Chapter 19: Approaches to a Sustainable Food System

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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:

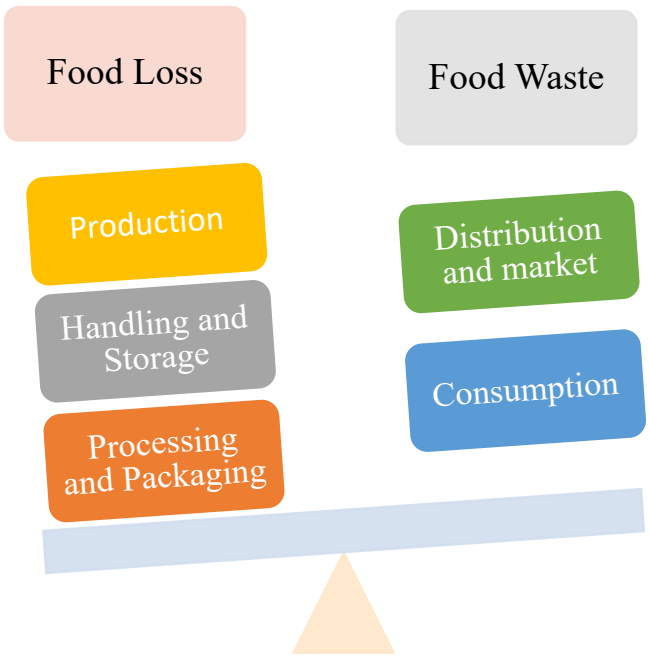

Figure 19. 1: Schematic representation of Food Loss and Waste at different stages of food chain.

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. 1: Comparison of Food Loss and Waste in Developing vs. Developed Countries

Parameters	**Food Supply Chain**	**Developing country**	**Developed country**
Food Loss (%)	Production	14	11
	Handling and Storage	15	9
	Processing and Packaging	1	1
Food Waste (%)	Distribution and market	8	6
	Consumption	6	29
Total Food Loss and Waste (%)		44	56

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

Food Commodity	Losses (%)
Grains (Cereals)	4.6-6
Fruits and Vegetables	4.6-15.9
Dairy	0.9
Meat	2.7
Fish	5.2 (Inland) 10.5 (Marine)
Poultry	7.2 (Egg) 6.7 (Poultry meat)

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

Stage	Strategy
Production Stage	• Government investments in infrastructure • Improve harvesting techniques • Improve market access • Organize extension services and educate farmers • Increase tax incentives for donating unsellable edible foods.
Handling and Storage Stage	• Improve transportation facilities • Provide access to cheap handling and storage technologies • Invest in storage facilities (warehouses, cold storage, etc.) • Improve the ability and knowledge of workers to employ safe food handling practice • Use of appropriate and clean containers for the products.
Processing and Packaging Stage	• Improve capacity of process line • Improve packaging to keep food fresher for longer

Stage	Strategy
	• Standardize date labels to prevent consumer confusion • Establish other ways to use peels and trimmings • Improve the knowledge and ability of workers • Facilitate sanitary and cleaning inspections.
Distribution and Marketing Stage	• Improve inventory systems • Establish online marketplaces to facilitate sale (donation) of perishable products • Change food date labeling practices and in-store promotions Improve institutions related to this stage • Improve transportation vehicles • Provide guidance on storage and preparation of food to consumers • Improve the knowledge and ability of workers • Improve market places (storage, covered areas) • Interlink with research institutions to predict consumer demand changes.
Consumption Stage	• Facilitate increased donation of unsold foods from cafeterias and restaurants • Implement consumer education and campaigns, both nationally and regionally • Reduce portion sizes Provide education about home economics in education institutions and communities • Involve women in food safe campaigns • Effective use of leftovers Training for restaurant, cafeteria, and supermarket management to forecast customer demand and reflect demand in food purchasing to avoid bulk purchases • Implement good storage practices • Correctly interpret label dates; Distribution of excess food to charitable groups

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).

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.

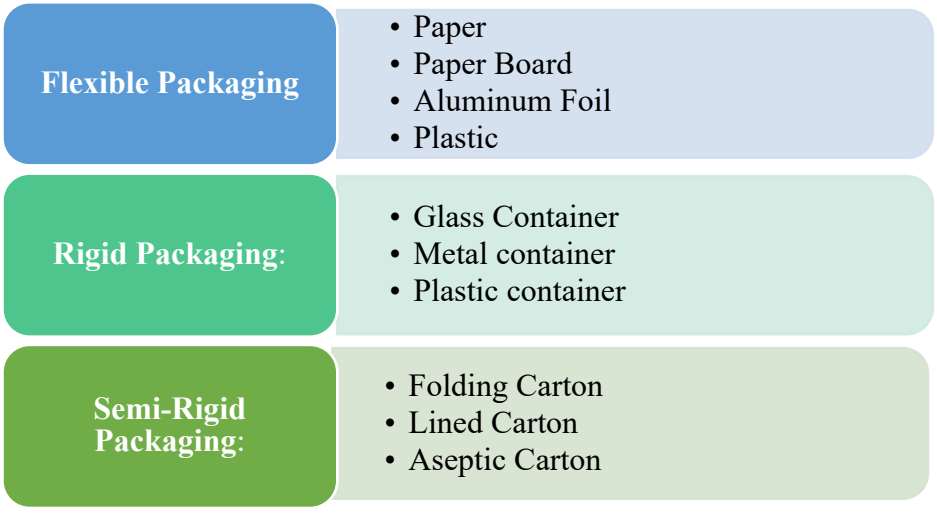

Figure 19. 3: Different kinds of packaging materials

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.

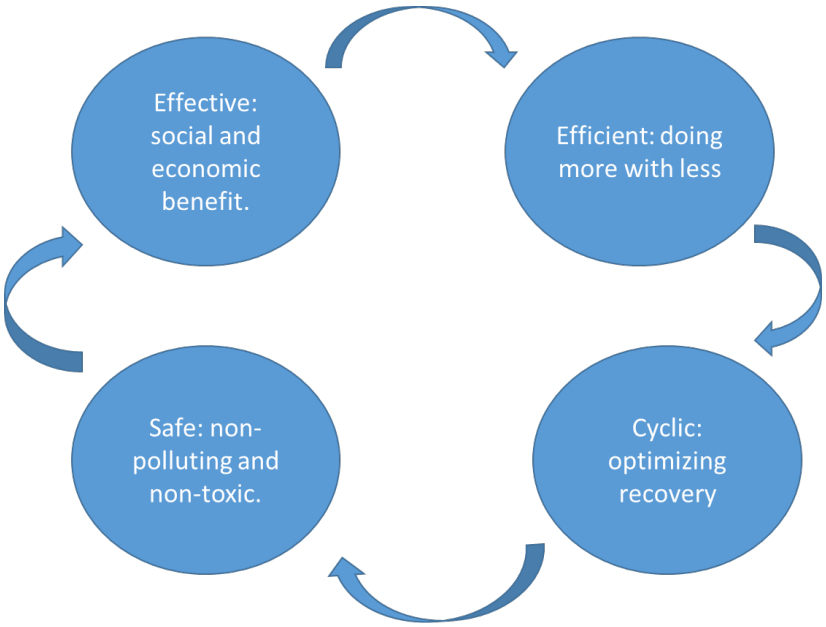

Figure 19. 4: Principles of Sustainable Packaging

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 (ε-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.

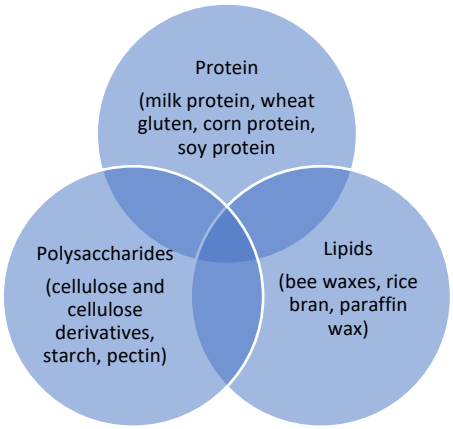

Figure 19. 5: Materials for making Edible films

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 by20305; a 53% increase in water extraction (WRAP UK, 2014).

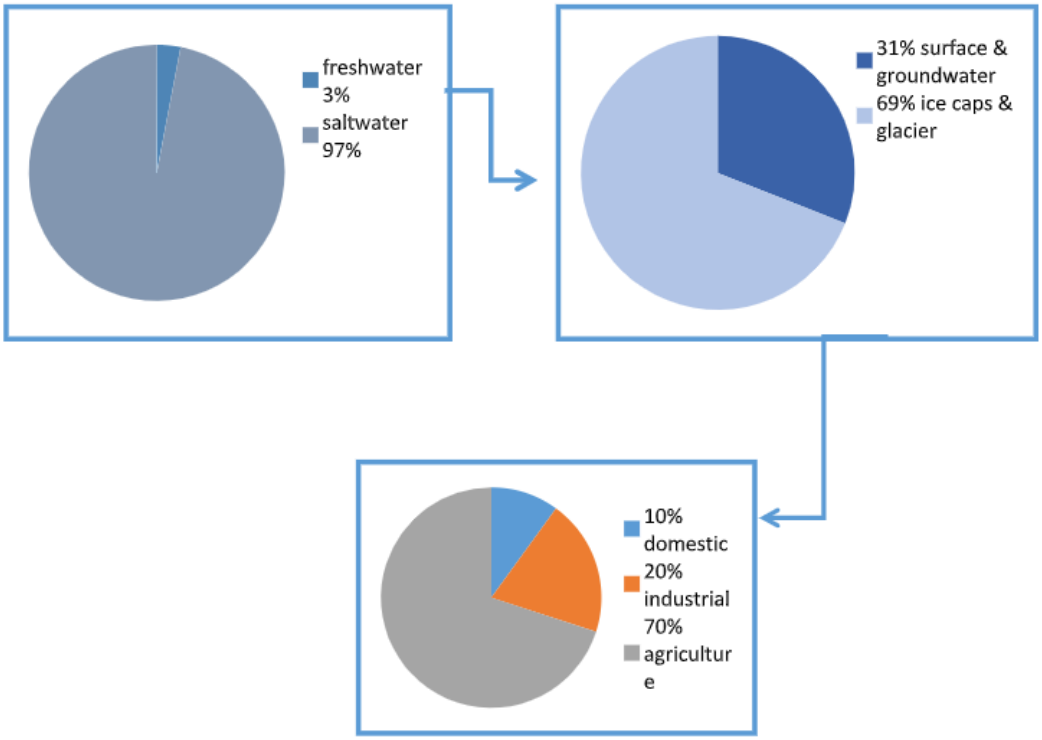

Figure 19. 6: World total stored water and its usage

Source: *Institution of Chemical Engineers (IChemE), Green Paper*

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

- Leaks
- Sanitary use
- Waste streams
- Laundry
- Minimizing Water Use

Four main areas in food-processing facilities should be considered for minimizing water use (figure 7):

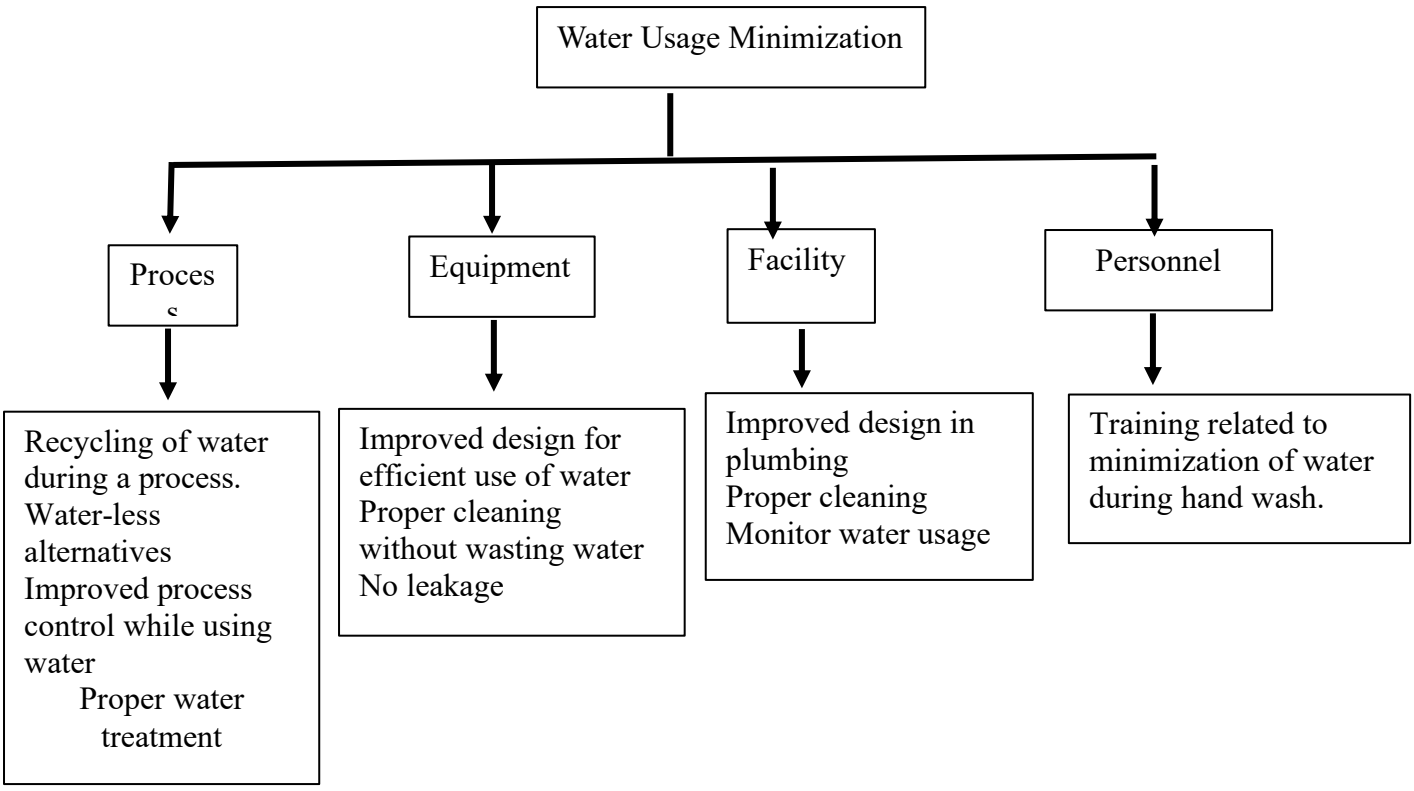

Figure 19. 7: Areas where water use can be minimized in a food industry

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.

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Useful Weblinks

Reducing food loss and waste. http://www.fao.org/save-food/resources/keyfindings/en/ and click 'infographics' for additional information.