that it is able to provide.
One of the proven theories on choice of food we make is that the acceptance of a food is basically the result of the interaction between food and man at a certain moment. The other theory of the influence of consumers’ decision to accept or reject a food depends on:

- Food characteristics (chemical and nutritional composition, physical structure, and properties),
- Consumer characteristics (genetic such as taste genetics, age group, gender, and physiological and psychological state) and those of the consumer’s environment (family and cultural habits, religion, education, fashion, price, or convenience). Now days the safety of the product also plays an important role in decision making. Extrinsic factors such as advertising, branding, packaging and labelling or price of the product also influence the food choices.

Familiarity is a powerful predictor of liking for food. Unfamiliar foods tend to be disliked. A memory of the flavour helps in identifying foods that significantly depart from what the visual and olfactory cues suggest it should taste like. We relate the place with the food and would not mind travelling the distance to experience that same taste again.

Individuals do not experience the same taste sensations. This variation comes from genetic differences as well as taste perceptions. When a food is placed in the mouth, it may taste pleasant to some if it is sweet (just as it might with mildly salty, fat-related and meaty tastes, although these have been less well explored), and unpleasant if it is bitter or excessively sour. This has been termed flavour–flavour learning.

### Role of senses in making food choices

The simple act of putting food in our mouths and beginning to chew signals three different sets of glands to release enzyme-rich saliva, which lubricate the mouth and activate the “tastants”—that is, the chemicals that stimulate our taste receptors—contained within the masticated food. When you eat, the brain receives different sensory inputs. The eyes provide inputs about the appearance of the food, the nose detects the aroma, the taste buds on the tongue detect the flavour, the texture - and the information is integrated in the final sensory perception. For an individual, each perceived sensation would work together and help in choosing the food. In a study by Delwiche (2004) it was reviewed how the consumers make subjective judgments using one or more of the five senses every time they select or eat any food. For example, potato chips, celery, and some cereals have a crunchy sound when they are eaten; the taste and smell of foods can be highly appealing or unacceptable; and the appearance and feel of a food also are important in determining its acceptability.

Ayurveda correlates chemicals with taste. It insists that every meal we eat should have all tastes; the tastes are proof of the presence of certain categories of chemicals. It acknowledges that food should be tasty for it to be consumed willingly. Only tasty food can stimulate our senses. But at the same time, it insists on balancing tastes. Too much of any single taste is not advisable.

Figure 1 depicts the expectations of our different senses when selecting and evaluating a food product.
Food quality has both subjective and objective aspects. Appearance, texture, and flavour are largely subjective attributes, whereas nutritional and microbial qualities are not.

**Vision**

Eyes are the organs that capture the vision - transmit it to the brain where it mixes with memory. Thus, if you have seen it before then you may instantly recognise the food; even if you are not able to instantly remember the name you will at least remember when and where you saw it the last time. The appearance of a food includes its size, shape, colour, structure, transparency or turbidity, dullness or gloss, and degree of wholeness or damage.

The growing obesity crisis is but one of the signs that humankind is not doing such a great job in terms of optimizing the contemporary food landscape. While the blame here is often put on the global food companies – offering addictive foods, designed to hit ‘the bliss point’ in terms of the pleasurable ingredients (sugar, salt, fat, etc.), and the ease of access to calorie-rich foods – we wonder whether there aren’t other implicit cues in our environments that might be triggering hunger more often than is perhaps good for us. Here, we take a closer look at the potential role of vision. Specifically, we question the impact that our increasing exposure to images of desirable foods via digital interfaces might be having and
ask whether it might not inadvertently be exacerbating our desire for food (what we call ‘visual hunger’). For example, a decorated chocolate cake, a burger, a cheesy pizza which is visually tempting.

In society at large, there is a growing awareness of just how much people like to take pictures of the food that they have ordered in restaurants, and chefs wanting to design food in most pleasing manner. Increasingly, it would appear that people are spending more time looking at virtual images of appetizing foods, and paying less attention to the actual foods being consumed (see figure 2). Worse still, many of us eat while mindlessly watching screens (TV, or smartphone), failing to focus our attention on the flavour experience which might the very source of lower satiety, and higher-calorie food intake. The pleasure of seeing virtual food (the hunger for images, or ‘digital grazing’) while eating has in some sense superseded the pleasure of seeing the real thing. And while some might be tempted to see this as the fault of industry/marketers, it is important to remember, given the growing popularity of consumers taking pictures of food, that the problem here would appear to be, at least partly, self-inflicted. Excessive food photography and over exposure to pictures of food may also lead to satiation.

Figure 16. 2: Growing craze for food photography

Given the current obesity crisis, it would seem advisable to pay particular attention to any environmental factor that may influence our relation to food, and potentially sensitize the brain to food stimuli.
Smell

Foods especially when they are hot give out volatile vapours which we call aroma. Even before we eat, these vapours rise and enter our nostrils, then travel up and reach the end of the nose between the two eyes. Aromas are transmitted to a special part of the brain that houses emotions. Thus, two people - A and B may smell the same 'samosa' but A maybe transported to a time when he got scolded by the mother for finishing his own and his brother’s share and B maybe transported to a lovely roadside shack in the hills of Dalhousie where he had the best samosa 10 years ago. Some aromas may be instantly recognised while others may need effort and reference.

As per scientific concepts of tasting, aroma is strictly the odour/smell which we sense before eating that is when the food is still outside your mouth. Aromas have the power to make our mouth water in anticipation of eating very tasty food. Similarly, some aromas can completely put us off like rancid food’s smell and tell us that they have decomposed and thus, have become unfit for consumption.

We all know coffee has a wonderful aroma, but what do you think about cucumber? Most of us would say no or maybe. Please try this - take a normal bite of cucumber and while chewing pinch your nose for a few seconds and then release it. Most of the people would answer - yes cucumber has an aroma/odour but only inside the mouth. This is called aromatics. So, the sense of smell has 2 paths aroma from outside mouth and aromatics from the inside mouth; but they are captured by the same hair-like structure seated deep inside forehead in-between the eyes.

Food aroma/odour has been shown to influence food choices, portion selection, and can promote a specific desire to consume certain foods. Even when satiated, the sight or smell of a desirable food can stimulate appetite. People that exhibit a higher level of dietary restraint have been shown to be more responsive to food odour cues, resulting in a higher appetite and desire to consume the cued food item. Others have suggested exposure to a desirable savoury odour increases reactivity and attention to all food, leading to a general desire to eat. Frequently, these studies focus on responsiveness to energy dense, highly palatable foods such as pizza, or ice-cream. In this sense, responsiveness to energy-dense foods may be one important mechanism that promotes energy intake by stimulating appetite, by increasing the number of eating events, and types of foods selected. A similar phenomenon has been described as non-homeostatic hunger or “hedonic hunger,” where susceptible individuals are more sensitive to food cues and seek food spontaneously, eating for pleasure, irrespective of any underlying need. Individual differences in appetite responsiveness to rewarding properties of the food environment can be measured using the “power of food scale,” which also suggests that, for some people, food odour is a very powerful stimulus that can motivate eating in the absence of hunger, snacking, and promote positive energy balance.

Texture

This refers to those qualities of a food that can be felt with the fingers, tongue, palate, or teeth. Foods have different textures, such as crisp crackers or potato chips, crunchy celery, hard candy, tender steaks, chewy chocolate chip cookies, and creamy ice cream, to name but a few. Not only Indian food but chips are being added even to Burgers and Pizzas.
to make them crunchy and crispy. This is one of the ways of introducing ‘sonic seasoning’.

Individuals have a preferred way to manipulate food in their mouths (i.e., mouth behaviour) and that this behaviour is a major driver of food choice, satisfaction, and the desire to repurchase. Texture, which is currently thought to be a major driver of product choice, is a secondary factor, and is important only in that it supports the primary driver — mouth behaviour. Currently there is a trend to include the textural properties of the product in the message, for example, crunchy, chewy, or creamy. Sometimes these words are used to connote more quality or emotional aspects such as freshness or mood, but at other times to connote texture preferences. However, with concepts that employ texture messaging, the underlying belief is that (1) these textural characteristics are of interest to most consumers; (2) these textural words are clearly understood by both marketers and product developers; and (3) products can be easily optimized using current product development and sensory tools.

Figure 16. 3: Food textures that people like

Figure 3 describes the different textures we like in food. Texture preferences changes during various stages, for instance older individuals who have experienced dental issues indicated that they could no longer enjoy many of the foods that were preferred when they were younger. While some studies have also concluded that taste sensitivity, and chewing behaviour differ by gender.
Flavour = Taste + Aroma

Flavour is a combination of taste and smell/aroma and is largely subjective. If a person has a cold, food usually seems to be tasteless. However, it is not the taste buds that are affected but the sense of smell. People vary in their sensitivity to different tastes. Sensitivity depends on the length of time allowed to taste a substance. Sweet and salt tastes are detected quickly (in less than a second), because they are detected by taste buds on the tip of the tongue; in addition, they are usually very soluble compounds. Bitter compounds, on the other hand, may take a full second to be detected because they are detected at the back of the tongue. The taste may linger, producing a bitter aftertaste.

Sensitivity to a particular taste also depends on the concentration of the substance responsible for the taste. The threshold concentration is defined as the concentration required for identification of a particular substance. The threshold concentration may vary from person to person; some people are more sensitive to a particular taste than others and therefore are able to detect it at a lower concentration.

Let’s understand this better with an example: There are 3 friends Nehmat, Ravi and Aryan. They are around 8 years old. One day they all had a glass of milk each at Nehmat’s house. All three glasses of milk had the same quantity of sugar - 1 teaspoon each. Ravi found the milk to be too sweet whereas Aryan found the milk less sweet, almost bland. Nehmat was the only one who enjoyed her milk. 3 kids - same sugar - but 3 different perceptions of sweetness.

Below the threshold concentration, a substance would not be identified but may affect the perception of another taste. For example, sub-threshold salt levels increase perceived sweetness and decrease perceived acidity, whereas sub-threshold sugar concentrations make a food taste less salty than it actually is. Another debatable topic is that the flavour enhancers such as MSG (monosodium glutamate) also affect taste sensitivity by intensifying a particular taste in a food though there are no specific studies to establish this as a fact.

Temperature of a food also affects its flavour. Warm foods generally taste stronger and sweeter than cold foods. For example, melted ice cream tastes much sweeter than frozen ice cream. There are two reasons for the effects of temperature on flavour. The volatility of substances is increased at higher temperatures, and so they smell stronger. Taste bud receptivity also is an important factor. Taste buds are most receptive in the temperature range between 20-30°C, and so tastes will be more intense in this temperature range.

Psychological factors also affect taste sensitivity and perception. Judgments about flavour are often influenced by preconceived ideas based on the appearance of the food or on previous experience with a similar food. For example, strawberry flavoured foods would be expected to be red. However, if coloured green, because of the association of green foods with flavours such as lime, it would be difficult to identify the flavour as strawberry unless it was very strong. Colour intensity also affects flavour perception. A stronger colour may cause perception of a stronger flavour in a product, even if the stronger colour is simply due to the addition of more food colouring. Texture also can be misleading. A thicker product may be perceived as tasting richer or stronger simply because it is thicker and not because the thickening agent affects the flavour of the food. Other psychological factors that may come into play when making judgments about the flavour of foods include time of
day (for example, certain tastes are preferred at breakfast time), general sense of well-being, health, and previous reactions to a particular food or taste.

Taste Sensitivity: driving our food choices

We already know that there are two types of taste - basic tastes and ayurvedic tastes. Now let us learn a little about them.

**Basic Tastes** include - Sweet, Salty, Sour, Bitter and Umami. Western contemporary science says only these 5 can be called tastes. Do you think it does justice to our Indian food? Using these 5 tastes can we describe all the elements of your 1 portion of vegetable e.g. aloo gobi? Only salt and oil/fat are covered what is left out is haldi (turmeric), garlic, ginger, different spices and chillies. In addition to this, what is left out is that special taste that we get when we eat jamuns, amlas, and roasted gram (chana).

Whatever has been left out has always been covered under Ayurveda as tastes. Jamuns, roasted gram (chana), tea, and coffee have a unique taste where you feel your entire mouth is kind of drying out. This is called astringency in English and kashaya in Ayurveda.

Now let us look at the term - 'Mirch Masala'. Some of us have started using just one word to describe this both - Spiciness. Do you think the sensations in your mouth when eating a single piece of clove is the same as when eating green chilli? The answer is yes to some extent. That’s why ‘mirchi’ and ‘masala’ both are ‘katu’ in Ayurveda and “pungent” in western science. Yet masalas and mirchis are not substitutable. We can distinguish between them when we are eating any cooked food.

Why can’t the Ayurvedic tastes astringency and pungency be included under basic tastes? Scientifically basic tastes are those that are captured on the tongue by our taste buds and Ayurvedic tastes are not captured on the tongue but instead on the nerves in the face. Tastes that are captured by the taste buds on the tongue are basic tastes. Astringency and pungency are not captured by the taste buds on the tongue hence they cannot be considered as basic tastes.

Taste is the most important deciding factor of choice we make in food. Taste is a complex sense. In addition to sensations arising in taste receptors, it is influenced by chemical, tactile, warm, and cold receptors in the mouth, and particularly by olfactory sensations. Our inclination towards one particular taste sensitivity could lead to various health effects. For instance, a “sweet tooth” leads to obesity through excess sugar consumption, is an overly narrow theory. There are multiple links between taste perceptions, taste preferences, food preferences, and food choices and the amount of food consumed. The impact of taste factors on food intake further depends on sex and age and is modulated by obesity, eating disorders, and other pathologies of eating behaviour.

Taste is a key factor that impacts food intake. Although much research has been devoted to the study of the peripheral gustatory system and taste quality, current understanding of the specific interplay of receptor activation, signalling, and hormonal modulation remains complex. Genotypic variation results in various phenotypes of food preference and nutrient intake. Additionally, the hormonal milieu impacts food hedonics and macronutrient intake. Increased knowledge of chemosensory variation will allow insight into individual’s
eating behaviour and potentially identify therapeutic targets for chronic health problems such as obesity.

Thus, it is very important that habit of choosing balance in food should be inculcated from early life as it will influence later health. Food preferences are formed in infancy, and are tracked into childhood and beyond. Good food habits in childhood are important for preventing obesity later in life. Many studies show that children prefer high-energy, sugary, and salty foods. In pre-school age they tend to reject new foods. Thus, starting from the prenatal period, a varied exposure in utero and repeated experiences with novel flavours during breastfeeding and complementary feeding increase children’s willingness to try new foods and make balanced food choices.

Collectively, these data suggest that individuals with abnormal taste responsiveness (which leads to an altered perceived taste sensation evoked by foodstuffs, such as vegetables) may alter their intake of certain foods, thereby leaving them susceptible to perturbations in metabolic homeostasis. And this does indeed seem to be the case. For example, multiple investigators have shown sweet taste responsiveness to be correlated with body mass index (BMI). Moreover, the preference for consuming sugar-sweetened beverages was shown to be correlated with increased blood pressure. Bitter taste sensitivity/responsiveness has been associated with BMI, adiposity, and risk factors for cardiovascular diseases. Sensitivity to other taste qualities has also been associated with energy consumption and BMI. Thus, achieving a greater understanding of the factors that influence taste responsiveness could be potentially useful in our attempt at influencing nutritional intake and human susceptibility to diseases related to food intake patterns. Balance of all the tastes is the key to healthy diet.

It could also be noted that in some of the conditions the taste sense gets compromised and thereby affects the food choices. Abnormal taste function is present in healthy elderly people, and in patients with chronic renal failure and cancer. Smoking also decreases taste perception. In two separate population groups, a comparison of taste perception among samples of smokers and non-smokers revealed that the taste thresholds for bitter (using quinine hydrochloride) was significantly higher in smokers than in non-smokers. There was no significant difference in the taste thresholds for sweet, sour, or salt between smokers and non-smokers. Bitter is thus specifically affected. The age of the smoker, and thus presumably the duration of smoking, as well as the amount smoked, both adversely affected sensitivity to quinine solutions.

Humans use all of their senses to evaluate the sensory properties of a food. This evaluation begins before consumption and is based on how the food looks and smells; you would not choose green coloured fries or a grey coloured rice The acceptance or rejection of a given food occurs when the human brain jointly processes: (a) information obtained from observing, handling, and consuming the food in question; (b) information acquired from the surrounding social and cultural context; (c) information gained from the physiological effects (pleasure, satiety, dislike, discomfort, etc.) experienced when eating and after eating a certain food; and (d) comparison with information stored in the memory of past experiences.

One of the primary functions, or challenges, faced by the brain is to find nutritious foods and to avoid ingesting those substances that may be poisonous or otherwise harmful. While the senses of taste (gustation), smell (olfaction), and texture (touch or oral somatosensory) provide the ultimate arbiters of a food’s palatability, it is the sense of vision that provides a
far more effective means of foraging, predicting which foods are likely to be safe and nutritious to consume, and generating those expectations that will constrain the consumption experience. Contemporary neuroscience demonstrates just what a powerful cue the sight of appealing food can be for the brain, especially the brain of a hungry person. Diets have changed and nutritional theories have come and gone. Human convictions about taste, however, have remained quite consistent over time; they are characterized by continuity rather than change. Thus, taste as a new science strategy could be adopted. Taste’s therapeutic significance helps in choosing the right food. Healthy eating habits should be inculcated right from childhood. Child should be encouraged to choose right food. The second concept by which we can improve our diets is eating and knowing. Educate people of the calorie intake and nutritive value of foods which would encourage them to make healthy food choices. However, the most important thing to do is to ensure that healthy foods are tasty and attractive to eat!

Summary

- The key driver for eating is hunger. Other factors also influence food choices.
- Biological, economic, physical, social and psychological determinants, as well as attitudes, beliefs and knowledge about food affect food choices.
- The central nervous system is involved in controlling the balance between hunger, appetite stimulation and food intake.
- The macro-nutrients i.e. carbohydrates, proteins and fats generate satiety signals of varying strengths. Many people are unaware of what constitutes appropriate portion sizes and thus inadvertently consume excess energy.
- Taste’ is consistently reported as a major influence on food behaviour. ‘Taste’ is the sum of all sensory stimulation that is produced by the ingestion of a food. This includes not only taste per se but also smell, appearance and texture of food.
- Familiarity is a powerful predictor of liking for food. Unfamiliar foods tend to be disliked.
- The sight, smell, texture and flavour of a food determine whether it will be selected for consumption.
- Sensitivity to a particular taste also depends on the concentration of the substance responsible for the taste. The threshold concentration is defined as the concentration required for identification of a particular substance.
- Flavour is a combination of taste and smell and is largely subjective. Temperature of a food may determine its flavour. Psychological factors also affect taste sensitivity and perception.
- Basic tastes include- Sweet, Salty, Sour, Bitter and Umami. In addition, there are taste sensations of astringency and pungency which are well documented even in Ayurveda.
Key words

**Gustation** – sense of taste

**Kashaya** – astringent

**Katu** – pungent

**Olfaction** – sense of smell

**Oral-Somatosensory** – sensation arising in the mouth providing information on the structure and state of object in mouth

**Satiety** - satisfaction of appetite

**Sonic Seasoning** – is a scientific field that uses sound to make food taste better

Exercises

1. List the factors that may influence food choices of individuals.
2. Discuss the pros and cons of food photography.
3. What is the difference between aroma and aromatics?
4. Explain how texture and flavour play a vital role in choosing foods.
5. What do you understand by the term 'sonic seasoning'? How will you use it to make food taste better?
6. What are basic tastes? Why are astringency and pungency not covered under these?
7. How will you use the knowledge about taste being a major determinant of food choices to encourage individuals to choose healthy foods?
References

1. Ayurveda - Keeping healthy body healthy- paper on Genomics Research by Dr. Mital Mukherji of IGIB.


Chapter 17: Social and Behavioural Change for Improving Health Outcomes

- Theories and Approaches
- What is Social and Behavioural Change Communication?
- Theories of Behaviour Change and their Applications
  - At Individual Level
  - At Community Level
Chapter 17: Social and Behavioural Change for Improving Health Outcomes

**Social and Behavioural Change** refers to bringing about a positive transformation with a social system that includes changing behaviour of individuals and the society or social environment as a whole. This is often used in the context of improving public health outcomes, such as getting people to adopt vaccination to prevent polio or encouraging breastfeeding among new mothers. However, it finds application in a variety of settings for a broad range of activities such as higher enrolment of girls in schools, greater donation to charitable organizations and so on.

**Behaviour change** is an evidence-based process for changing knowledge, attitudes and practices of individuals or groups of individuals. This allows groups of individuals to define their needs, demand their rights, achieve their goals and sustain its benefits through a participatory and collaborative process that encourages both dialogue and action.

Individual behaviours are shaped and influenced by cultural practices, social norms and the economic and political landscape. Therefore, to bring about real and sustained change, it is important to consider the community as a whole.

**Social change** focuses on the community as the unit of change. It is geared towards changing behaviors on a large scale to eliminate harmful social and cultural practices, change social norms and structural inequalities within the community. This allows the community to transform their social system or organization through collaboration, partnerships, public-private dialogue and create joint ownership of the change process.

In this chapter, you will understand the concept of social and behaviour change, learn about key theories and approaches, and understand how these have been applied in practical settings around the globe. This chapter will largely focus on social and behaviour change in the context of public health. The key takeaway of this chapter is to not only understand how people and societies have been transformed but also be able to apply these to your own settings and environment to achieve goals relevant to your group, community and society as a whole. For example, you may feel that in your college or office, people have a culture of snacking on unhealthy food, particularly fried snacks and sweetened beverages. How would you mobilize people to take charge and transform their habits and environment and change the college/office culture? Let us learn by first understanding some basic theories and approaches to behaviour change.

**Theories and Approaches**

Bringing about social change is one of the most difficult tasks. Change is not only challenging at the individual level but also at the group and community level. Creating a national movement around behaviour change, that too regarding a complex set of behaviours surrounding habits that permeate every aspect of our lives, every single day, is a monumental task, to the say the least. The first step to creating behaviour change is to generate awareness among people about the particular behaviour to be adopted or discarded.
Traditionally, ‘Information, Education and Communication’ (IEC) has been used for this purpose. This involves working with individuals, communities and societies to develop communication strategies to promote positive behaviour that are appropriate to their settings. For example, informing people about eating fresh, seasonal and local fruits and vegetables is a positive behaviour that needs to be adopted as it is good for health and the environment. Merely providing people with information and teaching them how they should behave does not lead to desirable change in their response/behavior. However, when there is a supportive environment with information and communication (teaching) then there is likely to be a desirable change in the behavior of the target group.

What is Social and Behavioural Change Communication?

**Behaviour Change Communication (BCC)** is a step forward from IEC towards enabling action from individuals, communities and societies. It entails providing a supportive environment that will enable people to initiate and sustain positive behaviour, in addition to spreading awareness. For example, providing information and ‘nudges’ to shop at clean and safe fruit and vegetable markets encourages people to consume fresh, seasonal and local fruits and vegetables.

However, there is no single strategy that works for all individuals and behaviours. Interventions need to be context specific. The more complex the behaviour, the more well thought-out the interventions need to be. Thus, social and behaviour change communication (SBCC), often also only “BCC” or “Communication for Development (C4D)” is an interactive process with individuals, groups or communities which forms a two-way communication process. SBCC is a strategic use of communication to promote positive outcomes, based on proven theories and models of behaviour change.

**SBCC** is a systematic process starting with formative research and behaviour analysis, communication planning leading to implementation, followed by monitoring and evaluation. The target audience is carefully analyzed and segmented, messages and materials are prepared and pilot-tested, and delivery mechanisms such as mass media (which include radio, television, billboards, print material, internet), interpersonal channels (such as client-provider interaction, group presentations) and community mobilisation are used to achieve defined behaviour change objectives.

Theories of Behaviour Change and their Applications

There are several theories of behavioural change to draw from to design a large-scale social and behavioural change movement at the individual and community levels. Many of these relate to health specifically. We will explore each one of them one by one.

At the individual level are theories such as Health Belief Model, Theory of Reasoned Action and Planned Behaviour, Trans-theoretical model/Stages of change and Social Learning Theory. More recently, the ‘Nudge Theory’ has gained worldwide attention in influencing behaviour. At the community level are Diffusion of Innovations Theory and Community Mobilization. More recently, the ‘Systems Leadership Approach’ is gaining traction globally to bring about large-scale behaviour change.
At Individual Level

The Health Belief Model is one of the oldest theories on behaviour change (Rosenstock, 1974). Developed in the 1950s by social psychologists Irwin M. Rosenstock, Godfrey M. Hochbaum, S. Stephen Kegeles, and Howard Leventhal at the U.S. Public Health Service, suggests that people’s beliefs about health problems, perceived benefits of action and barriers to action, and self-efficacy explain engagement (or lack of engagement) in health-promoting behaviour. This means that people will not adopt a positive health behaviour or change a negative one unless they believe they are at risk of a disease, understand the benefits of the behaviour change, are able to overcome barriers to adopting that health behaviour and have self-efficacy, i.e. they believe they have the ability to perform the health behaviour and have a sense of control on themselves and their environment.

Case Study: The Health Belief Model was applied to a nutrition education intervention for staff members of a university (Abood et. al, 2003). An 8-week nutrition education programme was created to promote healthful dietary behaviours that reduce risks for cardiovascular disease and cancer. The intervention focused on specific health beliefs, nutrition knowledge, and dietary practices to demonstrate the effect of the intervention. The participants were divided into two groups. One group received the intervention and the other did not. As a result of this education programme, perceived benefits of healthy nutrition practices and nutrition knowledge related to cardiovascular disease and cancer significantly improved among the participants who received the intervention. These participants also significantly reduced total calories, fat, saturated fat, and cholesterol intake compared to those participants who were not part of the intervention. This experimental case-study suggests that targeting people’s beliefs, perceptions and improving their self-efficacy in adopting healthy behaviours leads to improved health outcomes. Therefore, if you were to design a health intervention, it would be useful to create and design education programmes accordingly.

Theory of Planned Behaviour and Reasoned Action Approach (ToRA or TRA) was developed by Martin Fishbein and Icek Ajzen in 1967. It posits that an individual’s decision to engage in a particular behaviour is based on the outcomes the individual expects will come as a result of performing the behaviour. This theory was later revised and expanded to overcome any discrepancies in the Attitude-Behaviour relationship with the Theory of Planned Behaviour (TPB) and Reasoned Action Approach (RAA) (Fishbein & Ajzen, 2011). TRA states that a person’s intention to perform behaviour is the main predictor of whether or not they actually perform that behaviour. This is further influenced by social norms. TPB also adds that perceived behavioural control in performing the behaviour plays a critical role in individuals actually performing that behaviour.

Case Study: In the context of improving health, it is a challenge to get people to exercise to reduce the incidence of obesity and its related health issues. How would we apply this theory to motivate people to exercise? In 1981, a study by Bentler and Speckart examined to what extent attitudes caused behaviour change. Their study revealed that the intent to exercise was determined by a person’s attitude toward exercise, as predicted by the Theory of Reasoned Action (Bentler et al, 1981). Similarly, Mok WK, et al (2013) studied 486 students ranging in age from 11 to 18 years in Hong Kong. By means of self-administrated questionnaire, demographic data, past physical activity and variables of theory of planned behaviour, such as attitude, subjective norm and perceived behavioural control were measured. Results of this study gave evidence that the theory of planned behaviour was a
useful framework for prediction of physical activity intention and behaviour of adolescents in Hong Kong. Among the variables, perceived behavioural control and past behaviour also played a significant role.

What does this mean in terms of bringing about behavioural change in people? It implies that we need to first examine people’s attitude towards that particular behaviour and see if they have any intention to perform it. This would likely predict if they actually perform it. So, for example, you would like to get people in your organization or college to exercise more, according to this theory, you would need to first examine their existing attitudes and intention to exercise. If their attitude towards exercise are negative, then you would have to work towards changing their attitude first and make sure they have the intention to exercise. This theory underlines the need to consider attitudes and intentions when designing any large-scale intervention.

Trans-theoretical Model of Behaviour Change (TTM) is an integrative theory of therapy that assesses an individual's readiness to act on a new healthier behaviour and provides strategies or processes of change to guide the individual. The model is composed of constructs such as: stages of change, processes of change, levels of change, self-efficacy, and decisional balance (Prochaska, 2013). TTM integrates processes and principles of change from across leading theories, hence the name Trans-theoretical. According to TTM, health behaviour change involves progress through six stages of change: pre-contemplation (not ready for change), contemplation (getting ready for change), preparation (ready for change), action (creating change), maintenance (monitoring), and termination. Ten processes of change have been identified for producing progress along with decisional balance, self-efficacy, and temptations. The ten processes of change include, Consciousness-raising (Get the facts), Dramatic relief (Pay attention to feelings), Self-re-evaluation (Create a new self-image), Environmental re-evaluation (Notice your effect on others), Social liberation (Notice public support) — realizing that society is more supportive of the healthy behaviour, Self-liberation (Make a commitment), Helping relationships (Get support), Counterconditioning (Use substitutes), Reinforcement management (Use rewards) and Stimulus control (Manage your environment).

As per findings from basic research, any population at risk of a disease may be categorized into the following stages: 40% in pre-contemplation, 40% in contemplation, and 20% in preparation (Prochaska & Velicer, 1997). This approach highlights the need for targeted interventions based on the stage a particular population may be in. Therefore, this model suggests a more personalized approach to designing behaviour change intervention to help populations to reach the next stage of the desired behaviour change.

Case Study: Fifty-hundred-and-seventy-seven overweight or moderately obese adults (BMI 25–39.9) were recruited from large employers to be randomly assigned to receive stage-matched interventions as per the TTM Model (Johnson et al, 2008) or be in the control group that did not receive the TTM-based intervention. Those randomly assigned to the treatment group received a stage-matched multiple behaviour change guide and a series of tailored, individualized interventions for three health behaviours that are crucial to effective weight management: healthy eating (i.e., reducing calorie and dietary fat intake), moderate exercise, and managing emotional distress without eating. Assessments were conducted at four time points: baseline, 3, 6, and 9 months. All participants were followed up at 6, 12, and 24 months. The study revealed that at the end of the intervention, after 24 months, those participants who were classified to be in the pre-action stage for healthy eating at baseline and received treatment were significantly more likely to have reached
Protons or Maintenance stage than the comparison group. The intervention showed similar effects on managing emotional distress without eating, and consumption of fruits and vegetables. Those who were in a pre-action stage for both healthy eating and exercise at baseline and received the TTM-based treatment -30% lost 5% or more of their body weight vs. 18.6% in the comparison group. This study demonstrates the ability of TTM-based tailored feedback to improve healthy eating, exercise, managing emotional distress, and weight on a population basis. The treatment produced the highest population impact to date on multiple health risk behaviours (Johnson et al., 2008). What does this study mean for designing population-based interventions? This underscores the importance of first identifying the readiness of a population to make a desired behaviour change such as exercising, healthy eating, stress-management and then designing targeted interventions based on their respective stages. This would generate the maximum likelihood to move them to the maintenance stage where the desired positive behaviour has been achieved and only needs to be maintained.

**Social Learning Theory** proposes that new behaviours can be acquired by observing and imitating others. This theory emphasizes that learning takes place in a social context and is a cognitive not a purely behavioural process (Bandura, 1977). The recent discovery of "mirror neurons" in primates provide support for a neurological basis for imitation. These are neurons which fire both if the animal does something itself, and if it observes the action being done by another (Rizzolatti et al., 2004). According to this theory, learning can take place even when there is no reproduction of the action or reinforcement of the behaviour, although learning may occur through observation of rewards and punishments. The learner is not a passive recipient of information. Cognitive processes, behaviour and environment all influence each other (Bandura, 1977). This theory has useful applications in bringing about large-scale behaviour change, particularly through the influence of media, celebrities or heroes that people are likely to emulate.

**Case studies:** Representations in the media are influential because people construct their views of society and desired behaviours based on what they see. If efforts to change beliefs are directed towards the sociocultural norms and practices at the social system level of a particular population, they can be highly effective in bringing about change in behaviour (Singhal et al., 1993). This lends credence to the entertainment-education approach or the infotainment approach to social and behavioural change.

This approach has been effectively used by Mexican creative writer-producer-director at Televisa, (the Mexican national television system). He has created a methodology to produce entertainment-education telenovelas. This methodology includes a formal, reproducible set of design and production techniques for the construction of persuasive mass media messages. It took Sabido eight years (from 1967 to 1975) to hone his methodology of producing entertainment-educational telenovelas. He created four historical-cultural soap operas for Televisa, each designed to promote and celebrate the rich cultural heritage of Mexico. The success of these historical-cultural soap operas convinced Sabido that telenovelas were ideally suited for educating Mexican viewers about various development topics since telenovelas were highly popular in Mexico. They achieved spectacular reach among the audience, ratings reaching millions of viewers for half-an-hour daily, five times a week, for about one year, representing massive exposure to an educational message. The melodrama in a telenovela represented a natural confrontation of 'good' role models against 'bad' ones, providing a unique opportunity to promote 'socially desirable' behaviours and dissuade 'socially undesirable' behaviours (Sabido, 1989). He subtly incorporated educational messages in entertainment content,
without making them too blatant, in order to produce a value-based, morally coherent, and a realistic telenovela, with believable characters and locales.

Based on Sabido’s method, a television drama called Hum Log was launched in India. Hum Log (‘We People’), a particularly popular television soap opera, was broadcast in India from 1984 to 1985. Hum Log featured educational messages about women’s status, family harmony, and smaller family size norms. It attracted a very large-sized audience, setting a record for television ratings in India (up to 95 percent), and getting through to the mass population of India as no television series had ever done before. The Hum Log broadcasts had particularly important impacts on certain audience segments (Singhal et all 1993). For example, many young women in the audience identified with Badki, a positive role model for female equality, who modelled her rejection of the traditional role for Indian young women by seeking a professional job outside the home, selecting her own husband, etc. (Singhal et all 1993). However, Hum Log delivered mixed results in terms of influencing the audience as Sabido’s methodology was not directly applied to this teleserial (Singhal et all 1993).

**Nudge Theory** has come into prominence, popularized by Richard Thaler and Cass Sunstein. Nudge is a concept in behavioral science, political theory and behavioral economics which proposes changing the ‘choice architecture’ to influence the behavior and decision making of groups or individuals in such a way that an individual or group is ‘nudged’ into performing the desired behaviour without taking away their freedom of choice (Thaler & Sunstein, 2009). A simple example of a nudge would be placing healthy foods in a school cafeteria at eye level while putting less-healthy junk food in harder-to-reach places. Individuals are not actually prevented from eating whatever they want but arranging the food choices that way causes people to eat less junk food and more healthy food (Thaler & Sunstein, 2009).

They argue that nudges can be used effectively to improve decisions about health, money and many other situations in life. They describe two systems of thinking, “The Reflective System” and the “Automatic System”. These have been further elaborated by Daniel Kahneman (Kahneman, 2011), the Nobel Prize winning behavioural economist who, along with Amos Tversky, first introduced the idea that humans are not rational decision makers through their ‘Prospect Theory’ that posits that systematic cognitive biases influence decision-making. The Nudge Theory draws from this idea.

According to the Two Systems of Thinking idea, The Automatic or Fast System is rapid, feels instinctive and does not involve any kind of deliberation. The actions that result from it are automatic, such as ducking when a ball is thrown at you. The Reflective or Slow System is deliberate and self-conscious and is engaged when people decide which college to attend, where to go on trips etc. (Thaler & Sustein, 2004; Kahneman, 2011). Since people often rely on the Automatic System for decision-making, their decisions are not always rational but are influenced by their cognitive biases. For example, the status quo bias can be seen when people are very likely to continue a course of action since it has been traditionally the one pursued, even though this course of action may clearly not be in their best interest. That is, people often lean towards the ‘default option’. This can be effectively used to nudge people towards a desirable decision by making it the default option such as serving salad with a burger instead of fries at restaurants. Nudge Theory has been widely applied in policy recommendations across health, economics, finance, environment, schools etc.
Case Study: The insights from behaviour economics and Nudge have been applied in the Indian setting (K. Subramanian, 2019). The Beti Bachao Beti Padhao (BBBP) scheme was launched on 22nd January 2015 to improve child sex ratio and empower girls and women. This campaign demonstrated the powerful use of the insight on ‘social norm’ in its ‘Selfie with Daughter’ initiative. Social norms dictate the way people behave. Changing people’s behaviour means changing social norms. By introducing a new norm and making people believe that this is the social norm, people can be nudged to adopt it. One of the aims of BBBP scheme was to stop parents from viewing girls as a burden and start celebrating them instead. The selfie campaign showcased examples of parents celebrating their daughters and taking a selfie to demonstrate it. This campaign became viral on social media encouraging people to act according to this new norm (K. Subramanian, 2019). Thus, Nudge can be applied effectively to change attitudes and behaviours.

**Community Level**

**Diffusion of Innovations Theory** is a theory that seeks to explain how, why, and at what rate new ideas and technology spread. Proposed by Everett Rogers in 1962, it proposes that four main elements influence the spread of a new idea: the innovation itself, communication channels, time, and a social system. The innovation must be widely adopted in order to self-sustain. The categories of adopters are innovators, early adopters, early majority, late majority, and laggards. Within the rate of adoption, there is a point at which an innovation reaches critical mass (Rogers 1962).

*Case Study:* One of the most prominent examples of the application of this theory is the spread of social media social networks such as Facebook. At first, when Facebook was started in 2004, it was limited to first Harvard University and then universities in the US only. These were the early adopters. As Facebook expanded its capacity to include more and more people, its base grew until the vast majority of people with access to internet are on Facebook.

In **Community Mobilization** action is stimulated by a community itself, or by others, that is planned, carried out, and evaluated by the community’s individuals, groups, and organizations on a participatory and sustained basis to improve the health, hygiene and education levels so as to enhance the overall standard of living in the community.

*Case Study:* A unique nine-year collaborative programme between Vietnamese and international medical scientists and an aid organization have established an innovative and successful community-based dengue vector control programme in Vietnam (Vu et al., 2004). The use of predacious copepods combined with new water management practices by nine communes in northern and central Vietnam helped eliminate the main dengue vector mosquito, Aedes aegypti. The model was enthusiastically taken up by communities with apparent ease and a high level of acceptability as demonstrated by post-project sustainability and expansion.

**Systems Leadership Approach** for sustainable development is an innovative and adaptive model that is a departure from the traditional hierarchical, top-down and linear approaches to implementing change. In this framework, complex systems such as environment, food and health are dealt with at three levels- Individual, Community and the
Systems Levels. The first focuses on collaborative leadership, the second on advocacy and collaboration and the third, on insights on the complex systems. It uses the CLEAR Framework leading change through five key elements of the systems change process. These are not necessarily sequential – they may overlap or repeat in cycles throughout the course of an initiative.

1. Convene and Commit - Key stakeholders engage in moderated dialogue to address a complex issue of mutual concern. They define shared interests and goals and commit to working together in new ways to create systemic change.

2. Look and Learn - Through system mapping, stakeholders jointly build a shared understanding of the components, actors, dynamics, and influences that create the system and its current outcomes, generating new insights and ideas.

3. Engage and Energize - Diverse stakeholders are engaged through continuous communication to build trust, commitment, innovation and collaboration. Inspiration, incentives and milestones help drive progress and maintain momentum.

4. Act with Accountability - Shared goals and principles set the direction of the initiative, while measurement frameworks help track progress. Coordination and governance structures can be developed as initiatives mature.

5. Review and Revise - Stakeholders review progress regularly and adapt the initiative strategy accordingly. Adopting an agile, flexible, innovative and learning-centered approach allows for evolution and experimentation.

Summary

- Social and Behavioural Change refers to bringing about a positive transformation with a social system that includes changing behaviour of individuals and the society or social environment as a whole.

- Individual behaviours are shaped and influenced by cultural practices, social norms and the economic and political landscape. Therefore, to bring about real and sustained change, it is important to consider the community as a whole.

- Bringing about social change is one of the most difficult tasks. Change is not only challenging at the individual level but also at the group and community level.

- Behaviour Change Communication (BCC) is a step forward from IEC towards enabling action from individuals, communities and societies. It entails providing a supportive environment that will enable people to initiate and sustain positive behaviour, in addition to spreading awareness.

- There are several theories of behavioural change to draw from to design a large-scale social and behavioural change movement.
Some of these theories are at the individual level such as Health Belief Model, Social Learning Theory, Nudge Theory and, some are at the community level such as Diffusion of Innovation Theory, Community Mobilization and Systems Leadership Approach.

Key Words

**Behaviour change** - is an evidence-based process for changing knowledge, attitudes and practices of individuals or groups of individuals.

**C4D** - Communication for Development

**SBCC** - Social and Behaviour Change Communication

**Exercises**

1. What do you understand by the term SBCC? How is it different from IEC?
2. Briefly describe the ‘Nudge theory’ of behaviour change.
3. List some theories of behaviour change that can be applied at the individual level. Explain any one in detail.
4. Giving suitable examples explain any two theories of behaviour change which are applicable at the community level.
5. What are the five key elements of the systems change process? Elaborate.

**References**

multiple behavior intervention for weight management: Effectiveness on a population basis. Preventive Medicine, 46, 238-246.


Section 4: Eat Sustainable

18. Food Ecosystem and Sustainability
19. Approaches to Sustainable Food System
Chapter 18: Food Ecosystem and Sustainability

- Understanding the Food Ecosystem and Sustainability issues

- Challenges of the food ecosystem
  - Land use for food and protection of biodiversity
  - Use of fertilizers and chemicals in farm operations
  - Water for irrigation
  - Food loss and wastage

- Potential solutions
  - Nutritious food and healthier food choices
  - Promoting sustainable and regenerative agricultural practices
  - Protecting and restoring forests and other natural ecosystems
  - Investing in a more diversified protein supply
  - Reducing food loss and waste
  - Building Food smart cities, digitization and stronger rural livelihoods
Chapter 18: Food Ecosystem and Sustainability

‘Sustainability’, often quoted across forums discussing development agenda, is a complex concept. What does sustainability really mean? With reference to ecology it means the avoidance of the depletion of natural resources in order to maintain a balance. The UN World Commission on Environment and Development defines sustainable development as ‘development that meets the needs of the present without compromising the ability of future generations to meet theirs’.

Simply put, think of a bucket with water pouring in and draining out at the same time. If the amount of water pouring in is equal to the amount draining out, the level of water in the bucket remains the same. However, if the rate at which water drains out is faster than the rate at which it gets into the bucket, the level of water in the bucket would gradually decrease. That’s essentially what we are observing in the world today. We are draining the resources faster than they can be replenished.

Typically, environment, economy and society form the three-pillars of sustainability. These three pillars converge on a singular goal of ensuring a bright future for the next generation. This brings us to a pertinent question, how does food become integral to the sustainability discussion?

The World’s population is expected to reach 9.8 billion by 2050. To feed this population, we would put extreme pressure on the earth’s climate, natural resources and ecosystems. At present some 11 percent (1.5 billion ha) of the globe’s land surface (13.4 billion ha) is used in crop production (arable land and land under permanent crops). This area represents slightly over a third (36 percent) of the land estimated to be to some degree suitable for crop production. This implies agriculture alone is the largest use of land on this planet. Yet, roughly one-third of the food (1.3 billion tonnes) produced globally gets wasted or lost. Food losses and waste amounts to roughly US$ 680 billion in industrialized countries and US$ 310 billion in developing countries. The situation becomes even more grim when we consider the rates of malnutrition globally. About 815 million people globally, regularly go to bed hungry. Children under five years of age face multiple burdens: 150.8 million are stunted, 50.5 million are wasted and 38.3 million are overweight. Many of these children would never reach their full physical and cognitive potential. Sustainable food production and responsible food consumption therefore become central to the risks related to human health as well as environmental sustainability. In fact, goal # 12 of the 2030 Agenda for Sustainable Development aims to ensure sustainable consumption and production patterns.

This chapter integrates the concept of food production, consumption and utilization (food ecosystem) with sustainability by studying the elements involved, both from a challenges and potential solutions perspective.

Understanding the Food Ecosystem and Sustainability Issues

A Food Chain describes how energy and nutrients move through an ecosystem. The length of food chain is determined either by the dynamical stability of food webs or by the availability of limiting food resources. The length of food chain also involves complex
relationships between food chain length and ecological processes like the history of community organization, resource availability, habitat stability and ecosystem size (Post, 2002). A Food Web is an important tool for understanding the ecological interactions that define energy flow, predator-prey and other relationships. It is particularly important to understand and study the food web in context to ecosystems as there are various concerns like climate change, habitat loss, changes in food production and consumption patterns, etc. (Pimm, 1984; Daily, 1997; Dunne, 2009)

**Food Ecosystem** refers to a community of living organisms existing in concurrence with physical non-living environment. These living and non-living components are linked to each other through nutrient transfer cycles and energy flows. In agriculture and food production systems, ecosystem services are provided by entities which can be incorporated into crop production systems enabling production increase, minimizing environmental impacts by modulating the use of fertilizers, pesticides, energy, and irrigation and soil management practices. Apart from soil and irrigation, the temperature also plays vital role in managing the various processes of food production ecosystem. It has been reported that minimal rise in temperature alters the food web structure and ecosystem by changing the ratio disproportionately between predators and herbivores resulting in changed distribution of organisms. Technically, these interactions between different biotic and abiotic entities of ecosystem are known as 'Ecological intensification.' This revolves around the concepts of optimization of resources and sustainability. Ecosystem size determines food-chain length.

A **sustainable food ecosystem** (SFS) is a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised (FAO, 2018)

The resource footprints could also be termed as 'Ecological Footprint' which are defined as an aggregated indicator of demand on nature and can be measured using a standardized area unit termed a ‘global hectare’ (gha). This is usually expressed on a per capita basis (gha/capita). The ecological footprint estimates the area of land required to support the resource consumption of a defined population, usually for one year (WWF, 2006). For example, the environmental impact of producing beef and veal generates a footprint figure of 0.0157 gha/kg (when consumed at home) as compared to fresh potatoes which has a footprint of 0.0003 gha/kg. This is because the production of beef and veal is more energy and resource intensive and requires larger areas of land. Thus, sustainable food consumption also becomes an important part of food ecology. The type of food and drink consumption pattern defines the food production resource utilization pattern in a community and marginal changes in diet patterns could significantly impact the ecological footprint and could make sustainable diet more achievable (Duchin, 2005; Leitzmann, 2005). Sustainable diet favouring ecological basis may be characterized by maintaining optimal nutritional supply on one side and maintaining lower ecological impact while producing per kilogram of food.

While discussing ecological footprint and ecological balance in food production and consumption ecosystem, it is also important to have an insight on ecological resilience. The concept of ecological resilience in the context of global change refers to stabilizing the ecosystem productivity by utilizing high plant diversity and through increasing resistance to climate extremes (Oliver et al. 2015; Isbell, 2015). In recent past, the extreme climate events
like heat waves, floods, droughts have adversely affected the food production and this may be addressed by enhancing the resilience of food production systems (i.e. maintaining production of sufficient and nutritious food) through diversification of agro-ecosystems (Reyer et al., 2015; Bullock et al., 2017). To achieve resilient food production systems, it would be required to merge the ecological and sociological approaches across multiple stakeholders from the farm to the global scale. This may start at farm gate with farmers making right choice of crop varieties in response to changing climatic conditions and diversification in livestock. At global scale, it would require coordinated implementation of adaptive strategies across farms, scientific and technical knowledge exchange to and among farmers (Weiner, 2017).

The studies on impacts of human nutrition on land use, nutrient balances and water consumption have shown that optimizing only one aspect of resources has potentially severe impacts on other resources. As the food supply is based on demand patterns, the changes in diet habits would impact resource consumption, resource footprints and ecological balance (Thaler et al., 2013).

Figure 1 presents an integrated flow chart of various entities (abiotic-biotic) and activities in a food system showing dynamic interactions which exist between the food production and consumption systems. These drivers also elaborate the concept of ecosystem services which link ecology and society. Ecosystem services can be defined as the processes of the ecosystem which benefit the human beings and can be broadly categorized as cultural, regulating and supporting services (Costanza et al., 1997; Bommarco et al., 2013). In our context food ecosystem services can include cultural services (modern, traditional and ethnic food systems), regulatory services (food safety, codex, SPS regulations, government policies) and supporting services (enabling infrastructure, technology, trained workforce).

![Figure 1: Integration of drivers in a food system](https://www.futureoffood.ox.ac.uk/what-food-system)
Challenges of the food ecosystem: The Indian perspective

The green revolution of 1960s has gradually transformed India from a food insecure country to a self-sufficient nation. In 2017-18, total food grain production was estimated at 275 million tonnes (MT). India is the largest producer (25% of global production), consumer (27% of world consumption) and importer (14%) of pulses in the world. India’s annual milk production was 165 MT (2017-18), making India the largest producer of milk and pulses, and has the world’s second-largest cattle population 190 million in 2012. It is the second-largest producer of rice, wheat, sugarcane and groundnuts, as well as the second-largest fruit and vegetable producer, accounting for 10.9% and 8.6% of the world fruit and vegetable production, respectively.

Despite the rapid development in agriculture sector, India continues to face multiple challenges. The economic progress has also led to a structural transformation wherein the economy has diversified to manufacturing (industry) and service sectors. Subsequently, agriculture’s contribution to Gross Domestic Product (GDP) has steadily declined from more than 50% in the 1950s to 17.1%.

The contrast in this development journey can be seen in the malnutrition indicators. India ranks 102 out of 117 countries on the Global Hunger Index. With a score of 30.3, India suffers from a level of hunger that is serious.

Land use for food and protection of biodiversity

Current practices of agricultural production are resource intensive, regionally biased and skewed towards carbohydrate-rich cereal crops such as rice and wheat. The increasing food production has led to an imbalance in soil nutrient levels, decline in water table and an overall depletion in the soil health. Soil health is considered good when it has at least 5 per cent organic matter. Unfortunately, the national average for organic matter in soil in India is 0.4 per cent.
Despite being one of the leading producers for many food grains and cash crops (figure 2), India struggles with agricultural productivity on account of many factors. A major proportion of land holdings are small or marginal which face problems with using advanced mechanization and irrigation facilities. Most of the small land holdings are fragments of larger land holdings which have been passed on within the family or leased to farmers by a large holder. In latter case, formal lease agreements are often missing thereby restricting the farmer’s access to formal credit, subsidies or crop insurance.

**Use of fertilizers and chemicals in farm operations**

Imbalanced application of different plant nutrients through fertilizers is a widespread problem in India. The major reasons are lack of adequate knowledge among farmers about the nutritional requirement of crops, poor access to proper guidelines on the right use of plant nutrients, inadequate policy support through government regulations, and distorted and poorly targeted subsidies.
According to the 29th Parliamentary Standing Committee Report, about 292 districts account for consumption of 85 per cent of all of the country’s fertilisers. Besides, there are discrepancies in the use of fertilisers on the basis of chemical ratios. The current consumption ratio of nitrogen, phosphorus and potassium (NPK) is 6.7:2.4:1 against their desirable ratio of 4:2:1.

As noted by the Economic Survey of India (2015-16), use of pesticides without following proper guidelines, use of sub-standard pesticides and lack of awareness about pesticide use have led to an increase in pesticide residues in food products in India.

**Water for irrigation**

India is facing a major challenge on the water front. Its per capita water availability of 1544 cubic meters per year, as reported in 2011, has already fallen below the cut-off point of 1700 cubic meters, placing it among the water stressed nations of the planet. Of the total 140 million hectares of net sown area, only 48.8 per cent is under irrigation and rest is rain fed. Of the net irrigated area of 68.38 million hectares, about 60 per cent is irrigated through groundwater.

Estimates suggest that in the next three decades, the global food systems will need 40-50 per cent more freshwater than today. Municipal and industrial demand for water will increase by 50-70 per cent during this period, while demand for energy sector will increase by 85 per cent. Irrigation sector with almost 78 per cent share dominates the present and future water use scenario in India.

In addition to land and labour productivity, the concept of ‘water productivity’ has therefore become prominent in the recent times with the aim of ‘more crop per drop’. Various initiatives including crop diversification, rain-water harvesting, alternate cropping patterns, micro-irrigation, hydroponics and related technologies, knowledge and practices amongst farmers, subsidies etc. are under-way to address water productivity.

**Food loss and wastage**

After agricultural produce is harvested, it requires a robust storage infrastructure in order to minimise any losses due to adverse weather conditions or in the process of transportation. Food loss is understood to occur when the food produced for human consumption is discarded or suffers a reduction in quantity or is diverted for non-food purpose. The primary cause is lack of adequate handling, storage facilities and failure to connect produce to markets in a timely manner. Food waste, on the other hand, is understood as the waste that occurs in the hands of consumers, conscious or unconscious due to habitual excesses or other rejection factors.

Central Institute of Post-Harvest Engineering and Technology (CIPHET), Ludhiana an ICAR (Indian Council of Agricultural Research) Institute conducted a study on “Assessment of Quantitative Harvest and Post-Harvest Losses of Major Crops and Commodities in India” and submitted its final report in March 2015. The study estimated that annual value of harvest and post-harvest losses of major agricultural produces at
national level was of the order of Rs. 92,651 crores calculated using production data of 2012-13 at 2014 wholesale prices.

In order to arrest post-harvest losses of horticulture and non-horticulture produce and to provide integrated cold chain and preservation infrastructure facilities from the farm gate to the consumer or from the production site to the market, Ministry of Food Processing Industries (MoFPI) has been implementing the Central Sector Scheme of Cold Chain, Value Addition and Preservation Infrastructure since 2008-09.

It is estimated that saving one-fourth of the food currently lost or wasted globally would be enough to feed hungry people in the world, of which the highest number (about 194.6 million) are in India. An eye-opening revelation had been made by a report cited in CSR journal. It says, “Indians waste as much food as the whole of United Kingdom consumes”. It is worth mentioning that food that is lost and wasted, converts into greenhouse gases and has a direct impact on global warming, besides resulting in loss of water and other resources used during cultivation. Already the fourth largest economy, India is the world’s third largest greenhouse-gas-emitter.

Addressing food loss therefore can make significant contribution to addressing hunger as well as environmental sustainability.

Potential solutions

So, what are the potential solutions to the challenges which have been discussed in the above section? There are several lessons to learn from nations around the globe which can be applied in the local context. Let us examine some of these:

Nutritious food and healthier food choices

Nutritious food and healthier food choices are at the apex of food and land use reforms. Consumption patterns of 1.3 billion Indians and more than 9 billion people globally are critical factors which shape how food and land use evolves over a period of time. A significant body of evidence has emerged on environmental impacts of various diets, with many studies concluding that a plant-based diet with few animal source foods confers both improved health and environmental benefits.

Food and Agriculture Organization (FAO) defines ‘sustainable diets are those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources’.
As per figure 3, meat seems to be a low contributor to global food wastage in terms of volumes (less than 5% of total food wastage), however, it has a significant impact on climate change with more than 20% contribution towards carbon footprint. This is due to the methane emissions by ruminants, emissions related to animal feed production as well as emissions from manure management. All these emissions get added up to produce a kilogram of meat.

In order to achieve human and planetary health, our diets should balance the positive elements with the negative. Protective foods such as fruits, vegetables, whole grains, legumes and nuts should be included in daily meals. Whole grains should be preferred over refined. Unhealthy foods such as salt, sugar, saturated fats should be consumed with restriction. Red meat consumption should be in moderation.

In the above context, alternative proteins that can act as substitutes for traditional animal-based food are attracting considerable financial investment, research attention and interest in the media as a pathway to meeting the nutritional needs and food demands of a predicted mid-century population of 10 billion, in a healthy and sustainable manner.
Promoting sustainable and regenerative agricultural practices

Agriculture priorities need to be reoriented to not only produce sufficient calories to feed a growing population but also to encourage dietary diversification that nurtures human health and supports environmental sustainability. Wheat and Paddy (Rice) will face challenges as temperatures gradually increase on account of climate change. Climate resilient or climate ‘smart’ crops such as pulses and millets offer a potential solution while also adding more nutrition to the food basket of a household.

A significant reduction in yield gaps from current croplands is the need of the hour. Crop and water productivity should be dealt with in tandem. Cropping patterns should be realigned with water endowments of that state/geography. Judicious water use in agriculture may also be promoted by rationing irrigation water supplies. Farmers cultivating water guzzler crops like paddy and sugarcane can purchase extra requirement of water from farmers cultivating less water intensive crops.

Traditional techniques such as crop rotation, controlled livestock grazing etc. should be encouraged alongside new advanced practices of bio-based fertilizers and pesticides. Zero tillage, raised bed planting, direct seeded rice, crop residue management and cropping diversification (horticulture, bee keeping, mushroom cultivation, etc) seed/fodder banks, ICT-based weather advisories and knowledge sharing are also critical factors while moving towards sustainable production.

Farmers continuously experiment to get better results and are a powerhouse of knowledge. This wealth of knowledge and best practices should be consolidated and made available to all the farmers across the country via an easy-to-understand and convenient platform. This is of particular interest to small and marginal farmers who need improved extension services and could benefit from examples from other states.

| Uzhavan app, Ag mobile, CCMobile app, IFFCO Kisan are some of the applications developed keeping in mind the need of the hour requirements in farming. Several notable initiatives like e-choupal, Agri market, Kisan Suvidha and the more recent e-NAM had long been trying to place agriculture as the forerunner. |

In a bid to tackle malnutrition, the government is working on a POSHAN (Partnerships and Opportunities to Strengthen and Harmonize Actions for Nutrition) atlas that will map the crops and food grains grown in different regions of the country because the solution to tackling malnutrition lies in promoting regional cropping patterns and embracing local food rich in protein and micronutrients.

Protecting and restoring forests and other natural ecosystems

Protecting and restoring global forests could reduce annual net greenhouse gas emissions by more than eight gigatons carbon dioxide equivalent (GtCO2 e) by 2050, which is consistent with limiting global heating to 1.5-degrees Celsius.

India is ranked 10th in the world, with 24.4% of land area under forest and tree cover, even
though it accounts for 2.4% of the world surface area and sustains the needs of 17% of human and 18% livestock population.

Strong and coordinated governance of land and oceans implies feeding humanity on existing agricultural lands. Between protecting nature and expanding agriculture, there is a real trade-off. However, a zero-expansion policy is imperative so as to avoid encroachment of new agricultural lands into natural ecosystems such as forests. A ‘Half-earth’ strategy is therefore recommended for biodiversity conservation i.e. conserve at least 80% of biodiversity by protecting 50% of Earth as intact ecosystems.

This approach also lends itself to management of oceans to ensure fisheries and aquaculture do not negatively impact ecosystems. The ocean could sustainably supply 80 to 90 million metric tonnes of seafood protein a year (versus around 50 to 60 million tonnes unsustainably sourced today), reducing demand for land to supply protein and improving human health at the same time.

India contributes to about 6.3 per cent of the global fish production. However, as one of the sustainable development goals is to aim for a better aquatic balance, India has a long way to go to become a country which uses 100 per cent sustainable fishing practices. The onus is not only on the supply side, but also demand, where the consumers too should be accountable for the fish they purchase and know how it is sourced.

**Investing in a more diversified protein supply**

Over the years, India has seen a steady increase in meat consumption. This trend has obvious repercussions with respect to greenhouse gas emissions, carbon footprint and ecosystem preservation as discussed earlier.

Recently alternate protein sources have emerged such as plant-based proteins, lab-cultured meat, insects and aquatic based proteins which have the potential to provide consumers with sustainable, reliable, healthier and ethical (in some cases) protein sources.

India has a wealth of natural biodiversity and several indigenous crops like millets, pulses happen to be ideal ingredients for plant-based proteins. Industrial animal agriculture contributes significantly to climate change, pollutes our air and water and uses a tremendous amount of land, water and other precious natural resources. For instance, raising chickens releases 40 times more carbon dioxide per calorie of protein than lentils. About 70% of India’s antibiotics are given to farm animals. The World Health Organisation has said that antibiotic resistance is one of the biggest threats to global health, food security, and development today. Animal protein supply is often threatened by zoonotic diseases and could also pose public health challenges on account of the same.

It will, however, be important to develop suitable regulatory frameworks for some of the novel products such as lab-cultured meats or insect proteins. Collaboration with scientific experts, research and development institutions and other stakeholders would be crucial to support innovation and at the same time ensure public health, safety and appropriate labelling for such products.

Animal protein will continue to play an important role: certain vulnerable groups, such as women of childbearing age and young children in low-income countries will indeed need to
increase their animal protein consumption to improve their health. More sustainable production of meat, dairy and eggs is therefore also essential.

Reducing food loss and waste

Substantial reduction in food losses (supply side) and food waste (consumption level) is essential for the global food system to ensure planetary health. Tangible steps in this direction could include improvement in post-harvest infrastructure, improved food transport, packaging and processing, increased collaboration across the supply chain, training and education of all stakeholders across the value chain.

United Nations Sustainable Development Goal 12 (SDG 12) on “Ensuring sustainable consumption and production patterns” includes a specific food waste reduction target: “by 2030, to halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses”.

Preventive solutions at upstream level include resource efficient and regenerative agricultural practices, access to low-cost handling and storage facilities. Post-harvest solutions at intermediate level include increased processing of perishables (e.g. food parks), active and intelligent packaging solutions and use of technology to trace and communicate balance shelf life. Recovery solutions at downstream level include surplus food recovery through food banks, redistribution of close to shelf-life but safe food items through social supermarkets at discounted prices.

Building Food smart cities, digitization and stronger rural livelihoods

Innovative high-tech horticulture e.g. hydroponics, vertical farming and low-tech circular economy models e.g. composting of organic matter are experiencing a rise in the urban and peri-urban areas. There are many advantages to urban farming. The land requirement is quite low, water consumption is 80 percent less, the water is recycled and saved, it is pesticide-free and in cases of high-tech farms there is no real dependency on the weather.

Other ways to strengthen local food economies is to have better urban planning, public procurement and new digital platforms to efficiently connect producers with consumers. Technologies such as automation, decision support system and agriculture robots are being widely adopted in the sector globally. Farmers are using the Internet of Things and smart sensors to get access to valuable information like soil moisture, nutrient levels, temperature of produce in storage and status of farming equipment. The sector is also ripe for the use of big data analytics and artificial intelligence, technologies that have been deployed successfully in various sectors across the globe.
Agriculture employs more than half of the total workforce of the country. The share of population depending on agriculture for its livelihood consists of landowners, tenant farmers who cultivate a piece of land, and agricultural labourers who are employed on these farms. In India, as cities have grown in size and economic opportunities have increased in allied sectors, a gradual rural to urban migration has occurred in response.

Meanwhile, there is a major challenge in attracting young entrepreneurs to rural areas and keeping them there, whether for farming (increasingly knowledge-based and digital agriculture), for other nature-based activities (such as natural forest protection and restoration) or for non-agricultural businesses.

The gap between rural and urban incomes are growing and this warrants serious efforts. Key actions identified to enable an equitable transition include investment in rural infrastructure and value addition, training and capacity building, supporting the rights of women and indigenous communities.

Women can be powerful ‘change agents’ thanks to their central role in agriculture and decision making related to nutrition, health and family-planning. Promotion of gender equality should be executed in such a way to improve access of women to land, labour, water, credit and other resources.

Demographic transition is typically used to explain how population growth and economic development of a country are connected while it goes through a change from non-industrial to industrial. A salient feature of this transition is switch from a regime of high birth rates-mortality rates to low birth rates-mortality rates.

As India undergoes demographic transition, it is important to invest in education for girls and women, maternal and child health and auxiliary health systems. Life expectancy in India has undergone a significant change from 49.7 yrs (1970-75) to 69 (2013-17). Sustaining quality of life therefore becomes paramount. Unchecked urbanization and migration might become a barrier for last mile connectivity of health services. In such circumstances, women are often the first to get affected. Therefore, a gender equality lens must be applied to address demographic transition as well.
Summary

- Sustainability requires direct action to conserve, protect and enhance natural resources. It's time that we all should start looking at the choices we make and understand how the food we eat can impact our climate.

- The avoidance of the depletion of natural resources in order to maintain an ecological balance is termed as Sustainability.

- Typically, environment, economy and society form the three-pillars of sustainability. A sustainable food ecosystem would cater to all safe and wholesome food without impacting the society, economy and environment.

- The sustainability challenges in food ecosystem are lack of adequate advanced mechanisation and irrigation facilities, imbalanced application of different plant nutrients through fertilizers, resource intensive agricultural practices, lack of adequate handling and storage facilities for produce leading to food loss which ultimately converts into greenhouse gases and has a direct impact on global warming and thus affecting environment.

- Agricultural system can be made sustainable and regenerative by encouraging traditional techniques such as crop rotation, controlled livestock grazing etc., use of new advanced practices of bio-based fertilizers and pesticides and by sharing knowledge and best practices among farmers.

- A plant-based diet with few animal source foods confers both improved health and environmental benefits since meat has a significant impact on climate change with more than 20% contribution towards carbon footprint.

- Eating foods that are grown locally improves the economy in our community and also helps in maintaining sustainable ecosystem.

- More sustainable production of meat, dairy and eggs could be achieved by investing in a more diversified protein supply.

- Environment could be saved by protecting and restoring global forests. A ‘Half-earth’ strategy is recommended for biodiversity conservation i.e. conserve at least 80% of biodiversity by protecting 50% of Earth as intact ecosystems.

- Substantial reduction in food losses (supply side) and food waste (consumption level) is also essential for the global food system to ensure planetary health. Tangible steps in this direction could include improvement in post-harvest infrastructure, improved food transport, packaging & processing, increased collaboration across the supply chain, training and education of all stakeholders across the value chain

- Investment in rural infrastructure and value addition, digitization, training and capacity building, supporting the rights of women and indigenous communities would help delivering stronger rural livelihoods.
Key Words

**Artificial intelligence** – computer systems which can handle tasks normally requiring human intelligence

**Biodiversity** – the variety of plant and animal life in a habitat

**Carbon footprint** - the amount of carbon dioxide released into the atmosphere as a result of an activity

**Cold chain** – a temperature-controlled supply chain

**Data analytics** – science of analysing raw data to make conclusions about information

**Ecosystem** – refers to the living and physical components of an area and how they are linked to each other

**Global warming** - a gradual increase in the overall temperature of the earth's atmosphere

**Greenhouse gases** - a gas that contributes to the greenhouse effect by absorbing infrared radiation. Carbon dioxide and chlorofluorocarbons are examples of greenhouse gases.

Exercises

1. Briefly explain the need for sustainability of food ecosystems.
2. Discuss the challenges faced and possible solutions for the following:
   i. Chemicals used in agriculture
   ii. Water for irrigation
3. What can be done to reduce food loss and waste in the country?
4. Why is it better to eat plant-based, local and seasonal food?
5. Write a short note on sustainable agricultural practices.
6. How can the protein supply be diversified? Discuss giving relevant examples.
7. How can rural livelihoods be protected? Why is it important to do so?

References


Chapter 19: Approaches to a Sustainable Food System

- Reducing Food Loss and Waste
  - Occurrence of food losses and waste in Food Supply Chain
  - Trends in food loss and waste
  - Strategies to reduce food loss and waste

- Sustainable and Safer Packaging
  - Need and different types of packaging
  - Problems with different packaging materials
  - Recent safe and sustainable packaging technologies

- Reducing Water Usage in Food System
  - Importance of reducing water usage
  - Ways for minimizing water use in food industries

- Sustainable Food systems
  - Rural and urban food system
  - Inadequacies of Rural and Urban Food System:
  - Approaches for making healthy and sustainable urban food system
Chapter 19: Approaches to a Sustainable Food System

With the world’s population predicted to pass nine billion by 2050, the additional food required to feed future generations will put enormous pressure on our land and water resources. Today the world is facing a complex challenge; population growth, urbanization and rapidly developing economies are driving consumer demand for food. An expanding middle class leads to more people choosing western-style diets. These diets are high in protein, sugar and fat, all of which are expensive in terms of water for food production. At the same time there are more than two billion people living on less than US$2 per day. It is also estimated that 33% of the total food produced is lost and wasted every year (Gustavsson et al., 2011). So, there is an urgent need for switching towards sustainable food system which not only ensure the judicious use of the resources for the production of food but also ensure food for all. Keeping all these in view, this chapter aims to provide an overview to the students about the importance of reducing food loss and waste, safer and sustainable packaging, reduced water use in food processing and healthy and sustainable urban food system.

Reducing Food Loss and Waste

The Food and Agricultural Organization (FAO) reported that approximately one-third of all produced foods (1.3 billion tons of edible food) for human consumption is lost and wasted every year across the entire supply chain. The monetary value of this amount of Food Loss Waste (FLW) is estimated at about USD $936 billion, which does not include the social and environmental costs of the wastage that are paid by society as a whole. The amount of FLW is sufficient to alleviate one-eighth of the world’s population from undernourishment and address the global challenge to satisfy the increased food demand, which could reach about 150–170% of current demand by 2050 (FAO, 2018). Food loss and waste have many negative economic and environmental impacts. Economically, they represent a wasted investment that can reduce farmers’ incomes and increase consumers’ expenses. Environmentally, food loss and waste inflict a host of impacts, including unnecessary greenhouse gas emissions and inefficiently used water and land, which in turn can lead to diminished natural ecosystems and the services they provide.

According to FAO “Food loss and waste” refers to the edible parts of plants and animals that are produced or harvested for human consumption but that are not ultimately consumed by people. In particular, “Food Loss” refers to food that spills, spoils, incurs an abnormal reduction in quality such as bruising or wilting, or otherwise gets lost before it reaches the consumer. Food loss is the unintended result of an agricultural process or technical limitation in storage, infrastructure, packaging, or marketing.

“Food waste” refers to food that is of good quality and fit for human consumption but that does not get consumed because it is discarded either before or after it spoils. Food waste typically, but not exclusively, occurs at the retail and consumption stages in the food value chain and is the result of negligence or a conscious decision to throw food away.
Occurrence of Food losses and waste in Food Supply Chain

Food loss and waste apply to food products in the value chain starting from the moment that:

- Crops are ripe in the field, plantation, or orchard
- Animals are on the farm in the field, sty, pen, shed, or ready for slaughter
- Milk has been drawn from the udder
- Aquaculture fish are mature in the pond
- Wild fish have been caught in the net.

The value chain ends at the moment food products are consumed by people, discarded, or otherwise removed from the food chain intended for direct human consumption. Therefore, food that was originally meant for human consumption but is removed from the food chain is considered food loss or waste, even if it is then used as animal feed or bioenergy.

Food loss and waste can occur at each stage of the food value chain (figure 1). These stages are as follow:

Figure 19.1: Schematic representation of Food Loss and Waste at different stages of food chain.
Some examples of how they can occur at each stage are:

- During production or harvest in the form of grain left behind by poor harvesting equipment, discarded fish, and fruit not harvested or discarded because they fail to meet quality standards or are uneconomical to harvest.
- During handling and storage in the form of food degraded by pests, fungus, and disease.
- During processing and packaging in the form of spilled milk, damaged fish, and fruit unsuitable for processing. Processed foods may be lost or wasted because of poor order forecasting and inefficient factory processes.
- During distribution and marketing in the form of edible food discarded because it is non-compliant with aesthetic quality standards or is not sold before “best before” and “use-by” dates.
- During consumption in the form of food purchased by consumers, restaurants, and caterers but not eaten

**Trends in food loss and waste**

In less-developed countries like India, FLW occurs mainly in the post-harvest and processing stage, which accounts for approximately 44% of global FLW. This is caused by poor practices, technical and technological limitations, labour and financial restrictions, and lack of proper infrastructure for transportation and storage. The developed countries, including European, North American, and Oceanian countries, and the industrialized nations of Japan, South Korea, and China produce 56% of the world FLW as shown in below table. Of this, 40% of FLW in developed countries occurs in the consumption stage, which is driven mostly by consumer behaviour, values, and attitudes. A large portion of the food waste occurs after preparation, cooking, or serving, as well as from not consuming before the expiration date as a result of over-shopping, which might be associated with poor planning and bulk purchasing. Table 1 compares the food loss and waste in developing and developed countries.
Table 19: Comparison of Food Loss and Waste in Developing vs. Developed Countries

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Food Supply Chain</th>
<th>Developing country</th>
<th>Developed country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Loss (%)</td>
<td>Production</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Handling and Storage</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Processing and Packaging</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Food Waste (%)</td>
<td>Distribution and market</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Consumption</td>
<td>6</td>
<td>29</td>
</tr>
<tr>
<td>Total Food Loss and Waste (%)</td>
<td></td>
<td>44</td>
<td>56</td>
</tr>
</tbody>
</table>

Source: WRI analysis based on FAO. (Gustavsson et al., 2011). Global food losses and food waste—extent, causes and prevention. Rome: UN FAO.

India achieved a record food grain and horticultural production of 281 and 315 million metric tonnes (MMT), respectively in 2018-19. In addition, India produces large quantities of pulses, oilseeds, sugarcane, milk, poultry, meat and fish. According to the FAO estimates, nearly 40% of the food produced in India is lost or wasted. Food Loss and Waste (FLW) is not confined to India alone, as the FAO studies have shown that yearly global FLW is nearly 30% of cereals, 40 to 50% of horticultural crops, 20% of oilseeds, meat and dairy products, and 35% of fish (NAAS, 2019).

Other sources, such as the Food Corporation of India, report a share of losses ranging from 10 to 15 percent of the total production. The Ministry of Food Processing Industries (MFPI) estimate losses of 23 million tons of grains, 12 million tons of fruits and 21 million tons of vegetables for a total approximate value of about 4.4 billion USD while total value of food loss and waste generated is supposedly 10.6 billion USD in 2014 (Segre et al., 2014). Table 2 presents the food losses in India in the different sectors.
Table 19. 2: Food Losses in India in different food sectors

<table>
<thead>
<tr>
<th>Food Commodity</th>
<th>Losses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grains (Cereals)</td>
<td>4.6-6</td>
</tr>
<tr>
<td>Fruits and Vegetables</td>
<td>4.6-15.9</td>
</tr>
<tr>
<td>Dairy</td>
<td>0.9</td>
</tr>
<tr>
<td>Meat</td>
<td>2.7</td>
</tr>
<tr>
<td>Fish</td>
<td>5.2 (Inland)</td>
</tr>
<tr>
<td></td>
<td>10.5 (Marine)</td>
</tr>
<tr>
<td>Poultry</td>
<td>7.2 (Egg)</td>
</tr>
<tr>
<td></td>
<td>6.7 (Poultry meat)</td>
</tr>
</tbody>
</table>

Annual losses in percentage of agricultural produce, milk, meat, marine and poultry products as reported by ICAR-Central Institute of Post-Harvest Engineering and Technology (CIPHET) study conducted in 2014

Strategies to Reduce Food Loss and Waste

Strategies to reduce the Food Loss and Waste depend upon integrated efforts for providing adequate infrastructure, technical support and creating public awareness for the critical loss points along the food chain from harvest to consumption. These include, harvesting/field drying, threshing/shelling, winnowing, farm storage, packaging, cold chain, transportation to market, market storage, avoiding wastage at the retailer and checking wastage in consumption. Possible strategies to prevent the Food Loss Waste at different stages in food chain are summarized in table 3.

Table 19. 3: Food Loss and Waste at Different Stages in the Food Chain

<table>
<thead>
<tr>
<th>Stage</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Stage</td>
<td>• Government investments in infrastructure</td>
</tr>
<tr>
<td></td>
<td>• Improve harvesting techniques</td>
</tr>
<tr>
<td></td>
<td>• Improve market access</td>
</tr>
<tr>
<td></td>
<td>• Organize extension services and educate farmers</td>
</tr>
<tr>
<td></td>
<td>• Increase tax incentives for donating unsellable edible foods.</td>
</tr>
<tr>
<td>Handling and Storage Stage</td>
<td>• Improve transportation facilities</td>
</tr>
<tr>
<td></td>
<td>• Provide access to cheap handling and storage technologies</td>
</tr>
<tr>
<td></td>
<td>• Invest in storage facilities (warehouses, cold storage, etc.)</td>
</tr>
<tr>
<td></td>
<td>• Improve the ability and knowledge of workers to employ safe food handling practice</td>
</tr>
<tr>
<td></td>
<td>• Use of appropriate and clean containers for the products.</td>
</tr>
<tr>
<td>Processing and Packaging Stage</td>
<td>• Improve capacity of process line</td>
</tr>
<tr>
<td></td>
<td>• Improve packaging to keep food fresher for longer</td>
</tr>
<tr>
<td>Stage</td>
<td>Strategy</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>• Standardize date labels to prevent consumer confusion</td>
</tr>
<tr>
<td></td>
<td>• Establish other ways to use peels and trimmings</td>
</tr>
<tr>
<td></td>
<td>• Improve the knowledge and ability of workers</td>
</tr>
<tr>
<td></td>
<td>• Facilitate sanitary and cleaning inspections.</td>
</tr>
<tr>
<td>Distribution and</td>
<td>• Improve inventory systems</td>
</tr>
<tr>
<td>Marketing Stage</td>
<td>• Establish online marketplaces to facilitate sale (donation) of</td>
</tr>
<tr>
<td></td>
<td>perishable products</td>
</tr>
<tr>
<td></td>
<td>• Change food date labeling practices and in-store</td>
</tr>
<tr>
<td></td>
<td>promotions Improve institutions related to this stage</td>
</tr>
<tr>
<td></td>
<td>• Improve transportation vehicles</td>
</tr>
<tr>
<td></td>
<td>• Provide guidance on storage and preparation of food to</td>
</tr>
<tr>
<td></td>
<td>consumers</td>
</tr>
<tr>
<td></td>
<td>• Improve the knowledge and ability of workers</td>
</tr>
<tr>
<td></td>
<td>• Improve market places (storage, covered areas)</td>
</tr>
<tr>
<td></td>
<td>• Interlink with research institutions to predict consumer</td>
</tr>
<tr>
<td></td>
<td>demand changes.</td>
</tr>
<tr>
<td>Consumption Stage</td>
<td>• Facilitate increased donation of unsold foods from</td>
</tr>
<tr>
<td></td>
<td>cafeterias and restaurants</td>
</tr>
<tr>
<td></td>
<td>• Implement consumer education and campaigns, both</td>
</tr>
<tr>
<td></td>
<td>nationally and regionally</td>
</tr>
<tr>
<td></td>
<td>• Reduce portion sizes Provide education about home</td>
</tr>
<tr>
<td></td>
<td>economics in education institutions and communities</td>
</tr>
<tr>
<td></td>
<td>• Involve women in food safe campaigns</td>
</tr>
<tr>
<td></td>
<td>• Effective use of leftovers Training for restaurant, cafeteria,</td>
</tr>
<tr>
<td></td>
<td>and supermarket management to forecast customer</td>
</tr>
<tr>
<td></td>
<td>demand and reflect demand in food purchasing to avoid</td>
</tr>
<tr>
<td></td>
<td>bulk purchases</td>
</tr>
<tr>
<td></td>
<td>• Implement good storage practices</td>
</tr>
<tr>
<td></td>
<td>• Correctly interpret label dates; Distribution of excess food</td>
</tr>
<tr>
<td></td>
<td>to charitable groups</td>
</tr>
</tbody>
</table>

**Sustainable and Safer Packaging**

Packaging is the science, art and technology of enclosing or protecting products for distribution, storage, sale and use. Packaging also refers to the process of design, evaluation, and production of packages. Packaging of foods is perhaps one of the most challenging industrial activities, since safety of the foods we eat is dependent upon it. Packaging is heavily integrated into our daily lives, we see it all around us, on everyday items such as chocolate bars and potato chip (crisp) packets. As explained below, the main use for packaging is protection of the goods inside, but packaging also provides us with a
recognizable logo and information, so that we instantly know what goods are inside.

Packaging can be defined as a tool that protects and contains our goods with the aim of minimizing the environmental impact of our consumption. Ideal packaging can be compared with that of a banana, orange peel, coconut and eggshell - the packaging provided by Mother Nature.

**Need and different types of packaging**

Packaging is an important tool for making a product wholesome and safe for the consumption. Packaging is a form of food preservation which not only protects the product from the external factors - air, moisture etc. but also helps in creating a perception of a product quality to the consumers. So packaging is important as it helps in maintaining the freshness and nutrition of the product (figure 2).

![Diagram showing the need for packaging](image)

**Figure 19.2: Schematic diagram showing the need of packaging.**

There are different types of packaging:

**Individual packaging:** This means the packaging of individual items of goods and includes the technique of application of appropriate materials and containers, etc. to protect each individual item of goods, or to increase the merchandise value as well as the conditions of the goods to which those techniques are applied. This could also be called as ‘Primary Packaging’.
**Inner packaging**: This means the inner packaging of packaged goods, the techniques of application of the appropriate materials or container, etc., with consideration of the protection of goods against water vapour, light, heat, impact, etc. as well as the condition of the goods to which these techniques have been applied. This could also be called as ‘Secondary Packaging’.

**External packaging**: This indicates the outer packaging of packed goods, in other words, the techniques of placing the goods in a box, bag or other container such as a barrel or can, etc., or bundling without the use of a container, and adding markings to identify the goods as cargo; as well as the conditions of application of these procedures. This could also be called as ‘Tertiary Packaging’. In case of food packaging, the word ‘goods’ can be substituted by ‘food’.

**Status of Packaging Industry in India**

The packaging industry in India is very dynamic and influences all other industries directly or indirectly. The packaging industry, which stood at $32 billion in 2015, had grown at a compound annualized growth rate (CAGR) of 15 percent for the last five years, and is expected to continue growing at a CAGR of 13 to 15 percent in the coming years. According to the Packaging Industry Association of India, the Indian packaging industry was the fifth largest in the world in 2016.

The Indian packaging industry constitutes about 4 percent of the global packaging industry. The industry is underpenetrated, and thus offers significant business opportunities, since India's per capita packaging consumption is only 10.5 kg per year, as compared to 109 kg in the U.S., 65 kg in Europe, 45 kg in China and 32 kg in Brazil.

Different kinds of packaging material are depicted in figure 3.

**Figure 19. 3: Different kinds of packaging materials**
Problems with different packaging materials

Out of all types of packaging material plastic is widely used for packaging of food. It is estimated that worldwide production of plastics was approximately 322 million tons in 2015 which is a 3.5% increase as compared to 2014. In 2014–15, India produced 8.3 million tons of plastics and about 43% of annually produced synthetic polymers are utilized by packaging industry, which is more than the world average of 39%. According to statistics at present, about 99% of all plastic materials are manufactured by the petrochemical industries, i.e., they are produced from petroleum based (non-renewable) resources. Production and processing of plastics are energy exhaustive processes; those lead to increased emissions of greenhouse gases (GHGs) of enormous magnitude contributing to global warming. Moreover, plastics on burning release venomous emissions such as carbon monoxide, chlorine, hydrochloric acid, dioxin, furans, amines, nitrides, styrene, benzene, 1, 3-butadiene, and acetaldehyde which pose threat to environment as well as to public health. Apart from degrading air quality, plastics generate lots of waste after use that has adverse effects on environment (leaching of chemical in aquifers, soil pollution). Waste generated from the plastics has been a pressing problem for many years because of their resistance to degradation (Yadav et al., 2018).

This marine and soil litter of plastic first degrades into micro and then into nano-sized particles that could thus easily penetrate into living organisms such as fish and then be fed up the food chain, all the way to humans with dramatic deleterious long-term adverse effects. Researchers have estimated that if production and use continue within the current linear framework, and if nothing is done by 2050 there may be more plastic than fish in the ocean, by weight (World Economic Forum, 2016).

To tackle issues related to oil-based packaging, a lot of attention has been paid to raw materials to replace non-renewable oil resources. However, currently marketed bio-sourced bioplastic (such as Bio-PE, PLA, and more) use food resources such as corn or cane sugar. They contribute to increased food security concerns and pressure on agricultural land. Moreover, most of these bio-sourced bio-plastics are not biodegradable nor home-compostable (bio-PE, bio-PET) or are fit only for industrial composting (PLA) which contributes to complicating the waste management: separate collecting and sorting of these materials are thus needed (Endah, 2018).

Therefore, there is an urgent need of an innovative safer and sustainable packaging which aims to address food waste and loss reduction by preserving food quality, as well as food safety issues by preventing food-borne diseases and food chemical contamination. Moreover, it must address the long-term crucial issue of environmentally persistent plastic waste accumulation as well as the saving of oil and food material resources.

Recent safe and sustainable packaging technologies

Sustainable packaging is packaging which:

1. Is beneficial, safe and healthy for individuals and communities throughout its life cycle;
2. Meets market criteria for performance and cost;
3. Is sourced, manufactured, transported, and recycled using renewable energy;
4. Maximizes the use of renewable or recycled source materials;
5. Is manufactured using clean production technologies and best practices;
6. Is made from materials healthy in all probable end-of-life scenarios;
7. Is physically designed to optimize materials and energy; and
8. Is effectively recovered and utilized in biological and/or industrial cradle-to-cradle cycles.

Principle of sustainable Packaging

The Australian-based SPA has developed four principles for sustainable packaging (SPA, 2005):

1. **Effective: social and economic benefit.** The packaging system adds real value to society by effectively containing and protecting products as they move through the supply chain and by supporting informed and responsible consumption.

2. **Efficient: doing more with less.** The packaging system is designed to use materials and energy efficiently throughout the product life cycle. Efficiency can be defined through reference to world’s best practice at each stage of the packaging life cycle.

3. **Cyclic: optimising recovery.** Packaging materials used in the system are cycled continuously through natural or industrial systems, with minimal material degradation. Recovery rates should be optimised to ensure that they achieve energy and greenhouse gas savings.

4. **Safe: non-polluting and non-toxic.** Packaging components used in the system, including materials, finishes, inks, pigments and other additives, do not pose any risks to humans or ecosystems. When in doubt the precautionary principle applies.

Figure 4 outlines the principles of sustainable packaging.
Some recent safer and sustainable packaging technologies are:

**Bio-degradable Plastic:** Biopolymers or bioplastics are intrinsically biodegradable and their use would reduce the damage inflicted to the environment by petrochemical plastics due to their extended lifetime in the environment. They are polymers utilized by bacteria as carbon and energy reserve material and accumulated by them when other essential nutrients are depleted from the medium. Plant derived starches has been used to produce biodegradable plastic articles viz. pharmaceutical capsule by blow molding process. Further sources of biodegradable materials are poly lactic acid, poly malic acid, or poly (ɛ-caprolactones), which are synthesized chemically. In contrast, poly B-hydroxy alkanoates (PHAs) are produced microbially from renewable, plant-derived feedstock. It can be processed by traditional techniques used in the plastic industry viz. injection moulding, PHA has the potential to become an important source material for biodegradable plastics. It has been estimated that in the year 2002 only 3% of the estimated annual 15 million tonnes of plastic-packaging waste were biodegradable.

Sources of biodegradable plastic are:

- Biopol polymers: produced by fermentation of carbohydrate by the bacterium *Alcaligenes eutrophus*.
- Poly (L-lactide): derived directly or indirectly from starch or sucrose.
- Starch based materials: incorporation of starch into traditional plastics.
- Cellulose-based: microbial cellulose is mixed with chitin, chitosan, CM-cellulose guar gum, collagen, dextran and gelatin.
- Pectin-based: Reaction of pectin with polyol like glycerol, sorbitol propylene glycol and ethylene glycol.
- Pullulan: Microbial polysaccharide is synthesized by the fungus *Aureobasidium pullulans*.
- Poly hydroxyalkanoate (PHA): bacterial polyesters.

**Edible Packaging:** Edible films and coatings are based on proteins, polysaccharides and/or lipids have much potential for increasing food quality and reducing food-packaging requirements. Edible films formed as coating or placed between food components provide possibilities for improving the quality of heterogeneous foods by limiting the migration of moisture, lipids, flavour/aromas, and colours between food components. Edible coatings also have the potential for maintaining the quality of foods even after the packaging is opened. In addition, edible films formed as coatings on foods could have an impact on overall packaging requirements. Edible coatings also have the potential for carrying food ingredients and improving the mechanical integrity or handling characteristics of the food.

Materials for Edible Films are shown in figure 5.

![Figure 19. 5: Materials for making Edible films](image)

**Requirements of Edible Films and Coatings**

These edible films and coatings should:

- prevent product dehydration.
- control transmission of gases, vapour and solutes.
- provide mechanical protection to foods.
- restrict microbial invasion.
- have good mechanical properties.
• serve as a carrier for additives, viz. antioxidants, antimicrobial agents, flavours, colouring, nutrients, etc.

• conform in composition to the regulations those apply to the food product concerned.

Reducing Water Usage in Food System

We often consider the carbon footprint of our food, but most of us don’t consider the water footprint. Water scarcity is increasing; in a climate-changed world, water stress is becoming more widespread. Rainfall and water availability are likely to become more uncertain, with significant consequences for food production.

Importance of reducing water usage

Food production is reliant on water, with an estimated 70% of all extracted freshwater used for agriculture alone. A further 20% is used in the production and processing industries, leaving just 10% for domestic use e.g. drinking water (IChemE).

An estimated 97% of water is stored in our oceans as saltwater; just 3% of all water on earth is fresh water and the majority of it is found in glaciers and ice caps (figure 6). Reliance on freshwater for the maintenance of life places strains on this limited resource. Population growth will require 60% more food by 2050 and thus a 19% increase in agricultural water use. The water consumed in the production of an agricultural or industrial product is termed ‘virtual water’.

Studies have shown that these pressures on freshwater will continue to increase due to a combination of climate change, increasing population and socioeconomic demands. At present 7% of the world’s population live in water scarce areas. With population expansion, it is anticipated that 67% will live in water scarce areas by 2050 (McKinsey, 2009). Future increases in food production will be required to feed the population and increased production will need larger water supplies. It is estimated that global water withdrawal will grow from 4,500 billion m3/year to 6,900 billion m3/year by 20305; a 53% increase in water extraction (WRAP UK, 2014).
Ways for minimizing water use in food industries

Water is important to the food-processing industry for many reasons. In most foods, water is the primary ingredient or constituent. Water is extensively used in most food plants as a processing aid and for clean-up and sanitizing. Conservation and reuse of water saves money and reduces a food company’s exposure to rising water costs and potential shortages.

Determining Water Usage

One of the first steps in a water use reduction program is to develop an understanding of how water is currently being used in a food-processing facility. A water balance, or audit, may be conducted to track the input and output of water used throughout a facility. The balance should be comprehensive and may include the following areas or uses:

- Process operations such as cooling, cooking, size reduction, evaporation and cleaning
- Utilities, such as steam and condensate losses
Four main areas in food-processing facilities should be considered for minimizing water use (figure 7):

**Sustainable Food Systems**

Food systems include all the interconnected activities of agriculture, forestry or fisheries involved in the production, aggregation, processing, distribution, consumption and disposal of food products (FAO, 2018). Food system does include a single system, but it is composed of various sub system (e.g. farming system, waste management system etc.). Sustainable Food System is a food system which ensures nutritious food for all without compromising the food needs of future generations. SFS is comprising of three pillars which are as follow:
- **Economic Sustainability**: Generate jobs/incomes and profits
- **Social sustainability**: Nutritious and healthy food for all population
- **Environmental sustainability**: Reduction in carbon footprint, water footprint and food losses, improvement in soil and plant health

**Rural and urban food system**

Let us examine the rural and urban food systems and see how they differ.

**Rural Food System**

The global rural population is now close to 3.4 billion and is expected to rise slightly and then decline to 3.1 billion by 2050. Africa and Asia are home to nearly 90% of the world's rural population in 2018. According to UN (2018), India has the largest rural population (893 million), followed by China (578 million). Rural Food System consist of diverse local food systems that provide the foundations of rural people’s nutrition, incomes, economies and culture. In rural India local food system is predominately food production system (farming) where farmers are growing food that is locally acceptable by utilizing the local available resources. Much of grown food is consumed at the household level and small surpluses sold in the local markets. In this way each link in the food chain offers economic niches for many more people such as millers, carpenters, iron workers and mechanics, local milk processors, bakers, small shopkeepers etc. The livelihoods and incomes of a huge number of rural dwellers are thus dependent on the local manufacture of farm inputs and on the local storage, processing, distribution, sale and preparation of food (Pimbert, 2005).

**Urban Food System**

The world is experiencing unprecedented urban growth. Today, over half of the global population is urban and by 2050 an additional 2.5 billion people are expected to live in urban areas. According to census 2011, Level of urbanization increased from 27.81% in 2001 Census to 31.16% in 2011 Census. Indian urban population was estimated at 37.7 crores in 2011.

An urban food system can be conceptualized as “a set of activities ranging from production through to consumption. These activities include production, processing and packaging and distribution, retailing and consumption. Distribution and retailing are particularly important parts of urban food systems; they include “all activities involved in moving the food from one place to another and marketing it”. It is important to note that food in urban areas is overwhelmingly purchased rather than produced by households. The final set of activities in urban food systems relate to the consumption of food, which includes “everything from deciding what to select through to preparing, eating and digesting food”.

A well-functioning urban food system can be regarded as one that ensures a high level of food security to residents, while simultaneously contributing to sustainable social and economic development. Food security can be defined as being when “all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life” (FAO, 2009: 1). Food
Safety and Standards authority of India (FSSAI) is the statutory body under Central Government which ensures food safety in India.

Poor urban dwellers face unique nutritional challenges around accessing nutritious food, adequate employment, social protection, and adequate water, sanitation, and hygiene facilities, all of which affect food security and nutrition. With rapid urbanization and globalization, people’s daily diets are changing:

- Urban populations tend to consume more calories, yet a lower proportion of these calories comes from cereals or carbohydrates and more comes from fat.

- Urban populations consume more meat and other protein, or consume different animal protein sources than rural counterparts, but less dairy.

- They also consume more fruits and vegetables overall, though consumption of these food groups differs between richer and poorer urban populations.

- Urban dwellers consume more non-basic foods, including sugary snacks among children, food away from home, and processed foods.

IFPRI report, found that 66% of households consume packaged snacks high in fat, with two-thirds consuming these daily. With more people adopting ‘urban diets’, there have been some changes in the food supply chain also. For instance, the move away from staples such as rice and wheat to vegetables, fruits, dairy, meat and fish requires more infrastructure such as cold storage, etc. There is also a growing preference for retail supermarkets over traditional markets among urban consumers.

**Inadequacies of Rural and Urban Food System**

Rural food system is characterized by food production system, but in today’s time farming is losing its charm and is no longer a family pursuit. It has become more and more dependent on external inputs like seeds, water, pesticides etc. Excessive use of pesticides and ground water for increasing crop yield resulted in degradation of environment and depletion of water resources. It is estimated that agriculture alone accounts for roughly 70 percent of global freshwater withdrawals and causes water pollution. Food Production system is also a major contributor of greenhouse gases (GHG) emissions. According to FAO report, at present food systems are responsible for a significant share (20-35 percent) of greenhouse gas emissions.

Urban food system in India is now facing with the twin-burden of under- and over nutrition. Comprehensive National Nutrition Survey (CNNS), a cross-sectional, household survey covering more than 1,10,000 children and adolescents (0-19 years) in both urban and rural areas across all 30 states of India showed that 35% of children under the age of five are stunted (low height-for-age) and 17% are wasted (low weight-for-height), whereas in school going children (5-9 years) 22% are stunted and 4% were overweight or obese. In India, rapid increase in urbanization led to changes in the dietary patterns. Now people in cities are moving from plant-based diets to diets with a higher proportion of energy from
animal-source foods, added sugars and fats which is a major cause of diet related non-communicable diseases (NCDs) such as diabetes and cardiovascular diseases. CNNS report (2019) revealed that around 10% of children in the age group of 5 to 9 years and adolescents in the age group 10 to 19 years are pre-diabetic and 5% suffered from blood pressure.

**Approaches for Making Healthy and Sustainable Urban Food System**

Government has an important role to play in creating healthy public policies and supportive environments to facilitate access to safe, affordable, nutritious food. Urgent and coordinated action is required to support government to make food systems more efficient, inclusive and resilient to price volatility, weather shocks and climate change in times of rapid urbanization. In order to tackle the menace like malnutrition and other nutrient related diseases Government of India has started various national schemes including rural and urban development which are listed below:

- **Targeted public distribution system (TPDS)**- Food distribution system providing subsidized ration to people belonging in BPL category both in rural and urban areas.

- **Mid-day meal scheme (MDM)**- Established to provide hot cooked meal to primary school children in schools run by various government bodies to ensure both nutrition of children and attendance in school.

- **ICDS**- Started in 1975 under Ministry of Women and Child Development, it provides supplementary food, vaccination, primary education, health facilities to children below 6 years and pregnant, lactating women and adolescent girls. Anganwadi centres are established to provide education, supplementary food to its beneficiaries in both rural and urban areas.

- **Poshan Abhiyaan**- Poshan Abhiyaan is India’s flagship programme to improve nutritional outcome for children and other beneficiaries by leveraging technology, a targeted approach and convergence.

- **’Eat Right India’**, started by FSSAI, built on three broad pillars of ‘Eat Healthy,’ ‘Eat Safe’ and ‘Eat Sustainable’, aims to engage, excite and enable citizens to improve their health and wellbeing. It is a collective effort to make both the demand and supply-side interventions through the engagement of key stakeholders. The movement provides citizens with information like their nutrient requirements, what to eat, when to eat, and how to lower the intake of sugar, salt and fat.

- **FSSAI established a Food Fortification Resource Centre (FFRC)**, as a ‘resource hub’ to promote fortification of food as part of its mandate to assure ”safe and wholesome food” to all.

In order to make Rural Food System more sustainable Government of India is taking various steps such as:
• Improving **connectivity and marketing** infrastructure in rural areas.

• Linking farms to markets through **contract farming**.

• **Diversification** out of staple grains towards high-value agriculture (fruits, vegetables, livestock)

• Increasing access to technology adoption for sustainable intensification

• Making agriculture production systems **climate-smart**

Apart from Government policies and schemes an individual can also contribute for maintaining the sustainability of food system by adopting a sustainable healthy diet. According to FAO/WHO (2019) **Sustainable Healthy Diets** are dietary patterns that promote all dimensions of individuals’ health and wellbeing; have low environmental pressure and impact; are accessible, affordable, safe and equitable; and are culturally acceptable. A healthy diet is very effective in preventing malnutrition, diet related NCDs and promote over all well-being. Some tips for a healthy diet are listed below:

• Eating whole grains, legumes and a handful of nuts.

• Daily intake of at least one seasonal fruit.

• Reduction in intake of highly processed food and drinks (rich in fat, sugar, salt).

• Drinking safe and clean water

• Avoiding/Restricting oily and fried food in a diet.

Despite the big increase in world food production, there are still more than 800 million people who are chronically malnourished, 33% of the total food is lost and wasted, and there is a need of 6,900 billion m3/year water by 2030. Added to that, this growth in production has been accompanied by growing pressure on the environment. Understanding of the fact that the present food system is unsustainable is gradually increasing among scientists, institutions, businesses, policy makers, and citizens. Therefore, developing appropriate strategies to reduce food loss and waste, need for safer and sustainable packaging, reduced water use in food processing and healthy and sustainable urban food system are some of the most important issues related to sustainable development. A judicious use of resources can help find solutions that will provide the world’s growing population with a sufficient supply of healthy food within the environmental limits.
Summary

This chapter covered the different approaches to sustainable food system in terms of reducing food loss and waste, safer and sustainable packaging, reduced water use in food processing and healthy and sustainable urban food system which can be summarized as below:

- The Food and Agricultural Organization (FAO) reported that approximately 1.3 billion tons of edible food for human consumption is lost and wasted every year across the entire supply chain.

- Food loss and waste occurs at different stage of the food value chain such as production stage, handling and storage stage, processing and packaging stage, distribution and marketing stage, consumption stage.

- Strategies to reduce the Food Loss and Waste depend upon integrated efforts for providing adequate infrastructure, technical support and creating public awareness for the critical loss points along the food chain from harvest to consumption.

- Packaging is utmost important in preserving and extending the shelf life of the food products. Plastic is widely used in packaging of food products but it poses threat to environment as well as to public health because of their resistance to degradation.

- To make food packaging safer and sustainable people are working on innovative techniques of food packaging such as biodegradable and edible packaging.

- Apart from packaging, water is also an integral part of food processing industries. With depleting water resources, it is imperative to save and conserve water usage for processing of food.

- In food-processing industries for effective and efficient water usage various points need to be considered such as process of manufacturing food, equipment used, facility and personnel training for proper water use.

- Food system plays an important role for overall development of human beings. In India we can find both rural and urban food system. Various surveys such as Comprehensive National Nutrition Survey (CNNS) show that India’s rural and urban food system is now facing the twin-burden of under and over nutrition. To combat this Government of India has started various national schemes such as Mid-day meal scheme, Poshan Abhiyaan etc.
Key Words

**Bio-degradable Plastic:** Plastic that can be decomposed by the action of microorganisms.

**Comprehensive National Nutrition Survey (CNNS):** It is a survey carried out by Ministry of Health and Family Welfare to assess the malnutrition burden amongst children and adolescents in India.

**Edible Packaging:** It is a king of packaging which can be eaten along with the food product.

**FAO:** Food and Agriculture Organization is a specialized agency of United Nations that leads international efforts to defeat hunger.

**Food Loss:** Food loss refers to food that spills, spoils, incurs an abnormal reduction in quality such as bruising or wilting, or otherwise gets lost before it reaches the consumer.

**Food Waste:** Food waste refers to food that is of good quality and fit for human consumption but that does not get consumed because it is discarded either before or after it spoils.

**Green House Gases (GHGs):** Gases such as carbon dioxide, methane, nitrous oxide, water vapour etc. that causes greenhouse effect.

**Packaging:** Packaging is the science, art and technology of enclosing or protecting products for distribution, storage, sale and use.

**Sustainable Food System:** It is a food system which ensures nutritious food for all without compromising the food needs of future generations.

**Urbanization:** It refers to the increasing number of people that live in urban areas.

**Water Footprint:** It is the amount of the water utilized in the production or supply of goods and services used by a particular person or group.

Exercises

1. What do you mean by the terms - Food loss and Food Waste? Describe in brief about food loss and waste in the Indian context?

2. Discuss the food losses and waste in different steps of food chain with suitable examples.

3. What are the strategies for reducing food loss and waste?

4. Describe in brief about the need for packaging of food.

5. Define the sustainable packaging and list the four principles of sustainable packaging.

6. Write a short note on edible and biodegradable packaging?
7. Describe giving details of the areas in food-processing facilities for minimizing water use.

8. List the three pillars of a sustainable food system?

9. Discuss the short comings of Indian rural and urban food system with the help of CNNS data?

10. Write a short note on various national schemes and steps taken by Government of India for making rural and urban food system more sustainable?

Activity:

1. Visit United Nation, FAO, and UNICEF official website and read their latest reports on sustainable development goals, sustainable food system, global food losses and waste and malnutrition.

2. Visit a food industry and look at the usage of water during processing of food. Observe how water is recycled in a food industry.

Reference


Useful Weblinks
Section 5: Coordination, Partnerships and Emerging Issues

20. Coordination and Partnerships
Chapter 20: Coordination and Partnerships

- Coordination between Government Programs and Schemes
- Private sector participation
  - Avenues of Collaboration
  - Key steps in Public-Private Partnerships
- Science and Research
- Higher education and learning
  - Practical Learning
  - Interactive learning
  - Promoting entrepreneurship
- Participation and role of professionals
- Global partnerships
- Organisations responsible for food safety and nutrition
- International Agreements
Chapter 20: Coordination and Partnerships

In order to achieve the end goal of any programme, a network of partnerships is required. A forum together with leaders and champions from government, businesses, civil society and the community can help bring together the vision of a programme. Let us learn about how coordination and partnerships are achieved.

Eat Right India movement is one such programme that requires convergent action in order to translate unified, concrete actions to show results.

Coordination between Government Programs and Schemes

As per the Food Safety and Standards Act, 2006, it is expedient in the public interest that the Union should take under its control the food industry. This clause enables the Union to legislate on the subject matter in the public interest.

Taking the case of Eat Right India Movement, it requires multiple interventions targeting all parts of food value chain that span all levels of governance and include representation from a wide range of stakeholders. Designing a robust food system, thus, requires partnered approach with a coordinated action plan. Given that mandates of most of the ministries/departments relate to food in one way or another, ‘whole of government approach’ is necessary. We must also be able to leverage synergies with various ongoing flagship programmes that directly or indirectly relate to food.

Convergence is the key for multi-sectoral programmes. The issues pertaining to food and nutrition, safety and hygiene are connected and require synergistic action involving all the major programmes in India.

Case Study: Eat Right India

FSSAI has launched ‘The Eat Right India’ movement to bring about social and behavioural change in diets whether people eat at home, at school, at workplace or when they eat out so as to prevent death and disease from unhealthy diets.

If Eat Right India has to scale up and sustain, consumer awareness and educational activities should be aligned and converged with established government programmes. Relevant programmes include the National Health Mission with renewed focus on wellness under ‘Ayushman Bharat’; School Health Program; Integrated Child Development Services scheme for children under 6 years of age and their mothers; Mid-Day Meal (MDM) scheme for school children and Anaemia-Mukt Bharat.

For reaching the community through the grass-root functionaries an Eat Right Toolkit and online video courses on Food Safety and Nutrition have been developed for the frontline workers namely ANMs (Auxiliary Nurse Midwives), ASHAs (Accredited Social Health Activists), Anganwadi workers (supervisors for child care centres) and mid-day meal
supervisors. The toolkit is an interactive training module with a manual for training frontline health workers on key messages of eating safe, eating healthy and eating sustainably. This toolkit is being integrated with health and wellness centres under ‘Ayushman Bharat’ to reach people at the grassroots level. An online course for frontline health workers has also been developed.

In addition, short and structured e-courses on food science and nutrition have also been developed for students, professionals and the general population to enhance their knowledge for professional and personal development. These courses include demonstrative and interesting training modules on various topics on food and nutrition at the basic and advanced levels. Participants can register online, take the courses at their own pace online and get themselves evaluated also online. This system allows these courses to be disseminated to a wide audience, quickly and conveniently.

Through 220,000 ANMs, 870,000 ASHAs workers under the Ministry of Health and Family Welfare and 12,93,000 Anganwadi Workers under the Ministry of Women and Child Development, very extensive reach of eat right messaging across the country is possible. Frontline workers can be trained to spread the Eat Right message for community education and outreach.

The Eat Right India movement is based on three pillars which align well with the various programs of Government of India. It envisages resolving various health issues with collaborative efforts from various stakeholders. For instance, special cleanliness drives in fruit and vegetable markets, street food vending areas in cities/towns could be jointly taken up under the Swachh Bharat Abhiyan. With Ayushman Bharat, as a part of preventive and promotive healthcare strategy, frontline health workers in the health and wellness centres could be trained on food safety and nutrition. The ‘Eat Right Toolkit’ and online courses would help empower the frontline workforce and able them to bring about change in the community. This could also be used for training of Anganwadi Workers under Poshan Abhiyan and complement their own training efforts. Promotion of fortified staples in safety-net programmes like ICDS, MDM and PDS is already part of stated policy of the government. This could be accelerated under Eat Right India. Together with Anaemia Mukt Bharat and the Poshan Abhiyaan, micronutrient malnutrition which is one of the major causes of lowered productivity can be addressed and rectified.

Jal Shakti Abhiyaan could have special focus on potable water supply in clusters of petty food vendors in places such as street food hubs, vegetable, fruit, meat markets. Recognizing these synergies and enabling cross-departmental collaboration would ensure a coherent approach to the food system.

The Eat Right India movement simplifies the fundamental truth, that safe and healthy food is at the heart of preventive and promotive healthcare. In order to create a sustainable culture and build trust the expected outcome is to promote personal responsibility of choosing the ‘right foods’.

In accordance to the philosophy of Gandhiji, community mobilization will help create local champions to take the movement forward. Empowering consumers to make the right choices and building their capacity will help strengthen systems to promote, propagate and sustain the culture of healthy living.
At the State/District level, the already established State Level Advisory Committees in association with various departments and local experts can alter the nutrition landscape of the States and progress towards a healthier India. This would also help evolve from the traditional governance to a more inclusive partnership at the State level.

With the growing concern of various public health ailments, the industry support towards accessible healthy choices in foods will also help empower and benefit both the businesses and the consumers.

Further, a strengthened partnership will build a strong network and associations to achieve global goals of health, safety and nutrition which will assist the economic growth of the country.

**Private sector participation**

Private sector comprises of big or small enterprises, companies, businesses from all sectors, include a defined supply chain and have resources that can be explored. The private sector participation is critical to execution of a programme where they play a key role as a stakeholder. To fast-track the programme and get funding which may be limited as per the government budget, the involvement of the private sector is essential. A healthy competition between the stakeholders is also needed to create a positive culture.

In the current times, the policy makers and analysts in various developing countries are seeing value in engagement with the private sector. The governments alone often cannot bear the cost of the growing demands of the public through its various programmes, thereby making the private sector a key stakeholder and inclusion as partners in implementation of programmes.

Delivering on the outcomes of any policy, requirement of partnerships is essential. The success of a programme can be achieved through the Public-Private Partnership models which can accelerate the developmental environment. The two models that drive the private-public sector engagement are the transactional or the transformational models as displayed in Figure 1. The transactional models involve commercial or philanthropic aspects of the coordination. The partners interaction is solely based on an exchange and fulfilment of individual needs. The learning move from the transactional to the transformation model is the basis of the public-private sector coordination. This may involve collaboration in terms of resources, skills and capabilities. Leveraging on the core competencies of each other aid in joint decision making, increased learning, and a sustained impact.
Factors driving Private Sector Partnerships are:

- **Societal**: Public agencies have been unable to satisfy basic water needs for all. The context is one of dwindling public funds, increased demand, large investment gaps, ageing infrastructure in need of rehabilitation, and calls for increased decentralisation.

- **Commercial**: The Dublin Water Conference in 1992 established water as an “economic good”. This challenged the traditional approach to water service provision, which held that water services were the domain of public agencies alone.

- **Financial**: There is a belief that the private sector can mobilise capital faster and cheaper than the public sector. The expectation that by shifting assets from public control into private ownership and capital markets, economic efficiencies can be unleashed.

- **Ideological**: This refers to the notion that “smaller government is better”.

- **Pragmatic**: Inability of governments to finance increasing capital, operation and maintenance costs of municipal water systems. Need to invest in infrastructure, increasing population, and constrained public finances.
Avenues of Collaboration

The engagement with the private sector is mutually beneficial. It increases opportunity for the private sector to be a part of policy decisions that affect them. The contributions that may be expected from the private sector can be in the form of financial or non-financial.

1. **Knowledge Dissemination** - One of the areas is involving the private sector to support the vision of the government priorities. Areas of mutual collaboration can be identified. The collaboration can also involve knowledge exchange which will help strengthen the areas of engagement.

2. **Corporate Social Responsibility** – Financial assistance towards a cause that is undertaken by the private sector may form linkages with specific government programs. The CSR can be targeted towards identified projects.

3. **Resource Mobilization** – The apt utilization of human, financial and other resources is fundamental to any programme. The private sector entities have access to better resources and may aid in specific activities. They can provide for expertise, funds, manpower and technical support. Through their network and operations, they can also assist in resource mobilization at the community level.

4. **Technical Expertise** – The private sector often harbours great minds and technical expertise; these can be utilized to work regionally as well as across the country. The companies can support the vision, build capacity, provide innovative technical support that can help Eat Right India to work in convergence with various sectors. The role can be identified in various areas.

5. **Policy advocacy and Communication** – The engagement and viewpoint in dialogue related to food and nutrition security can assist in building better policies. Inculcating the sense of ownership in the private sector will also help provide an element of sustainability. Focussed and targeted communication and advocacy can thus happen in a structured, organized and unified manner.

**Case Study: CHIFFS/ FACE/ ReCHaN**

1. FSSAI has joined hands with CHIFFS (CII-HUL Initiative on Food Safety Sciences) with the purpose of driving activities related to science based food safety in the country, to strengthen protection of consumers and create an innovative environment for the industry.

2. The CII Jubilant Bhartia Food and Agriculture Centre of Excellence (CII-FACE) is charged with the mission to improve the competitiveness of India’s agriculture and food processing sector, by catalysing innovation, building capacity and enhancing productivity across the agriculture and food value chain, ensuring food security and inclusive growth. FACE works closely with farmers, companies, developmental institutions, and the government.

3. ReCHaN is a collaborative initiative of FSSAI, IADSA and CII to foster a culture of best practices in the area of Manufacturing and Standards formulation of Health Supplements and Nutraceuticals.
Key steps in Public-Private Partnerships

Global Partnership for Results-Based Approaches has outlined the key steps to be followed for partnerships (Figure 2). The steps below highlight the critical phases which must be undertaken in a step-wise manner to implement a PPP project. The steps must always keep in perspective the needs of all stakeholders involved.

![Diagram showing the key steps in Public-Private Partnerships]

*Figure 20.2: Key Steps in forming Public Private Partnerships*
Science and research

Section 16.3(e) of the Food Safety and Standards Act, 2006 requires FSSAI to establish a system of network of organizations with the aim to facilitate a scientific co-operation framework by the co-ordination of activities, the exchange of information, the development and implementation of joint projects, the exchange of expertise and best practices in the fields within the Food Authority’s responsibility.

In this context, FSSAI has established a nationwide network for scientific research with an intent of ensuring a convergence of research activities in the area of foods safety and applied nutrition, sharing information on developments in the field of food testing methodologies and techniques for strengthening quality of food testing, generating/sharing of scientific data and information related to food safety and applied nutrition and utilizes such scientific data for development of food standards, both at national and international level, and in other risk management decisions and creating centres of excellence having different focus and expertise which will provide research and training that addresses timely, cutting-edge issues related to food safety and applied nutrition.

FSSAI has notified many technical standards and regulations. Robust institutional mechanism is now in place to set standards through 21 scientific panels and a scientific committee. There are nine technical panels that formulate guidance documents, code of practices and inspection metrics. Further, eight Standards Review panels have been set up to review food standards and provide inputs to the related scientific panel. FSSAI has also notified regulations for standards on health supplements, nutraceuticals, prebiotics and probiotic products, which are primarily intended for sustenance of a healthy life and fall in the category of functional foods.

Higher education and learning

As industry and service sectors continue to dominate the economy, the need for skilled manpower of approximately 250 million is expected by 2030, a major source of which could be the Higher Education System. With a population of an average age of 32 years, India has a high potential to become one of the largest suppliers of skilled manpower to global markets. However, only 8.11% employers believe that job seekers possess skills that align with industry requirements.

Currently, 79% of the organisations offer formal training to their employees. An industry-ready workforce will lead to a reduction in on-job training time for organisations leading to higher productivity, sustainable growth and food safety implementation.

In India, nutrition courses are offered by various universities at graduate and post-graduate levels through both regular and distance learning. However, there is still some vacuum that exists in the online space. There are professionals and students who intend to enter the field of nutrition with knowledge and skills on latest advances in research and industry. Therefore, in this era of digitization, the Food Safety and Standards Authority of India (FSSAI) intends to harness the power of the internet and offer online courses which are intended to train students and help professionals update their knowledge and skills specifically in the area of nutrition at their own pace.
Engaging with Higher Education Institutes on strengthening Capacity on Food Safety and Nutrition will impact several stakeholders. Through its Higher Education Outreach programme, FSSAI is trying to inculcate the concept of Eat Right India into the course curriculum for it to strengthen the food and nutrition content taught to the children. These are the Organisation itself, Faculty members, Students of Colleges and Schools, Industry, Government and ultimately the consumers of food. This will help Institutes with the added opportunities of offering and engaging with a bouquet of contemporary learning and skilling modules that will ultimately help enhance the employability and skills of the students of the implementing Institutes in alignment with the current industry requirements. Content can be mainstreamed either as part of the overall curriculum or offered as certificate courses. This is supported by relevant curricular plan, content, plus faculty development programs.

**Case Study: Mainstreaming content on Eat Right**

In its journey of moving from the narrow focus on adulteration to a more holistic approach of safe and wholesome food and to empower responsible citizens to Eat Right; FSSAI relies on a collaborative approach. The FSS Act 2006 in its statement and intent makes it clear that all stakeholders, be it the Regulatory Body, the Food Business Operators (FBOs), or the citizens of the country, have to be active agents and ensure they play their part in ensuring safe and wholesome food. Yet, any law is as good as its implementation, as real action or change is driven not by a thought alone, but by action and by taking responsibility. Food Safety cannot be viewed merely as a program or scheme, it has to be a culture and a habit, and Higher Education Institutes need to play a prominent role in this context.

FoSTaC is FSSAI’s Food Safety Training & Certification Program for Food Safety Supervisors across food sectors. Practical, industry-oriented training modules have been developed by FSSAI in collaboration with industry, domain experts and National Resource Persons and disseminated through various FoSTaC courses which are of Basic, Advanced and Special Level. The objective is for all licensed food businesses to have at least one trained and certified Food Safety Supervisor (FSS) under FoSTaC for every 25 food handlers in each premise. Academic Institutes may therefore integrate the FoSTaC curriculum as separate modules in their curriculum, or offer it as standalone certificate courses to their students and/or the food business community. Persons successfully trained and assessed under FoSTaC would be jointly certified by FSSAI and the Training Partner.

**Practical Learning**

1. Internship at FSSAI - FSSAI, in its mission to disseminate Food Safety awareness in the country, offers a basket of opportunities to develop and refine the skills of young talent. Internship scheme is one of these initiatives which is offered to students through a mutually beneficial inter-Industry-Academia association. Some of the project areas include, Regulations/Codex, Standards, FSMS, Quality Assurance, Risk Assessment and social and behavioural change.
2. **Support in Dissertation** - Through this scheme FSSAI provides real-time mentoring of students and provides them an opportunity to complete their research. The scheme gives a real-world exposure to policy making, regulatory and enforcement systems, and standard setting to the students.

3. **Fellowship in Food Analysis** - FSSAI has initiated a program called “Fellowship in Food Analysis (FIFA)” to incentivise the Junior Analyst Examination (JAE) qualified candidates to fulfil the relevant experience criteria for eligibility as a food analyst, through attachment at an FBO’s laboratory/testing laboratory. FIFA is a paid fellowship for a period of 3 years, after which the Fellows will be eligible for taking the Food Analyst Examination (FAE).

**Interactive learning**

**Eat Right Quiz** - The Eat Right Quiz, designed on Amazon Alexa platform, aims to enhance the knowledge of citizens, about the basics of food safety and nutrition, and thus removing myths related to them, in a simple playful manner. Eat Right Quiz aims to engage and encourage citizens to learn about safe, healthy and sustainable food through entertainment and competition. The Eat Right Quiz consists of questions, which are collated by the eminent experts of the food industry. The quiz can be played between individuals or between teams. The quiz consists two levels; basic and advance in four categories. The unique feature of this quiz is that after every right answer the device also gives brief information related to the answer.

**SNF Fellowships** - The Eat Right @School initiative of FSSAI has been designed to deliver and reinforce the message of safe and nutritious food to schoolchildren, through both curricular and co-curricular activities. Additionally, it aims at ensuring and enabling legislative and regulatory framework to promote safe and wholesome food in both government and private schools across the country. SNF Fellowship programme is designed for the implementation by students of Higher Education Institutes, for promoting social and behavioural change around food safety, hygiene, and healthy diets in school children.

**Promoting entrepreneurship - Food Innovators Network (FINE)**

This brings together entrepreneurs who provide innovative solutions to transform the country’s food safety and nutrition landscape. It is a comprehensive entrepreneurship platform that engages with start-ups working in the food space and provides mentorship, network access and regulatory support to them. It focuses on four challenge areas namely, Cheaper, Rapid and Anywhere Food Testing, Ensuring Availability of Healthy Foods, Educating India and Rethinking Food Labelling and Recovery of Surplus Food. It includes a FoSTaC Plus training course to orient start-ups, a FSSAI Buddy Programme to navigate the regulatory space and Eat Right Start-Up Awards as incentives and rewards to encourage innovative entrepreneurs.
Participation and role of professionals

Involving all stakeholders often helps achieve the targets. We associate with experts to capture skillsets, resources and offerings. That’s how value is created in an initiative. Professionals engage frequently in formal and informal conversations. Collaboration with professionals can encompass a wide range of activities with possible and innovative solutions to existing problems. Collaborative discussions with the partners focus on actions which relate to the goals of the programme.

Case Study: Network of Professionals (NetProFaN)

FSSAI has created the NetProFan which aims to form a network of professionals in food and nutrition, leveraging their strength and expertise, to support both demand and supply side initiatives of Eat Right India. The programme has envisioned collaboration of professional bodies and experts in the areas of food, nutrition and public health, to contribute towards national efforts for improving the status of food safety and nutrition. This will help growth of the associations and professionals and expand its outreach. The knowledge of these experts will assist in supporting Eat Right India. Their engagement with the higher education will help build capacity. This will in turn create a culture of safe and healthy food thereby bringing in the desired social and behaviour change. NetProFaN brings various Professional Associations to work together for a healthy future:

- Indian Dietetic Association (IDA)
- Nutrition Society of India (NSI)
- Indian Medical Association (IMA)
- Association of Food Scientists and Technologists of India (AFSTI)
- Indian Federation of Culinary Associations (IFCA)
- Association of Analytical Chemists, India Chapter (AOAC)
- Indian Public Health Association (IPHA)

Global partnerships

Engagement and collaboration with global agencies and countries provide a unique and multi-sectoral platform to deliver results across all sectors. The global exchange through such interactions ensures that learnings are effectively taken up and integrated within the existing systems via practical guidance.
Case Study: The Busan Partnership

This document specifically highlights a set of common principles for all development actors that are key to making development cooperation effective. They key focus areas are:

- Ownership of development priorities by developing countries: Countries should define the development model that they want to implement.
- A focus on results: Having a sustainable impact should be the driving force behind investments and efforts in development policy making.
- Partnerships for development: Development depends on the participation of all actors, and recognises the diversity and complementarity of their functions.
- Transparency and shared responsibility: Development co-operation must be transparent and accountable to all citizens.
- These principles are recognised and accepted by all those involved in development co-operation, from donor and recipient country governments to providers of south-south cooperation, international organisations, civil society, parliamentarians and local government. The wide participation of a range of actors with differentiated responsibilities and shared goals is one of the notable characteristics of this partnership.

Global partnerships help achieve two main objectives. First is to evaluate the efficiency of governments in creating an enabling environment to attain the potential efforts of policy and community mobilization within the country. The second is to observe how the development partners extend their support to the national programs and policies. This involves inclusive partnerships that is result oriented. The partnership must be transparent and should bring accountability to all stakeholders involved.

Organisations responsible for food safety and nutrition

There are several organisations across the globe which work in the area of food safety and nutrition. Let us learn about these and see how they can collaborate and partner to create a better food safety and security scenario in the world.

1. **FSSAI** – FSSAI lays down science-based standards for articles of food and regulates their manufacture, storage, distribution, sale and import to ensure availability of safe and wholesome food to 130 crore citizens of the country. The authority is also responsible for creating an information network across the country so that the public, consumers, etc receive rapid, reliable and accurate information about food safety and hygiene and related issues of concern.

2. **Codex Alimentarius Commission** – It is a joint inter-governmental body of the Food and Agricultural Organization of the United Nations (FAO) and WHO with 189 members (188 member countries and one Member Organization (EU)). Codex has worked since 1963 to create harmonized international food standards to protect
the health of consumers and ensure fair trade practices. India is a member of Codex Alimentarius Commission since 1964 and continues to be a partner in the international food standards development process. India actively participates in the Codex meetings, hosting and co-hosting Codex Committee meetings.

3. **EFSA** - EFSA is a European agency funded by the European Union that operates independently of the European legislative and executive institutions (Commission, Council, and Parliament) and EU Member States. It was set up in 2002 following a series of food crises in the late 1990s to be a source of scientific advice and communication on risks associated with the food chain. The agency was legally established by the EU under the General Food Law - Regulation 178/2002. The General Food Law created a European food safety system in which responsibility for risk assessment (science) and for risk management (policy) are kept separate. EFSA is responsible for the former area, and also has a duty to communicate its scientific findings to the public.

4. **FSANZ** - FSANZ’s purpose is to contribute to the cooperative food regulatory system by developing evidence-based standards, providing evidence-based advice, coordinating regulatory responses and providing information about food standards. FSANZ is established by the Food Standards Australia New Zealand Act 1991, which was enacted to implement an intergovernmental Agreement between the Australian Government and all states and territories and a treaty agreement between Australia and New Zealand. The object of the Food Standards Australia New Zealand Act is to ensure a high standard of public health protection throughout Australia and New Zealand and the objective of FSANZ is a safe food supply and well-informed consumers.

5. **International and National Non-Government Organizations**: Organizations like WHO, UNICEF, WFP, etc. play a very important role in achieving goals as declared in the Universal Declaration of Human Rights “Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing, and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age, or other lack of livelihood in circumstances beyond his control.” (Article 25).

   i. These organizations work towards global health and its issues which transcend national borders and political jurisdictions. Many of these organizations take active part in health projects both nationally and internationally. The various programs and competencies of these organizations contribute to the promotive or preventive health care (figure 3).
Support of these agencies can also assist policy framework or strengthen the existing policies. One of the major areas where these agencies can contribute is capacity building at the grass-root level. This will ensure that implementation of a policy or a program is flawless.

**International Agreements**

There are Treaties and Agreements between nations to ensure fair trade practices and at the same time ensure that member nations can protect the rights and ensure welfare of their citizens. These have been listed here:

1. **World Trade Organization (WTO)** – Established in 1995, WTO is the successor of General Agreement on Tariffs and Trade (GATT) established during the Second World War. The WTO rules are the results of agreements between its members. Through this agreement, WTO members can operate a non-discriminatory trading system that spells out their rights. Fair trade practices are ensured for both import and exports in the market. WTO is an umbrella agreement that is also used for dispute settling in trade.

2. **TBT & SPS** - The Technical Barriers to Trade (TBT) and Sanitary and Phytosanitary Measures (SPS) are agreements as a result of the Uruguay Round of Trade Talks following the WTO in 1995. The SPS agreements encompasses protection of
human or animal health from any food-borne illness, or human, animal or plant
carried diseases from pests etc. The TBT agreement undertakes all technical
regulations, voluntary standards and conformity assessment procedures to ensure
adherence and ease of business.

In this chapter you have learnt about how different government as well as non-government
agencies are co-ordinating and forging partnerships to ensure a scenario of safe food
across the globe.

Summary

1. Partnerships and coordination are essential for effective implementation of a
   programme.

2. Collaboration with the private sector is needed to lend support and enhance
   visibility of a programme.

3. There are various avenues of collaboration that can be explored basis the needs of
   a programme.

4. FSSAI is the apex food regulator which is responsible for the creation of
   scientifically backed standards and regulations for various food products.

5. The Eat Right India is an umbrella movement initiated by FSSAI which focusses on
   the Social and Behavioural Change aspects to better the nutrition status of people.

6. Ensuring that information of food safety, health and nutrition is integrated in the
   higher education system of India is essential to developing a skilled workforce in the
   country.

7. Formulation of Global Partnerships ensure that the program meets global
   benchmarks and instils learning.

Key Words

Convergence – moving towards a union or uniformity

Collaboration – the action of working with someone for a common goal

Partnership – an association of two or more people or bodies as partners
Exercises

1. What is the role of Public-Private Partnerships and how does it strengthen programme implementation and sustainability?
2. What are the key steps in PPP models and which steps are a must for QA/QC?
3. Briefly describe the organizations working for food safety and nutrition?
4. What do you mean by interactive learning, highlight by giving some examples?
5. Briefly describe how a PPP model can support expansion of an FSSAI initiative.

References

6. WTO. World Trade Organisation. Website: https://www.wto.org/english/thewto_e/whatis_e/inbrief_e/inbr_e.htm
Chapter 21: New Trends in the Food Sector and Emerging Safety Issues

- Emergence of new hazards
  - Microbial hazards
  - Chemical hazards

- Trends in Consumption
  - Fad diets
  - Understanding Superfoods

- Using technology to tackle challenges
  - Food processing
  - Food packaging
  - Food transport and storage
  - Food safety testing

- Future of food
  - Nutrigenomics
  - New food science
  - Gastronomic tourism

- Fake news and role of media
  - Hazard of fake news
  - Responsibility of media
Chapter 21: New Trends in the Food Sector and Emerging Safety Issues

The food ecosystem is constantly changing. Challenges like climate change, globalization of food industry, urbanization, emerging water- and food-borne diseases, antimicrobial-resistant bacteria, chemical contaminants in a greater number and variety of foods, increasing food costs, complexity of food supply chains, triple burden of malnutrition, changing food consumption pattern of consumers, etc. threaten food security and safety. New technologies and innovations are needed to address these challenges. Increasing food production, improving packaging, storage and transport to decrease food losses, newer methods of detection of contaminants and monitoring microbial growth, science-based methods of assessing risk and development of resource-efficient technologies are some of the ways of ensuring safe and wholesome food for the coming generations. This chapter discusses these trends as well as looks at emerging trends of fad diets and superfoods as well as sciences of nutrigenomics and molecular gastronomy.

Technological advances in tools for communication have created the problems of 'information overload' and misinformation in the media. Let us see how the consumers can benefit from the advancements in technology as well as protect themselves from negative impacts.

Emergence of New Hazards

Technology is one of the driving forces of innovation today and it is challenging some of the most established companies to adopt to the new changes so that they stay relevant. The world is facing the challenge of population growth with an expected 10 billion mouths to feed by 2050. While use of biotechnology can increase the food supply, innovative solutions are needed for improving processing and packaging to increase shelf life and safety of food. Emerging new threats/hazards demand constant monitoring of the food supply with early identification systems. According to EFSA, an emerging risk is defined as “A risk resulting from a newly identified hazard to which a significant exposure may occur, or from an unexpected new or increased significant exposure and/or susceptibility to a known hazard.” New biological or chemical hazards, which were not considered problematic earlier, are being detected in foods which earlier didn’t have these hazards. In addition, hazards are causing illness in a greater number of people or in regions where they didn’t exist earlier. These hazards have to be recognized and controlled before they become major threats.

Changes in the food consumption behaviour with expansion of commercial food services, new methods of large-scale food production, processing and preservation, and, environmental pollution have led to the emergence of newer food safety issues. Advances in food science and biotechnology have introduced new food products, crop varieties and genetically modified foods. With global treaties and lifting of trade barriers between nations there is a greater movement of food from one country to another. While this trend maybe welcome from the point of view of better trade and accessibility to diverse foods, it also raises concerns about introduction of pathogens in countries which were hitherto unexposed to them as well as emergence of allergies due to consumption of new foods, and other adverse effects.
Other hazards which are emerging world-wide are virulent new strains of microbes which do not respond to the standard treating protocol. Emergence of drug resistant strains of microbes is being blamed on indiscriminate use of medication both in veterinary practice and by humans. The microbes learn to adapt and undergo mutations which make them stronger and more resistant. Microbes are also being detected in foods which were earlier not believed to be carriers of pathogens. Let us learn about some of these emerging hazards in greater detail.

**Microbial hazards**

Emerging pathogens of concern are those pathogens which are either causing a new illness or the number of cases is now increasing sharply, or they are spreading the disease over a wider geographical area. For instance, increasing number of people are falling ill due to Listeria, *E. coli O157:H7* and multidrug resistant strains of Salmonella, Brucella, etc. Bird flu, Swine flu, Coronavirus and other infections have been making an appearance adversely affecting the food industry.

*Escherichia coli O157:H7* which causes diarrhea and hemolytic uremic syndrome, was earlier found in undercooked ground beef. It is now being detected in other foods like raw milk, apple cider, lettuce, brussel sprouts, uncooked sprouts, and soft cheeses made from raw milk. Listeriosis, caused by eating food contaminated with the bacterium *Listeria monocytogenes*, affects primarily pregnant women, newborns, and adults with weakened immune systems. It has been detected in foods like milk, soft cheeses, salads, processed meats and ready to eat chicken and meat preparations which are contaminated post cooking. It survives the cold chain storage and causes listeriosis in vulnerable individuals.

New parasites like *Cryptosporidium parvum*, which are resistant to chlorine and other disinfectants are being detected in treated municipal water which had otherwise been declared safe for drinking. North American outbreaks of cyclosporiasis, due to protozoan parasite *Cyclospora cayetanensis*, provide another example of a new disease which is now endemic in more than 27 countries. *Campylobacter jejuni* is now considered as the most common bacterial food-borne pathogen in most countries with several reporting the emergence of antibiotic-resistant strains. *Salmonella typhimurium DT104*, which infected wild and farm animals, is now increasing making people sick as well. Non-typhoidal strains of Salmonella are also increasingly leading to illness.

The threat of animal diseases being transmitted to humans has also been a major concern. Confirmed instances of the avian influenza viruses infecting humans have been documented. The type of virus with the greatest risk is the highly pathogenic avian influenza HPAI strain, H5N1. Outbreaks have become more common due to intensive poultry production. The influenza virus has shown presence of genes that have been adapted from both human and avian strains. Transmissible Spongiform Encephalopathies (TSEs) are another example of diseases which have emerged as a result of altering natural feed of animals. The prion disease jumped species and was implicated in human deaths as well.
Other examples of emerging pathogens include – *Toxoplasma gondii*, *Shigella*, *Vibrio parahaemolyticus*, *Yersinia enterocolitica*, etc. Antimicrobial Resistant (AMR) microbes is a growing concern which can be blamed on indiscriminate use of antimicrobial drugs, poor quality antimicrobials and use for non-therapeutic purposes in both humans and animals.

**Chemical hazards**

Use of new chemicals in food production, processing and packaging is introducing newer contaminants into our food supply. Earlier chapters have highlighted these concerns regarding pesticide residues, drugs used in animal husbandry and other chemical contaminants either occurring naturally in foods or being produced during processing or leaching into food from equipment or packaging. Advancements in analytical methods and equipment is enabling us to detect contaminants in foods which we considered as safe, with the prime example being of phthalates and other chemicals migrating from plastic bottles to water/food being stored in it. Plastic debris in the marine environment is contaminating the fish and other seafood with a cocktail of chemicals and microplastics.

**Microplastics – An Emerging Threat**

The United Nations warned about the presence of microplastics in fish in their Environment Project report for 2016. These tiny bits of plastic land up in the rivers and oceans due to poor waste disposal methods. They are ingested by marine life, which is food for man, thus increasing the risk of human exposure to these tiny bits of plastic and the chemicals present in plastics.

Milk, meat and eggs are usually the animal products in which residues of veterinary drugs were suspected, however in 2010 there was report of antibiotic residues in honey in India. This was because in commercial beekeeping, the bees are susceptible to infections and antibiotics are regularly used to tackle infections. Similarly, pesticide residues usually believed to be a problem in grains, vegetables and fruits are also finding their way into a greater number of processed foods and beverages in which contaminated water and raw ingredients have been used.

**Ban on serving food in a newspaper**

Use of newspaper for wrapping or serving food has been banned in India since 2016 as newsprint is made of toxic chemicals which leach into the food.

Chemical hazards may also naturally be present in plants and animals as has been discussed in earlier chapters. Increase in trade between countries has also introduced new foods to the population of the importing countries. In the country of origin, the local population had devised household cooking/processing techniques to get rid of these toxins. The technique if not transferred to the importing country could result in them suffering the adverse effects. Factors such as climate change and ocean acidification have probably resulted in increased risk of toxic algal blooms and its outbreaks in India.
Ciguatera fish poisoning was identified in 2016 in Indian city of Mangalore. The samples of *Lutjanus bohar* and *Pristipomoides filamentosus* tested in 2016 from Karnataka and Kerala region were found positive for ciguatoxins. Its presence in the fish does not affect the taste, odour or appearance of the fish which makes it difficult to identify and remove the contaminated fish. Lack of an accurate method to detect the disease in humans and toxin present in fish also make this toxin an important concern in food safety.

**Consumer fear regarding Food Irradiation and Genetically Modified Foods**

The possibility of change in the structure of food components like proteins on exposure to irradiation or the production of a new harmful substances is a fear among consumer groups. Similarly, genetic modification of crops is looked at as ‘meddling with nature,’ which can result in production of allergenic food or food leading to adverse health effects. Long term studies to demonstrate the safety of these foods need to be carried out.

**Trends in Consumption**

There is an increased awareness among people about diet-related diseases across the world. This has triggered the trend of seeking ‘health foods’ and unfortunately ‘quick-fix’ solutions which do not need too much of an effort on the part of the individual. This has popularised fad diets or use of superfoods which promise health miracles or an ideal body shape.

**Fad diets**

Fad diets are popular diets which promise rapid weight loss or some other health benefit for which there is no real scientific evidence. These diets promote short-term changes instead of life-long changes. Their popularity has no association with the diet’s effectiveness, nutrition soundness or safety. They, like fashion, gain popularity and a following for some time till they lose favour or until the scientific community highlights the adverse health effects that the diet is likely to cause. Most of these diets are low-calorie, weight-loss diets. Others are based on physiological or biochemical parameters like blood group. Creators of these diets often engage celebrities to endorse their diets. Most fad diets promise quick-fix solutions without much effort on the part of the consumer.

**Box 1: How to spot a Fad diet**

Fad diets can be easily identified as they tend to have the following features:

- Promoting only specific food groups or asking you to remove or drastically cut out certain food groups (for instance removing grains, vegetables, etc.)
- Promising rapid weight loss (more than 1 kg/week)
- Providing no scientific or medical evidence and relying on testimonies of celebrities or other individuals
- Offering ‘herbal’ supplements along with diet plan which will ‘melt’ or ‘burn’ the body fat.
Fad diets can sometimes lead to health problems. This is most often because they recommend cutting out of key foods from the diet. A number of these diets (e.g. Atkins, Keto diets, etc.) are low carbohydrate diets requiring the person to virtually cut out grains and some vegetables from the daily menu. Though keto diets have shown beneficial effects in patients of epilepsy, there is very little research data showing advantages for normal healthy people. In addition, diets high in animal protein have also been associated with increased urinary loss of calcium and increased load on kidneys. Some diets recommend the consumption of large amounts of a single food (like Cabbage Soup Diet, Banana and Milk Diet, Boiled Egg Diet, etc.). These diets cannot meet the nutrient needs of the body. Diets which drastically cut down on calories or any specific food group should only be undertaken on medical advice and under the supervision of a professional nutritionist. Trying out these diets on one’s own often results in symptoms like weakness, fatigue, dehydration, nausea and headaches. Highly restrictive fad diets should hence be avoided. These diets are not sustainable as they are very different from regular diets which people are accustomed to consuming. People tend to regain any weight lost as soon as they revert to their regular diet and lifestyle.

Understanding Superfoods

The dietary guidelines of all countries emphasize the need for healthy food patterns and making healthy food choices from all food groups. Few foods however stand out from the others in being packed with beneficial nutrients and phytochemicals. Including these in daily diets enhances the diet quality and offers additional health benefits beyond those attributed to the function of nutrients present in them. These foods are referred to as ‘functional foods’ or ‘superfoods.’ The list of superfoods is long, and several benefits are attributed to them (Table 1). The beneficial effects are attributed to bioactive substances present in them. What is important to understand is that these foods add to the quality of diets and by themselves cannot be responsible for maintaining health of individuals consuming them. People still need to practice healthy lifestyles and eat nourishing meals. The term ‘superfood’ may also be used by some as a marketing gimmick to trick consumers into buying certain food products. These products usually tend to contain one or more of ‘superfruits’ or ‘supergrains’ as ingredients. Any health claims made about the products should be supported by scientific research data.
Table 21.1: Some 'Superfoods' to Include in your Diet

<table>
<thead>
<tr>
<th>Superfood</th>
<th>Bioactive ingredients/nutrients</th>
<th>Health benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berries</td>
<td>Anthocyanins, fibre</td>
<td>Rich in antioxidants, protect against cancer, cardiovascular disease, etc.</td>
</tr>
<tr>
<td>Fatty fish (e.g. salmon, tuna, mackerel, sardines, etc)</td>
<td>Omega 3 fatty acids</td>
<td>Important for brain development and health, protects against cardiovascular diseases</td>
</tr>
<tr>
<td>Dark green leafy vegetables (spinach, mustard greens, kale, etc.)</td>
<td>β carotene, calcium, iron, fibre, several phytochemicals</td>
<td>Important for synthesis of haemoglobin, bone, eyes, and general health</td>
</tr>
<tr>
<td>Nuts (walnuts, almonds, etc.)</td>
<td>MUFA, protein</td>
<td>May reduce risk of cardiovascular diseases</td>
</tr>
<tr>
<td>Olive oil</td>
<td>MUFA, vitamin E, polyphenols</td>
<td>May reduce risk of cardiovascular diseases</td>
</tr>
<tr>
<td>Whole grains (oats, millets, brown/black rice, etc.)</td>
<td>Soluble and insoluble fibre, B vitamins, minerals and phytochemicals</td>
<td>Help in lowering cholesterol, protect against cardiovascular diseases, diabetes</td>
</tr>
<tr>
<td>Curd or yoghurt</td>
<td>Calcium, protein, live cultures of beneficial bacteria</td>
<td>Good for gut health, bones</td>
</tr>
<tr>
<td>Cruciferous vegetables (broccoli, cabbage, cauliflower, mustard greens, radishes, and turnips, etc)</td>
<td>Fibre, vitamins, and phytochemicals including indoles, thiocyanates</td>
<td>Protect against some cancers</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>Lycopene</td>
<td>May reduce risk of some cancers</td>
</tr>
<tr>
<td>Turmeric</td>
<td>Curcumin</td>
<td>Reduces inflammation, antioxidant, antiseptic</td>
</tr>
<tr>
<td>Tea especially green tea</td>
<td>Flavonoids like catechins and epigallocatechin gallate</td>
<td>May reduce risk of cancer, rich in antioxidants</td>
</tr>
</tbody>
</table>

Using technology to tackle challenges

Documenting the outbreak of food borne illnesses is one of the biggest challenges in India. Hospitals and physicians play an important role in notifying the government about any new disease or pathogen they suspect. To deal with the problem, real time monitoring and tracking needs to be done with hospitals and clinics uploading on dashboards any newly detected cases of food borne illness and, hence establishing an accessible database. Similarly, data on any hazard detected in food and likely to become a public health problem needs to be communicated effectively to the public with guidelines on how to manage the risk. Effective communication among stakeholders is the key to controlling and limiting disease outbreaks and minimizing consequent economic losses. With advances in communication technology this has become easier.
Food processing

New and improved technology is also helping to improve food production – increasing productivity, preserving nutrients and improving safety. Microwave Assisted Thermal Sterilization (MATS) is a new patented technology which promises to provide packaged meals which seem freshly cooked in flavour and appearance and which retain their original nutrients. In conventional processing packaged food is kept in pressurized cookers to inactivate pathogens, spoilage microorganisms and enzymes. To mask the damage caused by long exposure to high temperature, additional flavours or colour may be added to food. MATS technology significantly reduces thermal processing time and improves nutrient, flavour and colour retention. This is a post packaging sterilisation process in which a 915M Hz microwave signal induces dielectric heating within the packaged food, which is immersed in pressurized hot water, resulting in a much shorter heating step (Barbosa-Cánovas et al., 2014; DSTO, 2019).

Food packaging

Fruits and vegetables are one of the essential components of our daily diet providing us with vitamins, essential minerals, antioxidants, dietary fibres etc. However, fruits and vegetables are highly perishable commodities which can spoil during the pre- and post-harvest period due to spoilage microorganisms, insects, temperature, stress factor etc. The shelf-life of food is directly related to the type of packaging technology used.

Edible coating/packaging is one of the effective methods to tackle this problem. It provides a two-fold solution. Not only does it protect the wholesomeness of the fruits/vegetables by shielding it from the external environment, but also does not cause any harm to the environment since it is easily degradable. Edible coating can be safely consumed along with the fruit or vegetable (Raghav et al., 2016).

Food transport and storage

Contamination can enter at any stage of food supply chain from farm to fork which includes production, processing, packing, transportation, storage, shelf display and consumption. Achieving the objectives of food quality partly relies on physical traceability throughout the chain. As a result, the management of the supply chain, more significantly the cold chain related to the manufacture, distribution and sale of perishable, and condition-sensitive products, should be given high priority.

Better methods of traceability of food products can also limit economic loss and adverse health consequences. If a certain batch of food is found to be a health threat, then it can be traced and recalled from the market preventing people from getting exposed to the hazard. Radiofrequency Identification (RFID) Technology is increasingly being used to trace products in the supply chain. RFID is a form of auto-identification, like a bar code or a license tag containing a unique serial number. RFID tags can also incorporate additional data such as details of product and manufacturer and can transmit measured environmental factors such as temperature and relative humidity. RFID technology can be applied in the food industry for supply chain management, temperature monitoring of
foods, and ensuring food safety by tracking of food products during distribution and storage. These tags also monitor the shelf life of food products such as meat, fruit, dairy etc. to which they are attached. The tag senses temperature and integrates it over time to determine the shelf life of a product, which can be communicated to a reader. RFID technology has also been used in monitoring the ripening of climacteric fruits during transportation and vending. Efforts are on to develop mobile apps which can be used to check whether, for instance, the packet of frozen food you are buying was kept frozen throughout its journey from the factory to the supermarket shelf! You would probably not buy the frozen food if you discovered that it thawed during storage at a warehouse or supermarket because the power went off (Kumar et al., 2009).

Another new technology is that of *Thermochromic labelling* which uses a special ink on the package of food products. These are used for products which need to be kept at certain temperatures during storage or need to be served at a particular temperature. The ink changes colour when the threshold temperature is reached informing the consumer whether the food is now safe to eat. These sensor tags slowly change after a package has been opened and indicate when the time has come to discard the food. The colour of the sensors changes more quickly if the product is not stored at the proper temperature and indicates spoilage of food due to temperature or storage abuse. It is also being used in some countries to let the consumers know for instance, whether their food is hot enough to eat or their beer is chilled enough to drink.

Use of *Internet of Things (IOT) Solution* for the food supply chain has become more relevant to the practical world due to increased use of mobile devices, cloud computing and data analytics in the recent years. The IOT refers to a type of network to connect anything with the Internet based on stipulated protocols through information sensing equipment to achieve smart recognitions, positioning, tracing, monitoring, and administration. The application of IOT in food supply chains is considered as one of the promising applications in near future to address the traceability and monitoring of the complex supply chain. Application of IOT covers all sectors of food production from farm to plate by providing real-time visibility and enables the automated, intelligent actions needed to ensure food does not get degraded or contaminated, is prepared in optimal settings and is delivered on time (Nirenjana et al, 2018).

*Block Chain Technology* is a decentralized accounting system in which entries are recorded in sequence in multiple identical “ledgers” stored on computers in multiple locations. This makes tampering with any one ledger futile, creating a highly trusted record of transactions. This technology works by integrating growers, distributors and retailers on a common blockchain which includes a trusted record of all data of a given food’s journey through the end-to-end supply chain. Through this the user can trace the origin of a “contaminated” ingredient of the product in seconds which would have taken days by tracing through mix data of written and digital records. With this capability, retailers and restaurants can remove a contaminated item from circulation almost immediately and destroy only stock that came from that particular source. A blockchain-based cloud platform has been developed for the food industry by IBM Food Trust and is already employed by major food sellers.
Food safety testing

Advancement in techniques and instruments for detecting hazards has greatly contributed to management of hazards. These have an edge over conventional methods in that they can detect much lower levels of the contaminant and with greater accuracy. Food fraud/adulteration in meat, dairy, fish, etc. can now be tested by making use of the unique DNA composition of animals. Conventional DNA based molecular techniques are generally costly, time consuming and need trained staff. These challenges can be addressed by the DNAFoil technology, which is a portable and completely self-administered, on-site DNA test that does not require expensive PCR equipment or laboratory settings to confirm detection of food adulteration and it does it in as little as 30 minutes. It is a kit test method which includes a barrel that breaks, lyses, extracts, neutralizes and stabilizes DNA from various food matrices. This extracted DNA can be amplified by using enzymes and primers which can be further detected by running on test strip. Coupling micrometer-sized beads to DNA allows the results to be visualized by the naked eye (visible color reaction), enabling instant, simple to interpret, cost-efficient, and on-site detection, while eliminating the need for advanced expensive instrumentation. These DNAFoil kits are sensitive for target contamination and can detect any level of adulteration (down to 0.01%). These kits are also tolerant to a complex, high-salt, high-fat food matrix and do not require prior DNA purification and quantitation (Sheikha, 2019).

Raman Technology based rapid tests use Raman spectroscopy (RS) and its various derivative methods. It has been widely applied in detection of various substances in food. RS is a technique specialized in measuring the frequency shift of inelastic scattered light from the sample. When the photons from incident light strike a molecule, scattering photons of different frequency appear. These scattering photons are called as Raman Scattering and Raman spectroscopy is based on the effect of Raman scattering (Weng et al, 2019). Raman Spectroscopy is old technology but now a days it is coupled with machine learning and artificial intelligence to detect adulterants in edible oils and ghee. These are handheld devices and can be used as a pre-scanning equipment to detect the adulteration, so that analysts in laboratories don’t spend time and resources to test a sample which is already pure.

BioSensors – Bioelectric Tongue and Nose are analytical instruments comprising an array of nonspecific, low-selective, chemical sensors. They are now incorporated with biosensors to improve its performance and can be used in detection and quantification of pesticides, contaminants in several food and water samples. It can also be used in monitoring the ageing of beers, determination of analytes or markers in food products and detection of spoilage microorganisms in different foodstuff. These devices are fast, reliable and easy to use and satisfy the current demand of the food sector to detect various adulterants, contaminants, flavours etc. (Ceto et al., 2016; Podrazka et al., 2018).
Future of food

With advancement of technology and strides being made in the field of food science we can look forward to new food products which are safer and more wholesome. Smart agriculture solutions are likely to boost yields. Better transport and storage will reduce food waste by letting companies monitor conditions like temperature and humidity in real time. Science based solutions which make efficient use of resources is the thrust of all innovations in the food sector.

Researchers have developed a 3D printing technology to prepare food using ingredients like millets, green gram, spices, etc. Taking just five to seven minutes to print, followed by a microwave drying process, this technology may help in customizing food according to the individuals’ requirements.

New and innovative techniques are being used to assess and manage risks. Statistics, for instance, is being used for predictive modelling of microbiological outcomes. Predictive microbiology now offers risk managers scientific tools to estimate the consequences of different food handling and processing conditions on growth, survival and inactivation of pathogenic microorganisms. They will for instance, be able to predict if the food product is still safe after being transported at a particular temperature for a specified length of time, or if the power outage during its journey would have led to the spoilage. The United States Department of Agriculture (USDA) uses predictive microbiology to manage risks across the food chain using computational resources and sophisticated statistical packages (https://portal.errc.ars.usda.gov/). Databases like ComBase are now available for big and small food companies providing information on how microbes respond to different environmental conditions and how the microbe levels change over the course of time. Initiatives to develop microbiological modelling programs have been ongoing in the United States, the United Kingdom, Denmark, France, Australia and other countries for a number of years. These programs have resulted in the development of a wide range of microbiological modelling software packages

Nutrigenomics

Nutritional genomics is a new discipline which has been formed by the integration of the study of nutrition, molecular biology and genomics. It is the science of how nutrients affect the activities of genes (nutrigenomics) and how genes affect the interactions between diet and disease (nutrigenetics). This new science teaches us what specific foods tell our genes to do. Every protein which is synthesized by the cell is a product of gene expression. Nutrients and phytochemicals can interact with genomes causing changes in their expression. At the same time, deficiency of a nutrient can hamper DNA repair and hence normal function. If we learn how our genes operate, the instructions that the genes give to the body and its metabolism, we can radically change how food interacts with our body. This information can be used to lose weight and optimise health by preventing development of diseases.

Individuals may respond differently to the same diet- whereas one individual may put on weight if given a dessert daily, another may not gain an ounce. These varied responses to diet have been attributed to differences in genetic make-up. An exploration of nutrient-gene interactions is important for determining what will be healthful for an individual and
what could result in increasing the risk of diet-related diseases. Nutrigenomics will ultimately one day help to tailor diets based on individual’s genetic make-up. Nutrigenomics can be used in the future for development of customized nutraceuticals based on specific genetic profiles.

**New food science**

Food companies are also experimenting with *plant-based meat* to prepare burgers, sausages, etc. thereby reducing carbon footprint. In addition, scientists are producing *Cultured/Lab Grown Meat*. Such meat eliminates the need to sacrifice animals by growing muscle tissue in culture from animal stem cells. Cultured/in-vitro meat can be constructed and produced faster than the traditional meat with desired characteristics. Although appreciable progress has been made during recent years, important issues, including safety, characterization of social and ethical conditions, and the development of cost-effective culture media needs to be resolved. Consumer acceptance and confidence in cultured meat might be an important obstacle that might hinder the marketing process (Kadim et al., 2015).

In the interest of reducing chemicals used in foods for preservation, the search for natural antimicrobials has proposed the use of bacteriophages (viruses) which attack and kill disease causing bacteria. Studies have also proposed a cocktail of viruses to be consumed to tackle foodborne illness. This alternative approach uses lytic bacteriophages for managing bacterial infections. Although, antibiotics are an important way to manage diseases caused by pathogens, they kill beneficial microbes in the human gut system. Also, many bacteria are developing resistance to antibiotics, which makes the treatment more complicated (Moye et al, 2018).

**Gastronomic tourism**

Gastronomic tourism has become a major and rapidly growing component of the attractiveness of tourist destinations. People wishing to experience the local tastes in other countries or different states of their country, travel just for the gastronomic experience. The tourism industry is also rising to the expectations of tourists by organising gastronomic tours for experiencing the local cuisine. Such tours consist not only of food guides taking people to restaurants, but also organising cooking demonstrations, cooking classes, visits to vineyards, local food manufacturers and other kinds of culinary experiences. With the growth in this kind of tourism comes the immense responsibility of all stakeholders in providing safe and wholesome food to tourists. With street foods being a major attraction in most cities, creation of Street Food Hubs which provide safe food is an important step in promoting gastronomic tourism. These hubs have been certified by FSSAI after imparting vendors with the necessary training and capacity building.

While special efforts are being made to promote traditional cuisines and revive ancestral recipes, equal strides are being made in exploring new tastes and enhancing flavours of existing dishes. *Molecular gastronomy* is a scientific discipline which looks at the science behind food preparation- the physical and chemical transformations which take place during cooking of food. The knowledge is now being used to create new dishes and culinary techniques. Various new recipes have made their way to restaurant menus using
new ingredients or processing methods for preparation and food service. For instance, ice
creams and cocktails served with liquid nitrogen are increasing becoming popular. While
these foods are very attractive to look at and tickle the palates with new taste sensations,
this experimentation needs to be done with great care and diligence. The dish shouldn't
turn into a chemical experiment which is unmindful of the safety or the wholesomeness of
the food (Cousins et al., 2010; Gheorghe et al. 2014; This, 2013).

Fake news and role of media

Need a question to be answered? The internet offers opportunities to access a lot of
information. Although there is a lot of good quality nutrition information available, there is
abundance of misleading or inaccurate information as well. Social as well as other forms of
media are also full of information. You may often find it difficult to distinguish valid nutrition
information from misinformation. A good way to know is to look at the source of information –
can the source be trusted? The person/body providing the nutrition information should
be qualified to do so. Box 2 lists some pointers for you to discern whether a website is
reliable.

<table>
<thead>
<tr>
<th>Box 2: Is this website reliable? Questions to ask</th>
</tr>
</thead>
<tbody>
<tr>
<td>To determine whether a website is reliable to offer nutrition information, ask the following questions:</td>
</tr>
<tr>
<td>1. Where is the information coming from? The web address generally gives a clue. Web addresses ending in ‘gov’ usually belong to the government, ‘edu’ are associated with educational institutes and ‘org’ belong to organizations. These are generally reliable. The ones ending in ‘com’ represent businesses and one would need to check on their credentials.</td>
</tr>
<tr>
<td>2. Who is giving the information? Is the author a qualified professional? Has the information been reviewed by experts in the field or is it just someone’s blog or personal view on the subject?</td>
</tr>
<tr>
<td>3. When was the website last updated? The website could have out-dated information. Nutrition is an ever-changing science, what is valid today may not be applicable a few years later.</td>
</tr>
<tr>
<td>4. Why is the website providing this information? Is the information there for public good or does the organization/business have a commercial interest like selling a product?</td>
</tr>
<tr>
<td>5. What is the message? Read beyond the headline/caption and see the details of the article. Is the information in agreement with other reliable sources of information or contradicting common knowledge? If it goes against the existing knowledge, then it is advisable to cross-check with other resources as well.</td>
</tr>
</tbody>
</table>

Hazard of fake news

Fake news consists of deliberate misinformation spread through traditional news media or
social media. Digital media has increased the spread of fake news. Fake news is written and
published usually with the intent to mislead in order to damage an agency, entity, or person,
and/or gain financially or politically, often using sensationalist, dishonest, or outright
fabricated headlines to increase readership. For media outlets, the ability to attract viewers
to their websites is necessary to generate online advertising revenue. Publishing a story
with false content that attracts users, benefits the advertisers and improves their ratings.
Some news items tell a lopsided story, basing it on results of a single research study or without a balance of expert opinions. As a result, the news item may become controversial. Tight deadlines and limited understanding of the scientific aspects of research studies may lead to inaccurate reporting which misleads the consumer and creates confusion. Box 3 highlights some red flags for identifying fake news on social media.

### Box 3: Red flags for Fake News/Information on Social Media

These are some pointers to look for to know that the information circulated on social media is fake news:

- News is sensational and you have never heard about it from reliable sources. For instance, miracle cures attributed to a food product or claims that a food product in circulation has been made from non-edible harmful substances.
- The sender asks you to ‘Forward to all the people you know’.
- The message is forwarded, and you don’t have a clue as to who is the original sender and whether they are a subject expert.
- The message has been debunked on websites.

### Responsibility of media

The media is a very powerful entity as it moulds public opinion. Fake news in any kind of media whether mass media or social media has in the past triggered riots and violence. Fabricated and exaggerated claims in the media are not just related to politics but from time to time one has come across news related to public health and nutrition. Such kind of news or claims are not just misleading but also damaging to health. They create a lot of mistrust and erode the trust placed in media.

In 2018, several newspapers reported of a WHO advisory that ‘if adulteration of milk and milk products is not checked immediately, 87% of citizens would be suffering from serious diseases like cancer by the year 2025 (in India)’. FSSAI had ascertained that no such advisory was issued by the WHO at all and FSSAI or WHO were not even approached for clarifications.

It is hence the responsibility of the media houses and social media platforms to clamp down on fake news. Media needs to increase coverage on aspects of food safety and nutrition which educate the public about eating safe and healthy food. However, there have been many instances of circulation of false and malicious videos on various social media platforms on safety and quality of food available in the country. It is a matter of serious concern as it leads people to believe that most of the food available in the country is unsafe (see box 4).
False propaganda is neither good for citizens nor for food businesses. It also erodes global trust in our food system and food businesses, and potentially has far reaching public health, social and trade implications. Press Council of India has issued an advisory to all the media houses, to verify all facts before publishing any news related to food safety.

Summary

- Changes in the food consumption behaviour, globalization, new technologies of food production, increasing mobility of population, climate change and a greater strain on the public health infrastructure have led to the emergence of newer food safety issues.

- Emerging pathogens of concern are those pathogens which are either causing a new illness or the number of cases is now increasing sharply, or they are spreading the disease over a wider geographical area.

- Multidrug resistant microbes like Salmonella, Brucella, etc. are causing major problems. Outbreaks due to Listeria are increasing in recent years. Cryptosporidium parvum, Cyclospora cayetanensis, Campylobacter jejuni, Non-typhoidal strains of Salmonella, avian influenza viruses, Toxoplasma gondii, Shigella, Vibrio parahaemolyticus, Yersinia enterocolitica, etc. are some emerging biological hazards.
• Uncontrolled use of growth hormones and antibiotics, environmental contaminants such as Persistent bioaccumulative toxins, chemicals leaching from plastics, newspapers, packaging materials etc. are some examples of emerging chemical hazards.

• In an attempt to stave off diet-related chronic diseases, people are looking for quick solutions like fad diets or superfoods. Unless coupled with healthy lifestyle changes and balanced and wholesome diets, these trends can result in adverse health effects.

• Advancements in technology have helped tackle some challenges related to the food sector. Improved processing technologies, better methods of transporting, storing and packaging have led to safer food with better shelf life.

• Radiofrequency Identification (RIFD) Technology is increasingly being used to trace products in the supply chain. Thermochromic labelling which uses a special ink are used for products which need to be kept at certain temperatures during storage. Block chain technology is a decentralized accounting system in which entries are recorded in sequence in multiple identical "ledgers" stored on computers in multiple locations. This makes tampering with any one ledger futile, creating a highly trusted record of transactions.

• Advancements in techniques and instruments for detecting hazards has greatly contributed to management of hazards.

• Predictive microbiology is used as a scientific tool to estimate the consequences of different food handling and processing conditions on growth, survival and inactivation of pathogenic microorganisms.

• Nutrigenomics as a science can one day help to tailor diets based on individual’s genetic make-up and for development of customized nutraceuticals based on specific genetic profiles.

• Gastronomic tourism has become a major and rapidly growing component of the attractiveness of tourist destinations.

• With advancement of technology and strides being made in the field of food science we can look forward to new food products which are safer and more wholesome. Science based solutions which make efficient use of resources is the thrust of all innovations in the food sector.

• Fake news consists of deliberate misinformation spread through traditional news media or social media. False propaganda is neither good for citizens nor for food businesses. It also erodes global trust in our food system and food businesses, and potentially has far reaching public health, social and trade implications.
Key Terms

**Gastronomic tourism** - food guides taking people to restaurants, but also organising cooking demonstrations, cooking classes, visits to vineyards, local food manufacturers and other kinds of culinary experiences.

**Microplastics** – extremely small pieces of plastic debris in the environment

**Molecular gastronomy** - is a scientific discipline which looks at the science behind food preparation- the physical and chemical transformations which take place during cooking of food.

**Nutrigenomics** - as a science can one day help to tailor diets based on individual’s genetic make-up and for development of customized nutraceuticals based on specific genetic profiles.

**Predictive microbiology** - is used as a scientific tool to estimate the consequences of different food handling and processing conditions on growth, survival and inactivation of pathogenic microorganisms

Exercises

1. Define emerging food safety issues and discuss factors responsible for their emergence.
2. Describe the important emerging microbial and chemical hazards giving suitable examples.
3. Define Antimicrobial Resistance. Why is resistance to antibiotics a problem in India?
4. What is Radiofrequency Identification (RIFD) Technology? How is it useful in Food traceability?
5. Define Nutrigenomics and discuss its role in personalized nutrition.
6. What do you understand by Gastronomic Tourism?
7. Define role and responsibilities of media in addressing the problem of fake news.
8. Describe some advancements which have been made in food safety testing.

Activity

Do a literature review and list some breakthroughs in food processing/ packaging/ food testing technology.
References


16. This, H. (2013). Molecular gastronomy is a scientific discipline and note by note cuisine is the next culinary trend. Flavour, 2(1), 1.

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<td>Advanced Glycation End</td>
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<tr>
<td>AGMARK</td>
<td>Agriculture Marketing</td>
</tr>
<tr>
<td>AIDS</td>
<td>Acquired Immunodeficiency Syndrome</td>
</tr>
<tr>
<td>AO</td>
<td>Adjudicating officer</td>
</tr>
<tr>
<td>AOAC</td>
<td>Association of Official Analytical Chemists</td>
</tr>
<tr>
<td>APEDA</td>
<td>Agricultural and Processed Food Products Export Development Authority</td>
</tr>
<tr>
<td>BHOG</td>
<td>Blissful Hygienic Offering to God</td>
</tr>
<tr>
<td>BIS</td>
<td>Bureau of Indian Standards</td>
</tr>
<tr>
<td>BPA</td>
<td>Bisphenol A</td>
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<td>BSE</td>
<td>Bovine spongiform encephalopathy</td>
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<td>CAC</td>
<td>Central Advisory Committee</td>
</tr>
<tr>
<td>CAGR</td>
<td>Compound Annual Growth Rate</td>
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<tr>
<td>CEO</td>
<td>Chief Executive Officer</td>
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<td>CFTRI</td>
<td>Central Food Technological Research Institute</td>
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<td>CIFT</td>
<td>Central Institute of Fisheries Technology</td>
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<td>CII</td>
<td>Confederation of Indian Industry</td>
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<tr>
<td>COVID-19</td>
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<td>CSR</td>
<td>Corporate Social Responsibility</td>
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<td>DALY</td>
<td>Disability Adjusted Life Years</td>
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<td>DART</td>
<td>Detect Adulterants with Rapid Tests</td>
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<td>DDT</td>
<td>Dichlorodiphenyltrichloroethane</td>
</tr>
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<td>DDWS</td>
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<td>DES</td>
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<td>DMI</td>
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<td>DNA</td>
<td>Deoxyribonucleic Acid</td>
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<td>DO</td>
<td>Designated Officers</td>
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<td>DON</td>
<td>Dissolved Organic Nitrogen</td>
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<td>DWSSC</td>
<td>Domestic Workers’ Sector Skill Council</td>
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<td>EAST</td>
<td>Easy, Attractive, Social and Timely</td>
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<td>FoSCoRIS</td>
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<td>FSA</td>
<td>Food Systems Approach</td>
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<td>GAP</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>GHP</td>
<td>Good Hygiene Practices</td>
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<td>GI</td>
<td>Geographical Indicators</td>
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<td>GMP</td>
<td>Good Manufacturing Practices</td>
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<td>GVP</td>
<td>Good Veterinary Practices</td>
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<td>HACCP</td>
<td>Hazard Analysis and Critical Control Point</td>
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<td>HEIs</td>
<td>Higher Education Institutes</td>
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<td>HIV</td>
<td>Human Immunodeficiency Virus</td>
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<td>Human resources</td>
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<td>Indian Council of Agricultural Research</td>
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<td>ICDS</td>
<td>Integrated Child Development Services</td>
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<td>ICE-GATE</td>
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<td>IFTTC</td>
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<td>kcal</td>
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<td>MDM</td>
<td>Mid-Day Meal</td>
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<td>MOFPI</td>
<td>Ministry of Food Processing Industries</td>
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<td>MoU</td>
<td>Memorandum of Understanding</td>
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<td>MPEDA</td>
<td>Marine Products Export Development Authority</td>
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<td>MPRNL</td>
<td>Monitoring of Pesticide Residues at National Level</td>
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<td>Maximum Residue Limit</td>
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<td>MSME</td>
<td>Micro, Small and Medium Enterprises</td>
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<td>NABL</td>
<td>National Accreditation Board for Testing and Calibration Laboratories</td>
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<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
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<td>NCCP</td>
<td>National Codex Contact Point</td>
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<td>NCDC</td>
<td>National Centre for Disease Control</td>
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<td>NCR</td>
<td>Non-Conforming Report</td>
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<td>NetCOFaN</td>
<td>Consumer Organization Network</td>
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<tr>
<td>NetProFaN</td>
<td>Network of Professionals in Food and Nutrition</td>
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<td>NGO</td>
<td>Non-governmental Organization</td>
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<td>NHANES</td>
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<td>National Nutrition Mission</td>
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<td>PAH</td>
<td>Polycyclic Aromatic Hydrocarbons</td>
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<td>PCB</td>
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<td>parts per billion</td>
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<td>Polyvinyl chloride</td>
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<td>Repurpose Used Cooking Oil</td>
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<td>Safe and Nutritious Food</td>
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<td>SOP</td>
<td>Standard Operating Procedure</td>
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<td>SWIFT</td>
<td>Single Window Interface for Facilitating Trade</td>
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<td>TSE</td>
<td>Transmissible Spongiform Encephalopathies</td>
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<td>TVC</td>
<td>Television Commercial</td>
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<td>Union Territory</td>
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<td>WASH</td>
<td>Water, Sanitation and Hygiene</td>
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<td>WHO</td>
<td>World Health Organization</td>
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