MANAGEMENT OF HAZARDS IN FOOD

Food Safety and Hygiene becomes an emerging demand in the food industry and is a universal concern. Therefore, maintaining food safety & hygiene is a compelling requisite for food entrepreneurs to sustain in today's competitive market.
The International Organization for Standardization created ISO 22000 standard to manage food safety and security and specifies the essentials for a **food safety management** system that involves:

- Interactive communication
- System management
- Prerequisite programs
- HACCP principles (Hygiene analysis and critical control points)

The food safety management system identifies, evaluates, and controls food hazards, at all levels of the food supply chain; be it during ingredient supply, food preparation, packaging, storage, transportation, etc.

- **Food safety and hygiene** are crucial to reducing the risk of food-borne illnesses that may cause through biological hazards such as pathogenic bacteria, viruses, and parasites, or chemical hazards or natural toxins.
- If the food safety guidelines are not followed precisely, people can fall sick and may even lead to death.
- If the food is improperly stored, handled, cooked, or refrigerated, bacteria can grow leading to food contamination.
- At times, there would be issues like product recall, where seller may request consumers to return a product after the discovery of any product defects or safety issues that might endanger the consumer or put the seller at risk of legal action

Hence, complying food safety guidelines is essential to maintain the quality as well as the shelf life of the food products.
An effective food safety management system that is based on seven principles of HACCP can help businesses to identify and control hazards before they threaten the safety of your food and customers.

The **seven principles of HACCP** include

Hazard Analysis

Hazard Analysis is a preventive approach to food safety, which identifies biological, chemical, and physical hazards in the production process that may lead to an unsafe finished product and defines controls to reduce these uncertainties to a safe level.

Critical Control Point (CCP)

The points that can be applied at stages of the process to eliminate or reduce the hazards to an acceptable (critical) level. Say, for example, if rice is cooled too slowly, it may result in food poisoning. Here, cooling is the critical control point.

Critical Limits

The safety limits that determines a maximum and minimum value for each CCP. It separates the acceptable (safe) product from the unacceptable (unsafe) product. Critical limits can be monitored by measurement or observation. Example – Time, Temperature, Chemical, etc.

Monitoring

Monitoring procedures include observations or measurements to assess whether the CCP is being met. And that appropriate steps are being followed to ensure food safety.

Corrective Action

The actions that need to take if there is any deviation from the established critical limit. Corrective actions ensures that the products are not injurious to health or otherwise adulterated as a result of the deviation enter commerce

Verification
The important aspect of verification is to determine that the food safety management plan is properly implemented and all the hazards were identified. Verification monitors whether the plan & guidelines are functioning as designed and are effective.

Record Keeping & Documentation
Record Keeping & Documentation contains complete records & forms to show that checks have been carried out at appropriate intervals in line with the Food Safety Policy. The food industries can be audit ready by following the appropriate documentation & record keeping procedures.

The food hygiene and safety management software solution like ionhaccp will help food industries to handle, store, and sell safe food to customers while ensuring compliance with the necessary standards like Safe Quality Food (SQF) initiative, Hazard Analysis and Critical Control Points (HACCP), and ISO 22000.

Food safety management tools

The management of microbiological hazards for can be divided into five steps

1) Conduct a risk assessment: The risk assessment and consequential risk management decisions provide a basis for determining the need to establish microbiological safety objectives.

2) Establish food safety objectives: A microbiological food safety objective is a statement of the maximum level of a microbiological hazard considered acceptable for consumer protection. These should be developed by governmental bodies with a view to obtaining consensus with respect to a food in international trade.

3) Achievable food safe& objectives: The food safety objectives should be achievable throughout the food chain. They can be applied through the general principles of food hygiene and any product specific codes and HACCP systems. The HACCP requirements must be developed by the food industry.

4) Establish microbiological criteria, when appropriate: This must be performed by an expert group of food microbiologists.

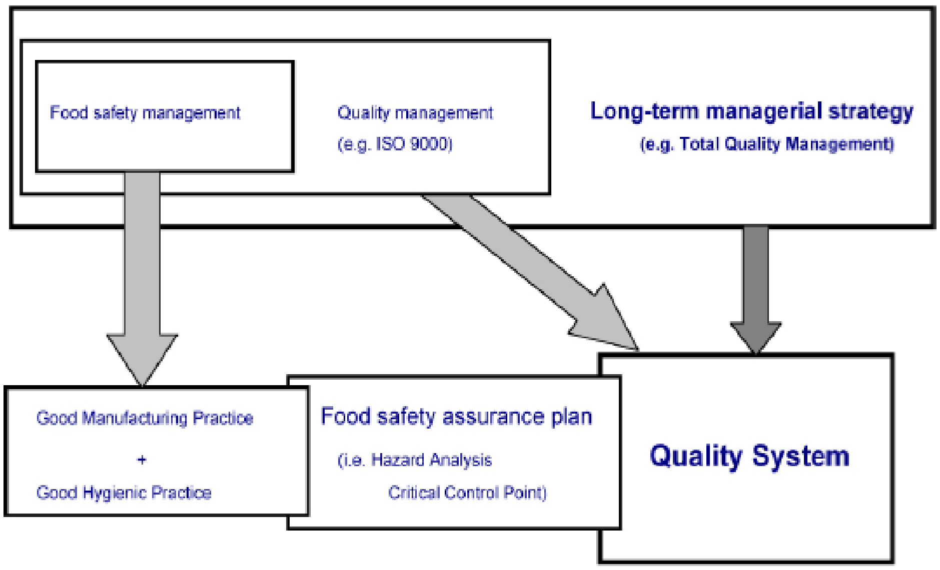
5) Establish acceptance procedures for the food at port *of* entry: A list of approved suppliers as determined by inspection of facilities and operations, certification, microbiological testing and/or other testing such as pH and water activity measurements.

Hazard Analysis Critical Control Point (HACCP)
Most food poisoning can be prevented by the application of the basic principles of food hygiene throughout the food chain. This is achievable through:
(1) Education and training of food handlers and consumers in the application of safe food production practices.
2) Inspection of premises to ensure consistent hygienic practices are adhered to.
3) Microbiological testing for the presence or absence of foodborne pathogens and toxins.

HACCP can be applied throughout the food chain from primary production to final consumption and its implementation should be guided by scientific evidence of risks to human health. **As** well as enhancing food safety, implementation of HACCP can provide other significant benefits.
In addition, the application of HACCP systems can aid inspection by regulatory authorities and promote international trade by increasing confidence in food safety.

Outline of HACCP
In order to produce a safe food product with negligible levels of food borne food pathogens and toxins, three controlled stages must be established:
(1) Prevent microorganisms from contaminating food through hygienic production measures. This must include an examination of ingredients, premises, equipment, cleaning and disinfection protocols and personnel.

2) Prevent microorganisms from growing or forming toxins in food. This can be achieved through chilling, freezing or other processes such as reduction of water activity or pH. These processes, however, do not destroy microorganisms.
3) Eliminate any foodborne microorganisms, for example by using a time and temperature processing procedure or by the addition of suitable preservatives.



Food safety management tools (

Seven principles of HACCP

Principle 1
Conduct a hazard analysis. Prepare a list of steps in the process where significant hazards occur and describe the preventative measures.
The HACCP team should list all of the hazards that may reasonably be expected to occur at each step from primary production, processing, manufacture and distribution until the point of consumption. The evaluation of hazards should include:
- The likely occurrence of hazards and severity of their adverse health effects.
- The qualitative and/or quantitative evaluation of the presence of hazards.
-Survival or multiplication of the microorganisms of concern.
-Production or persistence in foods of toxins, chemicals or physical agents.
-Conditions leading to the above.

***Principle** 2*
Identify the Critical Control Points (CCPs) in the process.
The HACCP team must identify the Critical Control Points (CCP) in theproduction process which are essential for the elimination or acceptable reduction of the hazards which were identified in principle 1.

A series of questions is answered, by making a decision tree, which lead to the decision as to whether the control point is a CCP. A CCP must be a quantifiable procedure in order for measurable limits and monitoring to be achievable in principles 3 and ***4.*** If a hazard is identified for which there is no control measure in the flow diagram, then the product or process should be modified to include a control measure.

Principle 3

Establish Critical Limits for preventative measures associated with each identified CCP.

Critical Limits must be specified and validated if possible for each CCP. The Critical Limit will describe the difference between safe and unsafe products at the CCP. The Critical Limit must be a quantifiable parameter: temperature, time, pH, moisture or a,, salt concentration or titratable acidity, available chlorine.

Principle 4

Establish CCP monitoring requirements. Establish procedures from the results of monitoring to adjust the process and maintain control.

Monitoring is the scheduled measurement or observation of a CCP relative to its critical limits. The monitoring procedures must be able to detect loss of control at the CCP. Monitoring should provide the information in time (ideally on-line) for correcting the control measure. Ideally by following the trend in measured values then correction can take place before deviation from the critical limits.
Physical and chemical measurements are often preferred to microbiological testing because they may be done rapidly and can often indicate the microbiological control of the product. Microbiological testing based on single samples or sampling plans will be of limited value in monitoring those processing steps which are CCPs, this is mainly because the conventional microbiological methods are too time consuming for effective feedback.
All records and documents associated with monitoring CCPs must be signed by the person(s) doing the monitoring and by a responsible reviewing official(s) of the company.

Principle 5

Establish corrective actions to be taken when monitoring indicates a deviation from an established Critical Limit.

Specific corrective actions must be developed for each CCP in order to deal with deviations from the Critical Limits. The remedial action must ensure that the CCP is under control and that the affected product is appropriately recycled or destroyed as appropriate.

Principle 6

Establish procedures for verification that the HACCP system is working correctly.

Verification procedures must be established. These will ensure that the HACCP plan is effective for the current processing procedure. NACMCF (1992) gives four processes in the verification of HACCP:
(1) Verify that Critical Limits at CCPs are satisfactory.
(2) Ensure that the HACCP plan is functioning effectively.
(3) Document periodic revalidation, independent of audits or other verification procedures.
(4) It is the government's regulatory responsibility to ensure that the HACCP system has been correctly implemented.

The frequency of verification should be sufficient to confirm that the HACCP system is working effectively. Verification and auditing methods, procedures and tests, including random sampling and analysis, can be used to determine whether the HACCP system is working correctly.

Principle 7

Establish effective record-keeping procedures that document the HACCP system.

HACCP procedures should be documented. Records must be kept to demonstrate safe product manufacture and that appropriate action has been taken for any deviations from the Critical Limits.

Temperature control of microbiological hazards

The cooking step is an obvious CCP for which Critical Limits of temperature and time can be set, monitored and corrected. The time and temperature of the cooking process should be designed to give at least a **6** log kill of vegetative cells, that is 10^7 cells reduced to 10 cells**.** It will not kill spores and hence the time required to cool the food to a safe temperature needs to be monitored to prevent spore outgrowth.

A list of time and temperature equivalencies is given in Table below.

Equivalent cooking time and temperature regimes (Department of Health, UK).

Temperature (°C)[a]	Time
60	45 minutes
65	10 minutes
70	2 minutes
75	30 seconds
80	6 seconds

[a] To convert to °F use the equation °F = (9/5)°C + 32. As a guidance: 60°C = 140°F.

An example of the effect of cooking temperature on the survival of ***E.coli*** 0157:H7 is given in Table below. It can be seen that accurate temperature monitoring is necessary since the relationship of cell death to temperature is logarithmic. In other words, a small decrease in cooking temperature can result in considerable numbers of cells surviving the process.

Effect of cooking temperature on the survival of *E. coli* O157:H7.

Temperature (°C)	Time for viable count to be reduced by 6 log cycles[a] (min)
58.2	28.2
62.8	2.8
67.5	0.28

[a] For example 10^7 cfu/g to 10 cfu/g.
Data taken from Table 2.3; $D_{62.8} = 0.4$, $z = 4.65$.

The cooling period must be short enough to prevent spore outgrowth and germination from mesophilic ***Bacillus*** and ***Clostridium*** spp. Notably, the cooking process would create an anaerobic environment in the food which is ideal for ***Clostridium*** spp.

The control of the holding temperature of foods after processing and before consumption is crucial for safe food production. General recommended holding temperatures are:
Cold served foods < 8°C
Hot served foods > 63°C
At cold serve temperatures (< 8°C) Clostridium spp. are not a problem since they do not grow below 10°C. ***St.*** aureus produces toxins above 10°C, but is able to multiply down to 6.l"C. Subsequently temperature abuse can lead to St. aureus growth and toxin production. Since ***St.*** aureus toxin is not inactivated by reheating to 72"C, St. aureus toxin production must be prevented. Chilled foods should be stored below 33°C to assure safety from spore germination and subsequent toxin production by Cl. botulinum .

STORING FOOD

INSTRUCTIONS:

Employees who will be receiving and storing food maintain the storage areas, including dry, refrigerated and freezer storage, by following these steps:

Storage Upon Receiving:

1. Place foods in the proper storage area (refrigerator or freezer) quickly to avoid bacterial growth.
    - 41°F or lower – refrigerator temperatures
    - 0°F or below – freezer temperatures
    - 50° to 70°F at 50 to 60% humidity – dry storage temperatures

2. Place foods into appropriate storage areas immediately upon receipt in the following order:
   - Refrigerated foods
     Store foods in designated refrigerators. If food products are stored together in a refrigerator, they should be placed on shelves in the following order:
     - Prepared or ready-to-eat foods (top shelf)
     - Fish and seafood items
     - Whole cuts of raw beef
     - Whole cuts of raw pork
     - Ground or processed meats
     - Raw poultry (bottom)
   - Frozen foods
   - Dry foods
3. Keep all food items on shelves that are at least 6" above the floor to facilitate air circulation and proper cleaning.
4. Store food out of direct sunlight.
5. Use First In First Out (FIFO) rotation of products in all storage areas to assure that oldest products are used first. Products with the earliest use-by or expiration dates are stored in front of products with later dates. Mixing old food with new food is not acceptable.
7. Make sure items are dated with receiving date and/or use-by date.
8. Store food in original container if the container is clean, dry, and intact. If necessary, repackage food in clean, well-labeled, airtight containers. This also can be done after a package is opened. Food is NEVER put in chemical containers and chemicals are NEVER placed in food storage containers.

Storeroom sanitation:

1. Maintain clean and uncluttered storage areas. Storage areas should be positioned to prevent contamination from areas where garbage is stored.
2. Dispose of items that are beyond the expiration or "use by" dates.
3. Store all items on shelves at least 6" above the floor to facilitate air circulation and proper cleaning.
4. Check for signs of rodents or insects. If there are signs of the presence of rodents or insects, notify the maintenance or the person in charge.

Temperature Control:

1. Check the temperatures of all refrigerators, freezers, and dry storerooms at the beginning of each shift. This includes both internal and external thermometers, where appropriate.
   - Refrigerator temperatures should be between 36 and 41ºF.
   - Freezer temperatures should be between -10 and 0ºF.
   - Storeroom (dry storage) temperatures should be between 50 and 70ºF.
2. Record cold storage unit temperatures on the appropriate temperature log.
3. Notify designated person immediately of any unacceptable temperatures.
4. Limit overloading refrigerated storage areas, as this prevents air flow and makes the unit work harder to stay cold.
5. Use caution when cooling hot food in the refrigerator, as this warms the unit and can put other foods into the temperature danger zone.

6. Keep units closed as much as possible to maintain proper temperatures.
7. Defrost all units on a regular schedule to aid in proper maintenance and air circulation.

MONITORING AND RECORDKEEPING:

1. Designated person will keep logs for all cold storage units. All corrective action will be noted on temperature logs.
2. Temperature logs will be reviewed by person in charge to make sure there are no temperature deviations and necessary corrective action was taken.
3. Follow up on all reported problems.
4. Monitoring logs will be kept: ☐ Minimum required by federal regulation (a period of six months following a month's temperature records) or ☐ One school year from the date of the second annual food safety inspection (DPI recommendation).

CORRECTIVE ACTION:

Discard any potentially (Time/Temperature Control for Safety Food) stored at conditions that render the product unsafe to eat. Re-train employees or volunteers.

PHYSICAL METHODS TO CONTROL MICROORGANISMS

For thousands of years, humans have used various physical methods of microbial control for **food preservation**. Common control methods include the application of high temperatures, radiation, filtration, and desiccation (drying), among others. Many of these methods nonspecifically kill cells by disrupting membranes, changing membrane permeability, or damaging proteins and nucleic acids by denaturation, degradation, or chemical modification. Various physical methods used for microbial control are described in this section.

Heat

Heating is one of the most common—and oldest—forms of microbial control. It is used in simple techniques like cooking and **canning**. Heat can kill microbes by altering their membranes and denaturing proteins. The **thermal death point (TDP)** of a microorganism is the lowest temperature at which all microbes are killed in a 10-minute exposure. Different microorganisms will respond differently to high temperatures, with some (e.g., endospore-formers such as *C. botulinum*) being more heat tolerant. A similar parameter, the **thermal death time (TDT)**, is the length of time needed to kill all microorganisms in a sample at a given temperature. These parameters are often used to describe sterilization procedures that use high heat, such as **autoclaving**. Boiling is one of the oldest methods of moist-heat control of microbes, and it is typically quite effective at killing vegetative cells and some viruses. However, **boiling** is less effective at killing endospores; some endospores are able to survive up to 20 hours of boiling. Additionally, boiling may be less effective at higher altitudes, where the boiling point of water is lower and the boiling time needed to kill microbes is therefore longer. For these reasons, boiling is not considered a useful sterilization technique in the laboratory or clinical setting.

Pasteurization

Boiling and autoclaving are not ideal ways to control microbial growth in many foods because these methods may ruin the consistency and other organoleptic (sensory) qualities of the food. Pasteurization is a form of microbial control for food that uses heat but does not render the food sterile. Traditional **pasteurization** kills pathogens and reduces the number of spoilage-causing microbes while maintaining food quality. The process of pasteurization was first developed by Louis **Pasteur** in the 1860s as a method for preventing the spoilage of beer and wine. Today, pasteurization is most commonly used to kill heat-sensitive pathogens in milk and other food products (e.g., apple juice and honey). However, because pasteurized food products are not sterile, they will eventually spoil.

The methods used for milk pasteurization balance the temperature and the length of time of treatment. One method, **high-temperature short-time (HTST) pasteurization**, exposes milk to a temperature of 72 °C for 15 seconds, which lowers bacterial numbers while preserving the quality of the milk. An alternative is **ultra-high-temperature (UHT) pasteurization**, in which the milk is exposed to a temperature of 138 °C for 2 or more seconds. UHT pasteurized milk can be stored for a long time in sealed containers without being refrigerated; however, the very high temperatures alter the proteins in the milk, causing slight changes in the taste and smell. Still, this method of pasteurization is advantageous in regions where access to refrigeration is limited.

Refrigeration and Freezing

Just as high temperatures are effective for controlling microbial growth, exposing microbes to low temperatures can also be an easy and effective method of microbial control, with the exception of **psychrophiles**, which prefer cold temperatures (see **Temperature and Microbial Growth**). Refrigerators used in home kitchens or in the laboratory maintain temperatures between 0 °C and 7 °C. This temperature range inhibits microbial metabolism, slowing the growth of microorganisms significantly and helping preserve refrigerated products such as foods or medical supplies. Certain types of laboratory cultures can be preserved by **refrigeration** for later use.

Freezing below −2 °C may stop microbial growth and even kill susceptible organisms. According to the US Department of Agriculture (USDA), the only safe ways that frozen foods can be thawed are in the refrigerator, immersed in cold water changed every 30 minutes, or in the microwave, keeping the food at temperatures not conducive for bacterial growth.[1] In addition, halted bacterial growth can restart in thawed foods, so thawed foods should be treated like fresh perishables.

Bacterial cultures and medical specimens requiring long-term storage or transport are often frozen at ultra-low temperatures of −70 °C or lower. These ultra-low temperatures can be achieved by storing specimens on **dry ice** in an **ultra-low freezer** or in special **liquid nitrogen** tanks, which maintain temperatures lower than −196 °C.

Pressure

Exposure to high pressure kills many microbes. In the food industry, **high-pressure processing** (also called **pascalization**) is used to kill bacteria, yeast, molds, parasites, and viruses in foods while maintaining food quality and extending shelf life. The application of high pressure between 100 and 800 MPa (sea level atmospheric pressure is about 0.1 MPa) is sufficient to kill vegetative cells by protein denaturation, but endospores may survive these pressures.

Desiccation

Drying, also known as **desiccation** or dehydration, is a method that has been used for millennia to preserve foods such as raisins, prunes, and jerky. It works because all cells, including microbes, require water for their metabolism and survival. Although drying controls microbial growth, it might not kill all microbes or their endospores, which may start to regrow when conditions are more favorable and water content is restored.

In some cases, foods are dried in the sun, relying on evaporation to achieve desiccation.

Freeze-drying, or lyophilization, is another method of dessication in which an item is rapidly frozen ("snap-frozen") and placed under vacuum so that water is lost by sublimation. Lyophilization combines both exposure to cold temperatures and desiccation, making it quite effective for controlling microbial growth. In addition, lyophilization causes less damage to an item than conventional desiccation and better preserves the item's original qualities. Lyophilized items may be stored at room temperature if packaged appropriately to prevent moisture acquisition. Lyophilization is used for preservation in the food industry and is also used in the laboratory for the long-term storage and transportation of microbial cultures.

The water content of foods and materials, called the **water activity**, can be lowered without physical drying by the addition of solutes such as salts or sugars. At very high concentrations of salts or sugars, the amount of available water in microbial cells is reduced dramatically because water will be drawn from an area of low solute concentration (inside the cell) to an area of high solute concentration (outside the cell). Many microorganisms do not survive these conditions of high osmotic pressure. Honey, for example, is 80% sucrose, an environment in which very few microorganisms are capable of growing, thereby eliminating the need for refrigeration. Salted meats and fish, like ham and cod, respectively, were critically important foods before the age of **refrigeration**. Fruits were preserved by adding sugar, making jams and jellies. However, certain microbes, such as molds and yeasts, tend to be more tolerant of desiccation and high osmotic pressures, and, thus, may still contaminate these types of foods.

Radiation

Radiation in various forms, from high-energy radiation to sunlight, can be used to kill microbes or inhibit their growth. **Ionizing radiation** includes X-rays, gamma rays, and high-energy electron beams. Ionizing **radiation** is strong enough to pass into the cell, where it alters molecular structures and damages cell components. For example, **ionizing radiation** introduces double-strand breaks in DNA molecules. This may directly cause DNA mutations to occur, or mutations may be introduced when the cell attempts to repair the DNA damage. As these mutations accumulate, they eventually lead to cell death.

Both **X-rays** and **gamma rays** easily penetrate paper and plastic and can therefore be used to sterilize many packaged materials. In Europe, **gamma irradiation** for **food preservation** is widely used, although it has been slow to catch on in the United States. Packaged dried spices are also often gamma-irradiated. Because of their ability to penetrate paper, plastic, thin sheets of wood and metal, and tissue, great care must be taken when using X-rays and gamma irradiation. These types of ionizing irradiation cannot penetrate thick layers of iron or lead, so these metals are commonly used to protect humans who may be potentially exposed.

Another type of radiation, **nonionizing radiation**, is Ultraviolet (UV) light ; it causes **thymine dimer**s to form between adjacent thymines within a single strand of DNA. When DNA polymerase encounters the thymine dimer, it does not always incorporate the appropriate complementary nucleotides (two adenines), and this leads to formation of mutations that can ultimately kill microorganisms.

UV light can be used effectively by both consumers and laboratory personnel to control microbial growth. UV lamps are now commonly incorporated into **water purification** systems.

Of all the ways to prevent food spoilage and foodborne illness, gamma irradiation may be the most unappetizing. Although gamma irradiation is a proven method of eliminating potentially harmful microbes from food, the public has yet to buy in. Most of their concerns, however, stem from misinformation and a poor understanding of the basic principles of radiation. In the United States, the CDC, Environmental Protection Agency (EPA), and the Food and Drug Administration (FDA) have deemed irradiation safe and effective for various types of meats, poultry, shellfish, fresh fruits and vegetables, eggs with shells, and spices and seasonings. Gamma irradiation of foods has also been approved for use in many other countries, including France, the Netherlands, Portugal, Israel, Russia, China, Thailand, Belgium, Australia, and South Africa. To help ameliorate consumer concern and assist with education efforts, irradiated foods are now clearly labeled and marked with the international irradiation symbol, called the “radura.” Consumer acceptance seems to be rising, as indicated by several recent studies.

Membrane Filters

Filtration can also be used to remove microbes from water using **membrane filtration**. Membrane filters for liquids as they have small pores that filter out microorganisms. Typically, membrane filters that are used to remove bacteria have an effective pore size of 0.2 µm, smaller than the average size of a bacterium (1 µm),

WASTE MANAGEMENT

Waste Management in Food Industry

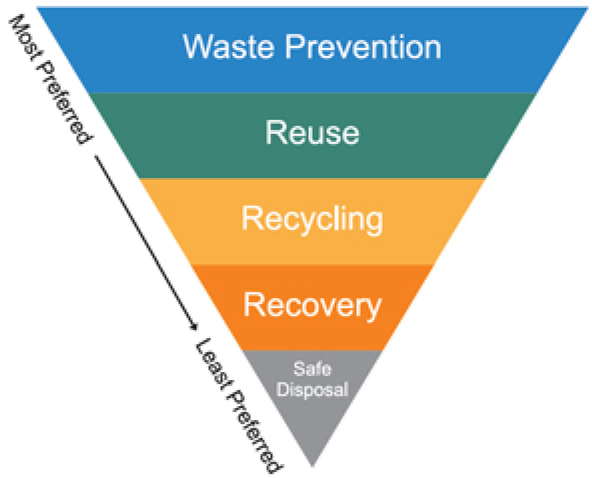
Large amounts of food is being wasted throughout the food supply chain; in primary production, during distribution and sale of food products, the preparation and serving of food in commercial and domestic environments.

According to the Food and Agriculture Organization (FAO), annually one third of the food produced in the world for human consumption gets lost or wasted. Interestingly, in developed countries food is mostly being wasted at the consumption stage, which means it is being discarded even if it is still suitable for human consumption. In this case, consumer behavior plays an important role in prevention of food waste, which can be accomplished by raising awareness among individuals, households, and consumers in general.

On the other hand, in developing countries and industrialized areas food losses mainly occur in initial agricultural production. Primarily this is caused due to poor agriculture and natural resource management, and very often due to unfavorable climatic conditions. In fact, this is not a problem of only developing countries. Even in the United States, a good portion of food is thrown away uneaten - from farm to landfills. This impacts the environment, society and economy.

Social initiatives, awareness campaigns and stringent of legal requirements have thrust the consumers, as well as food industry, to take steps towards reduction of waste. Although for some sectors food waste is inevitable; yet, a significant amount of unnecessary loss can be avoided with better management systems throughout the food supply chain.

The internationally accepted approach of waste management hierarchy helps food establishments to prioritize waste management practices in order to handle waste in a sustainable manner. It sets out the preferred order of waste management options, from the most preferred to the least one. Prevention of waste is the most preferred and often the least costly option.



Food service sector is one of the most significant areas of food waste. Besides many other actions that can be taken, the simplest and the most preferable practice is prevention of waste at the source. A good example regarding food service establishments is reducing portion sizes at restaurants and cafeterias this will consequently reduce the amount of food wastes in this sector.

Despite the fact that landfilling is the least preferable waste management option, yet food waste generated from leftovers, perished produce and spoiled food is the number one material taking up landfill space.

Food waste is much more costly that is obviously seen, and its impact is much more serious. When food is wasted all of the natural resources that were expended in the supply chain are also lost, including the use of land, water and energy. Except for economic impact, the impact that food waste have on environment and society is bitterer. Broad-scale effects of food wastage contribute to global environmental problems such as pollution and climate change.

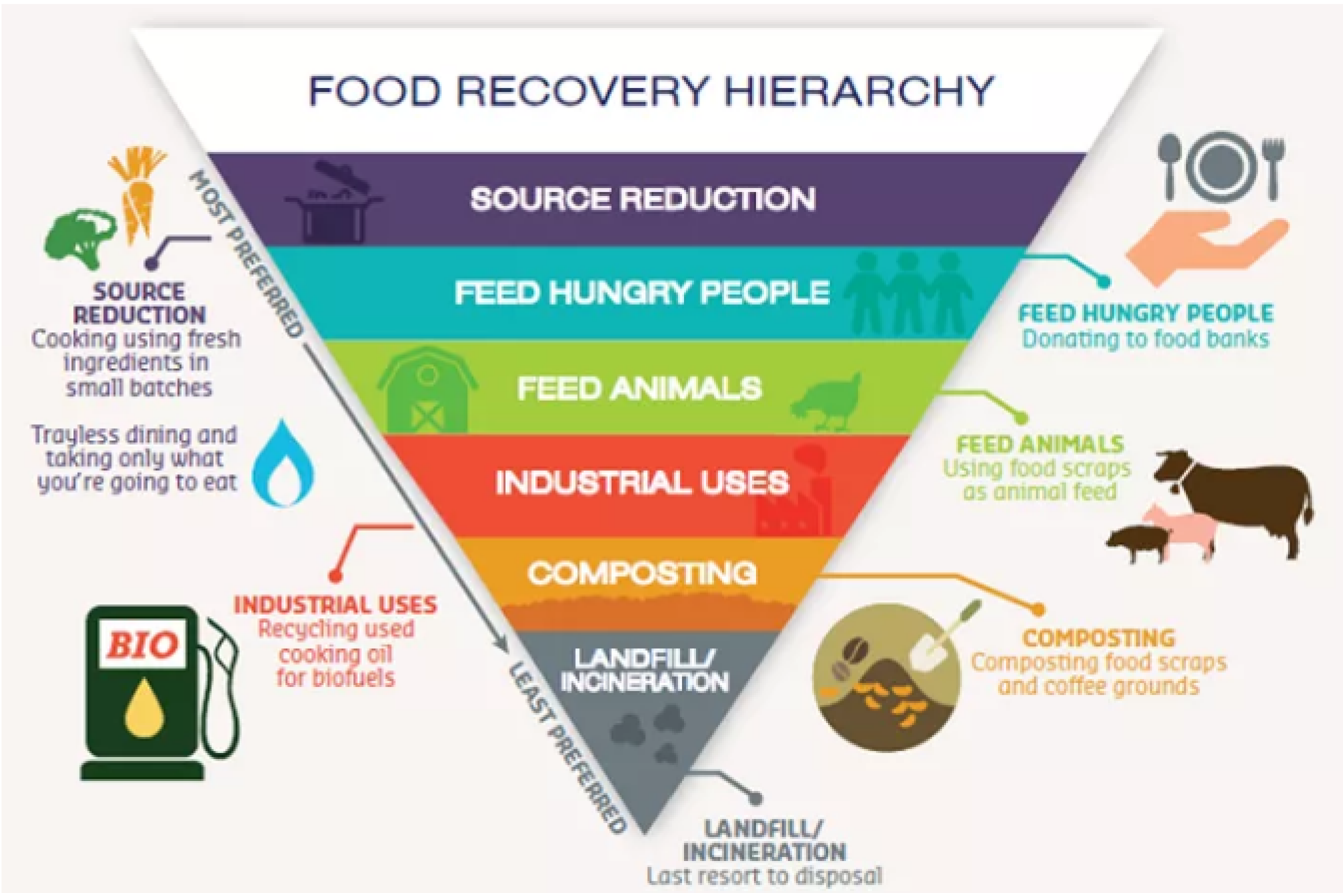
International Organization for Standardization (ISO) has developed a numerous number of international standards which help organizations to improve their management systems and optimize their processes related to quality (ISO 9001), environment (ISO 14001), energy (ISO 50001), and so on.
Professional Evaluation and Certification Board (PECB) is a certification body for persons on a wide range of professional standards. Among others it also offers ISO 14001 training and certification services for professionals wanting to gain a comprehensive knowledge of the main processes of an EMS; project managers or consultants wanting to prepare and to support an organization in the implementation of an EMS; auditors wanting to perform and lead EMS certification audits, and staff involved in the implementation of the ISO 14001 standard.

ISO 14001 and Environment Trainings offered by PECB:

- Certified ISO 14001 Lead Implementer (5 days)
- Certified ISO 14001 Lead Auditor (5 days)
- Certified ISO 14001 Foundation (2 days)
- ISO 14001 Introduction (1 day)

EPA's Food Recovery Hierarchy

- EPA's Food Recovery Hierarchy is an excellent resource to follow for food processors and beverage producers as it provides the guidance to start a program that will provide the most benefits for the environment, society and the food manufacturer.



Notably, landfill is the least favored disposal option for waste generated in food and beverage producers worldwide. There are sustainable, effective and profitable waste management options including:

- making animal feed,
- composting to create nutrient-rich fertilizer,
- anaerobic digestion to produce energy-rich biogas,
- recycling/reusing waste for utilization by other industries,
- feeding surplus food to needy people

PEST MANAGEMENT STANDARDS

Pest Management Standards in the Food Industry: Food safety audits may be carried out by auditors from within the company or from an independent organization. The audit is generally based on a series of criteria set out to ensure the highest standard of compliance with a specific aspect of food safety. The section which deals with pest management will usually require zero infestation and conformity with criteria covering type of pest management programme; permitted materials and techniques and record keeping. Care is essential when setting criteria to ensure that they achieve the required result. Over –prescriptive criteria may place unnecessary restrictions on the pest management programme, extending the period before control is achieved.

Risk-based standards: If standards and guidelines for pest control are to achieve the aim of promoting best practice they must be practical and flexible. The standard should be risk-based in order to address the issues raised by the following:

Risk to public health due to activities of pests: Pests are known to carry a range of pathogens which can be transmitted to humans either through contaminated food or their presence in the environment. Risk to food safety This will be the priority for all engaged in the production, storage, transport, processing and sale of food. The risks include:

• Physical contamination of product by rodent droppings, insect parts or other foreign bodies
• Introduction of micro organisms
• Damage to product or packaging Risk to public safety and the environment The irresponsible or inaccurate use of pesticides may present a hazard to technicians, site staff and members of the general public, as well as to the environment through contamination of water, damage to plants and the effect on non-target species of animals.

Environmental management and pesticide reduction: There should be an increased reliance on environmental management and inspection of the site to reduce the attraction to pests.

Pest management programmes should aim to reduce the use of pesticides, particularly outdoors, by enhanced prevention programmes based on proofing and hygiene.

For example, reliance on toxic rodent baits outdoors as a permanent indicator of rat activity is no longer acceptable. Knowledge of the site, its history and potential for infestation through regular and thorough inspections will replace perimeter baiting as the first line of defence.

Pest Awareness and Staff Training: Training should be given appropriate to the personnel concerned, for example using the CIEH DVD Pests on the Menu. As a minimum all departmental personnel should be aware of the pests that they are likely to encounter in their part of the process and the importance of pest prevention. Particular attention should be given to incoming goods such as raw materials or packaging.

Pests and their habits: Training on the identification and habits of the more common pests of the food industry can be given by the pest control contractor or through independent consultants. This is best achieved in the form of a brief presentation rather than distribution of literature, and where appropriate can be tailored to particular industry segments for example, bakery or confectionery.

Pest prevention: The importance of pest prevention through good hygiene, stock management and exclusion practices should be emphasized. Site personnel have the day to day responsibility of ensuring a pest management programme is maintained.

Pest control report: Inspection reports must be concise and legible and stored in an easily accessible binder. A typical pest control report will contain as a minimum:

• Treatment date
• Details of the pest control contractor and name of technician servicing the site
• Details of the customer and name of the contact person on site
• Type of visit: scheduled, follow-up, callout, etc
• Pests found
• Action taken
• Pesticide used
• Location of baits and monitors (this may be in the form of a checklist or plan)
• Quantities used
• Risk assessment

• Post treatment precautions
• Recommendations on proofing, hygiene and storage
• Details of follow-up inspections

Rodent Management:
- Commensal rodents can cause considerable damage to stored grain and structures. If rats or mice are present in and around such facilities, it is because they are able to find food, water (in the case of rats), places to hide and places to nest and rear their young.
- Good sanitation practices, combined with steps to prevent rodent entry into structures and the elimination of rodent harborage, will reduce rodent problems. While sanitation and rodent-proofing may not eliminate rodents, they will limit the size of rat or mice populations the premise can support.
- Sanitation and Habitat Modification Clean, orderly facilities will not support large numbers of rodents. Attention to key elements that rodents require for survival, food and shelter, is important in limiting the habitat's carrying capacity for these species.
- Sanitation involves good housekeeping, including proper storage and handling of food materials. Warehouses, processing areas, packaging areas and similar structures may provide excellent habitat for commensal rodents. -
- Finished products should be stored in rodent proof structures whenever possible.

- Shelter is an invitation for a rodent problem (especially when shelter is near a food source). Particularly when structures are not rodent-proof, it may be difficult to prevent rodents from feeding on food products; however, it is possible to achieve good rodent control by taking away their shelter.
- When mice and rats are unable to hide or rest, they cannot remain in any location for long. Regular removal of debris and weed control around structures will reduce the amount of shelter available to rodents. In any event, keeping the periphery of buildings and other structures clean of weeds and debris (including stacked lumber, firewood and other stored materials) will discourage rodent activity and allow easier detection of rodent signs.
- Cleaning up also puts rodents under stress. This makes it more likely they will accept lethal quantities of baits (rodenticides) if these are used as part of a control program. Water sources should be eliminated wherever possible. Rats require water daily for their survival, unless feeding on very moist foods. While house mice can survive without water (obtaining it from their food), they will drink when water is available. Drainage ditches and water runoff areas must allow water to flow quickly away from structures so no standing water accumulates.
- Where no sources of water are present, rats cannot thrive. Further, reduction of water sources enhances the effectiveness of liquid rodent baits.
- Storage Food products must be stored properly on commercial premises. Where possible, these materials should be kept in rodent-proof containers or rooms. Sacked foods should be kept in orderly piles, preferably on pallets so they can be readily moved. Warehouse personnel should not pile supplies against the walls on top of these strips. This permits easier inspection and treatment in rodent control work. Intersecting stored products with frequent aisles and daily sweeping or vacuuming of spilled foods should be routine. Promoting these practices is the only chance of achieving some degree of control in a warehouse that cannot be economically rodent-proofed and is under constant rodent pressure from the surrounding area.
- Nonfood supplies such as boxes, machinery, sacked goods, lumber, building supplies, etc., should be stacked away from the walls and kept off the ground to aid access to the area. These need to be inspected for rodent infestation as frequently as the food stores.
- Reduction of outdoor harborage around the premises will assist in relieving the constant pressure from outside rodent populations. Racks should hold stacked lumber, building supplies, rubbish, etc,. at least 18 inches (45 cm) off the ground.

- Other outdoor harborage such as weeds, brush and junk piles should be trimmed or removed. Sources of water should be dried up and the cause eliminated by repairing leaky faucets and plumbing, draining standing water or covering open water supplies that cannot be handled any other way.

Importance of Personal Hygiene

It is imperative for safe food-handling outcomes for all workers to be familiar with standard sanitation and hygiene practices. Figure below shows the cycles of transmission of micro-organisms. One of the basic principles is to break the cycle by avoiding cross-contamination, which can be achieved by ensuring personal hygiene practices are followed:

The cycle of bacterial transmission

Proper personal hygiene is critical in any food service premise.
Personal hygiene includes:
• Showering and bathing regularly
• Keeping hair clean hair and covered or tied back
• Keeping clean clothing and footwear that is used only at work
• Handwashing regularly • Using clean utensils for tasting food
• Using separate cloths for cleaning and wiping plates

Hand washing Proper and regular hand washing is a critical part of any food safety system. one must always wash hands after:
• Sneezing, coughing, or touching your mouth or nose
• Using the bathroom
• Smoking or using toothpicks
• Handling raw foods
• Cleaning and wiping tables, food preparation surfaces, or equipment
• Handling soiled objects, garbage, or money

The steps for proper hand washing are as follows:

1. Wet hands with warm water.
2. Apply liquid soap and lather for at least 20 to 30 seconds.
3. Scrub backs of hands, wrists, all fingers, and under nails.
4. Rinse under running water, pointing down toward the drain.
5. Dry with a paper towel.
6. Turn off taps and open bathroom door using the paper towel