

A. Food safety and food hygiene: Bangladesh context

Introduction:

Food safety, food security, food nutrition are challenges for public health for a third world country like Bangladesh. From the last couple of decades, the country has been fighting to ensure food security through livestock products meat, milk and egg. With significant economic development, the country achieved great success in ensuring food nutrition through supply of meat and eggs and a marginal deficiency of milk production to consumers. Within the last ten years, the issue of food safety has been raised as adulterated and low-quality foods spread over the markets, raising public health concern to a critical level. Unsafe/contaminated food causes many acute and life-long diseases, ranging from diarrheal diseases to various forms of cancer. An estimate shows that globally food-borne and waterborne diarrheal diseases taken together kill about 2.2 million people annually, of them 1.9 million are children. However, in Bangladesh dependable assessment of the public health impact due to food contamination is not available due to absence of a regular monitoring system. The data from icddr,b indicate that 501 hospital visits per day for treatment of diarrhoea that were attributable to food and water borne causes. General scenario on food contamination demonstrates a widespread non-compliance with hygienic practice in food handling between food producers and food traders such as street food traders.

Food adulteration with harmful chemicals is also common in Bangladesh. Heavy metals in animal feed; formalin in milk; fatal food poisoning after eating chicken meat, high residues of banned pesticides, and chemical preservatives in fresh produce confirm the widely held suspicion that food control in Bangladesh is inadequate. Food adulteration may occur through various ways. The number of incidents of intentional adulteration is much higher compared to the unintentional ones in the country.

Probable causes of adulteration:

- Farmers are using a vigorously mix of toxic chemicals in their efforts to fight insect pests - and that they are not sufficiently aware of the need to stop using them before harvesting.
- Deliberate adulteration of produce to extend its shelf life, using chemical preservatives without concern for the health of consumers.
- Contamination by microorganisms, leading to acute food poisoning cases in consumption of fruit, occasionally with tragic consequences.

Although, few cases of the acute effect such as food poisoning are reported but, the chronic effect of such events such as cancer, kidney disorders and birth defects is unlikely to be observed in short term, because the manifestation of the disease only occurs after long-term, low-level exposure. Food contamination and consumers exposure to food hazards have major implication on the food security and consumers health in Bangladesh.

To fight against threats to food safety and protect public health, the Food Safety Act, 2013 was passed by the Bangladesh National Parliament on October 10, 2013, which came into effect on February 1, 2015.

The Food Safety Act establishes basic definitions, goals, and principles for food safety. It also defines procedural rules and coordination mechanisms between different public administrations responsible for food regulation. It sets out general food safety and health protection rules, regulates inspections, detention, and seizure rules of suspect food and classifies breaches.

With regard to production practices, the way forward is to educate farmers in using agro-chemicals and to move towards less toxic alternatives (recognizing that the farmers will look for the most convenient or cheapest means of controlling pest or disease). More work is needed to understand what advice farmers are being given; what chemicals they are using; where they are getting them. There may also be initiatives to control the availability of toxic pesticides which are banned but are still produced in neighbouring countries; there may still be stockpiles of such chemicals in Bangladesh which need to be disposed of safely.

Regarding the fraud question, inspection and prosecution are a key element in consumer protection. Adding or injecting formalin is not a safe practice even if the shelf life of milk and other fresh produce making longer. Those who do so should fear the consequences if they are caught doing so. Here, transparency is vital. Eventually consumers will avoid suppliers with a poor track record.

Labelling and packaging to improve traceability are also important to maintain the integrity of the food chain. Other countries face the same problem of criminal adulteration – in China, the apparently deliberate use of melamine in dried milk to boost the protein content was a recent case with serious food safety consequences; in Europe criminal gangs are substituting cheap replacements for high value commodities such as olive oil. Lessons may be learnt from others in how to combat such food-based frauds.

Finally on the food handling question, contamination occurs from use of unclean water, or other unsanitary practices, the inability to maintain a cold chain, cross contamination between different food products.

Again, education is part of the solution; but also investment in food handling infrastructure (cold chain, processing, packaging, market infrastructure). If people want safer food, they may have to pay more for it. Paying more is not a guarantee of safety in itself. And for many in Bangladesh, paying more is not an option. Several government departments have a role to play in consumer protection, whether by educating the producers to produce safer food, by testing samples, by prosecuting cases where unsafe food is being sold.

Issues in Dairy Cattle:

- Food Adulteration; Food preparation; Painful Hygiene practice.
- Environmental pollution, industrial wastage used in feed preparation.
- Insufficient production of vaccine.
- Treatment by Quack or fraudulent person/frequent use of antibiotics.
- No proper testing of animal feed.
- Low cost concentrate feed and wrong eating habit.
- Low quality mineral/vitamin mix.
- Consumption of raw milk products, errors in pasteurization.
- Chemical adulteration of milk.
- Emerging heat resistant pathogens.
- Pathogenic *E. coli*, *Salmonella* kills at 70°C; whereas spores of *E. coli* kills at 130°C.

Issues in Chicken:

- *Salmonella*, *E. coli* and *Campylobacter* are ‘commensals’ of chickens. However, some strains of *Salmonella*, *E. coli* and *Campylobacter* can cause illness in humans.
- Transmission of *Salmonella*, *E. coli* from poultry to eggs before egg shell formation.
- Handling of the raw chicken in the kitchen becomes crucial to maintaining safety of the chicken meat.

Issues in Feed:

- Naturally occurring toxins – mycotoxins, marine biotoxins and toxins occurring in poisonous plant.
- Colouring agents (Red 40, Yellow 5 and Yellow 6) contain Benzedrine like contaminants which are carcinogenic agents.
- Heavy metals such as lead, cadmium and mercury cause neurological, cancer and kidney damage.
- Tannery wastes converted into protein concentrate are now added to poultry and fish feed and chromium sulphate is commonly used in the tanning process which is a carcinogenic agent.

Novel approach to address food safety:

- Food Safety Counts! WHO’s 5 keys.
- Follow Recommended Standard Guidelines.
- Control use of antibiotics.
- Using Biological Control Agents – Probiotics, Prebiotics and Predator bacteria.
- Enhance Innate and adaptive immunity.
- Lifestyle Change – living without / minimal Medicine.
- Using Biochemicals to clean food manufacturing plants.
- Using natural food colouring agent such as beet root, baby spinach, outer skin part of orange and lemon.

Food Safety Counts! WHO's 5 keys:

- Clean: Wash hands, cutting boards, utensils.
- Separate: Keep raw meat, seafood, and poultry away. from ready-to-eat Foods.
- Cook: Cook food to the right temperature.
- Chill: Refrigerate promptly.
- Safe: Use safe water and raw materials.

Recommended 'One health Approach' Guidelines to combat food safety issues:

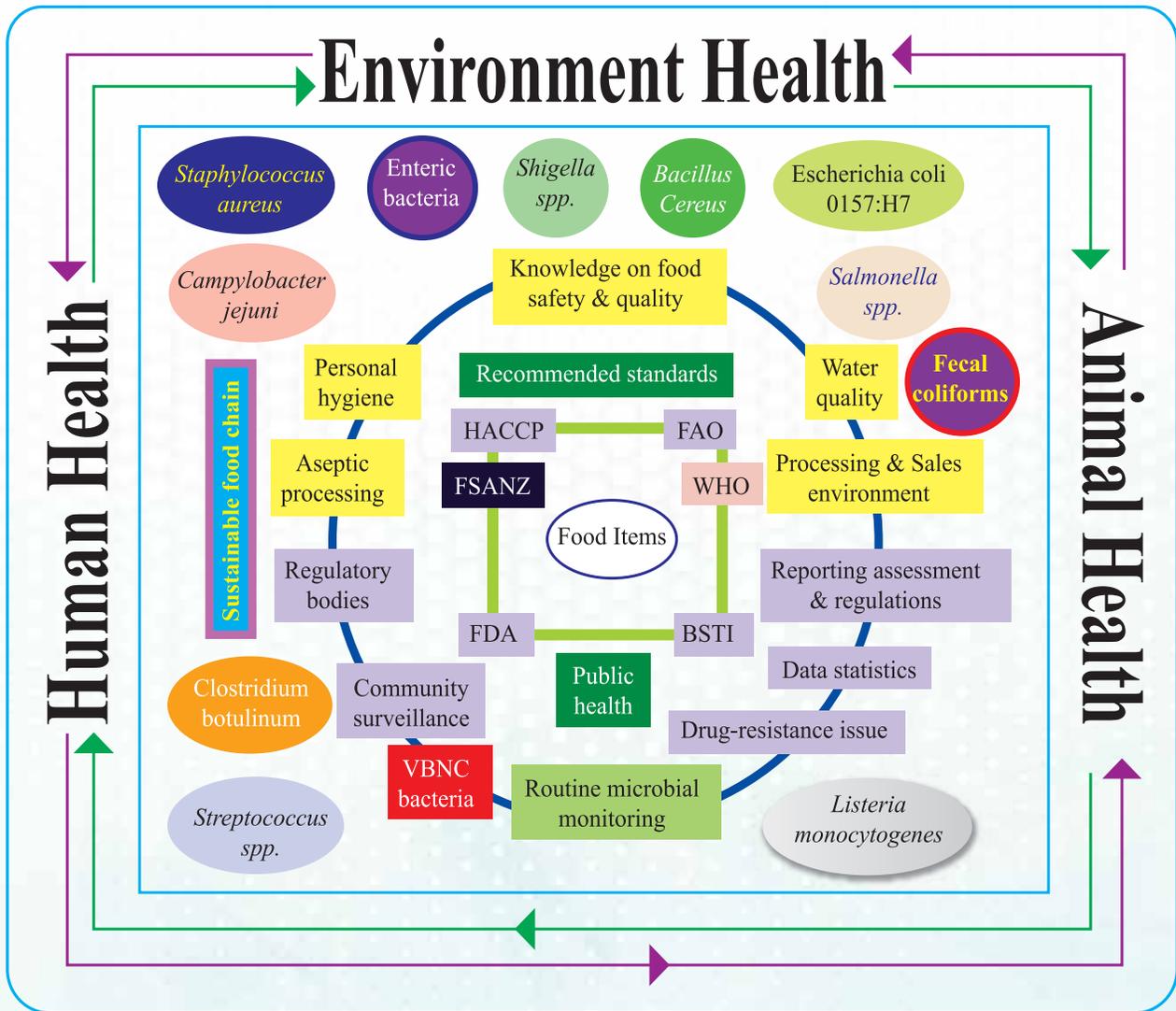


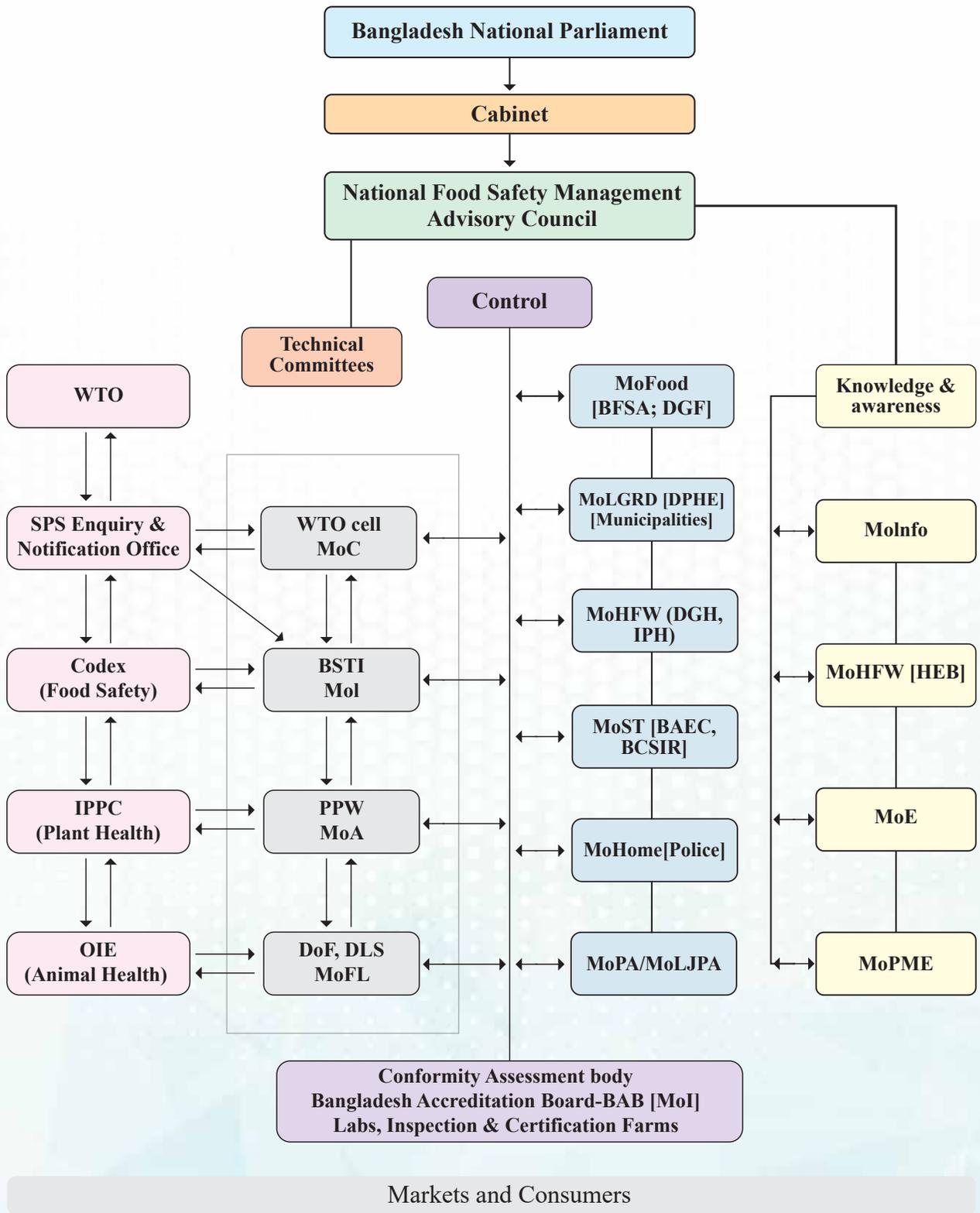
Fig. 1: One health to combat food safety

Wayout to ensure food safety in Bangladesh:

- Mandatory Testing of all locally produced, imported /exported of all Livestock inputs and its food products before marketing for detection of Heavy metals, different parameters of food, antibiotics, pesticide residues, toxins, adulterants, spoilage, pathogenic organisms and AMR test.
- Restricted and prescribed use of antibiotics, no harmful chemicals, pesticides and growth hormones.
- Healthy Animal – ensure custom made vaccination and artificial insemination. accurate and right doses of anthelmintics, proper nutrition.
- Good Hygiene practice during milk production, pasteurization, transportation and selling to consumers.
- Vaccination coverage to meet the famers demand.
- Zero tolerant in food safety issues (Proper Implementation of food safety related laws and rules).

An effective food safety regulatory framework, people's awareness, safe and hygienic production systems are imperative to ensure safe food for consumers in a country. Bangladesh is lacking it for a long time which resulted serious public health issues. However, considering the current situations, it can be recommended that WHO, FAO and OIE suggested 'One Health Approach' covering sectors from feed production to food consumption should be implemented. The technical committee of the 'One Health Food safety' will guide the Bangladesh Food Safety Authority (BFSA), which should be an autonomous apex food safety regulatory body to perform all kind of coordination. On the other hand, there is a severe shortage of modern food testing laboratories. Existing laboratories of government and non-governmental organisations need to be strengthened to ensure food safety.

New National Food Safety Regulatory Framework



B. Food Safety and Food Hygiene : Global Context

Introduction:

Like air and water, food is fundamental to life itself. Peoples need it to survive and thrive. But food is so much more. It's a source of enjoyment. It's an expression of culture and faith. It's an art form. And it brings families, friends and communities together. Food is an essential part of what it means to be human. Which is why unsafe food is so unacceptable. It turns what should be a source of nourishment and enjoyment into a source of disease and death.

Food safety is an area of public health action to protect consumers from the risks of food poisoning and foodborne diseases. Unsafe food is responsible for hundreds of thousands of deaths every year. It can lead to a range of health problems: diarrhoeal disease, viral disease; reproductive and developmental problems, cancers etc. which mainly caused by chemicals, viruses, bacteria and parasites.

Food safety is thus a pre-requisite for food security. Consumers are increasingly concerned about safe food. They don't want any chemicals, unwanted residues – or antibiotics – they want Quality Food. And yet food safety has not received the political attention it deserves.

Because of massive under-reporting, the global burden of foodborne disease remained unknown until WHO published the first estimates in 2015. WHO estimated that each year worldwide, unsafe food causes 600 million cases of foodborne diseases and 0.42 million death of which 30% of foodborne deaths occur among children under 5 years of age.

Why it is a Global Concern?

Food Migration: The economy of most developing countries depends heavily on the export of food and food products. Food markets and food supply chains are now massive global industries. For example, food grown in country A may be exported to country B for processing. It is then incorporated into a final product in country C, along with other ingredients manufactured in countries D, E, and F. Then it is sold in country G. If there is a safety problem, recalling food products can be extremely complex – and even more difficult when they are sold over the internet.

People's Migration: Food safety is not an issue for one country. It is an issue for every country and every region. Foodborne diseases affect both developing and developed countries, and affect the elderly, and children most causing strain on the health system. With more people travelling, and food supply chains increasingly becoming global, foodborne diseases, like other diseases, have the potential to spread widely. However, most foodborne disease is preventable with proper food handling and attention to good practices and hygiene.



Fig. 2: People's Migration

WHO's Report: Foodborne Disease Epidemiology:

- The overall burden of Food borne diseases (FBD) was estimated at 33 million Disability-adjusted life years (DALYs)
- The African and south east Asian regions had the highest burden.
- Microbial pathogens were responsible for most (79%) of the burden: 584 million cases of illness, around 450,000 deaths and 26 million DALYs each year. The most important pathogens were Salmonella spp., toxigenic Escherichia coli, Norovirus and Campylobacter in that order.
- Foodborne macro-parasites were responsible for around 13 million cases, 45,000 deaths and a burden of 6 million DALYs each year. Most important were the tapeworms responsible for cysticercosis; fish associated fluke (common in south-east Asia); and roundworms, which are sometimes foodborne and are widespread in poor countries.
- Chemicals were responsible for 3% of the overall burden (220,000 cases, 20,000 deaths and 1 million DALYs), of which 900,000 DALYs were associated with aflatoxins, 240,000 DALYs with dioxins and 18,000 with cassava cyanide.

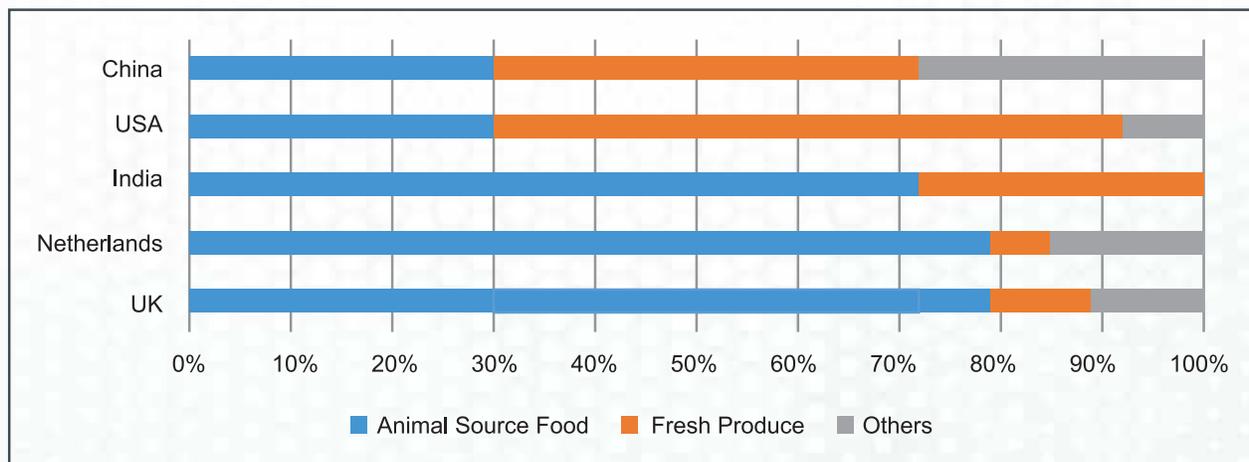


Fig. 3: Animals Source Food and Fresh Produces are responsible for Food borne Illnes



Fig. 4: Surveillance Pyramid for Foodborne Diseases.

What is ‘Going on’ in food safety?

All of these means food safety is everyone’s issue. Many organizations have an interest in food safety in developing countries: -

One Health Approach – WHO works closely with the Food and Agriculture Organization of the United Nations (FAO) and the World Organization for Animal Health (OIE) to promote multi-sectorial responses to food safety hazards, risks from zoonoses, and other public health threats at the human-animal-ecosystem interface and provide guidance on how to reduce these risks. One Health is the collaborative effort of multiple disciplines such as public health, animal health, plant health and the environment working locally, nationally, and globally to attain optimal health for people, animals, and our environment. The approach is to design and implement programs, policies, legislation and research in which multiple sectors communicate and work together to achieve better public health outcomes. The areas of work that particularly relevant include food safety, the control of zoonoses, and combatting antibiotic resistance (AMR).

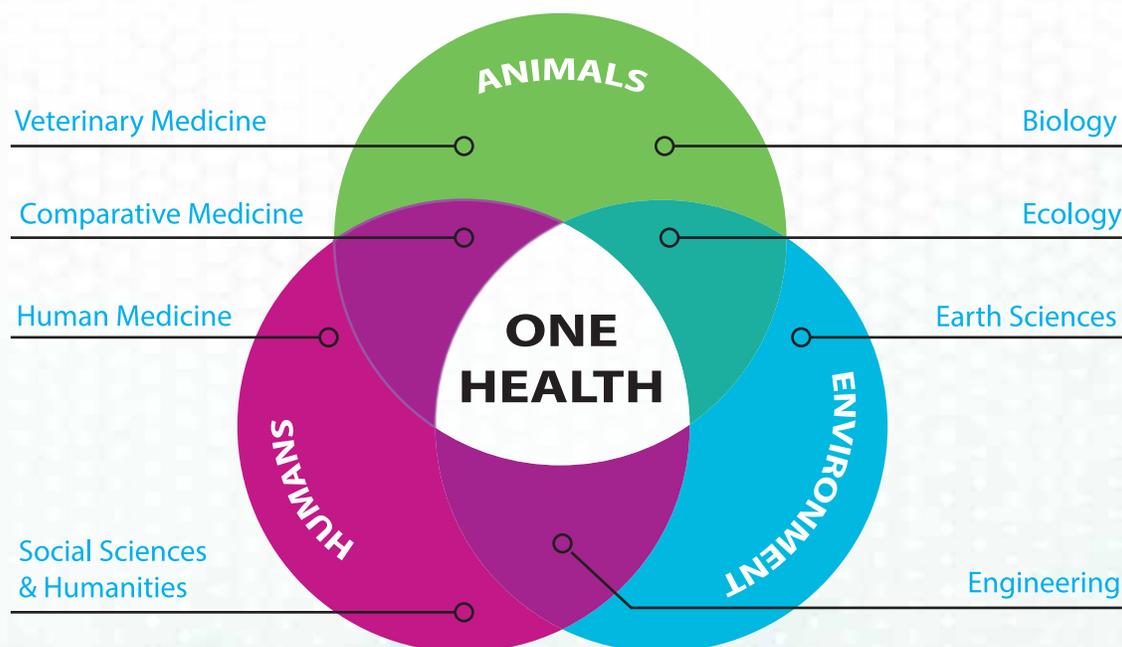


Fig. 5: One Health Approach of WHO, FAO and OIE

The International Food Safety Authorities Network (INFOSAN):

To connect national food safety systems, WHO and FAO launched a global voluntary network in 2004 to

- Promote the rapid exchange of information during food safety related events;
- Share information on important food safety related issues of global interest;
- Promote partnerships and collaboration between countries, and between networks;
- Help countries strengthen their capacity to manage food safety emergencies.

Food Safety Approach in different Countries:

Bio Control approach in Europe, Australia and New Zealand: These countries are now focussed on natural methods to reduce the presence of harmful and spoilage bacteria in food. Recent studies shows the development of broad spectrum biocontrol agent such as Bdellovibrio or bacteriophages in combination with lactic acid. This will allow these countries to lead the world in the development of new food processing technologies and preservation techniques to extend the storage life of chilled foods.

Mechanism of Action of Probiotics

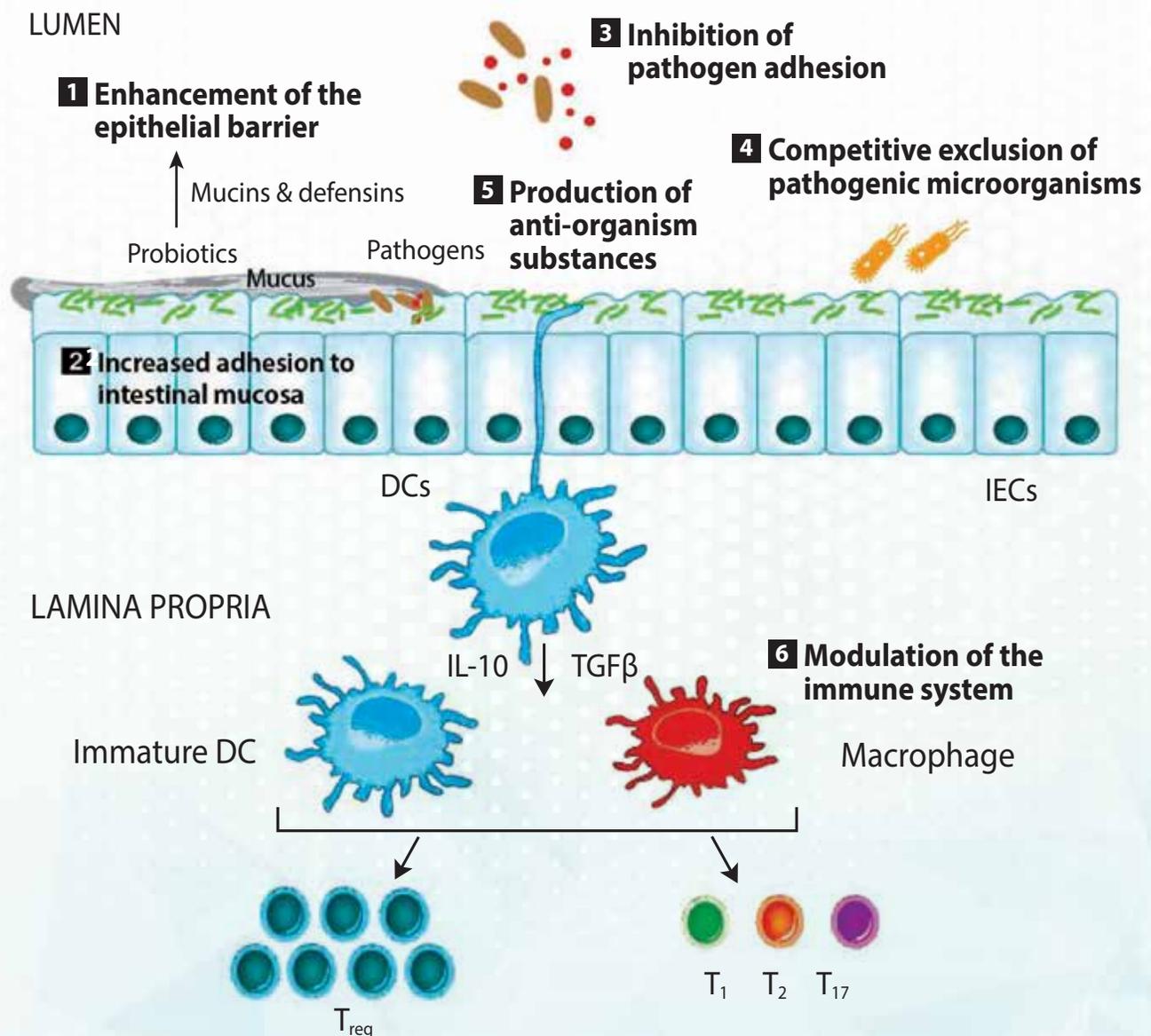


Fig. 6: Mechanism of Action of Probiotics

Approach in USA:

- **Enhanced Traceability-**

The FDA aims to implement an advanced traceability systems to identify the source of food, their location tracking with inbuilt internet of things (IoT) sensors to identify contaminated food, take necessary precautionary and preventive measures and standardize the process across the global supply chain for increased food security and trust. It will also facilitate the critical tracking of events and data monitoring in real-time.

- **Retail Modernization-**

Online food delivery has become popular with consumers more than ever after the deadly pandemic shock the entire world. The FDA is willing to work with regulatory authorities and relevant stakeholders to address and resolve the vulnerabilities faced by the industry. The FDA requires digital tools to monitor food temperature to ensure food safety across all stages of the food systems. New business models and increased buzz around food online delivery is giving a rise to new and modern retail culture across the States.

- **Outbreak response and illness prevention-**

The traceability standards, as discussed earlier, will generate a plethora of data at multiple points. This data using additional tools will be used to analyse associated risks and take corrective and preventive measures. The FDA has outlined the use of artificial intelligence (AI) and machine learning (ML) to strengthen the compliances followed for food imported from elsewhere in the world.

- **Culture of Food Safety-**

Empowering consumers to access new technologies at a few clicks and by making them aware through training, research, and education to promote food safety and appropriate measures.

Approach in Nigeria:

Nigeria had severe challenges with safety of food and drugs; in the 1980s more than 50% of drugs sampled did not meet standards. In 2001, under the leadership of Dr Dora Akunyili the National Agency for Food and Drug Administration and Control (NAFDAC) underwent dramatic restructuring and reform and the next decade saw substantial improvements in food and drug safety and governance. For example, a reduction in substandard drugs of 80% was achieved.

Approach in South Africa:

Until the late 1990s street-vended foods in South Africa were perceived as unsafe and most decision makers believed that they should be outlawed. Research showed that street food vendors could produce safe foods, with low bacterial counts, although there was still a need for proper hygiene conditions and access to basic sanitary facilities. Through a combination of evidence, policy advocacy, and programmes to improve hygiene opinion shifted: food vending was no longer perceived as a nuisance by health authorities (Von Holy & Makhoane, 2006).

Approach in China:

- 2006 Duck Egg of Doom: China culled more than 5,000 ducks that farmers have fed with a cancer-causing dye to make their eggs look redder and fresher.
- 2008 Melamine Milk Scandal: six infants were killed and 300,000 were left sickened after consuming infant formula contaminated with the industrial chemical melamine.
- 2009 Formaldehyde Pudding: inspectors found that pork blood pudding in Wuhan was manufactured with formaldehyde, corn starch, industrial grade salt, artificial food colourings, and a variety of other additives.
- 2013: Cross Dressing Meat: Chinese officials arrested 904 people who allegedly sold adulterated and mislabelled meat products treating rat, mink, and fox meat with chemicals in order to pass them off as beef and mutton.
- 2015 Forty Year Old Meat: Chinese authorities seize more than 100,000 tonnes of smuggled meat - some of it more than 40 years old, according to state media.

Conclusion:

Improving food safety in countries requires sustained investments in several areas, from stronger regulation, to better laboratories, more stringent surveillance and better training and education. Historically, upgrades to food safety systems have been triggered by large-scale outbreaks of foodborne diseases.

Fortunately, food safety crises like that are rare. But many outbreaks of foodborne disease are quickly forgotten by policy makers and the public. Lessons are not learned, the same mistakes are repeated, and people continue to suffer. Although its effects are felt by individuals, families and communities, food safety is not an issue that can be addressed only with local solutions.

WHO is continuously striving to help improve national food systems and legal frameworks to implement adequate infrastructure to manage food safety risks. The International Food Safety Authorities Network (INFOSAN) and the UN Food and Agriculture Organization (FAO) are available to the entire spectrum of the food value chain for rapid responses, information sharing especially during food safety emergencies. Information about food safety and technology to improve food quality standards globally are the future for safe-food industry.

Topic-2: Food Safety & Food borne illness: Two different interrelated issues

1. Food Safety:

Food safety refers to routines in the preparation, handling and storage of food meant to prevent foodborne illness and injury. From farm to factory to fork, food products may encounter any number of health hazards during their journey through the supply chain. Safe food handling practices and procedures are thus implemented at every stage of the food production life cycle in order to curb these risks and prevent harm to consumers.

Food safety is crucial to protect consumers from health risks related to common allergens and foodborne illnesses. In and of itself, this is a good enough goal to reach using proper processing and handling procedures, but there are other reasons, too. Safe food products shield companies and stakeholders from costly penalties and legal action.

It is important to have food safety knowledge for a number of reasons:

- Firstly, it can be the difference between illness and health; in some cases, the difference between life and death.
- Secondly, it will help you to avoid legal troubles when selling your products or making food for others.

Three objectives have emphasized on food safety:

1. Adequate and stable supply of safe and nutritious food.
2. Increased purchasing power and access to food of the people.
3. Adequate nutrition for all individuals, especially women and children.

The Basic Principles of Food Safety:

Every food Establishment uses, processes, and sells food in different ways. However, the general issues and key principles of food safety remain the same, whatever the style of the operation.

All food safety training programs should contain the “big three” factors that could cause food to become unsafe. The basic three principles that we must train all managers and food workers are:

1. Personal Hygiene for Food Professionals
2. Time & Temperature Control
3. Cross-contamination Prevention

Food Safety Assurance:

Food safety Assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use. (FAO 1997).

A Set of conditions and measures taken during the food chain stages; production, processing, storage and distribution in order to ensure that, the product consumption does not represent a risk to the human health.

Importance of food safety:

- Food safety and sanitation are important determinants of food utilization and nutrition
 - Elaborate linkage with development – governs individual and community health, national productivity, and promotes export potentials
 - Food being the primary mode of transmission of infectious pathogens
 - Low-income people tend to acquire unsafe/less quality of food due to lack of purchase capacity
- National Food policy-2006 and other relevant policies and plan have given importance on food safety.

Policy linkage:

Food safety is recognized as a priority issue by the Government of Bangladesh with a view to reduce the burden of food-borne diseases on public health and increase national productivity. The Ministry of Health and Family Welfare has set up a Food Safety Unit within the Institute of Public Health of the Directorate General of Health Services. For strong coordination of the activities related to food safety and a visible impact, this Unit is being supported to develop technical and managerial capacity to tackle food safety issues.

Within the Ministry of Health and Family Welfare, an institutional structure headlined by a high level Food Safety Working Group has been set up. Focal points have been established within the DGHS and the Ministry to co-ordinate on food safety issues. Technical assistance has been provided to develop strategies and actions for prevention and control of food adulteration and contamination. A Food Safety Documentation Centre has been set up in the National Health Library.

The advisory support to the FSWG and assisting it in developing capacity and skill development plans notably in the areas of laboratory analysis, risk-based food inspection and food-borne illness surveillance.

Objectives of Bangladesh National Food policy

- Ensuring availability of safe and nutritious food,
- Ensuring access to safe food
- Ensuring utilization and nutrition especially for women and children
- Food safety to fulfilment of vision 2021
- Poverty will be reduced to 15% by 2021
- Nutrition achievement of 85% of the population
- By 2021 a minimum daily intake will be 2122 kilocalories
- Ensure primary healthcare and sanitation for all
- Average longevity will be increased to 70 years
- Efforts for the reduction of child and maternal mortality

Bangladesh Food Safety Framework

- **Regulatory Framework**
- **Institutional arrangement Framework**

In Bangladesh, most of the foodstuffs, be they manufactured or processed, are unsafe for consumption or adulterated to varying degrees. This problem persists at every level of the food chain from preparation to consumption. Food manufacturers, processors, restaurants, fast food outlets and so forth are all involved in one way or another in this corrupt practice of adulteration. Foods are adulterated by using various harmful chemicals and toxic artificial colours, on the one hand, and rotten perishables turned to poisonous foods are stored, sold and served to consumers in an unhygienic atmosphere, on the other. The unhygienic and unsafe treatment of food is seriously impacting public health by causing numerous chronic and non-chronic diseases. Despite different

reasons for the unsafe treatment and adulteration of foodstuffs in Bangladesh, this will concentrate on the regulatory failures to combat the current food safety problems persisting in Bangladesh.

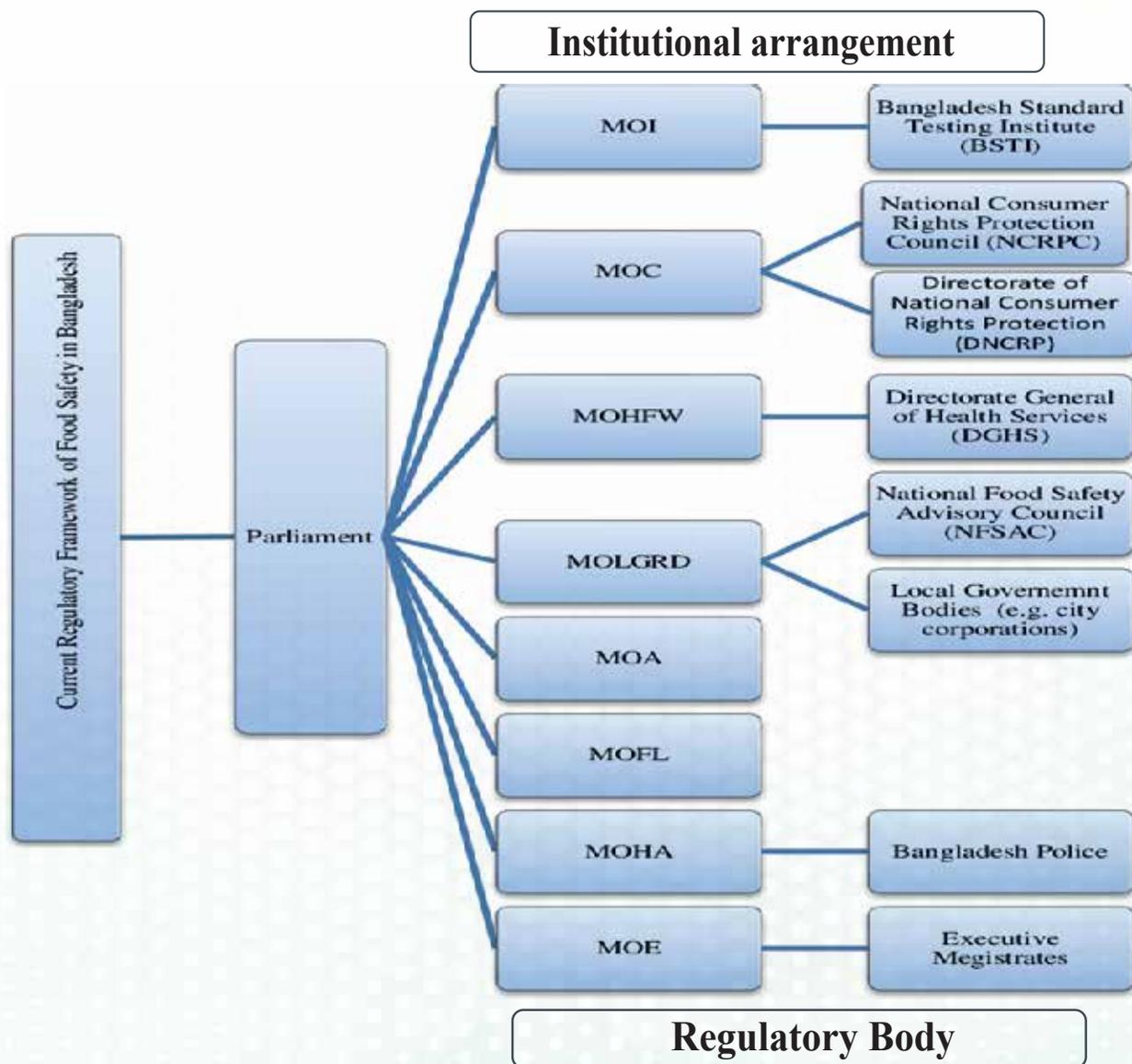


Fig. 7: Bangladesh Food Safety Framework

Rules and Regulations related to food safety:

Bangladesh Food Safety Authority (BFSA) follows the following rules

1. The Food Safety Act., 2013
2. Food Safety (Food processing & administration system) rules, 2014
3. Food safety (Contamination, Toxins & Harmful Residues) regulations, 2017
4. Food safety (Labeling) regulations, 2017
5. Use of food additives regulations, 2017
6. Food sample collection, testing & analysis regulations, 2017
7. Food safety (Technical Committee) rules, 2017
8. Food safety (Food Hygiene) regulations, 2018

Laws, Ordinance and rules: related to food safety:

1. Fish and Animal Feed Act 2010
2. The Animal Slaughter and Meat quality Control Act 2011
3. Bangladesh Animal Disease Act, 2005
4. Bangladesh Animal and Animal Product Quarantine Act, 2005
5. Bangladesh Accreditation Act 2006
6. Destructive Insects and Pest Rules, 1966 amended up to 1989
7. The Pesticide (Amendment) Act, 2009 and the Pesticide Rules 1985 amended up to 2010
8. Local Government (City Corporation) Ordinance, 2008
9. The Radiation Protection Act, 1987
10. Bangladesh Standard Specification for Grades on Milled Rice
11. Agricultural Produce Market Act 1964 (revised in 1985)
12. Pure Food Rules 1967
13. Bangladesh Standards and Testing Institution (BSTI) ordinance (1985) amended as BSTI act 2003

Food borne illness:

Food borne disease is the sickness caused by dangerous microorganisms and/or toxic chemicals due to the ingestion of contaminated food. Food borne diseases severely affects infants, young children, elderly people which ultimately creates a vicious cycle of diarrhoea and malnutrition, damages the national economy, delay development and reduces international trade.

There are broadly three different types of microorganisms in aspect of food safety:

Microbial foodborne illness:

- I) the good: - Good microorganisms are useful which are used to make food and drinks (e.g., cheese, yoghurt, beer and wine); medicine (e.g., penicillin); and to digest food in the gut.
- II) the bad and: - Bad microorganisms, or spoilage microorganisms, do not usually make people sick, but they cause our food to smell bad, taste horrible and look disgusting.
- III) the dangerous: - Dangerous microorganisms make people sick and can even kill and these are called “pathogens”. Most of these microorganisms do not change the appearance of the food. An example is the green mould on bread which can produce toxins.

Some common dangerous foodborne microorganisms are:

Bacteria – Salmonella, Shigella, Campylobacter, listeria and E. coli;

Parasites – Giardia, Trichinella; and

Viruses – Hepatitis A, Norovirus.

Sources of Microorganisms: Microorganisms are mostly found in

- Faeces;
- Soil and water;
- Rats, mice, insects and pests;
- Domestic, marine and farm animals (e.g., dogs, fish, cows, chickens and pigs) and
- People (bowel, mouth, nose, intestines, hands, fingernails and skin).

Topic-3: Animal Feed and Adulterant Issues Related to Food safety

Introduction:

Safe food plays an important role, whether domestically produced, imported or exported. Ensuring safe food is paramount for the protection of human health and for enhancement of the quality of life. The demand of safe and hygienic food of animal origin (beef, mutton, chicken, ducks, eggs, milk and milk products) is increased and will continue to rise because of high-income elasticity of demand. Unsafe food represents a major threat to public health in Bangladesh. Each year millions of citizens suffer bouts of illness following the consumption of unsafe food.

- The feed safety hazards are associated with entire food safety chain that consequences risks to human health and economic impact in product destruction or market losses etc.
- Examples are heavy metals in animal feed, antibiotics, pesticide and veterinary drugs, aflatoxin, dioxin residues in meat, milk and eggs.

Food Production Chain:

Food production chains are extremely complex which involve with production, processing, trade and consumption (Fig.8) All stakeholders such as farmers, processors, transporters, distributors (wholesale & retail), and consumers are equally responsible from primary production to final consumption ensuring that the food products are safe, healthy and nutritious.

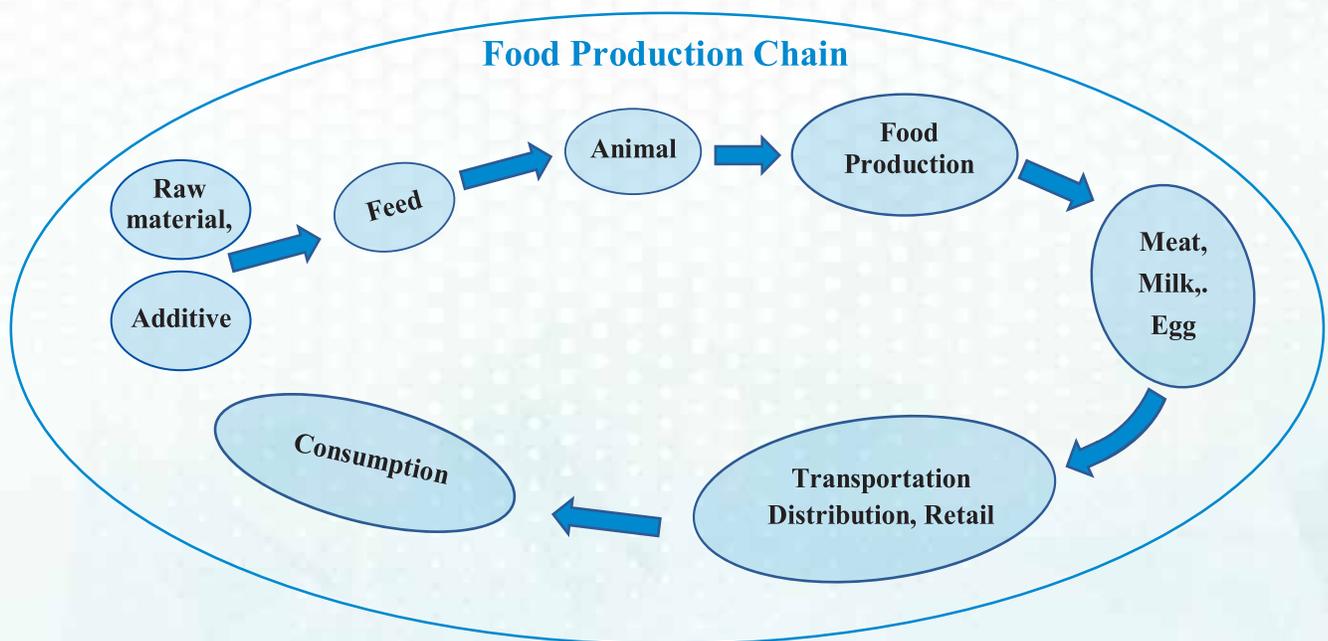


Fig. 8: Food Production Chain

Feed Management:

The global food system is experiencing profound changes in consumption patterns, especially in the increasing demand for livestock products, leading to worldwide growth in intensive livestock production. In turn, there is an increasing need for adequate feed materials which need to be wholesome and safe for the animal as well as free of undesirable or toxic substances (Figure 9) that could compromise the quality and safety of animal-derived foods (Fink-Gremmels, 2012; Sharma et al., 2015).

Food safety hazards associated with animal feed can be biological, chemical or physical (radionuclides). Each hazard is associated with particular sources and routes of contamination and exposure. The role of water as a potential source of hazards should not be overlooked. Hazards may be introduced with source materials or via carryover or contamination of products during handling, storage and transportation.

Most of the dairy and poultry farmers are facing the problem of adulterated and inferior quality of commercial feeds and feed ingredients. Feed labelling and control is inadequate.

Most feed millers do not disclose the necessary information on the packaging with regards to feed composition, ingredients, date of manufacturing, date of expiry, storage guidelines, energy levels, and protein and vitamin contents. Feed millers are widely suspected of minimizing feed production costs either by use of inferior quality ingredients and/or inclusion of lower proportions of high value ingredients. Poor packaging materials contribute to reduced quality and shelf life.



Fig. 9: Sources of Contamination in Animal Feed

International standards, guidelines and recommendations on food quality and safety are being regularly issued by FAO/WHO Codex Alimentarius Commission and also by the EU Commission. The objective of the Codex Code of Practice on good animal feeding (CAC/RCP 54-2004) aims to ensure the safety of food for human consumption (Figure 10) through adherence to good animal feeding practice at the farm level and good manufacturing practices (GMPs) during the procurement, handling, storage, processing and distribution of animal feed and feed ingredients for food-producing animals.

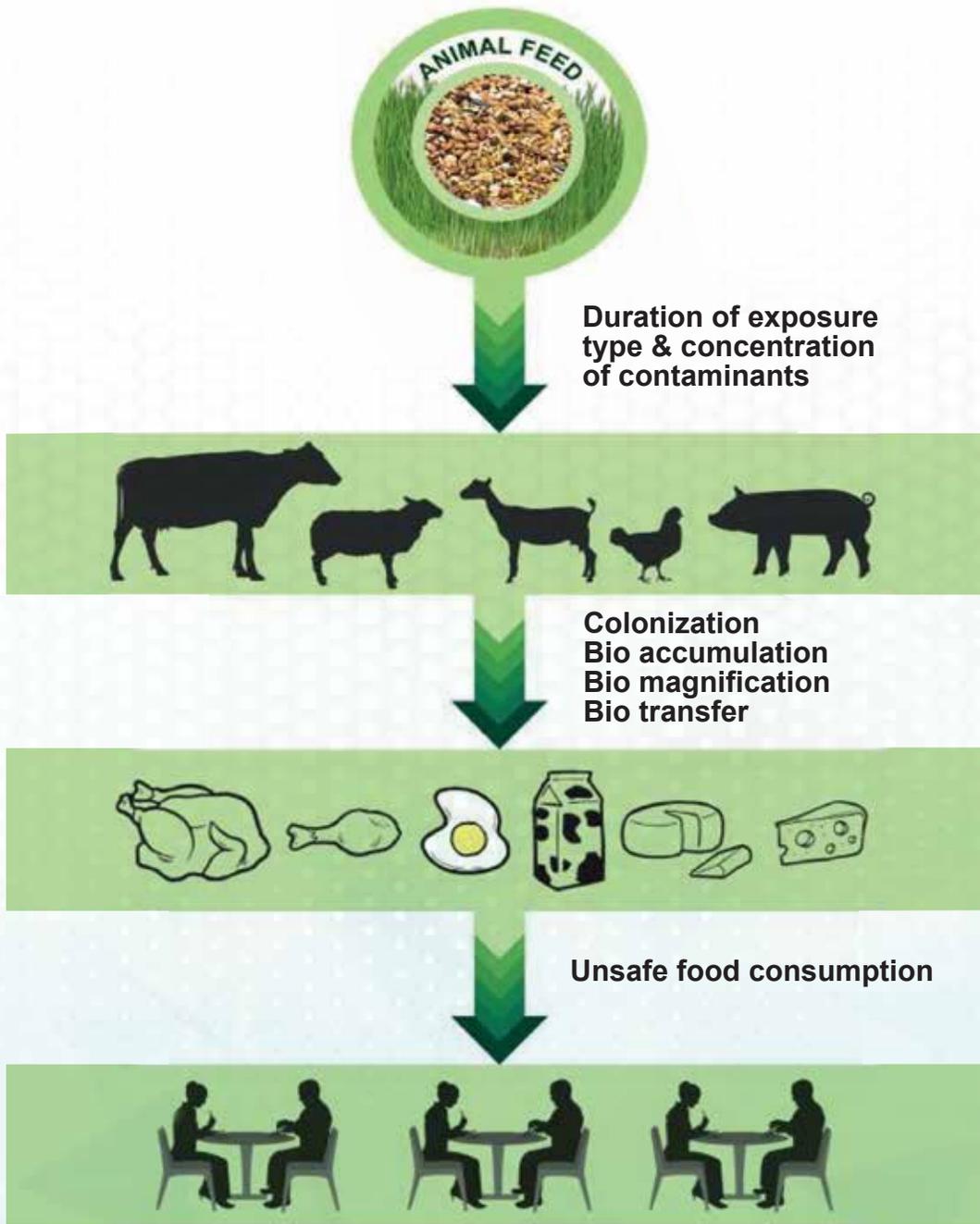


Fig. 10: Safe Animal Feed-Safe Food - Safeguard Human Health

Organic Livestock Production:

There is a growing market for organic meat and organic livestock production can contribute to animal welfare and environmental protection.

Benefits of Organic Livestock: Although livestock are usually the last part of the farm to be certified organic, they are often central to the farm and can contribute to its success. Livestock play an even more critical role on organic farms than they do on conventional farms. Livestock on an organic farm play a key role in:

- Nutrient cycling - a process in which nutrients are returned to the soil through manure and compost. Amending soils with animal manures can increase microbial biomass, enzymatic activity and alter the structure of the microbial community
- Incorporation of feed crops, such as alfalfa or grasses into crop rotations helps to build soil organic matter
- Increasing cropping options, adding diversity to the agro-ecosystem
- Weed control - feed crops can be used to suppress and control weeds and animals can be used to graze out weeds on crops or pastures
- Preparing the ground for cropping. Livestock such as pigs can ‘plough’ rough or new land before planting vegetables or grains, reducing tillage and weed control costs
- Interrupting insect and disease cycles by taking land out of cropping
- Adding value to grass-lands and promoting the use of green manures
- Reducing the financial risks of farming by converting lower quality grain crops and screenings into profit and spreading income more evenly over the year
- A good starting point to learn more about organic livestock production is the Organic Livestock Handbook published by Canadian Organic Growers.

Adulteration Issues in Bangladesh:

Adulteration issues in Bangladesh is very much precarious. Consumers in Bangladesh become victims of serious adulteration in food. Here food safety laws, regulations and administration are rather ineffective. Food safety administration and inspection does not include the monitoring of the entire chain of production and transaction. The country has although set some goals for domestic consumption and increasing export of fresh and processed foods, but adequate food safety control has not yet been achieved to gain access to the European and global markets. It is agreed that to ensure quality and safety of foods in this country ‘from farm to table’ pre-harvest and post-harvest hygienic functions are very much neglected. The primary prevention ‘on-farm’ exposure to food-borne hazards due to pathogens and residue producing chemicals persisting in the food chain is not given due importance (Rahman, 2010).

The Government of Bangladesh is however encouraging the private sector to put the food processing and marketing into the context of industrial standard. In recent years a modern abattoir namely Bengal Meat Ltd has been established to offer consumers wholesome meat.

Numerous food processors are producing, processing and preparing foodstuffs in serious unhygienic environments. Most common practice of food adulteration is:

- Mixing with non-food ingredients;
- Substituting with under quality food substances or fabrication;
- Texturing to mask the poor quality or under processing;
- Adding decomposed foods to fresh foods and putting up for sale;
- Misleading labels of foods;
- Misrepresentation of foods;
- Using health hazardous agents in foods as preservatives;
- Attracting consumers by introducing colouring and flavouring chemical adulterants;
- Sick, infected and poisonous dead chickens are used in soup preparation.

The concept of above-mentioned non-food substances or ingredients to food products as adulterants have posed health hazards among consumers. In a number of cases there may be paralysis and long-term carcinogenic effect. As a consequence, the public are deprived of wholesome foods and are implicated with two major disadvantages:

- Paying more money but getting lower quality of foods.
- Highly injurious to health, even causing death.

The situation of food safety needed in relation to hygiene and production of foods of animal origin in Bangladesh is briefly narrated below.

Adulteration in Meat and Meat products:

- The most frequent chain of events leading to meat borne illness involves food producing animals, which are healthy carriers of the pathogens that are subsequently transferred to humans through production, handling and consumption of meat and meat products.
- Bangladesh has a large livestock population but for long time meat processing has remained to a very small section of people.
- Most meat is handled under unsatisfactory sanitary conditions in both rural and urban areas. There is generally poor pre-slaughter conditions, sanitation, removal of waste materials, and disposal of offal.
- The supply of meat constitutes for all communities of urban and rural areas a factor of economic, hygienic and public health importance, but the situation of meat production and processing with regard to handling, slaughtering and dressing of food animals takes place in a much disorganized way and unsanitary conditions.
- There are many self-made field abattoirs in rural and urban areas, small towns and even in cities where slaughtering of cattle, sheep and goat by unauthorized butchers in fields, bushes, backyards or at some street corners.
- The dressed carcasses are made into various cuts and sold to customers. There is neither any humane method of slaughter nor any pre-slaughter or ante-mortem examination.

- The public due to unawareness and non-enforcement of laws many a times buy meat, which cannot ensure protection to consumers from the potential danger of inferior quality meat.
- The finished products are transported to meat shops by rickshaw, cart, vans and shoulder carriage, often lying on unclean surfaces and exposed to health hazardous agents. Blood, ruminal and intestinal contents are either left where the slaughter has taken place or washed down a drain to eventually end up in a pond or a watercourse.

Adulteration in Milk and milk products:

- Supply of milk from widely scattered sources, non-availability of cooling before and during transportation, careless handling and distribution under improper hygienic condition and wilful adulteration with pond or river water are all unsanitary activities under which milk is being sold.
- Milk after production is kept in buckets or earthenware pails and sold to Gowalla and milkmen, who ultimately collect milk in big vessels and transport to town and cities on shoulder carriage or bicycle or by road transports and rail.
- In many cases the vessels in which the milk is delivered without coverings, the utensils are not properly washed and cleaned and made possible bacterial contamination.
- The milkmen to prevent its splashing from the container place banana and date leaves in milk. They do not give attention that the leaves could be abode of pathogens.

Adulteration in Poultry meat:

- The use of antibiotics, hormones, steroid etc. in poultry feeds is thought to be common and a cause of public health concern.
- During these pre-harvest and post-harvest activities like transportation, Scalding, plucking and evisceration etc. in both wet market and household.
- Contamination with heavy metals including Arsenic through contaminated water.

Adulteration in Eggs:

- The use of antibiotics, hormones, steroid etc. in poultry feeds is thought to be common adulteration in eggs.
- Unclean or soiled egg marketing is the source of contamination.
- Improper handling and transportation lead to rotting of eggs. Salmonella organisms have been found to be frequently present in dirty and cracked duck eggs (Rahman, 2003).
- Contamination with heavy metals including Arsenic through contaminated water.

Topic-4: The HACCP Principles and Guidelines in Food Safety

HACCP & Potential risks in food:

What is HACCP?

HACCP is a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product.

HACCP: - HACCP is an internationally recognized system for reducing the risk of safety hazards in food.



Fig. 11: HACCP & Potential risks in food.

Why is HACCP stands for:-

Hazard Analysis and Critical Control Point. It is a seven-step process in which a food establishment or producer can use to develop a food safety plan. This system is designed to fight safety hazards potentially present in food throughout the manufacturing process. Any company that is involved in manufacturing and processing food has the potential to implement the HACCP system and is highly encouraged to do so. It is used to protect consumers and employees from biological, chemical, and physical hazards that have the possibility of making their way into our food system.

H=HAZARD=Danger to health; A=ANALYSIS=Investigation of the hazard

C= CRITICAL=Crucial for containment; C=CONTROL=Handling of conditions

P=POINT=Position in the process

Why is HACCP?

HACCP- Prevent Foodborne illness.

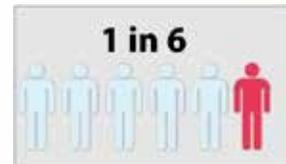
United States Department of Health and Human Services

Centre for Disease Control and Prevention (CDC) states that:

- 48 million people get sick due to one or another of 31 pathogens
- 128,000 people end up in the hospital
- 3000 die annually
- 7757 Foodborne disease outbreaks in the US between 1998-2008



- Foodborne illness affects 1 in 6 Americans every year.



- Poultry accounts for 19% of deaths due to foodborne illness (Listeria and Salmonella)



United States Department of Agriculture (USDA) foodborne illness with cost:



15.6 billion \$ per year

Cost/year in US associated with illness caused by foodborne pathogens



10 billion \$ per year

The average cost of a recall



700 Recalls per year in the US

HACCP & Potential risks in food-Bangladesh

- Burden of Food borne Illness
- Limited data available in Bangladesh
- About 230,000 children die from Diarrhoea each year in Bangladesh
- Typically, 25-30% population suffer an episode of foodborne illness/annum
- Bangladesh 40 million cases/annum; 110,000 cases/day

Source: FAO BFSP 2011

HACCP applies to the entire Food Chain (Farm to Fork)

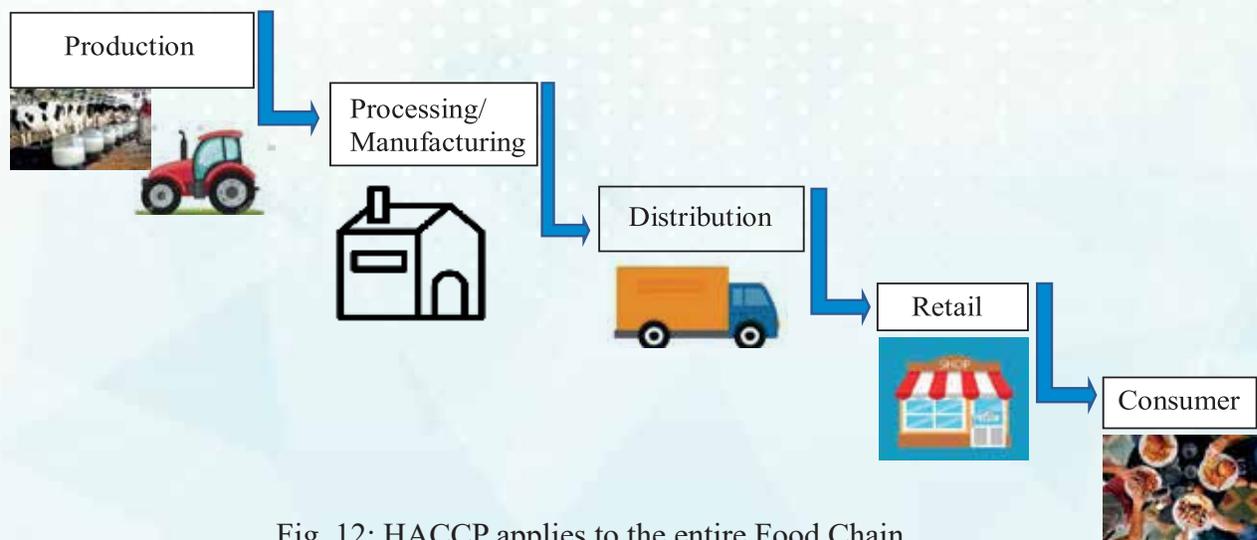


Fig. 12: HACCP applies to the entire Food Chain

What is Hazard?

A hazard is any object, situation, or behavior that has the potential to cause injury, ill health, or damage to property or the environment.

What is ISO?

ISO (International Organization for Standardization) is an independent, non-governmental, international organization that develops standards to ensure the quality, safety, and efficiency of products, services, and systems.

What is contamination?

Contamination - The transfer of microorganisms from one place to another is called “contamination”. Microorganisms depend on someone or something to move them around.

History of HACCP & ISO:

Food safety for the manned space program Pillsbury NASA -National Aeronautic Space Administration (Natick Army Laboratory)	Incorporated HACCP in the regulation due outbreaks of Clostridium botulinum FDA	First international definitions for HACCP	Develop of ISO 22000 with the major contribution to Food Safety Management System
1950's	1974	1993	2000

Food Safety Hazard:

A food hazard can be defined as being any biological, chemical or physical agent found in food that has the potential to cause harm, injury or illness. Food safety hazards may occur naturally, be unintentionally introduced or intentionally introduced.

Identifying hazards:

- Firstly, it makes good business sense. The worst-case scenarios for not identifying and controlling food hazards adequately are food poisoning outbreaks, product recalls, regulatory action and potential damage of product brand.
- Another driving force behind the requirement to identify food safety hazards is to comply with Codex Alimentarius Commission (CAC) HACCP and Global Food Safety Initiatives (GFSI) recognized standards.
- Hazard identification is a fundamental requirement of HACCP Principle.

Food safety hazard categories:

Potential hazards are required to be identified at each step in the **process**, for all of **raw materials** and for each **type of food** business manufactures, processes, packs or holds.

Types of Potential Food safety hazards:

1. Biological
 2. Chemical
 3. Physical
- Depending on customer requirements and country of manufacturing, also be required to specifically identify radiological and allergen hazards separately.
 - Traditionally, allergens and radiological hazards have been classified as a ‘chemical’ hazard.
 - Other specific hazards/risks; Environmental/ethical risks

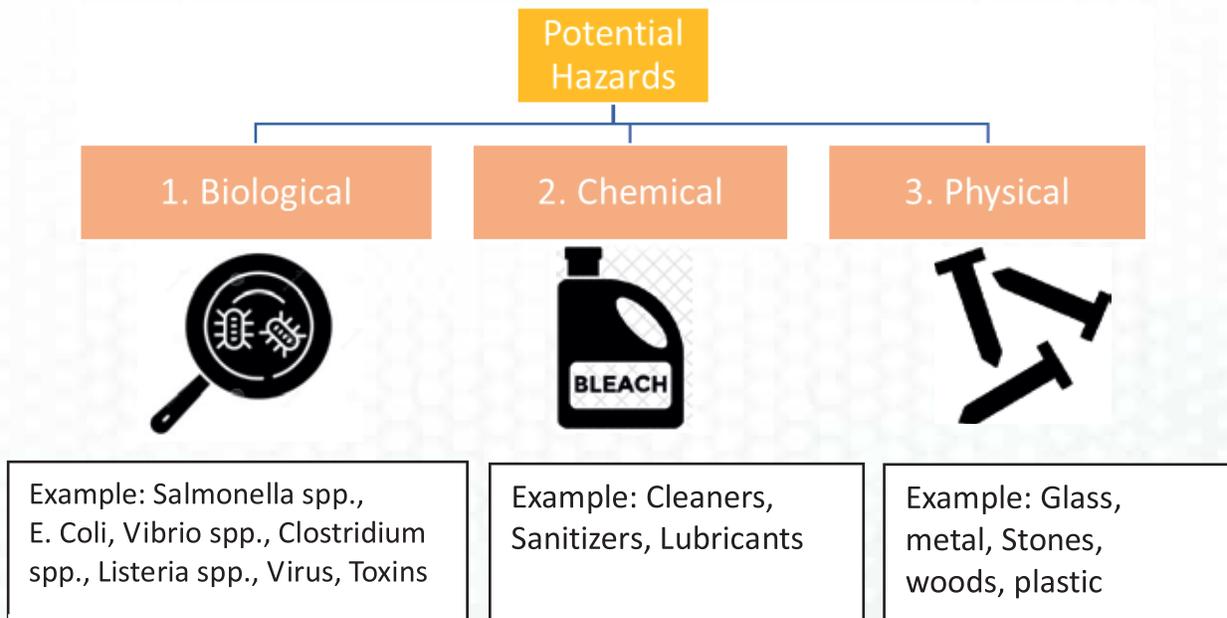
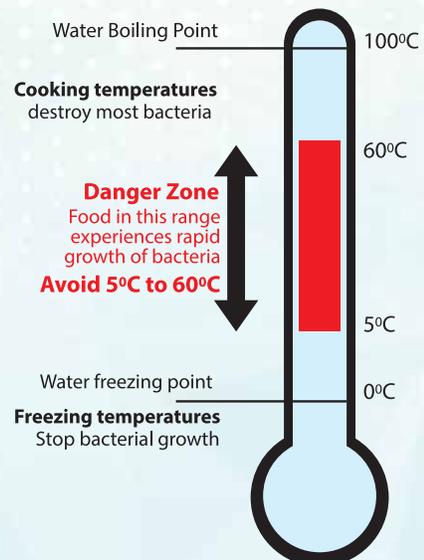


Fig. 13: Potential Food Safety Hazards

Different Hazards and their Controls:

1. Biological Hazards and Controls:

- Microorganisms, such as bacteria and viruses contaminate food and produce serious toxins on the food, which lead to unpleasant illnesses.
- Microorganisms transfer onto food from unclean hands, unclean clothes, pests, animals and air.
- Microorganisms thrive within particular temperatures, pH levels and moisture, and therefore there are a number of microorganisms which are able to multiply when in ideal growth conditions.



- There is a 'Danger Zone' which allows microorganisms to grow rapidly.
- This zone refers to temperatures between 8°C and 60°C. When in the 'Danger Zone' bacteria can double in number every 20 minutes, and it has been suggested that after four hours the number of bacteria is high enough to cause serious illness.
- Below the temperature of 8°C, the growth of bacteria is slowed down and essentially paused, and when food is above the temperature of 60°C, bacteria die.
- Cooking food, the food must reach a core temperature of 75°C to ensure all bacteria is killed.
- Storing food in chilled conditions, foods must be kept between the temperature of 0°C and 5°C.
- Refrigerators should be set at 3°C or 4°C.

Example of Microbiological Hazards:

- Pathogenic (Harmful) Bacteria
- Virus - Hepatitis A virus; Norwalk virus
- Toxin - Bacterial toxins e.g., from *Clostridium botulinum*, *Staphylococcus aureus*, *Bacillus cereus* - Mycotoxins i.e., produced by moulds, e.g., aflatoxin

Common Pathogenic Bacteria Carried by Food:

- *Aeromonas hydrophila*
- *Bacillus cereus*
- *Campylobacter jejuni*
- *Clostridium botulinum*
- *Clostridium perfringens*
- *Escherichia coli (E.coli)*
- *Listeria monocytogenes*
- *Salmonella species*
- *Shigella dysenteriae*
- *Staphylococcus aureus*
- *Vibrio cholera*
- *Yersinia enterocolitica*

Toxins:

- Algal toxins
- Naturally occurring toxins, e.g., mushroom, potatoes

Parasites & Protozoa: (flat worms, tapeworms & flukes)

- *Trichinella spiralis*
- *Cryptosporidium*
- *Giardia lamblia*

Pathogens:

- Able to cause sickness/diseases through: Invasion (*Infection*) e.g., Salmonellosis
- Live harmful bacteria are eaten Toxin (*Intoxication*) e.g., Staphylococcal
- Waste products (toxins) produced by bacteria are ingested

Bacterial-Caused Foodborne Illness:

Intoxication Caused by	Infection Caused by
<ul style="list-style-type: none"> • Staphylococcus (infected food handler) • Bacillus (cooked rice) • <i>C. perfringens</i> (produce, soil) • <i>E.coli</i> (minced beef) 	<ul style="list-style-type: none"> • Salmonella (chicken) • Shigella (faecal contamination) • Campylobacter (chicken)
Shorter incubation period: 1-12 hours	Longer incubation period: 6-72 hours

Where do pathogens come from?

- Low quality raw materials
- Poor personal hygiene
- Inadequate cooking
- Improper storage / holding temperature
- Improper reheating
- Cross contamination - improper segregation
- Past use-by time

Factors Affecting Microbial Growth:

i) Temperature

- Grow ideally at body temperature (37.5°C)
- Also grow at temperature higher or lower than this

Example

Salmonella @ 37°C; *Clostridium perfringens* @ 43- 47°C

Listeria monocytogenes @ 2°C

- Fridge temperature (5°C) will slow bacteria growth
- Hot temperature (above 70°C) will kill most bacteria



ii) Time

- At an ideal temperature, bacteria will double in number every 20 minutes

O'clock	Bacteria
12.00	1
12.20	2
12.40	4
1.00	8
2.00	64
3.00	512
4.00	4096
5.00	32768
6.00	262144
7.00	2097152

iii) *Moisture*

- Bacteria must receive their food in some kind of water solution
- This solution is described as water activity (A_w)

Water Activity (A_w) in Foods

Definition: The water activity (A_w) of a food is the ratio between the vapor pressure of the food itself, when in a completely undisturbed balance with the surrounding air media, and the vapor pressure of distilled water under identical conditions. A water activity of 0.80 means the vapor pressure is 80 percent of that of pure water.

Group	Minimum A_w Value	Critical limit of water activity in foods
Most Bacteria	0.91	The water activity level that limits the growth of the vast majority of pathogenic bacteria is 0.90aw (0.70aw for spoilage molds). The lower limit for all microorganisms is 0.60aw.
Most Yeast	0.88	
Moulds	0.82	

Water Activity of Selected Foods:

Food	Water Activity	Standard water activity
Cheese	0.95-1.00	Most foods have a water activity above 0.95 and that will provide sufficient moisture to support the growth of bacteria, yeasts, and mold. The amount of available moisture can be reduced to a point which will inhibit the growth of the organisms.
Fresh Meat	0.95-1.00	
Cured Meat	0.87-0.95	
Milk Powder	0.20	

iv) *Acidity (pH)*

- Acidity or alkalinity of food is measured by pH
 - pH 1-6 = acidic
 - pH 7 = neutral
 - pH 8 -14 = alkaline

pH Value of Some Foods:

Product	pH	Most bacteria Grow in pH
Minced Beef	5.0-6.3	Most bacteria grow best around neutral pH values (6.5 - 7.0), but some thrive in very acid conditions and some can even tolerate a pH as low as 1.0.
Chicken	6.2-6.7	
Butter	6.1-6.4	
Milk	6.6-7.0	

2. Chemical Hazards and Controls:

Chemical substances can transfer onto food and contaminate it.

- Chemical substances include mycotoxins, sodium nitrate, pesticides, kitchen cleaning products and pest control products.
- To avoid chemical hazards, ensure that cleaning procedures and sanitation in the workplace is of a high standard.
- Be aware how food has been treated previously, such as whether the food has come into contact with pesticides.
- It is also important to ensure chemicals in the workplace are stored separately from food products.

Chemical Hazards:

a) Naturally Occurred

Mushroom, some tapioca species, bamboo shoots and some fish species.

b) Commercially Intentionally Added

Pesticides, herbicides, colouring, additives, flavour enhancer, etc.

c) Unintentionally Added

Cleaners, sanitizers, lubricants and other hazardous chemicals

Chemical Used in Food Processing:

Point of Use	Type of Chemicals
Growing Crops	Pesticides, herbicides
Raising Livestock	Hormones, antibiotics, biological residues
Production/Processing	Food additives, processing aids
Plant Maintenance	Lubricants, paints
Plant Sanitation	Cleaners, sanitizing agents

Definition

Critical Control Point (CCP) is the point where the failure of Standard Operation Procedure (SOP) could cause harm to customers and to the business, or even loss of the business itself. It is a point, step or procedure at which controls can be applied and a food safety hazard can be prevented, eliminated or reduced to acceptable (critical) levels.

Control of Chemical Hazards:

- Prior to receipt of raw materials, food ingredients and packaging materials
- Upon receipt of these materials
- During processing
- During storage
- During the use of sanitizers, cleaning agents, lubricants, etc.
- Prior to the shipment of finished products

3. Physical Hazards and controls:

Physical Hazards:

Physical hazards involve physical foreign objects coming into contact with food, such as nails, plasters, glass, soil, stone, plastic and hair.

- To avoid physical hazards, ensure that those handling foods have a high standard of personal hygiene and are dressed appropriately.
- Hair must be tied back, no jewelry use, gloves used as and when necessary.
- Anything is dropped or smashed around food, for example glass or plastic, the food must be thrown away to ensure no fractures of glass or plastic are within the food.

Examples of Physical Hazards:

Natural or man-made:

Feathers, hair, rodents' droppings, metal, nail, glass, rock/sand, paint flakes, jewellery/button, cigarette butts, band aid, writing pen caps, carcass ID tags, needles, grease, bone, metal.

Sources of physical hazards:

- Contaminated raw materials
- Design of facilities and equipment
- Faulty production procedure
- Improper employee practices

Prevention and control of physical hazards:

- Applying Good Manufacturing Practices
- Using appropriate ingredients & supplies specifications
- Obtaining letters of guarantee / certificate of analysis from all suppliers
- Able to identify types & sources of physical hazards
- Able to determine critical control points
- Training employees in Good Hygiene Practices

Allergenic Hazards:

- Allergic reactions occur when a particular food enters the human digestive system and stimulates an allergic reaction.
- The immune system reacts to particular proteins in foods which the body considers harmful, the symptoms can be frightening, involving difficulty breathing, swelling of the tongue and a skin rash.
- Common foods which can trigger allergic reactions include:
 - Dairy Products
 - Peanuts
 - Tree Nuts
 - Shellfish
 - Wheat
 - Soy
- It is important to understand and identify the types of hazards which exist during the food production journey, to ensure that consumer health and safety is protected as far as possible.

Factors associated with food borne microbiological hazards

Factors should be: Personal hygiene, water quality, temperature, pH, moisture, processing and sale environment, knowledge on food safety etc.

Extrinsic factors including the knowledge on food safety, food processing water quality and other factors influencing food contamination have been noted to enhance the public awareness on hygiene practice as well as the aseptic handling of food items.

The possible major microbial species including the Viable But Non Culturable (VBNC) bacteria contaminating foods have also been deciphered.

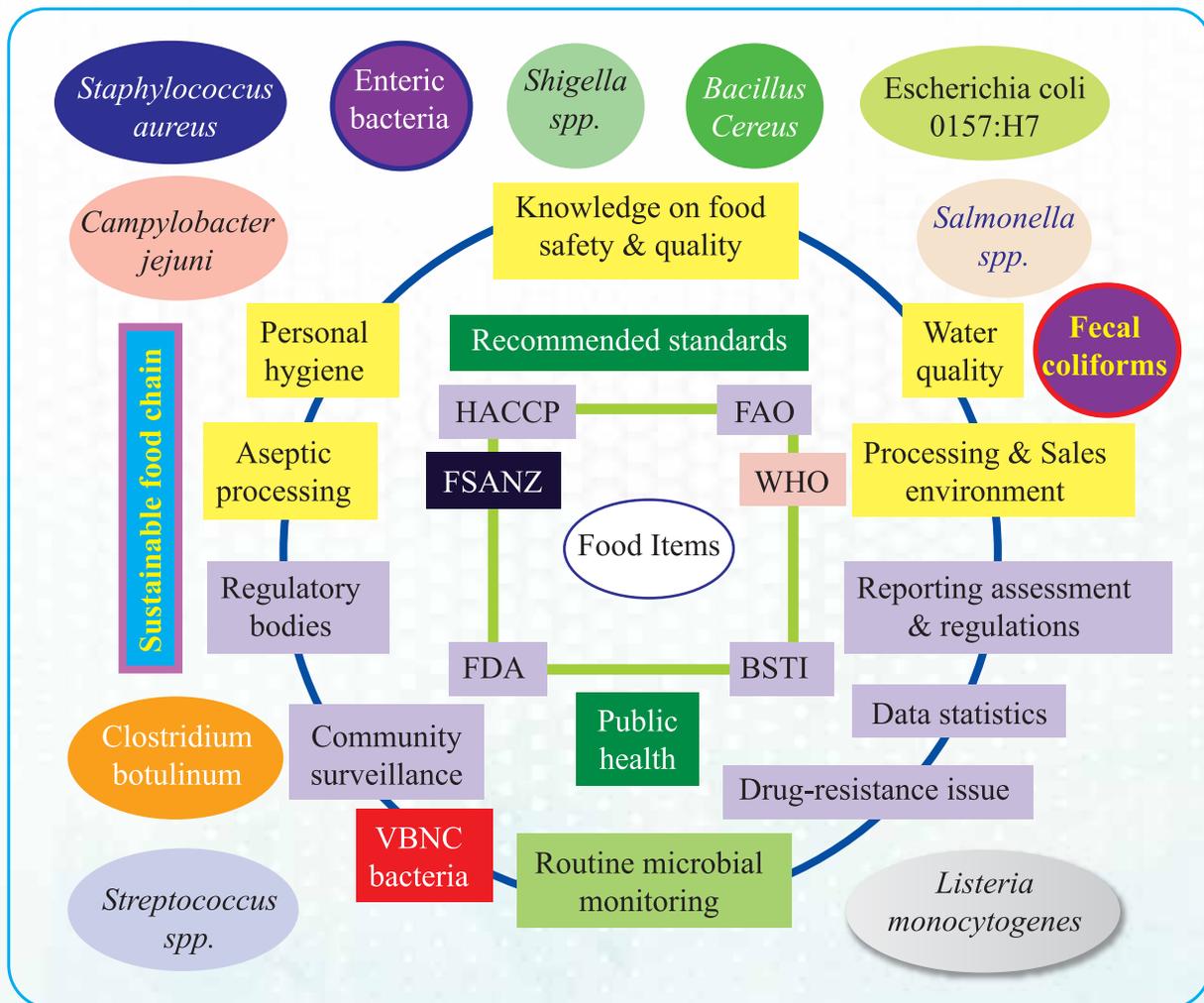


Fig. 14: Food borne microbiological hazards

The proposed inter-connection between the international regulatory bodies (mainly FDA, WHO, FAO and HACCP), the recommended food borne microbial limits (principally set by FSANZ), and the major food legislative organization of Bangladesh, BSTI have been shown.

Common aspects of the onset food borne disease outbreaks in Bangladesh

The below schema emphasized on the inadequate of regulatory bodies in food protection as well as the impact of insufficient practice of unhygienic maintenance of food in triggering the food borne diseases: infection, intoxication, toxic-infection, and opportunistic infection of food items consumed.

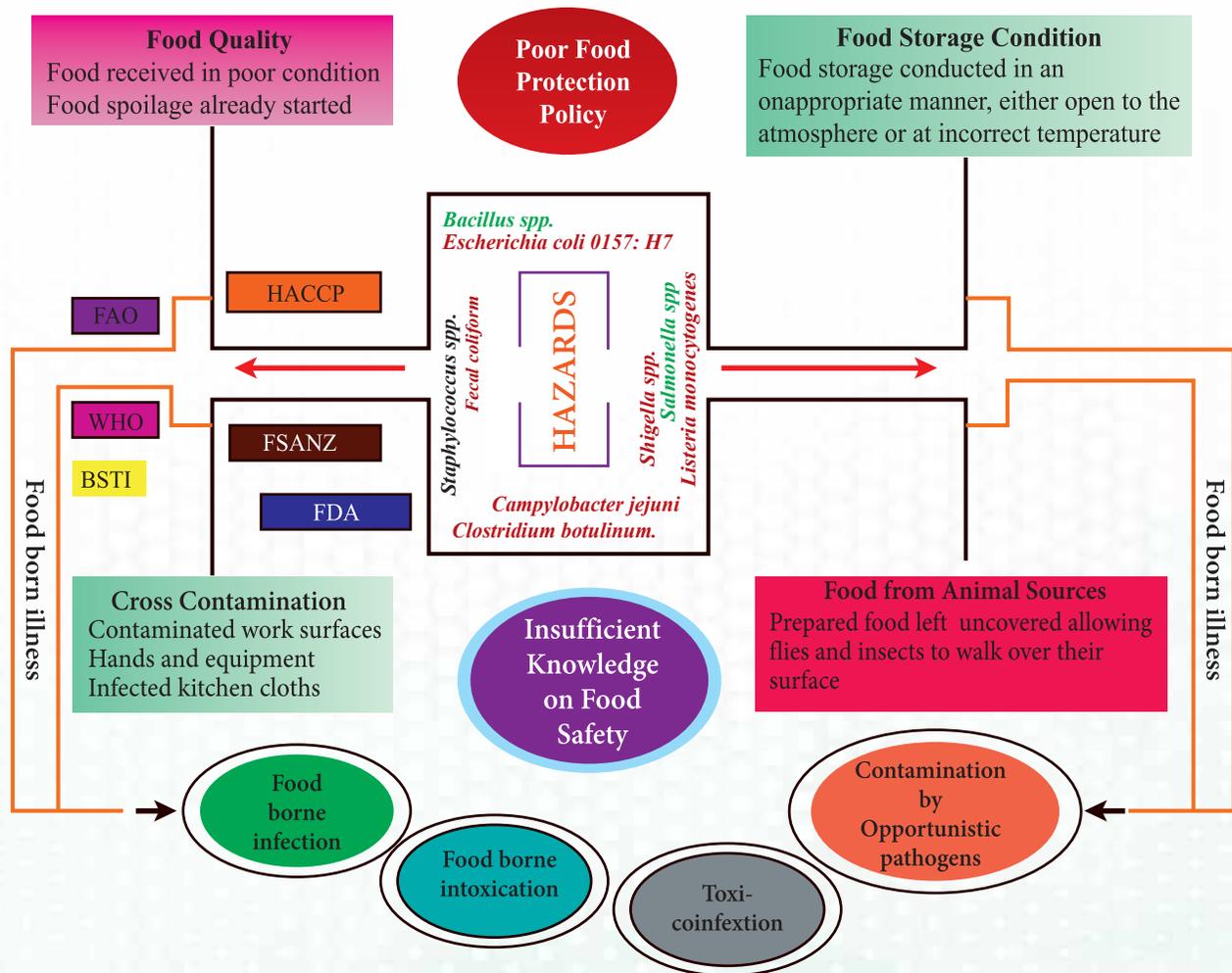


Fig. 15: Common aspects of the onset food borne disease outbreaks in Bangladesh.

The Seven (7) Principles of HACCP

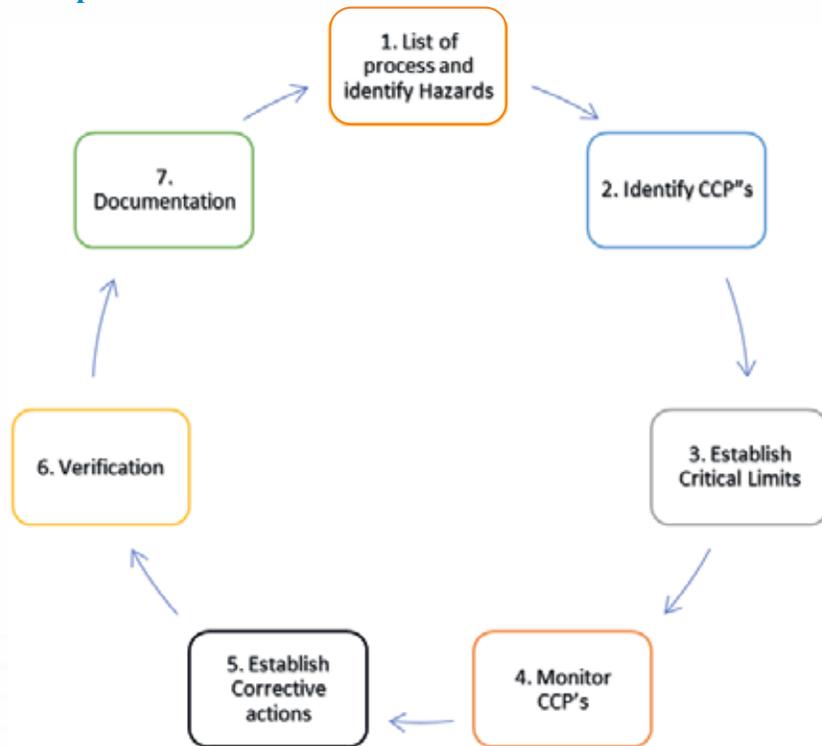
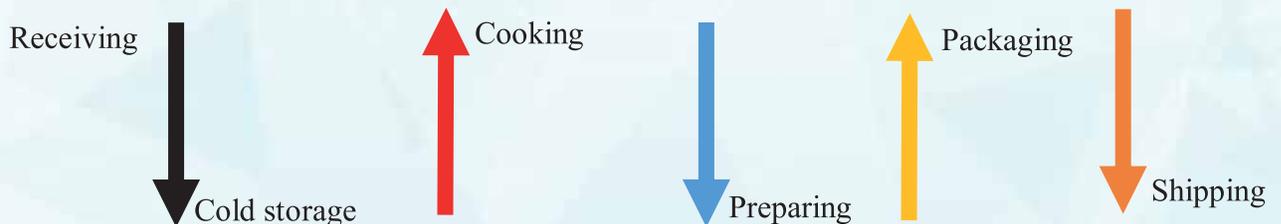


Fig. 16: Principles of HACCP

1. List of Process and identify hazards

Process	Biological	Chemical	Physical
Receiving	Bacteria on raw products Bacterial growth	Pesticides or cleaning residues	Glass, metal, or plastic Fragments of packaging materials
Cold Storage			
Cooking			
Preparing			
Packaging	Cross contamination raw products		
Shipping			

2. Identify CCP's



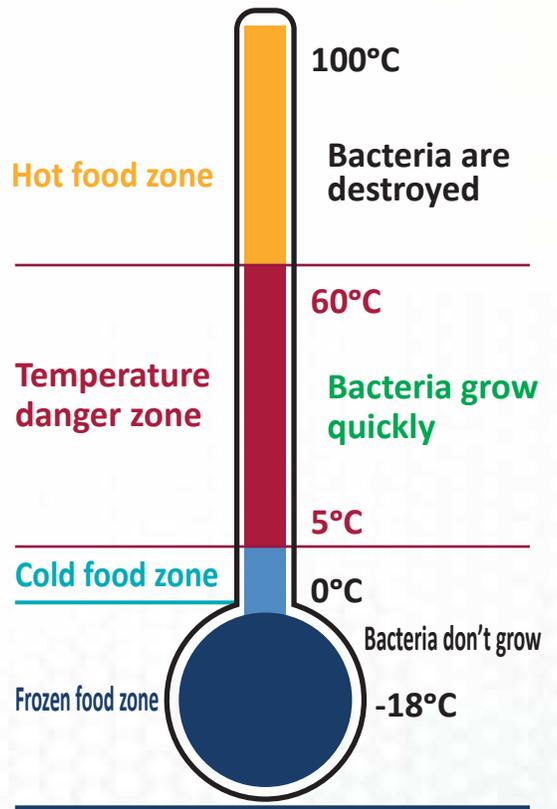
3. Establish Critical Limits

Temperature for hot holding.
Keep food warm once cooked.

Do not leave Food in the danger zones a pathogen can rapidly multiply.

Fridge and coolers: Set temperature to 4°C or less for chilled food

- The temperature danger zone is between 5°C and 60°C, when it is easiest for harmful bacteria to grow in food
- Minimise the time that food spends at these temperature in order to keep food safe
- Refrigerated food needs to be kept at 5°C or below
- Hot food needs to be kept at 60°C or above



4. Monitor CCP

Thermo-couple probe sends temperatures to electronic device

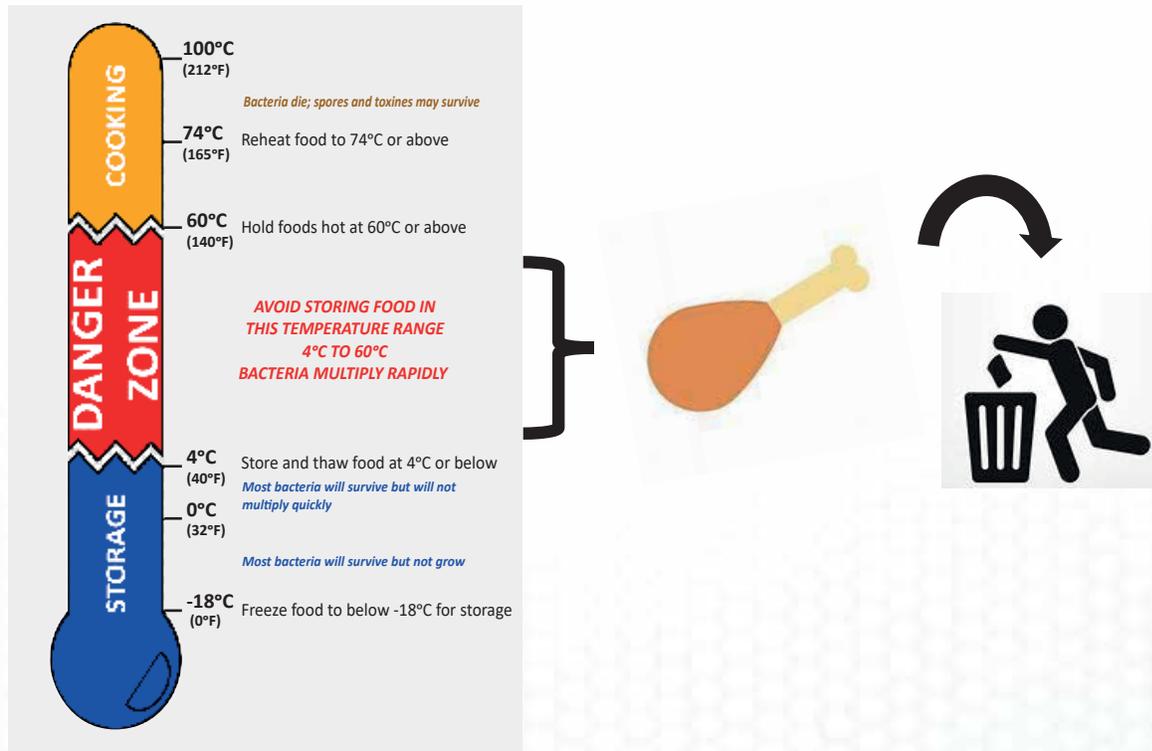
Electronic device sends time and Temperature information to monitoring record software system

Software platform continuously records time and temperature monitoring



5. Establish corrective actions

If products under going cold storage exceed 4⁰ C for > 2 hours, they must be discarded establish corrective actions



6. Verification

Audit the HACCP system:

The third (3rd) party audits [e.g., Safe Quality Food (SQF)] as a requisite to do business with specific retailers/customers



7. Documentation/Record Keeping



Fig. 17: Documentation/Record Keeping

Guidelines for application of HACCP principles:

- HACCP is a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product.
- For successful implementation of a HACCP plan, management must be strongly committed to the HACCP concept.
- A firm commitment to HACCP by top management provides company employees with a sense of the importance of producing safe food.
- HACCP is designed for use in all segments of the food industry from growing, harvesting, processing, manufacturing, distributing, and merchandising to preparing food for consumption.
- Prerequisite programs such as current Good Manufacturing Practices (cGMPs) are an essential foundation for the development and implementation of successful HACCP plans.
- Food safety systems based on the HACCP principles have been successfully applied in food processing plants, retail food stores, and food service operations.
- The seven principles of HACCP have been universally accepted by government agencies, trade associations and the food industry around the world.
- The following guidelines will facilitate the development and implementation of effective HACCP plans. While the specific application of HACCP to manufacturing facilities is emphasized here, these guidelines/diagram/steps should be applied as appropriate to each segment of the food industry under consideration.

C O D E X
A L I M E N T A R I U S
International Food Standards



Pre requisite program (PRP) for HACCP implementation:1

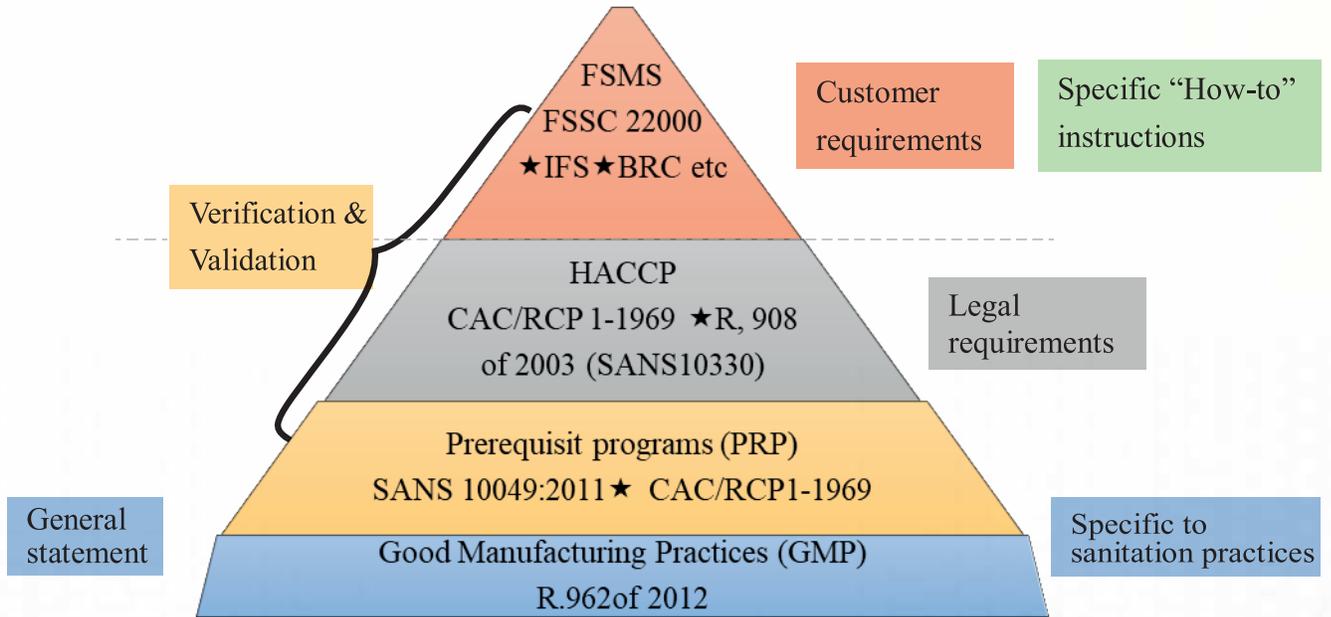


Fig. 18 The Food Safety Management System (FSMS), Food Safety System Certification (FSSC), Good Manufacturing Practices (GMP)

Pre requisite program (PRP) for HACCP implementation:2



Fig. 19 Steps of PRP for HACCP implementation

The HACCP Implementation Steps

1. Assemble the HACCP Team

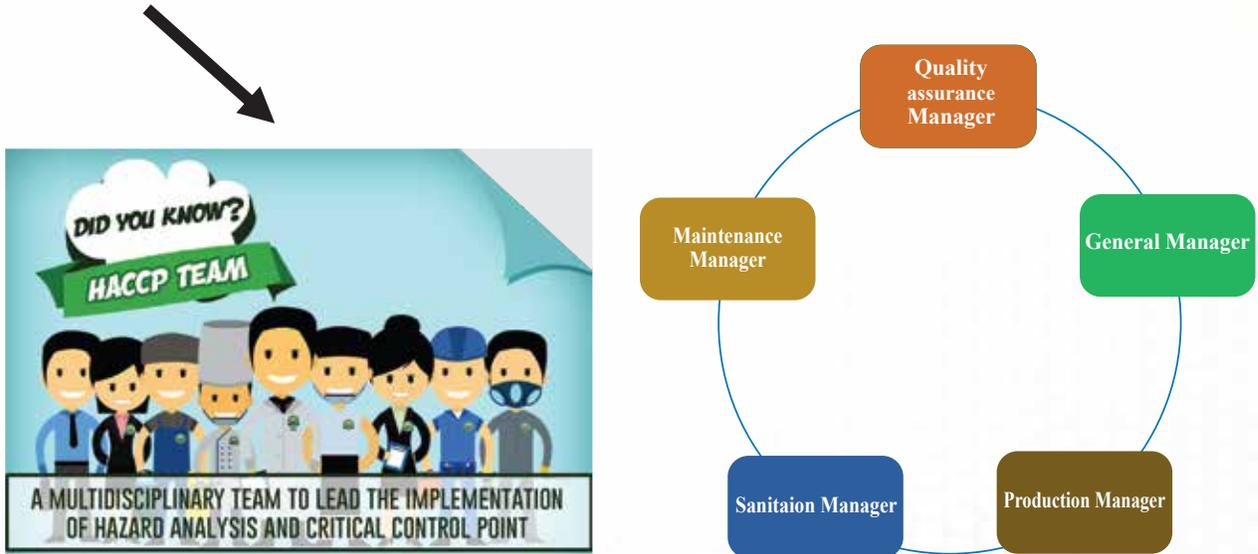
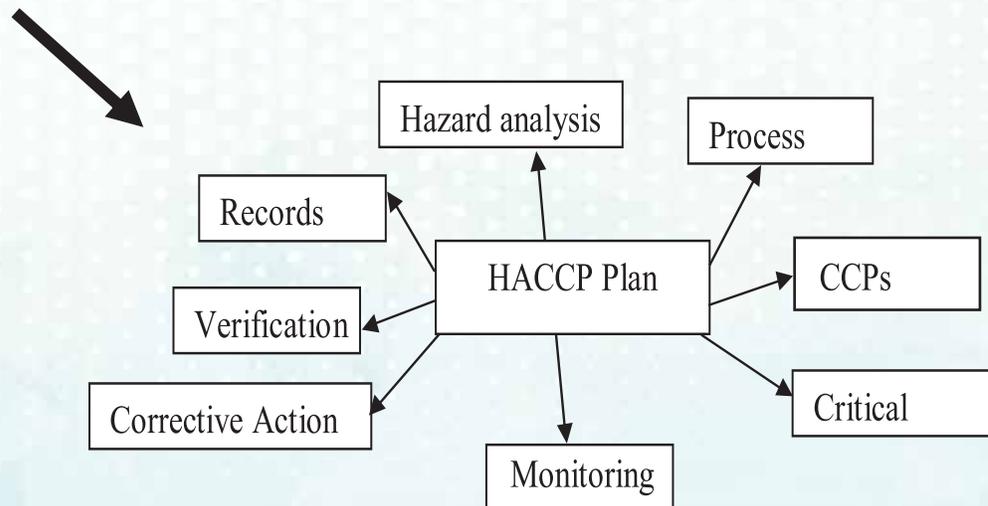


Fig. 20: Assemble the HACCP Team

2. Identify products/Foods/Processes that must be covered by the HACCP Plan

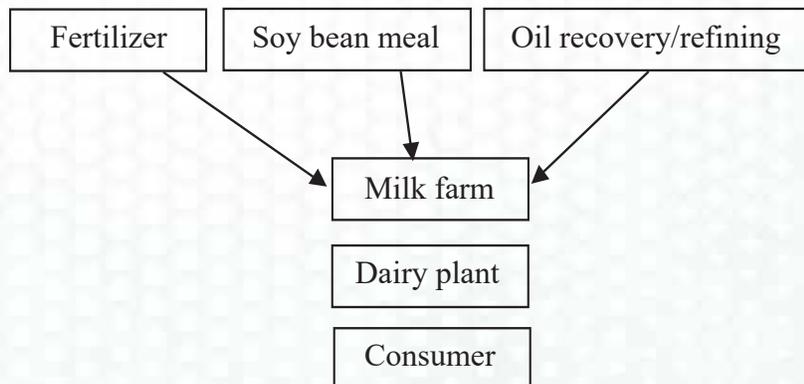


3. Develop a list of ingredients, materials, equipment and recipes/formulations



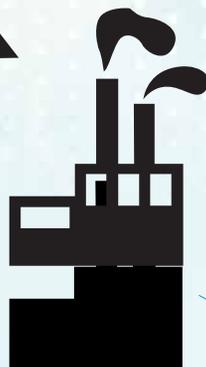
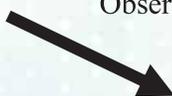
Ingredients	Packaging Materials	Equipment
Eggs	Envelops	Scale
Meat	Plastic bags	Thermometer

4. Develop a process flow diagram



5. Verify the Flow diagram

Observe the production process, checking if there is anything missing



Topic-5: Implementation of the HACCP plan

The successful implementation of a HACCP plan is facilitated by commitment from top management. The next step is to establish a plan that describes the individuals responsible for developing, implementing and maintaining the HACCP system. Initially, the HACCP coordinator and team are selected and trained as necessary. The team is responsible for developing the initial plan and coordinating its implementation. Product teams can be appointed to develop HACCP plans for specific products. An important aspect in developing these teams along with monitor is to assure that they have appropriate training. Upon completion of the HACCP plan, operating procedures, forms and procedures for monitoring and corrective actions are developed. Often it is a good idea to develop a timeline for the activities involved in the initial implementation of the HACCP plan. Implementation of the HACCP system involves the continual application of the monitoring, record-keeping, corrective action procedures and other activities as described in the HACCP plan.

Maintaining an effective HACCP system depends largely on regularly scheduled verification activities. The HACCP plan should be updated and revised as needed. An important aspect of maintaining the HACCP system is to assure that all individuals involved are properly trained so they understand their role and can effectively fulfil their responsibilities.

Examples of Common Prerequisite Programs:

The production of safe food products requires that the HACCP system be built upon a solid foundation of prerequisite programs. Each segment of the food industry must provide the conditions necessary to protect food while it is under their control. This has traditionally been accomplished through the application of cGMPs. These conditions and practices are now considered to be prerequisite to the development and implementation of effective HACCP plans. Prerequisite programs provide the basic environmental and operating conditions that are necessary for the production of safe, wholesome food. Common prerequisite programs may include, but are not limited to:

Facilities: The establishment should be located, constructed and maintained according to sanitary design principles. There should be linear product flow and traffic control to minimize cross-contamination from raw to cooked materials.

Supplier Control: Each facility should assure that its suppliers have in place effective GMP and food safety programs. These may be the subject of continuing supplier guarantee and supplier HACCP system verification.

Specifications: There should be written specifications for all ingredients, products, and packaging materials.

Production Equipment: All equipment should be constructed and installed according to sanitary design principles. Preventive maintenance and calibration schedules should be established and documented.

Cleaning and Sanitation: All procedures for cleaning and sanitation of the equipment and the facility should be written and followed. A master sanitation schedule should be in place.

Personal Hygiene: All employees and other persons who enter the manufacturing plant should follow the requirements for personal hygiene.

Training: All employees should receive documented training in personal hygiene, GMP, cleaning and sanitation procedures, personal safety, and their role in the HACCP program.

Chemical Control: Documented procedures must be in place to assure the segregation and proper use of non-food chemicals in the plant. These include cleaning chemicals, fumigants, and pesticides or baits used in or around the plant.

Receiving, Storage and Shipping: All raw materials and products should be stored under sanitary conditions and the proper environmental conditions such as temperature and humidity to assure their safety and wholesomeness

Traceability and Recall: All raw materials and products should be lot-coded and a recall system in place so that rapid and complete traces and recalls can be done when a product retrieval is necessary.

Pest Control: Effective pest control programs should be in place.

Other examples of prerequisite programs might include quality assurance procedures; standard operating procedures for sanitation, processes, product formulations and recipes; glass control; procedures for receiving, storage and shipping; labelling; and employee food and ingredient handling practices.

Example of a Flow Diagram for the Production of Frozen Cooked Beef Patties



Examples of Questions to be Considered When Conducting a Hazard Analysis

The hazard analysis consists of asking a series of questions which are appropriate to the process under consideration. The purpose of the questions is to assist in identifying potential hazards.

A. Ingredients:

1. Does the food contain any sensitive ingredients that may present microbiological hazards (e.g., Salmonella, Staphylococcus aureus); chemical hazards (e.g., aflatoxin, antibiotic or pesticide residues); or physical hazards (stones, glass, metal)?
2. Are potable water, ice and steam used in formulating or in handling the food?
3. What are the sources (e.g., geographical region, specific supplier)

B. Basic Factors - Physical characteristics and composition (e.g., pH, type of acidulants, fermentable carbohydrate, water activity, preservatives) of the food during and after processing:

1. What hazards may result if the food composition is not controlled?
2. Does the food permit survival or multiplication of pathogens and/or toxin formation in the food during processing?
3. Will the food permit survival or multiplication of pathogens and/or toxin formation during subsequent steps in the food chain?
4. Are there other similar products in the market place? What has been the safety record for these products? What hazards have been associated with the products?

C. Procedures used for processing:

1. Does the process include a controllable processing step that destroys pathogens? If so, which pathogens? Consider both vegetative cells and spores.
2. If the product is subject to recontamination between processing (e.g., cooking, pasteurizing) and packaging which biological, chemical or physical hazards are likely to occur?

D. *Microbial content of the food:*

1. What is the normal microbial content of the food?
2. Does the microbial population change during the normal time the food is stored prior to consumption?
3. Does the subsequent change in microbial population alter the safety of the food?
4. Do the answers to the above questions indicate a high likelihood of certain biological hazards?

E. *Facility design:*

1. Does the layout of the facility provide an adequate separation of raw materials from ready-to-eat (RTE) foods if this is important to food safety? If not, what hazards should be considered as possible contaminants of the RTE products?
2. Is positive air pressure maintained in product packaging areas? Is this essential for product safety?
3. Is the traffic pattern for people and moving equipment a significant source of contamination?

F. *Equipment design and use:*

1. Will the equipment provide the time-temperature control that is necessary for safe food?
2. Is the equipment properly sized for the volume of food that will be processed?
3. Can the equipment be sufficiently controlled so that the variation in performance will be within the tolerances required to produce a safe food?
4. Is the equipment reliable or is it prone to frequent breakdowns?
5. Is the equipment designed so that it can be easily cleaned and sanitized?
6. Is there a chance for product contamination with hazardous substances; e.g., glass?
7. What product safety devices are used to enhance consumer safety?
 - metal detectors
 - magnets
 - sifters
 - filters
 - screens
 - thermometers
 - bone removal devices
 - dud detectors
8. To what degree will normal equipment wear affect the likely occurrence of a physical hazard (e.g., metal) in the product?
9. Are allergen protocols needed in using equipment for different products?

G. *Packaging:*

1. Does the method of packaging affect the multiplication of microbial pathogens and/or the formation of toxins?
2. Is the package clearly labelled "Keep Refrigerated" if this is required for safety?
3. Does the package include instructions for the safe handling and preparation of the food by the end user?
4. Is the packaging material resistant to damage thereby preventing the entrance of microbial contamination?

5. Are tamper-evident packaging features used?
6. Is each package and case legibly and accurately coded?
7. Does each package contain the proper label?
8. Are potential allergens in the ingredients included in the list of ingredients on the label?

H. Sanitation:

1. Can sanitation have an impact upon the safety of the food that is being processed?
2. Can the facility and equipment be easily cleaned and sanitized to permit the safe handling of food?
3. Is it possible to provide sanitary conditions consistently and adequately to assure safe foods?

I. Employee health, hygiene and education:

1. Can employee health or personal hygiene practices impact upon the safety of the food being processed?
2. Do the employees understand the process and the factors they must control to assure the preparation of safe foods?
3. Will the employees inform management of a problem which could impact upon safety of food?

J. Conditions of storage between packaging and the end user:

1. What is the likelihood that the food will be improperly stored at the wrong temperature?
2. Would an error in improper storage lead to a microbiologically unsafe food?

K. Intended use:

1. Will the food be heated by the consumer?
2. Will there likely be leftovers?

L. Intended consumer:

1. Is the food intended for the general public?
2. Is the food intended for consumption by a population with increased susceptibility to illness (e.g., infants, the aged, the infirmed, immunocompromised individuals)?
3. Is the food to be used for institutional feeding or the home?

Examples of How the Stages of Hazard Analysis are used to Identify and Evaluate Hazards*

Hazard Analysis Stage	Frozen cooked beef patties produced in a manufacturing plant	Product containing pre-cooked eggs prepared for foodservice	Commercial frozen pre-cooked, boned chicken for further processing
Stage 1 Determine potential hazards associated with product Identification with product	Enteric pathogens (i.e., E. coli O157:H7 and Salmonella)	Salmonella in finished product.	Staphylococcus aureus in finished product.

Stage 2 Hazard Evaluation	Assess severity of health consequences if potential hazard is not properly controlled.	Epidemiological evidence indicates that these pathogens cause severe health effects including death among children and elderly. Undercooked beef patties have been linked to disease from these pathogens.	Salmonellosis is a food borne infection causing a moderate to severe illness that can be caused by ingestion of only a few cells of Salmonella.	Certain strains of S. aureus produce an enterotoxin which can cause a moderate foodborne illness.
	Determine likelihood of occurrence of potential hazard if not properly controlled.	E. coli O157:H7 is of very low probability and salmonellae is of moderate probability in raw meat.	Product is made with liquid eggs which have been associated with past outbreaks of salmonellosis. Recent problems with Salmonella serotype Enteritidis in eggs cause increased concern. Probability of Salmonella in raw eggs cannot be ruled out. If not effectively controlled, some consumers are likely to be exposed to Salmonella from this food.	Product may be contaminated with S. aureus due to human handling during boning of cooked chicken. Enterotoxin capable of causing illness will only occur as S. aureus multiplies to about 1,000,000/g. Operating procedures during boning and subsequent freezing prevent growth of S. aureus, thus the potential for enterotoxin formation is very low.

	<p><i>Using information above, determine if this potential hazard is to be addressed in the HACCP plan.</i></p>	<p>The HACCP team decides that enteric pathogens are hazards for this product.</p> <p>Hazards must be addressed in the plan.</p>	<p>HACCP team determines that if the potential hazard is not properly controlled, consumption of product is likely to result in an unacceptable health risk.</p> <p>Hazard must be addressed in the plan.</p>	<p>The HACCP team determines that the potential for enterotoxin formation is very low. However, it is still desirable to keep the initial number of S. aureus organisms low. Employee practices that minimize contamination, rapid carbon dioxide freezing and handling instructions have been adequate to control this potential hazard.</p> <p>Potential hazard does not need to be addressed in plan.</p>
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* For illustrative purposes only. The potential hazards identified may not be the only hazards associated with the products listed. The responses may be different for different establishments.

Example I of a CCP Decision Tree

Important considerations when using the decision tree:

- The decision tree is used after the hazard analysis.
- The decision tree then is used at the steps where a hazard that must be addressed in the HACCP plan has been identified.
- A subsequent step in the process may be more effective for controlling a hazard and may be the preferred CCP.
- More than one step in a process may be involved in controlling a hazard.
- More than one hazard may be controlled by a specific control measure.



- C. Verification reports may include information on the presence and adequacy of.
 1. The HACCP plan and the person(s) responsible for administering and updating the HACCP plan.
 2. The records associated with CCP monitoring.
 3. Direct recording of monitoring data of the CCP while in operation.
 4. Certification that monitoring equipment is properly calibrated and in working order.
 5. Corrective actions for deviations.
 6. Sampling and testing methods used to verify that CCPs are under control.
 7. Modifications to the HACCP plan.
 8. Training and knowledge of individuals responsible for monitoring CCPs.
 9. Validation activities.

Examples of HACCP Records

- A. Ingredients for which critical limits have been established.
 1. Supplier certification records documenting compliance of an ingredient with a critical limit.
 2. Processor audit records verifying supplier compliance.
 3. Storage records (e.g., time, temperature) for when ingredient storage is a CCP.
- B. Processing, storage and distribution records
 1. Information that establishes the efficacy of a CCP to maintain product safety.
 2. Data establishing the safe shelf life of the product; if age of product can affect safety.
 3. Records indicating compliance with critical limits when packaging materials, labelling or sealing specifications are necessary for food safety.
 4. Monitoring records.
 5. Verification records.
- C. Deviation and corrective action records.
- D. Employee training records that are pertinent to CCPs and the HACCP plan.
- E. Documentation of the adequacy of the HACCP plan from a knowledgeable HACCP expert.

Topic-6: Good Manufacturing Practices (GMP) in Livestock food Industry

Good Manufacturing Practices (GMP) can be described by two major areas:-

1. Personal Hygiene of Meat Processor
2. Sanitation Practices in Meat Industry

1. Personal Hygiene of Meat Processor:

One of the best ways to maintain good overall health and wellness is to maintain proper personal hygiene. Personal hygiene helps to stay clean, giving a boost in confidence and positively impacting personal relationships, as well as reduce the risk for disease and negative medical conditions that stem from bad hygiene. Keep follow the ways people are able to practice proper personal hygiene.

Personal Hygiene Practices:

- **Wash hands frequently:** Washing hands is one of the most effective ways to reduce the spread of disease.



- Wet hands with clean water and apply soap.
- Wash hands (including under fingernails) and up to forearms vigorously and thoroughly with soap and warm water.
- Rinse hands well.
- Dry hands with a towel or air dry.
- Wash hands only in hand sinks designated for that purpose.
- Dry hands with single use towels. Turn off faucets using a paper towel, in order to prevent recontamination of clean hands.
- Harmful bacteria such as E. coli, Salmonella and Staphylococcus aureus and viruses (e.g. norovirus) present on the hands of food workers are removed by proper hand washing techniques.

- **When hand wash required:**

- When entering the facility before work begins.
- Immediately before preparing food or handling equipment.
- As often as necessary during food preparation when contamination occurs.
- In the restroom after toilet use and when return to work station.

- **Bathe:** Cleaning body washes away dead skin cells and dirt and helps fight the spread of disease. For older adults, it's recommended to shower or take a bath at least twice a week to achieve the positive effects. Arrive at work clean – bathed and used deodorant daily.



- **Shaving:** Shave daily before any staff starts work. Arrive at work clean shaved daily.



- **Brush Teeth:** Make sure brushing teeth twice a day, once in the morning and once at night, to maintain good oral hygiene along with regular dental check-ups. Arrive at work place with clean teeth.



- **Floss Teeth Daily:** In addition to brushing teeth, floss teeth once a day for optimal oral hygiene.



- **Hair Restraints:** All workers/employees must wear hair nets or caps. In cold kitchen and packaging, they should also wear glove and mask. Arrive at work clean – clean hair and must wear hair net or caps daily.



- **Take Care of Finger Nails:** Cleaning and trimming nails reduces your risk of handnails and infected nail beds. Maintain short, clean, and polish-free fingernails. No artificial nails are permitted in the food production area.



- **Wear Clean Clothes:** After wear clothes, wash them with a detergent and dry them immediately upon rinsing. Dirty clothes can harbour bacteria that could lead to body odour or even skin irritations.



- **Proper Dress/Clothing:**

- Wear butchery-issued apron on site, as appropriate.
- Do not wear apron to and from work.
- Take off apron before using the restroom.
- Change apron if it becomes soiled or stained.



➤ **Wear appropriate shoes:**

Clean sleeves and clean non-skid close toed work shoes (or rubber shoes) that are comfortable for standing and working on floors that can be slippery.



➤ **Cover Your Mouth When Cough or Sneeze:**

This is extremely important to avoid spreading germs to people or food place around you.



➤ **Cuts and Abrasions:**

Wounds and open sores should be antiseptically bandaged and covered with water proof protector.



➤ **Smoking:**

Smoking and tobacco/betel are prohibited, staff smoking outside building, and should wash before work.



➤ **Jewellery:**

Jewelleries are potential hazards and should be prohibited in meat processing area.



➤ **Get Restful Sleep:**

Restful sleep is essential to wellbeing, no matter your age. It is recommended for all adults to sleep between seven to nine hours a night.



➤ **Create a Routine:**

Whatever process may be to maintain good personal hygiene, make either a mental checklist or write it down. This way, actors will remember and keep up with the steps they need to take to stay clean and healthy.



➤ **Medical check-up and Visit the Doctor:**

Maintaining regular healthcare appointments can help to catch infections and illnesses early, making it easier to treat them. Visit healthcare provider when actors have a concern and schedule routine check-ups.



- **First Aid:** Ensure primary health care facilities at every meat processing plant or slaughter houses. This is most essential tools to mitigate any injury or cut, wounds of workers at the plant area in emergency basis.



2. Sanitation Practices in Meat Industry:

Sanitation Standard Operating Procedure (SSOP):

SSOP Models: Sanitation Standard Operating Procedure (SSOP)

Eg,

- Establishment Name
- Establishment Number
- Address

(Phone/Fax Numbers)

(Date)

Administrative structure is as follows:

President/Owner: Name & Signature

Manager: Name & Signature

Inspector: Name & Signature

The manager is responsible for implementing and daily monitoring of the Sanitation SOP, and recording the findings and any corrective actions. All records pertaining to this SSOP will be maintained on file and made available to respective Division of Meat Inspection personnel.

1. Pre-Operational Sanitation – Equipment and Facility Cleaning

A. General Equipment Cleaning:

All equipment, used for meat processing, will be cleaned and sanitized prior to starting production.

i. Established cleaning procedures includes:

- Equipment is disassembled, as necessary.
- Food debris is removed from equipment.
- Equipment parts are rinsed with water to remove remaining food debris.
- An approved cleaning solution is applied to equipment parts/surfaces and scrubbed as needed to remove soil.
- Equipment/parts are rinsed with potable water (48.8-60°C).
- Equipment/parts are inspected for cleanliness, and re-cleaned if necessary.
- Equipment/parts are sanitized with approved sanitizer, or 82.2°C water.
- Equipment is reassembled, re-sanitized and re-rinsed, if necessary.

ii. Implementation, Monitoring and Record keeping.

- The manager performs daily organoleptic, sanitation inspection after pre-operational cleaning and sanitizing.
- The results of this inspection are recorded on Form. If inspection finds that equipment is acceptably clean, then the appropriate box is checked and initialled.
- If corrective actions are needed, such actions to be completed and documented in the form.

iii. Corrective Actions.

- When the manager determines that equipment or parts are not properly cleaned, the cleaning procedure and inspection will be repeated.
- Corrective actions are recorded in the Form.

B. Cleaning of all facilities, including floors, walls and ceilings:

i. Cleaning procedures:

- a. Debris is swept up and discarded.
- b. Facilities are rinsed with potable (clean/filtered/drinking) water.
- c. Facilities are cleaned with an approved cleaner,

ii. Cleaning Frequency.

- Floors and walls are cleaned at the end of each processing day.
- Ceilings are cleaned as needed, but at least once a week.

iii. Implementation, Monitoring and Record keeping.

- The manager performs daily organoleptic, sanitation inspection after pre-operational cleaning of facilities.
- The results of this inspection are recorded in the Form.



- If inspection finds that the facilities are acceptably clean, then the appropriate box is checked and initialled.
- If corrective actions are needed, such actions to be completed and documented in the Form.

iv. Corrective Actions.

- When the manager determines that the facilities are not properly cleaned, the cleaning procedure and inspection are repeated.
- Corrective actions are recorded in the Form.

2. Operational Sanitation – Equipment and Facility Cleaning:

A. Slaughter Operations:

i. Established methods for carcass dressing includes:

- Employees will clean hands, arms, gloves, aprons, boots, etc., as often as necessary during the slaughter/dressing process.
- Employees will clean and sterilize knives, other hand tools, saws, etc., with 82.2°C water, as often as necessary during the slaughter/dressing process to prevent contamination of carcasses.
- Brisket saw is to be sterilized between each carcass, using 82.2°C water.
- Employees doing eviscerating will keep hands, arms, clothes, aprons, boots, knives, etc., clean during the evisceration process.
- If contamination occurs, the employee is to step away from the carcass to clean and sanitize their apron, boots and knives.
- They may need to wash hands and arms with soap and water.
- Carcass splitting saw is to be sterilized after each carcass with 82.2°C water.

ii. Monitoring and Record keeping.

- The manager is responsible for ensuring that employees hygiene practices, sanitary conditions and cleaning procedures are maintained during a production shift.
- The manager monitors these operational sanitation procedures once during each production shift and these results are recorded in the Form.

iii. Corrective Actions.

- When the manager identifies operational sanitation problems, the manager notifies employees to take appropriate action to correct the sanitation problems.
- Manager attempts to determine the cause of the contamination and takes corrective actions. Corrective actions are recorded in the Form.

B. Meat processing operations.

Meat processing is performed under sanitary conditions to prevent direct and cross-contamination of meat products.

i. Established personal hygiene procedures for employees during processing of meat products includes:

- Employees will wear hairnets during meat processing.
- Employees will clean and sanitize hands, gloves, knives, spatulas, cutting boards, etc., as necessary during processing to prevent contamination of meat products.
- Equipment, table or counter tops are cleaned and sanitized throughout the day as needed.
- Employees take appropriate precautions when going from a raw product area to a cooked product area, to prevent cross contamination of cooked products.
- Employees change outer garments, wash hands and sanitize hands with an approved hand sanitizer (equivalent to 50 ppm chlorine), and put on clean gloves for that room or area.

ii. Established procedures for meat product handling and storage includes:

- Raw and cooked processing areas are separate. There is no cross use of equipment between raw and cooked meat products.
- Outer garments, such as aprons, and gloves, are identified and designated specifically for either raw or cooked meat processing.
- Outer garments are maintained in a clean and sanitary manner and are changed at least daily, and if necessary, more often.

iii. Established procedures for insect and rodent control includes:

- Insect and rodent traps will be maintained in non-food handling areas.
- All areas (dry storage rooms, coolers, processing rooms, etc.) will be checked for visible rodent droppings and insects.

iv. Established procedures for mid-shift clean-up include:

- A full clean-up will be done for the meat processing areas and equipment, in the event that processing time exceeds 4.45°C for more than 5 hours.

v. Implementation, Monitoring and Record keeping.

- The manager is responsible for ensuring that employee hygiene practices, sanitary product handling procedures, pest and rodent control and mid shift cleaning procedures are maintained during a processing shift.
- The manager monitors these operational sanitation procedures once during each processing shift and these results are recorded in the Form.

vi. Corrective Actions. When the manager identifies operational sanitation problems, the manager notifies employees to take corrective actions and recorded in the Form.



Topic-7: Impact of Antimicrobial resistance in food safety

Antimicrobial is an indispensable part of veterinary medicine used for the treatment and control of diseases as well as a growth promoter in livestock. The frequent use of antimicrobials in veterinary practices may lead to the residue in animal originated products and creates some potential problems for human health. The presence of antimicrobial residues in animal originated foods may induce serious health problems such as allergic reaction, antimicrobial resistance (AMR) and lead to carcinogenic and mutagenic effects in the human body.

- The misuse or abuse of antibiotics in human medicine is thought to be a principal cause of AMR but some antimicrobial-resistant bacteria and their resistance genes originating from animals also responsible for developing AMR.
- The residual effect of antimicrobials in feed and food products of animal origin is undeniable, which is little known to the society due to the lack of proper information on antibiotic use, AMR surveillance and residue monitoring mechanism in developing countries.
- It is very important to reveal the current situation of antimicrobial uses in livestock production and insight into its public health significance.
- The safety levels of animal feeds and food products of animal origin must be strictly observed and public awareness should be developed against the indiscriminate uses of antimicrobial in animal production especially in relation with the food safety issue in Bangladesh.

Scenario of Antimicrobial uses in livestock:

- In recent years, the levels of animal product production and consumption have rapidly increased due to the demand of animal protein.
- Due to vast changes in food production and feeding regimens, the use of antimicrobials also increased in the livestock sector.
- In rural Bangladesh, 57.7% households own livestock, including large animals (cattle and buffalo), small ruminants (sheep and goats), and poultry (back yard and commercial). Government veterinary health care providers rarely (9.7%) visit these households.
- In the absence of adequate veterinary health care service, animal owners in rural areas avail low-cost animal health care from pharmacies and unlicensed village doctors (82.5%).
- In addition to feed additives, animal owners use antibiotics, largely at suboptimal doses upon suggestions of the informal animal health care providers.
- The prescribing and dispensing of antibiotics in animal sectors of Bangladesh are neither lawfully regulated nor their use lawfully audited.

- It is estimated that livestock alone uses 50–80% of the total antibiotics produced in most of the developed countries including Bangladesh.
- Medication practices in poultry sector of Bangladesh are very complex. In commercial poultry farms, especially in small and medium-scale settings the poultry and feed dealers are the main influencers on antibiotic usage.
- In Bangladesh, about 94.16% of poultry farmers use antibiotics in their farms to control disease and enhancement of egg production.
- In developing countries including Bangladesh 70 % of the total quantity of antibiotics used in the food-producing animal manufactured by local pharmaceutical companies.
- Most farmers in commercial poultry use antibiotics themselves directly from feed dealers or even directly from companies or suppliers.
- A major portion of antibiotics is sold to the customers or animal farm owners through over-the-counter.
- A study showed that more than 60% of farmers use antibiotics without the prescription of veterinarians.
- Only a very negligible amount of total sale of antibiotic is done through registered veterinarian or prescription (Antibiotic use and resistance in Bangladesh, Report 2018, GARP-BANGLADESH & CDDEP).
- The most commonly used antimicrobials in livestock production of Bangladesh are ceftriaxone, ciprofloxacin, gentamycin, cotrimoxazole, sulfadimidine, ampicillin, amoxicillin, trimethoprim, oxytetracycline, tylosin tartrate, tiamulin, norfloxacin, enrofloxacin, doxycycline, and colistin sulfate.
- The frequency distributions of common antibiotic groups prescribed for livestock production in Bangladesh are demonstrated in the figure below.

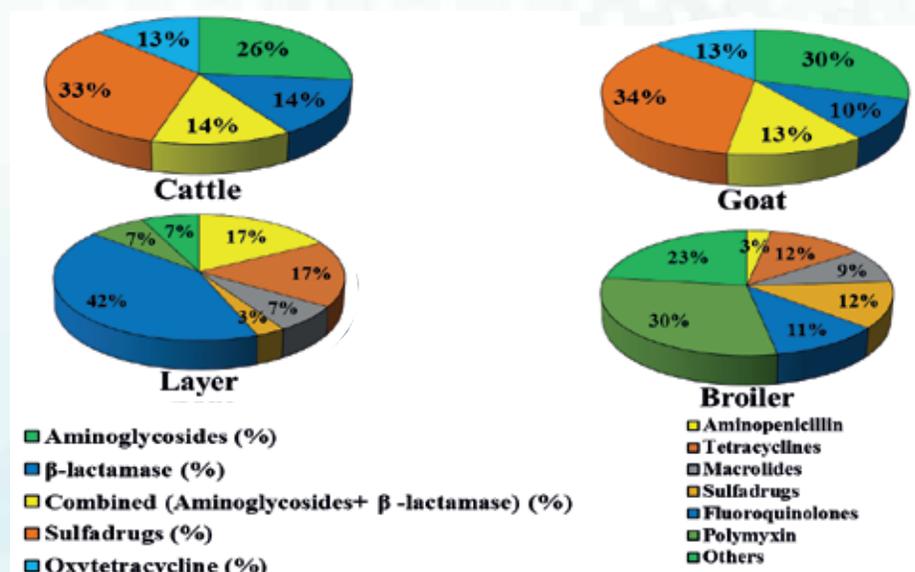


Fig. 20: Frequency distributions of different antibiotics prescribed for livestock in Bangladesh

Risks associated with the use of antimicrobials in food-producing animals

Antimicrobial residues:

- Antimicrobials extensively used for food-producing animals in different countries of the world including Bangladesh.
- Recent reports have revealed that the use of large amounts of antimicrobial drugs could result in the deposition of antibiotics as residues in animal products.
- Milk, meat, and other dairy products containing drug residues beyond the MRL may produce serious health problems to the consumers.
- Though good quality milk, meat, and other related products are a prime need for maintaining proper public health but the presence of antimicrobial residues in these food items and their subsequent consumption may cause serious health problems to consumers including the development of antimicrobial resistance, hypersensitivity reaction and cancer.
- The consequences of such resistance are even more threatening where antibiotics become ineffective clinically for the treatment of illness.
- The developing countries are at greater risk compared to developed countries due to poor detection facilities as well as lack of proper monitoring system of residues in foods considering the MRLs.
- Indiscriminate and irrational use of antimicrobials in livestock production especially in small farming without following the withdrawal period are the main causes of residues in animal originated food products in developing countries.
- Some studies demonstrated that antibiotics are deposited in the liver, kidney, muscle, and bones of poultry and livestock exceeding the MRL values.
- A high percentage of poultry meat and eggs for human consumption were found to have antimicrobial residues such as amoxicillin, tetracycline, ciprofloxacin, and enrofloxacin.
- A study performed at Chittagong region of Bangladesh on dairy and poultry farm which demonstrated that the tetracycline, amoxicillin, and ciprofloxacin residues were significantly higher in commercial farms compared to local and the concentration amoxicillin residue in milk and eggs were 56.16 µg/ml and 48.82 µg/g respectively.
- In another study tetracycline, ciprofloxacin, enrofloxacin and amoxicillin residues were found in poultry liver as 48%, 44%, 40%, and 42% cases respectively and the concentration of amoxicillin particularly in the liver was 16.92 µg/kg to 152.62 µg/kg and in breast muscle was 45.38 µg/kg to 60.55 µg/kg.

Antimicrobial resistance (AMR):

- Resistance to the antimicrobial drug is one of the most serious medical problems in the world including Bangladesh in which antimicrobial agent such as antibiotic is not effective for the treatment of infection due to the acquired resistance of bacteria to all available antibiotics.

- The improper antimicrobial drug used for humans is diffusive in developing countries and is a significant contributor to growing the public health threat of AMR resistant bacteria.
- The animal health system of Bangladesh is explicitly diversified involving unqualified healthcare providers and different influential groups at different stages.
- The absence of adequate, specifically state veterinary healthcare, regulatory and monitoring services and low financial capability of the farmers have created pavements for the unlicensed village doctors, poultry and feed dealers and pharmaceutical sales representatives to influence over the animal farm owners to take their decisions.
- In addition, increased demand of animal source protein, and knowledge gap on animal diseases, drugs and AMR burden have driven the farmers towards the misuse or overuse of antibiotics.
- The weak regulatory regimes for antimicrobial stewardship programs and multidimensional anomalies in the use antibiotics in veterinary practices have resulted in the emergence of AMR pathogens in animals of Bangladesh.
- The scientific reports that have published on multi-drug resistant (MDR) bacteria isolated from food animals and products in Bangladesh are summarized in Table 1.

i. Prevalence of antibiotic-resistant bacteria in Bangladesh:

Table 1: Prevalence of antibiotic-resistant bacteria isolated from foods of animal origin in Bangladesh.

Type of specimens	Antimicrobial resistant bacteria	Prevalence (%)
Poultry	MDR <i>E. coli</i>	36.6
Milk	MDR <i>C.jejuni</i>	57.1
	MDR <i>C. coli</i>	33.33
Poultry	MDR <i>C.jejuni</i>	49
	MDR <i>C. coli</i>	42
Milk	MDR <i>Salmonella</i> spp.	100
Beef	MDR <i>Salmonella</i> spp.	66.67
Poultry meat	MDR <i>Salmonella</i> spp.	93.10
Milk	MDR <i>S. aureus</i>	12
Poultry meat Egg	MDR <i>S. aureus</i>	53.85
	MDR <i>S. aureus</i>	90.91

- There is evidence that resistance in some human enteric pathogens has emerged due to the transfer of resistant bacteria or resistance genes from animals to humans via the food chain or via the contaminated environment.

- Of the AMR pathogens, *Salmonella* and MDR *E. coli* are the most abundant compared to other pathogens and among the MDR pathogens, *Escherichia coli*, *Salmonella*, *Enterobacter*, *Staphylococcus* and *Campylobacter* spp. are potential zoonotic pathogens creating direct human health hazards.

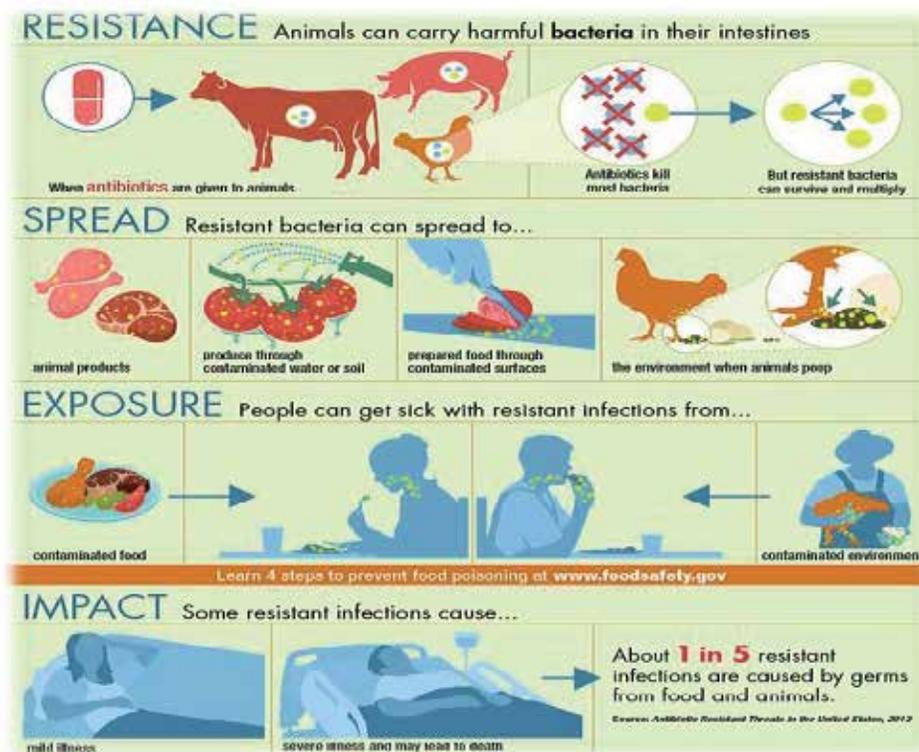


Fig. 21: AMR from farm to table

- Unhygienic animal husbandry practices like sharing of houses and water bodies with animals, disposal of farm wastes directly in the environment along with poor personal hygiene of farm workers and animal dwellers are exacerbating the risks of AMR dissemination in humans.
- Moreover, contamination of broiler meat, frozen chicken meat, bovine meat and milk as well as the animal originated food products with MDR bacteria, bringing the consumers closer to AMR hazards.

ii. Degree of antibiotic resistance in dairy and poultry of Bangladesh:

- Different species of antibiotic resistant bacteria have been documented from dairy, goat and wild animal sources in different areas of Bangladesh.
- Along with resistance against antibiotics commonly used in veterinary practices, *E. coli* isolated from milk, milkers' hands and farm environment carried *tetA* and *SHV* resistance genes and developed extreme resistance against azithromycin (100%) which is recommended to use in humans only.

- Milk of mastitis affected cows was identified as another important source of MDR *E. coli* with resistance against ampicillin (100%), amoxicillin (30-100%) and streptomycin (70-100%).
- In a study of bovine subclinical mastitis milk, *S. aureus* isolates showed highest resistance to oxytetracycline (74.5%), followed by oxacillin (55.9%), ciprofloxacin (49.6%), amoxicillin (42.0%), trimethoprim/sulfamethoxazole (30.0%), and to a less extent to gentamicin (17.9%), penicillin (11.0%) and erythromycin (8.2%).
- The disposal of farm waste directly into the environment contributes in the antibiotic resistant bacteria pollution and ultimately poses a health hazard to both farm animals and humans.
- MDR foodborne zoonotic pathogen *Salmonella* spp. carrying *tetA* and *SHV* resistance genes were reported from cow dung, milk, milkers' hand and dairy farm environment with resistance against a number of antibiotics like erythromycin (87.5%), tetracycline (86.76%), oxytetracycline (75.73%) and ertapenem (50%).
- Contamination of the animal originated food products by antibiotic resistant bacteria with resistance against tetracycline (100%), nalidixic acid (100%), oxacillin (100%), erythromycin (53.33%), ciprofloxacin (40%), doxycyclin (26.66%) and ampicillin (6.67%) was also reported.
- A total of eight antibiotic resistant (ABR) bacterial species were reported in layer, broiler, backyard poultry, ducks, pigeons and quails in nine different districts of Bangladesh.
- ABR *E. coli* was identified in different types of birds with a higher degree of resistance against ampicillin (80-100%), amoxicillin (60-100%) and kanamycin (80%).
- MDR *E. coli* isolates recovered from dead, sick and apparently healthy broilers showed a varying magnitude of resistance against tetracycline (45.5-100%), ampicillin (100%), trimethoprim-sulphamethoxazole (26.7-94.59%), nalidixic acid (25.7-91.89%), ampicillin (25.7%), streptomycin (20.8%) and ciprofloxacin.
- Of these, tetracycline, ampicillin, nalidixic acid and trimethoprim-sulphamethoxazole were the antibiotics against which *E. coli* from all the broiler sources developed resistance.
- Ubiquitous dissemination of MDR *E. coli* with resistance against tetracycline (100%), fluoroquinolone (85%), sulphamethoxazole-trimethoprim (85%), aminoglycosides (71%) and nitrofurantoin (21%) were identified in backyard poultry of Bangladesh.
- The *E. coli* isolates from the birds of unconventional farms were resistant against tetracycline (90%), amoxicillin (70%), sulphamethoxazole (90%) and other antibiotics commonly used in broiler and layer farms.

- Besides the farming settings, alarmingly MDR and XDR *E. coli* with resistance against oxytetracycline (93%), amoxicillin (91.9%), ampicillin (89.5%), trimethoprim–sulphamethoxazole (88.4%), tetracycline (84.9%) and carbapenems (89.6%) were reported in frozen chicken meats from various parts of Bangladesh.

Conclusion:

- The substantial use of antimicrobials in the food-producing animals has a major role to generate antimicrobial residues and the development of a serious problem of AMR.
- Antimicrobial resistance is considered as one of the most important global health issues and Bangladesh is assessed as having a high risk of AMR.
- The emergence and zoonotic spread of antibiotic resistance bacteria or associated-resistant genes is crucial because of their existence in animal farming environment, including soil, and water, animal products and by-products.
- AMR is a ‘One Health’ problem, and its rational containment warrants inclusion of the veterinary sector.

However, the following strategies can be adopted to reduce the antimicrobial uses in livestock and subsequently its impact on the human health.

- Development of an integrated and multi-sectoral action plan
- One Health approach
- Development of organic livestock production
- Use of alternative of antibiotics as growth promoters
- Proper and regular vaccination of livestock population
- Vitamins and minerals supplementation
- Use of herbal medicine as the alternative of antibiotics and
- Finally, strengthening the regulatory control of antimicrobial uses in livestock.

Topic-8: Food Safety Administration in Bangladesh

Food Safety Administration:

Food safety is a priority issue of the Government of Bangladesh and is seen as essential to attaining the national goals of food and nutrition security. The Bangladesh Pure Food Ordinance 1959, implemented under the Bangladesh Pure Food Rules 1967, governed Bangladesh's food regulations up to 2013. In 2013, a new Act, the Bangladesh Food Safety Act 2013, was passed, which supersedes the previous legislation. The Act includes provisions for national governing and implementing structures, and legitimizes the establishment of a national food safety authority, the Bangladesh Food Safety Authority, to implement the Act and coordinate all food safety and food control activities in Bangladesh. The BFSA is also tasked with the responsibility of revising all older rules and guidelines and enacting fresh regulations covering not only products, but all stages of the food system (production, inputs, storage, processing, transportation, distribution and markets). The BFSA does not have unitary control over inspection and control functions, but collaborates with several central and local government agencies responsible for food safety controls over different parts of the food sector. This entails coordination with 11 ministries and hundreds of field units across the food chain, especially in food safety enforcement and compliance monitoring; laboratory networking; food safety risk assessments; and communication (Figure 1).

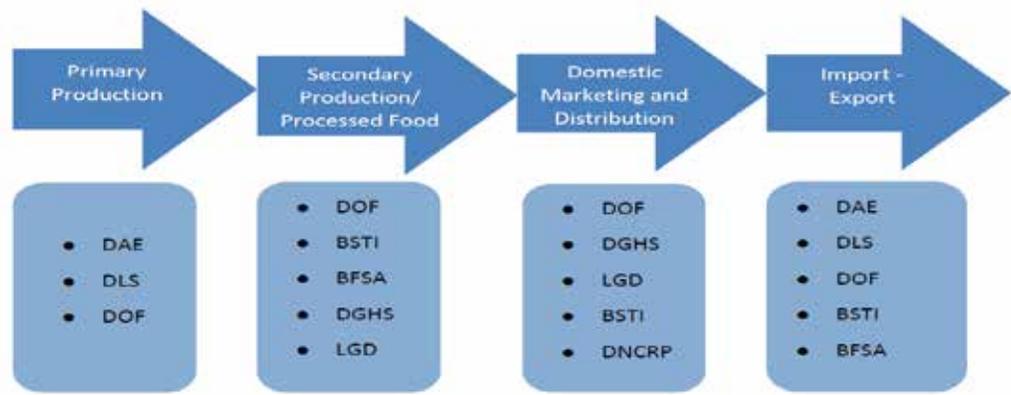


Fig. 22: Involvement of various departments and agencies in food safety across the food value chain

Role of different Food Safety Administrations in Bangladesh:

i) Bangladesh Food Safety Authority (BFSA)

The Bangladesh Food Safety Authority (BFSA) under the Ministry of Food was established in 2015 following Food Safety Act, 2013. The main duties and responsibilities of BFSA are "to regulate and monitor the activities related to manufacturing, importing, processing, storage,

distribution, and sale of food so as to ensure access of safe food through exercise of appropriate scientific methods, and to coordinate the activities of all organizations concerned with food safety management”. The BFSA is the main governing body for ensuring food safety and for establishing rules and regulations. This includes setting permissible limits of chemical contaminants, microbial contaminants, heavy metals, processing aids and food additives, mycotoxins, and MRLs of pesticides, veterinary and fishery drugs, antibiotics, etc. It also included in BFSA’s role is providing concerned authorities or organizations with necessary support to updating or upgrading permissible limits/MRLs at the highest safety levels for contaminants in food products. Which is determined by any other organizations under the existing laws, as well as monitoring the implementation. Food safety at the farm production level is controlled by the Department of Agricultural Extension (DAE), Department of Fisheries (DOF), and Department of Livestock Services (DLS). As per the Act, the BFSA has a role in coordinating the activities of DAE, DOF, and DLS by establishing a food safety network up to the field level¹. After the farm products become food, they are classified and monitored by the BFSA to control adulterated foods and food additives. BFSA regulates imported food products as per its regulations (i.e., food labelling, additives and contaminants regulations). During the import of food products, the Bangladesh Standards and Testing Institution (BSTI) checks for label of compliance and its standard marks on the food product. During enforcement, both BFSA and BSTI are responsible for testing food samples from the domestic market.

ii) Bangladesh Standards and Testing Institution (BSTI)

BSTI is the sole national quality certification body that also provides metrology and calibration services. Prior to the formation of BFSA, BSTI was the only national standard-setting entity, providing both voluntary and mandatory standards for product registration and certification to ensure the quality and safety of food products. BSTI plays a vital role in food safety management through the control of licenses, sampling, testing and monitoring of imported food products for compliance. BSTI performs market surveillance throughout the year and conducts mobile court drives. BSTI performs food testing for enforcement purposes as well as internal standard-making purposes and tests samples from other government agencies such as BFSA, LGEDs, Customs, etc. as per request for market surveillance and import clearance.

iii) Directorate General of Health Services (DGHS)

The DGHS under the Ministry of Health & Family Welfare (MoHFW) is also involved in food safety through its enforcement and surveillance activities. DGHS has food inspectors who work in coordination with BFSA to enforce specific quality and safety standards of food samples in the market. The National Food Safety Laboratory (NFSL) at the Institute of Public Health (IPH) is involved in food safety testing. IPH receives samples from both industry and the public sector. The cost of testing for government and private samples is borne by the government/respective departments and private companies respectively. The facility is equipped for both microbiological and chemical testing of various food and water samples.

iv) Bangladesh Council of Scientific and Industrial Research (BCSIR)

The BCSIR, under the jurisdiction of the Ministry of Science and Technology (MoST), is responsible for research and development activities in emerging technical fields. Under the BCSIR, the Institute of Food Science & Technology (IFST) focuses on food-related research and development. Three BCSIR labs in Dhaka, Chittagong, and Rajshahi provide research and technical support for food product testing/analysis to industry as well as authorities such as BFSA. IFST possesses the scientific capability to detect and test both microbial and chemical contaminants. Additionally, IFST provides training support and conducts research on a wide range of food products. The chemical lab of IFST is accredited for some parameters (toxicology, heavy metals, and chemical contaminants by EU). In addition, IFST follows the ISO standards for testing and is in the process of attaining formal accreditation. Courts in Bangladesh rely on IFST for testing in cases involving the prosecution of food establishments.

v) Department of Livestock Services (DLS)

Department of Livestock Services plays an important role in Food Safety in Bangladesh. It provides a lots of Veterinarians along with different diagnostic Lab. in the country.

DLS veterinarians are closely involved with safe food from animal origin. Sound Animal health is the prerequisite for safe animal protein. DLS plays a key role in the investigation of such outbreaks, all the way back to the farm and in formulating and implementing remedial measures once the source of the outbreak has been identified.

The World Organization for Animal Health (OIE) stated "Most reported outbreaks of foodborne diseases are due to contamination of foods with zoonotic agents, often during primary production."

Safe food can only be produced if healthy, clean, residue and stress-free animals are delivered to the slaughterhouse where a dedicated inspectorate, headed by a veterinarian, can ensure that high standards of animal welfare and food safety are maintained. This assurance should apply to all products of animal origin throughout the processing and marketing stages.

Quality Control Laboratory (QC Lab) under DLS

Quality Control Laboratory has set up at Savar, Dhaka for quality testing of Livestock Inputs and its Food Products.

The lab is responsible for the appropriate implementation of analytical tools and techniques for quality control, taking into account their nutritional, biological, chemical qualities. The lab playing a leading role in ensuring a harmonized approach between district hospitals, field laboratories, various industries, and other stakeholders. Potentially hazardous residues and contaminants are vigorously scrutinized, and strict authorization procedures are in place for new additives and crops for feed and food production, disease investigation, and food safety. In addition, certifications can help domestic producers export, further stressing the need for quality control to prevent diseases and boost the sector. The new quality control lab is expected to take in order to help exports of livestock commodities.



Fig. 23: Food safety regimens related to Veterinary services

The Role of Veterinarian in Food Safety:

i) Medicine Use: Vets who visit the farms will be guiding the farmer in his use of medicines for any animals that get sick. They will want to make sure that he uses the right medicine for the right species and the correct dose. One of the most important reasons for this is to ensure that any animal, which is sent to slaughter, has drug residues below the permitted limit before it is slaughtered. This period is known as the "withdrawal period". Vets also want to assist and advise the farmer in the use of antibiotics because of the risk this has in developing resistance. Bacteria that are resistant to antibiotics represent a risk to future generations of animals, which may get sick. If the bacteria are very resistant to antibiotics, there may be no medicines available to the farmer for him to treat a sick animal. It is also possible, in certain circumstances that these resistant bacteria could reach a slaughterhouse or a market, causing meat or milk to become contaminated, which in turn may cause antibiotic resistance to be transferred to the consumers of such products. In view of the above, the uses of antibiotics in feed on farm animals in Bangladesh is prohibited.

ii) Animal Feed Use: Vets also have interest in the food the animals consume. This is because, if the animal feed is incorrect or toxic, it will affect the health of the animals, and in some cases, the toxin in the animal feed can be absorbed by the animal and then passed on to the consumer in the milk, meat or eggs produced. Dioxins, heavy metals such as lead and mercury, polychlorinated biphenyls (PCBs), dichloro diphenyl trichloro ethane (DDT), radionuclides (radioactivity) and salmonella are well known examples of contamination in animal feed.

iii) Zoonotic Diseases: Diseases of great interest to them are zoonoses, which are diseases that can affect both animals and man. If vet suspects zoonoses, such as tuberculosis (TB), are on a farm, he wants to confirm the diagnosis and control the disease outbreak. He also wants to make sure that the disease does not enter the food chain, in this case, through the milk or through the meat.

iii) Market Level: Food animal markets, worldwide, are well known for spreading disease from farm back to farm or further down the "farm to fork" food chain. Therefore this is an area where additional measures are sometimes required such as "rest days" during which markets are kept empty while they are thoroughly cleansed. A 'public health' vet should routinely inspect live food animal markets for signs of ill health, contamination and poor welfare.

iv) Slaughter house Level: As defined by the Encyclopedia Britannica; "ante-mortem inspection identifies animals not fit for human consumption. Here animals that are down, disabled, diseased, or dead are removed from the food chain and labeled "condemned." Post-mortem inspection of the head, viscera, and carcasses helps to identify whole carcasses, individual parts, or organs that are not wholesome or safe for human consumption." In most developed countries ante- and post-mortem meat inspection at the slaughterhouse is carried out by vets. The World Organization for Animal Health (OIE) **"Control and/or reduction of biological hazards of animal and public health importance by ante- and post-mortem meat inspection are a core responsibility of Veterinary Services."**

v) Drug and Chemical Residue Checks: Traditional meat inspection procedures have now had modern additional checks added in order to safeguard the public health . These checks are to look for substances such as growth promoters, hormones, antibiotics or chemicals used legally or illegally in the production of the meat; with the aim of significantly reducing the risk of the public consuming meat with harmful chemicals. In the last few years, there have been many different problems with residues in food. Melamine in milk, growth hormone in feed lot cattle are examples.

vi) Food Safety through "Trace back": The aim of the trace back exercise is to find out where in the chain the problem has occurred. Did the problem occur at the point of sale in for example a restaurant? If not then did the problem occur at a food storage point? If so, which one and what other foods were stored at the time and at that place? This is highly relevant for example with ground beef and E. Coli O157 food poisoning. Traditionally once a vet has "vetted" an animal or animal product, he can issue a certificate describing what he has found.

Enforcement in Food Safety

- Enforcement of food safety laws and regulations in Bangladesh is weak due to several limitations within the legal and regulatory systems. Overlap of the regulatory responsibilities among various ministries and agencies and complexity due to numerous acts, laws, and regulations of different categories of food products contribute to limited enforcement and lack of coordination among ministries. Science-based food safety management systems are emphasized in the 2013 Food Safety Act. Under the Act, BFSA's role is to establish a food safety network, up to the field level, among authorities involved in the food safety management system for the development and implementation of Good

- Good Agricultural Practices (GAPs), Good Aquaculture Practices (GAQPs), Good Manufacturing Practices (GMPs), Good Hygiene Practices (GHPs), hazard analysis, food safety auditing systems, etc. Primary production, which starts at the farm level, is controlled by the DAE, DLS, and the DOF. As per the Fish Feed and Animal Feed Act, 2010, the DLS and DOF regulate feed control at the farm level. BFSA has limited implementation governance at the farm level. BFSA and BSTI play a vital role in food processing through the implementation of specific food product standards and enforcement policies. BSTI also performs inspection procedures and testing of food products during processing to regulate quality standards. However, BFSA regulates the standards for food additives, contaminants, toxins, pesticides, packaging and labeling, hygiene and sanitation management, and testing at the processing stage. City corporations, district health departments, sub-district health departments, and the Directorate of National Consumer Rights Protection (DNCRP) are responsible for the implementation of food safety through inspections. The Local Government Division (LGD), DGHS, and DNCRP ensure food safety at domestic distribution and marketing levels through the inspection of public markets, restaurants, supermarkets, and retail.

vii. The LDDP's approach to address food safety:

- Gap analysis of existing legislation for food safety enforcement and value chain-based inspection & mobile court operation;
- Baseline data on current level of food safety incidents;
- Support to establishment of quality assurance schemes;
- Surveillance and monitoring of microbial, chemical and residual;
- Establishment of animal origin food inspection program;
- AMR Surveillance and Risk Mitigation Program;
- Drafting legal amendments and regulations for stronger food safety enforcement;
- Multi-stakeholders' dissemination workshop on food safety, legal enforcement;
- Food safety and quality assurance- Regulatory frame work, Capacity development
- Food safety, quality assurance and public health;
- Capacity building support of DLS for risk-based inspection, assessment, monitoring, communication- DVH, FDIL, CDIL, Nutrition Lab equipments and necessary consumable;
- Improve selected network of food safety laboratories (Equipment for BLRI)
- Fees and consumables for selected network of food safety lab- Dairy Science, Microbiology and Central Laboratory of BAU;
- Establishment of modern animal slaughtering facilities at selected metro and district level.
- Establishment of Village Milk Collection Center (VMCC), dairy hubs, milk processing/cooling plants, feed processing facilities, etc.
- Exhibition and demonstration of safe and nutritious dairy products in selected schools.

Topic-9: Animal Slaughter, Meat Processing and Utilization of by-products to ensure food safety

Animal Slaughtering:

A. Preparation before Slaughter:

Stress in its many forms, e.g., deprivation of water or food, rough handling, exhaustion due to transporting over long distances, mixing of animals reared separately resulting in fighting should also be avoided because of its deleterious effects on meat quality. The most serious consequence of stress is death transported in poorly ventilated, overcrowded trucks in hot weather. Stress immediately prior to slaughter, such as fighting or rough handling in the lairage, causes stored glycogen (sugar) to be released into the bloodstream. After slaughter this is broken down in the muscles producing lactic acid. This high level of acidity causes a partial breakdown of the muscle structure causing the meat to be pale, soft and exudative. Long-term stress before slaughter such as a prolonged period of fighting during transport and/or lairage leads to exhaustion. The sugars are used up so that less is available to be broken down and less lactic acid is produced. The reduced acidity leads to an abnormal muscle condition known as dark, firm and dry (DFD) in beef. The condition is rarer in lamb. Such meat has a high pH (above 6.0) and spoils very quickly as the low acidity favours rapid bacterial growth.

B. Steps to be taken before slaughter:

1. The lairage should have small pens, corridors must curve and not bend sharply so that stock can see a way forward.
2. Stock must not be slaughtered in sight of other stock.
3. Plenty of clean water must be available.
4. The lairage must be well lightened and ventilated.
5. Do not hold stock in lairage for more than a day.
6. Only fit, healthy stock may be slaughtered for human consumption.
7. Fasting before slaughter reduces the volume of gut contents and hence bacteria and therefore reduces the risk of contamination of the carcass during dressing.
8. It is usually sufficient for the animals to receive their last feed on the day before slaughter.
9. Stock should have a rest period after arrival at the slaughterhouse.
10. Animals should be as clean as possible at slaughter.
11. Trucks used for transport must be washed after each load and the lairage at the slaughterhouse should be kept clear of faecal matter and frequently washed

C. Equipment for Slaughtering and Meat processing :

Equipment	Additional equipment
<ol style="list-style-type: none"> 1. Stunning gun, electrical head tongs or simple stunning equipment for direct blow 2. Knives: 3. Sticking - 15 cm sharpened on both sides 4. Skinning - 15 cm curved 5. A sharpening steel 6. Oil or water sharpening stone 7. Scabbard and belt for holding knives 8. Meat saw - hand or electric and cleaver 9. Block and tackle or chain hoist strong enough to hold the weight of the animal to be slaughtered 10. Skinning rack (dressing cradle) 11. A strong beam, tripod or track 2.4 to 3.4 m from floor 12. Spreader - gambrel or metal pipe 13. Several buckets 14. Working platforms 	<ol style="list-style-type: none"> 1. Scalding barrel or tank 2. Pot, barrel or system for boiling water 3. Bell scrapers 4. Solid scraping table or platform 5. Thermometer registering up to 70°C 6. Hog or hay hook 7. Torch or flame for singeing 8. Knocking pen 9. Bleeding hooks (for vertical bleeding) 10. Blood-catching trough 11. Wash trough (tripe) Sanitation of hands and tools: 12. Hand wash-basin 13. Implement sterilizers

D. Slaughtering method:

Stunning prior to bleeding:

- Most countries have legislation requiring that animals are rendered unconscious (stunned) by a humane method prior to bleeding.
- Exceptions are made for religions which require that ritual slaughter without prior stunning is practised, provided the slaughter method is humane.
- Stunning also makes sticking (throat-slitting) less hazardous for the operator.
- The animal must be unconscious long enough for sticking to be carried out, and for brain death to result from the lack of blood supply.

Methods of Stunning:

Direct blow to skull using a club or poleaxe:

- The blow must be dealt with precision and force, so that the skull is immediately smashed, causing instantaneous unconsciousness.
- In cattle the aiming point is in the middle of the forehead in line with the ears, where the skull is thinnest.
- In sheep and goats, the brain is more easily reached from the back of the neck.

Slaughtering mask:

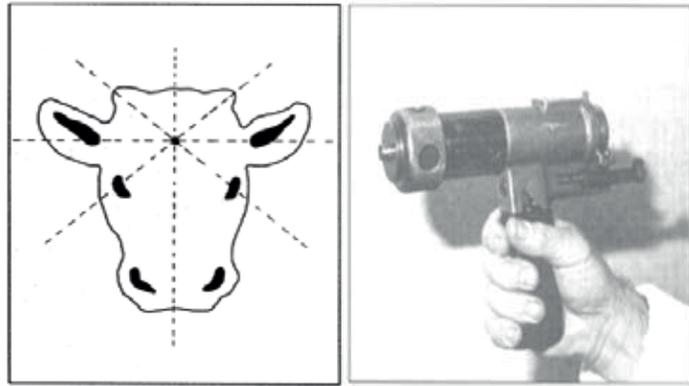
- A bolt held in the correct position by the mask is driven into the animal's brain by a hammer blow.
- The device is usually fitted with a spring which returns the bolt to its original position.

Free bullet:

- Fired from a pistol into the skull is effective but unsafe.
- This method has been used on horses and cattle.

Captive-bolt pistols:

- Pistols fitted with a blank cartridge are effective on cattle and sheep.



- After firing, the bolt returns to its original position in the pistol.
- The bolt may or may not be designed to penetrate the skull.
- With penetrating types, the brain becomes contaminated with hair, dirt and bone fragments.
- If brains are to be saved as edible tissue, then the non-penetrating type with a mushroom-shaped head should be used.

Electrical stunning:

- An electric current of high frequency but, in the case of manually operated equipment, of relatively low voltage (60–80 V) is passed through the brain of an animal for a few seconds to produce unconsciousness.
- If applied correctly a deep state of unconsciousness is invariably achieved.
- Strict safety rules must be observed.

Halal Method of Slaughtering:

Muslim method of slaughter

Many of the practices relating to the slaughter of animals and the consumption of meat by members of the Jewish faith also apply to Muslims. The welfare of the animals is a major consideration in both cases and eating of dead animals, consumption of blood and swine is forbidden.

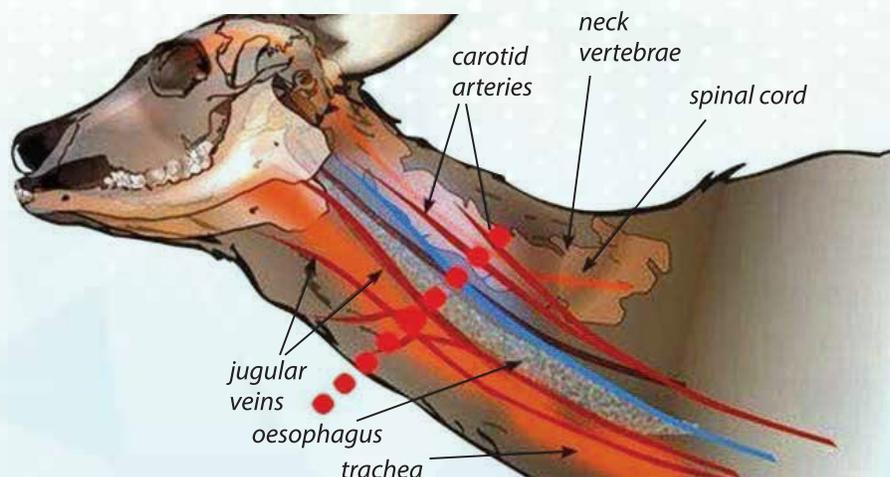


Fig. 24: Halal Method of Slaughtering

Rules of halal method

1. Before slaughtering “Bismillahi Allahu Akbar” should be uttered.
2. Slaughtering should be done by an adult sensible Muslim person.
3. Stunning is not prohibited.
4. Animals must not be slaughtered in the sight of the other animals.
5. Prior to killing animals should be fed water

Merits

- Same as Jewish method.
- Due to struggling there is more cardiac action and as a result more bleeding is ensured.

Disadvantages

- Waste of blood by contamination through the contents of the stomach escaping through esophagus.

E. Slaughtering or Bleeding (Halal Method):

- The objectives of bleeding are to kill the animal with minimal damage to the carcass and to remove quickly as much blood as possible as blood is an ideal medium for the growth of bacteria.
- Sticking, severing the major arteries of the neck, should immediately follow stunning.
- Care must be taken not to puncture the chest cavity or it will fill with blood.

Cattle and Buffalo:

- Insert the sticking knife carefully just above the breastbone at 45° pointed toward the head.
- Ensure that the carotid arteries and jugular veins are severed in one movement.

Sheep and Goat:

- Draw the knife across the jugular furrow close to the head severing both carotid arteries.
- Alternatively, the knife may be inserted through the side of the neck, though this requires more skill.

F. Bleeding on a Rail:

- The most hygienic system of bleeding and dressing is to shackle the animal immediately after stunning, then hoist it on to a moving rail.
- The animal is stuck while being hoisted to minimize the delay after stunning.
- Bleeding continues until the blood flow is negligible when carcass dressing should begin without further delay.
- The knife may be connected to a hose to reduce the risk of contamination.
- The hose may even be connected to a pump to speed the blood flow.
- Between 40 and 60 percent of the total blood volume will be removed though this will be reduced if sticking is delayed.
- The knife should be changed after each operation and returned to a sterilizer. Cutting the hide of sheep and cattle and opening out to make a clean entry for the sticking knife reduces contamination from the wound.

Horizontal Bleeding:

- Horizontal bleeding is claimed to give faster bleeding rate.
- This may be due to certain organs and blood vessels being put under pressure when animals are hoisted, thus trapping blood and restricting the flow.
- Bleeding on the floor is very unhygienic.
- The operation should take place on a specially designed, easily cleaned stainless-steel table which should be cleaned frequently.



F. Skinning of cattle and Buffalo:

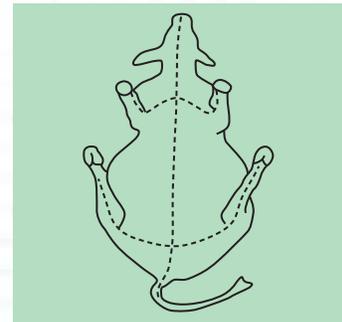
Precaution:

- The outer side of the hide must never touch the skinned surface of the carcass.
- Operators must not touch the skinned surface with the hand that was in contact with the skin.

Combined Horizontal/Vertical Methods:

Head:

- After bleeding, while the animal is still hanging from the shackling chain, the horns are removed and the head is skinned.
- The head is detached by cutting through the neck muscles and the occipital joint.
- Hang the head on a hook.
- Lower the carcass on its back into the dressing cradle.



Legs:

- Skin and remove the legs at the carpal (foreleg) and tarsal (hind leg) joints.
- The forelegs should not be skinned or removed before the carcass is lowered on to the dressing cradle or the cut surfaces will be contaminated.
- The hooves may be left attached to the hide.

Vertical Methods:

- Hide removal is carried out on the hanging carcass.
- The operations are as in the combined horizontal/vertical method, but as it is not possible to reach the hide from ground level more than one operator is needed.
- A single operator may work with a hydraulic platform which is raised and lowered as required.
- Automatic hide pullers are used in high-throughput slaughter houses.
- Some types pull the hide down from the hind, others from the shoulders upwards toward the rump.
- Automation of hide removal reduces contamination since there is less handling of the carcass and less use of knives.
- Moving overhead rails also improve hygiene by reducing carcass contact with operators, equipment such as dressing cradles and with each other since carcasses are evenly spaced.

Small Ruminants (Sheep and Goat):

- Sheep fleeces can carry large volumes of dirt and faeces into the slaughterhouse.
- It is impossible to avoid contamination of sheep and lamb carcasses when the fleece is heavily soiled.
- The fleece or hair must never touch the skinned surface, neither must the operator touch the skinned surface with the hand that was in contact with the fleece.

Vertical Methods:

- At sticking the animal is shackled by one hind-leg and left to bleed.
- Dressing commences with the free leg which is skinned and the foot removed.
- A gambrel is inserted into this leg and hung on a runner on a dressing rail.
- The second leg is freed from the shackle, skinned and dressed, then hooked on to the other end of the gambrel.
- The skin is opened down the midline and cleared from the rump.
- A spreader frame spreads the front legs to simplify work on the neck, breast and flanks.
- The front toes are held in each end of the frame which is then slung up on to a separate travelling hook.

G. Evisceration:

Cattle

- The brisket is sawn down the middle.
- In the combined horizontal/vertical system this is done with the animal resting on the cradle.
- The carcass is then raised to the half-hoist position and when hide removal is complete the abdominal cavity is cut carefully along the middle line.
- The carcass is then fully hoisted to hang clear of the floor so that the viscera fall out under their own weight.
- They are separated into thoracic viscera, paunch and intestines for inspection and cleaning.

Small ruminants:

- A small cut is made in the abdominal cavity wall just above the brisket, and the fingers of the other hand are inserted to lift the body wall away from the viscera as the cut is continued to within about 5 cm of the cod fat or udder.
- The Omasum is withdrawn, the rectum (tied off) loosened, and the viscera freed and taken out.
- The food-pipe (tied off) is pulled up through the diaphragm.
- The breastbone is split down the middle taking care not to puncture the thoracic organs which are then removed.

H. Splitting of carcasses:

Cattle

- Work facing the back of the carcass.
- Split the carcass down the backbone (chine) with a saw or cleaver from the pelvis to the neck.
- Sawing gives a better result but bone dust must be removed.
- If a cleaver is used, it may be necessary to saw through the rump and loin in older animals.
- The saw and cleaver should be sterilized in hot (82°C) water between carcasses.
- Power saws increase productivity.



Sheep / Goat

- Sheep/goat and lamb carcasses are generally sold entire.
- If necessary, they can be split by saw or cleaver, but a saw will probably be necessary for older animals.



I. Carcass Washing:

- The primary object of carcass washing is to remove visible soiling and blood stains and to improve appearance after chilling.
- Washing is no substitute for good hygienic practices during slaughter and dressing since it is likely to spread bacteria rather than reduce total numbers.
- Wiping cloths must not be used.
- Carcass spraying will remove visible dirt and blood stains.
- Water must be clean. Soiled carcasses should be sprayed immediately after dressing before the soiling material dries, thus minimizing the time for bacterial growth.
- In addition to removing stains from the skinned surface, particular attention should be paid to the internal surface, the sticking wound and the pelvic region.
- A wet surface favours bacterial growth so only the minimum amount of water should be used and chilling should start immediately.



J. Carcass dressing:

- The object of carcass dressing is to remove all damaged or contaminated parts and to standardize the presentation of carcasses prior to weighing.
- Where signs of disease or damage are found the entire carcass and offal may be condemned and must not enter the food chain, but more often the veterinarian will require that certain parts, for instance those where abscesses are present, be removed and destroyed.
- Factory personnel must not remove any diseased parts until they have been seen by the inspector otherwise, they may mask a general condition which should result in the whole carcass being condemned.
- Any instructions from the inspector to remove and destroy certain parts must be obeyed.



K. Refrigeration of Carcasses:

- Carcasses should go into the cooler as soon as possible and should be as dry as possible.
- The object of refrigeration is to retard bacterial growth and extend the shelf-life.
- Chilling meat post-mortem from 40°C down to 0°C and keeping it cold will give a shelf-life of up to three weeks, provided high standards of hygiene were observed during slaughter and dressing.
- Carcasses must be placed in the cooler immediately after weighing.
- The rate of cooling at the deepest point will vary according to many factors including the efficiency of the cooler, the load, carcass size and fatness.
- As a general guide a deep muscle temperature of 6–7° C should be achieved in 28 to 36 hours for beef and 24 to 30 hours for sheep carcasses.



- Failure to bring down the internal temperature quickly will result in rapid multiplication of bacteria deep in the meat resulting in off-odours and bone-taint.
- The cooler should not be overloaded beyond the maximum load specified by the manufacturers and spaces should be left between carcasses for the cold air to circulate.
- Otherwise cooling will be inefficient and the carcass surface will remain wet, favouring rapid bacterial growth forming slime.
- Once filled, a cooler should be closed and the door opened as little as possible to avoid sudden rises in temperature.
- When emptied, it should be thoroughly washed before refilling.
- Personnel handling carcasses during loading and unloading operations should follow the strictest rules regarding their personal hygiene and clothing and should handle carcasses as little as possible.

Meat By-products:

- The majority of the waste, in the meat industry is produced during slaughtering.
 - Slaughter house waste consists of the portion of a slaughtered animal that cannot be sold as meat or used in meat-products.
 - Such waste includes bones, tendons, skin, the contents of the gastro-intestinal tract, blood and internal organs.
 - Efficient utilization of meat by-products is important for the profitability of the meat industry.
 - It has been estimated that 11.4% of the gross income from beef by-products.
- The meat by-products (including organs, fat or lard, skin, feet, abdominal and intestinal contents, bone and blood) of cattle and lambs represents 66 and 68% of the live weight respectively.
 - More than half the animal by-products are not suitable for normal consumption, because of their unusual physical and chemical characteristics.
 - As a result, a valuable source of potential revenue is lost, and the cost of disposing of these products is increasing.
 - In addition to economic losses, unused meat products cause serious environmental pollution.
 - However, with improved utilization, meat by-products can give a good profit to meat processors.

Average Quantity of Different By-Products from Animals:

Item	Cattle		Sheep	
	%	kg	%	kg
Market live weight	600		60	
Whole carcass	63.0	378.0	62.5	37.5
Blood	18.0	4.0	2.4	
Fatty tissue	4.0	24.0	3.0	1.8
Hide or skin	6.0	36.0	15.0	9.0
Organs	16.0	96.0	10.0	6.0
Viscera (chest and abdomen)	16.0	96.0	11.0	6.6
Feet	2.0	12.0	2.0	1.2
Tail	0.1	6.0		
Brain	0.1	6.0	2.6	0.156

Utilization of meat by-products:

a) Utilization of Blood:

- Animal blood has a high level of protein (17%) with a reasonably good balance of amino acids and heme-iron.
- In Europe, animal blood has long been used to make blood sausages, blood pudding, biscuits and bread.
- In Asia, it is used in blood curd, blood cake and blood pudding.
- It is also used for non-food items such as fertilizer, feedstuffs and binders.
- According to the Meat Inspection Act of the United States, blood is approved for food use when it has been removed by bleeding an animal that has been inspected and passed for use in meat food products.
- Blood is usually sterile in a healthy animal.
- However, the use of blood in meat processing may mean that the final product is dark in colour, and not very palatable.

b) Utilization of Blood Plasma:

- Plasma is the portion of blood that is of greatest interest, because of its functional properties and lack of colour.
- It is used in food as an emulsifier, a stabilizer, a clarifier, a colour additive, and as a nutritional component.
- Most blood is used in livestock feed in the form of blood meal.
- It is used as a protein supplement, a milk substitute, a lysine supplement or a vitamin stabilizer, and is an excellent source of most of the trace minerals.
- Blood plasma has ability to form a gel, because it contains 60% albumin.
- Plasma is the best water and fat binder of the blood fraction.
- Plasma gels appear very similar to cooked egg whites.
- Plasma forms a gel at a protein concentration of 4–5% and the strength of the gel increases with increasing concentration.
- Blood plasma also has an excellent foaming capacity, and can be used to replace egg whites in the baking industry.

c) Utilization of Hides and Skins:

- Animal hides have been used for shelters, clothing and as containers by human beings since prehistoric times.
- The hides represent a remarkable portion of the weight of the live animal, from 4% to as much as 11% (e.g. cattle: 5.1–8.5%, sheep: 11.0–11.7%).
- Hides and skins are generally one of the most valuable by-products from animals.
- Examples of finished products from the hides of cattle and pigs, and from sheep pelts, are leather shoes and bags, rawhide, athletic equipment, reformed sausage casing and cosmetic products, sausage skins, edible gelatine and glue.

d) Utilization of Gelatin:

- Gelatin extracted from animal skins and hides can be used for food.
- The raw material can also be rendered into lard.
- Collagen from hides and skins also has a role as an emulsifier in meat products because it can bind large quantities of fat.
- This makes it a useful additive or filler for meat products.
- Gelatin is added to a wide range of foods, as well as forming a major ingredient in jellies and aspic.
- Its main use is the production of jellied desserts, because of its “melt in the mouth” properties, but is also added to a range of meat products, in particular to meat pies.

- Gelatin is also widely used as a stabilizer for ice cream and other frozen desserts.
- High-bloom gelatin is added as a protective colloid to ice cream, yoghurt and cream pies.
- The gelatine is thought to inhibit the formation of ice crystals and the recrystallization of lactose during storage.
- Gelatin can also be used as a binding and compounding agent in the manufacture of medicated tablets and pastilles.
- It is used as an important ingredient in protective ointment, such as zinc gelatine for the treatment of ulcerated varicose veins.

e) Utilization of Bone:

- 11% percent of pork carcasses, 15% of beef carcasses and 16% of lamb carcasses are bone.
- The marrow inside some of the bones can also be used as food.
- The marrow may be 4–6% of the carcass weight.
- For centuries, bones have been used to make soup and gelatine.
- Meat and bone meal (MBM) are widely recommended and used in animal nutrition as a protein source in place of proteinaceous feeds because of its content of available essential amino acids, minerals and vitamin B₁₂.
- MBM and related rendered protein commodities have potential for use in applications other than animal feed, including use as a fuel or a phosphorus fertilizer.

f) Utilization of Glands and Organs:

- Animal organs and glands offer a wide variety of flavours and textures, and often have a high nutritional value.
- They are highly prized as food in many parts of the world, particularly Southeast Asia.
- Those used as human foods include the brain, heart, kidneys, liver, lungs and spleen.
- They also include the tongue, the bovine pancreas and udder, the stomach and uterus of pigs, the rumen, reticulum, omasum and absomasum of sheep and cattle, and the testes and thymus of sheep and pigs.
- The brain, nervous system and spinal cord are usually prepared direct for the table rather than processed for industrial use.
- Heart is used as a table meat.
- Whole hearts can be roasted or braised. Sliced heart meat is grilled or braised.
- Heart meat is often also used as an ingredient in processed meats.
- Kidneys may be cooked whole or in slices, and are generally broiled, grilled, or braised.
- Liver is the most widely used edible organ. It is used in many processed meats, such as liver sausage and liver paste

- Animal intestines are used as food after being boiled in some countries.
- Animal intestines are also used in pet food or for meat meal, tallow or fertilizer.
- However, the most important use of the intestines is as sausage casings.
- Brains, nervous systems and spinal cords are a source of cholesterol which is the raw material for the synthesis of vitamin D3.
- Cholesterol is also used as an emulsifier in cosmetics.
- Bile consists of acids, pigments, proteins, cholesterol etc., and can be obtained from the gall bladder. It is used for the treatment of indigestion, constipation and bile tract disorders.
- Liver extract can be obtained from pigs and cattle, and has been used for a long time as a source of vitamin B12, and as a nutritional supplement used to treat various types of anaemia.
- Heparin is used as an anticoagulant to prolong the clotting time of blood.
- It is also used to thin the blood, to prevent blood clotting during surgery and in organ transplants.
- Progesterone and oestrogen can be extracted from pig ovaries. It may be used to treat reproductive problems in women.

g) Utilization of Edible Tallow and Lard:

- Animal fats are an important by-product of the meat packing industry.
- The major edible animal fats are lard and tallow.
- Lard is the fat rendered from the clean tissues of healthy pigs.
- Tallow is hard fat rendered from the fatty tissues of cattle or sheep.
- Lard and edible tallow are obtained by dry or wet rendering.
- Rendered lard can be used as an edible fat without any further processing.
- However, because of consumer demand, lard and tallow are now often bleached and given a deodorizing treatment before being used in food.
- Traditionally, tallow and lard were used for deep frying.
- However, this use is declining in the fast-food industry, due to consumer health concerns.
- An alternative liquid tallow product has been developed for the preparation of French fries and other fast foods, since less fat is absorbed.
- Tallow and lard are also used for margarine and shortening.
- Some edible lards are used in sausages or emulsified products

Topic-10: Meat Inspection: Antemortem and Post-mortem Inspection of Food Animals

The objectives of meat inspection programme are two folds:

- a. To ensure that only apparently healthy, physiologically normal animals are slaughtered for human consumption and that abnormal animals are separated and dealt with accordingly.
- b. To ensure that meat from animals is free from disease, wholesome and of no risk to human health.

These objectives are achieved by antemortem and post-mortem inspection procedures and by hygienic dressing with minimum contamination. Whenever appropriate the Hazard Analysis Critical Control Point (HACCP) principles should be used: The inspection procedures should be appropriate to the spectrum and prevalence of diseases and defects present in the particular class of livestock being inspected using the principles of risk assessment.

Pre-Slaughter Rest:

- Pre-slaughter rest is the period before slaughter when animals are rested in order to improve the meat quality and reduce the chances of contamination with gastrointestinal bacteria.
- During pre-slaughter rest fatigue could have negative influence on protective functions of the animals (low immunity) allowing rapid penetration of the microorganisms especially *E.Coli* through mucous membrane of the intestine to the blood stream and ultimately to the organs
- Normal feeding and resting for 48 hours brings gradual freeing of muscles and other organs from microorganisms, improve bleeding and keeping quality of meat.
- Pre-slaughter rest also helps in preserving glycogen level in the muscles and during the later phase this glycogen undergoes anaerobic respiration and results in production of lactic acids which has mild preservation effect on meat quality
- Under stressed conditions muscles do not receive enough oxygen which leads to higher lactic acid production often associated with compromised quality in terms of colour, texture and water holding capacity.

A. Ante-Mortem Inspection:

It refers to inspection of food animals conducted prior to (12 to 24 hr) slaughter to ascertain fitness or otherwise of the animals for slaughter.



Objectives of ante-mortem inspection

- 1) To detect the animals suffering from infectious or scheduled diseases (communicable to animals or human beings) such as FMD, Rabies, Anthrax, etc;
- 2) To detect diseases causing toxic or infectious conditions and which may escape detection in post mortem examination;
- 3) To prevent outbreaks of food poisoning resulting from the consumption of meat from animals which were ill at slaughter;
- 4) To make post-mortem inspection more efficient and less laborious;
- 5) To document information on animal diseases prevalent in the region;

Facilities for conducting ante-mortem inspection

1. For successful ante-mortem examination, procedure for adequate identification of the animals to be slaughtered need to be followed;
2. The lairage should be properly designed, well lighted and ventilated;
3. The lairage should have provision for isolation pens;
4. There should be competent assistant staff for handling of livestock and above all a competent veterinarian must be available;
5. A well designed code on veterinary ante-mortem inspection procedures, judgement principles and documentation of findings need to be maintained;

Procedure for ante-mortem inspection:

Immediately after the animals arrive at the slaughterhouse, they are examined by qualified veterinary personnel before being sent to the lairage where ante-mortem inspection is carried out 12 to 24 hours before slaughter by the qualified veterinarians.

Ante-mortem inspection can be carried out in two stages:

Stage-I: General examination

The animals are to be examined collectively to assess the overall health status so as to segregate them into three groups:

- 1) Healthy
- 2) Unhealthy (diseased)
- 3) Apparently healthy (doubtful cases)
 - The animals are examined while they are at rest and also in motion ;
 - They are observed for the gait, posture, fatigueness and for their response to external stimuli;
 - They are examined for abnormal behaviour like walking in circles, state of alertness, symptoms of tiredness and agitation;
 - Animals are examined for abnormal discharge from natural orifices like eyes, nose, mouth, anus, vagina etc. and/or swellings on any part of the body;
 - It is also important to observe for any evidence of cruelty to animals such as any sign of bruises, torn skin, and fractured bone indicating carelessness during transportation;

At the end of the first stage of examination, healthy **animals are cleared as fit for slaughter** whereas the other two groups are taken to the next stage of examination.

Stage-II. Detailed clinical examination

The animals classified as unhealthy (diseased) are subjected to further examination to correctly diagnose the illness while the animals placed in group three (Apparently healthy or doubtful cases) are examined to ascertain whether these animals are really sick and if so, what could be the nature of illness.

Animals are subjected to the following investigations:

- (i) Temperature, pulse and respiration rate should be recorded and animals suffering from fever must be retained for treatment preferably outside the meat plant.
- (ii) The lymph nodes are palpated and examined for any swelling and abnormalities and on this basis the animals are either rejected or passed with clear instructions for careful post-mortem examination

- (iii) Pregnant animals or animals having delivered a calf within the last 48 hours are not permitted for slaughter. Animals undergoing treatment or with a recent history of treatment as also experimental animals are not to be slaughtered unless a no objection certificate has been issued by veterinarians.
- (iv) Blood, urine and faces samples to be drawn for laboratory tests.
- (v) Pathognomonic clinical symptoms of the diseases for suspected animal to be carefully studied.
- (vi) The species, class, age, condition, colour and markings re-recorded in case of diseased or sick animals and in case of the animals in poor condition.

Table -Diseases and abnormalities encountered in ante-mortem inspection

General conditions	Specific infections		
	Cattle	Calves	Sheep/Goat
Moribund and exhausted status	Actinomycosis	Immaturity	Pneumonia
Emaciation	Actinobacillosis	Calf diphtheria	Caseous lymphadenitis
Anasarca	Tuberculosis	Arthritis	Enterotoxaemia
Poorness	Blackleg	Ringworm	FMD
External injuries	FMD	White Scour	
Localized swellings a) tumours b) abscesses c) oedema d) haematoma e) hernia	Anthrax	Salmonellosis	
Inflammatory conditions of skin a) urticaria b) eczema	Rinderpest		
Pregnancy	Mastitis		
Fractures	Ringworm Pneumonia		
Dystocia	Retained placenta		
Discharges from natural orifices			

Judgment decisions at ante-mortem inspection:

Post ante-mortem inspections, the animals can be subjected to any of the following three decisions.

Passed/Accepted/ Fit for slaughter: The animals free from any disease and normal can be directly sent for slaughter.

Rejected/ Condemned/ Unfit for slaughter: Animals suffering from fever, emaciated or dead emaciated or dead animals, immature or pregnant animals are considered unfit and not passed for slaughter. Animals with established symptoms of diseases are not sent for slaughter.

Suspected: Animals falling under this category are those for which decision regarding fitness for slaughter cannot be made at the ante-mortem inspection stage. The following possibilities exist under these circumstances.

(a) Slaughter under special precautions: Animals under suspected category if having symptoms of diseases.

(b) Delayed/Detained slaughter: If the animals require treatment, or have history of recent treatment/vaccination, animals in febrile condition, fatigued and excited state may require treatment before they are slaughtered.

(c) Segregated slaughter: Such decisions are made under special conditions such as dirty stock or animal suspected for some contagious diseases etc. Such animals are slaughtered at the end of the days kill or separately slaughtered and a thorough post-mortem examination is performed.

(d) Casualty and emergency slaughter: Casualty slaughter is required when an animal is not in acute pain or immediate danger of death but affected with a more chronic condition like benign superficial tumours, obturator paralysis and post-partum paraplegia etc. When an animal is in acute pain or suffering from condition like, fractures, severe injuries, uterine prolapsed etc., where a delay in slaughter would be contrary to the animal welfare, then animals require emergency slaughter. Prolonged recumbency in cows and sows after parturition, abscess formation in pigs due to *Corynaebacterium pyogenes*, pregnancy toxemia and enterotoxaemia in sheep and injuries and infection of udder and uterus in cattle are the several other causes of emergency slaughter.

B. Post-mortem Inspection:

Post-mortem examination/inspection refers to inspection of carcass and organs by qualified veterinarians to ensure that carcass and organs are fit for human consumption. During inspection, care should be taken not to contaminate the carcass and organs from diseased animals. The knives and other instruments used for cutting and examining organs, glands and tissues should be properly sterilized before and after use. The particular sequence should be followed during post-mortem examination so that each carcass and thereof organs are checked thoroughly.

Objectives of post-mortem examination:

Carcasses should not be sent to the chilling section without inspection after dressing. Some of the diseases are not apparent during ante-mortem examination can be detected easily in post-mortem examination. Thus, post mortem inspection ensures safe meat to the consumers and also controls diseases right at the farm level itself. It also directs to adopt a proper disposal procedure for condemned meat and offals. Since post-mortem inspection is performed for carcasses as well as their viscera, it ensures a systematic way of evisceration and handling of offal.

Facilities required for post-mortem examination:

- The area where the examination is being conducted should have sufficient and well distributed light. The natural light is considered better than artificial light. The intensity of light must be 540 lux ;
- The person carrying inspection need clean, sharp, stainless knives;
- There must be provision for hot and cold water;
- There should be a sterilizer to sterilize the knives, saws and cleavers. The postmortem examination should be carried out under hygienic conditions. The knives should be sterilized by dipping them in boiling water for 30 minutes or by autoclaving them for 10-15 minutes. (The sterilization of anthrax contaminated knives requires special consideration);
- To put a mark on carcass and its viscera, marking dyes should also be provided, which should be cheap, non-toxic and non-corrosive in nature. Marking indicates that the carcass has been inspected and guarantees the consumer about its wholesomeness. Marking of meat is done by (i) using a stamp (ii) branding or (iii) labelling. Common method Metal stamp dipped in a stamping ink;
- There should be provision of detained room side by the inspection site;

General consideration:

Following points should be considered during post-mortem examination/ inspection:

- The examination must be done as soon as possible. Carcasses of beef and pork set rapidly and if the inspection is delayed especially in cold weather the examination of lymph nodes becomes difficult;
- Carcass and organs are to be examined methodically following a definite sequence. Healthy carcass should be examined before inspecting the diseased or suspected ones;

- Great care must be taken at the time of inspection particularly in cases suspected for zoonotic diseases;
- The identity of carcass and its viscera should be maintained;
- Inspector should avoid unnecessary cuts considering the value of high-quality food. One should incise the carcass in such a way that the surface of the carcass appears clean and undistorted;

Post-mortem principles:

Visual perception

First the carcass and visceral organs should be examined visually for any visible abnormalities. Examination is done for any change of colour, atrophy, hypertrophy, neoplastic condition, etc.

Palpation

The organs are palpated for any change in consistency, sliminess or gelation, cyst, etc.

Incisions

The organs are incised, if needed. This is done to examine any parasite inside organ, structural deformity, etc.

Laboratory tests

These are done for confirmation and support the observation made by macroscopic examination. While examining the organs of carcass, lymph node of adjoining area must be examined.

Post-mortem Examination of Carcasses

Large animals

In case of large animals like cattle, sequence of post-mortem examination is as follows:

Head

- Verify the number, age and sex of the animal
- Inspect gums, lips and tongue for FMD, necrotic and other forms of stomatitis, actinomycosis and actinobacillosis (Palpate the tongue for the latter).
- Incise the internal and external masticatory muscles and tongue for *Cysticercus bovis*.
- Incise retropharyngeal, submaxillary and parotid lymph nodes for tuberculosis (TB) lesions
- For sheep & goat, the lips, gums and nasal cavities should be examined for contagious ecthyma.

Lungs

- Examine visually and then palpate for the detection of pleurisy, pneumonia, tuberculosis, fascioliasis and hydatid cysts.
- Incise the bronchial and mediastinal lymph nodes and expose the lung by giving deep incision from the base to apex (for checking TB lesions).
- Check the tumours, abscesses etc. by palpation.

Heart

- ✓ Examine the pericardium for traumatic or tubercular pericarditis.
- ✓ Incise the ventricles of the heart and pay attention to look for petechial hemorrhages on the epicardium and endocardium and cuts in the myocardium. Flavy condition of the myocardium is indicative of septic conditions.

Liver

- A visual examination should be made for fatty changes, abscesses, hydatid cysts, actinobacillosis, etc.
- For examination of fascioliasis, incise thin portion of left lobe of liver and examine the contents.
- For sheep and goat-lungs, heart and liver:
 - (i) Palpate lungs, heart and liver and accompanying lymph glands for abscesses.
 - (ii) Cut the bile duct for examining possible fluke infestation.

Stomach and intestines

- Check the serous surface of the intestine for TB lesions and actinobacillosis.
- Palpate the mesenteric lymph node and if necessary, incise and examine the same.

Spleen

- Examine the surface and substance for TB lesion, anthrax, hematoma and presence of infarcts.

Uterus

- Check for septic conditions by viewing, palpating and incising if necessary.

Udder

- Check the supra mammary lymph nodes by incising for the evidence of TB lesions.
- Check for abscesses if any.

General inspection of carcass

- Look for the injuries and bruises. Bruises are dark colour after 24 hours and there is watery condition after 24 to 38 hours. After 3 days, the area becomes rusty orange colour and soapy to touch.
- Look for inflammation, abscesses and TB lesions in the thoracic and abdominal cavities.
- Examine the kidneys.
- Incise and examine renal lymph nodes.

Post-mortem judgement

Similar to ante-mortem examination, a competent veterinarian has to submit its judgment report:

- Fit for human consumption
- Unfit for human consumption or total condemnation
- The affected organs must be condemned while rest can be passed for human consumption (partially condemned).
- The condemned carcass/ organs should be disposed off following scientific procedure.

Diseases and conditions for which carcass is totally or partially condemned:

The carcass is totally condemned for rabies, anthrax, glanders, rinderpest, foot and mouth disease, acute enzootic meningoencephalitis, acute pleurisy, contagious bovine pleuropneumonia, ovine foot rot, sheep-goat pox, swine fever, swine erysipelas, salmonellosis, fibrinous rhinitis, black leg, bovine viral diarrhoea, haemorrhagic septicaemia, listeriosis, pasteurellosis, coccidiosis, calf diphtheria, calf diarrhoea, malignant oedema, tetanus, etc.

The carcass in case of actinomycosis, actinobacillosis and Johnes disease, is totally condemned if accompanied with emaciation and in generalized form, otherwise the carcass is passed for human consumption after local condemnation. In case of corynebacterium infection, carcass is passed after removal of affected organs.

In case of heavy infestation (more than 10 cysts) with *Cysticercus bovis* and *Cysticercus cellulose*, carcass is totally condemned, otherwise the carcass is passed after removal of head, heart, diaphragm and oesophagus. *Trichinella spiralis* infected carcass is totally condemned. If carcass show the sign of fascioliasis with emaciation, then it is totally condemned, otherwise it is passed after trimming of liver.

Carcass is passed for consumption after removal of lung in case of emphysema and broncheolitis. If there is no fever, then carcass with sign of gastroenteritis is unconditionally passed.

The judgement of carcass suffered from tuberculosis depends on method of spread, extent of disease, character and age of lesion and general condition of the animal. Carcass is totally condemned when tuberculosis spreads through portal or pulmonary or systemic circulation. In case of localized tuberculosis, the carcass is passed after removal of the affected organs and associated lymph nodes.

Metabolic and nutritional disorders and intoxication:

The carcasses are totally condemned if they show any of the following sign: (i) Anaemia with emaciation, (ii) grass tetany, (iii) haemoglobinuria, (iv) jaundice, (v) ketosis with chronic indigestion, (vi) poisoning, (vii) bloat or (viii) impaction, etc.

Abnormal conditions: Abnormal conditions like, abnormal colour, taste and smell, buck smell, bore smell, etc. results in total condemnation of the carcass.

Topic-11: Handling, Preservation and Transportation of animal origin food products

Preservation/Storage of Meat:

Different types of bacteria can grow on animal products, so it's important to safely handle and store all types of meat. However, the different rules for handling different types of meat can be confusing. It may be perfectly safe to eat some meat a week after it was prepared or to freeze it for later. Other types should be thrown away after only a few days.

Safety issues are associated with anyone may eat. A healthy kitchen depends on knowledge of safe cooking and storage practices.

Selecting meat:

Follow these specific guidelines when selecting certain meats:

- Never buy meat that's past the expiration or sell-by date.
- Avoid any beef or mutton meat that's dark brown or discoloured, has a strong odor, or feels tough or slimy.
- Avoid any poultry meat that looks faded, has a strong odor, or feels tough or slimy.
- Avoid any meat that's in damaged, leaking, or torn packages, as it's likely been exposed to the air and harmful bacteria.

Handling of meat:

- Wash hands frequently when preparing any type of meat, or poultry. Bacteria can quickly spread between once hands and meat.
- Always wash hands with soap and water thoroughly before and after handling meat, whether it's raw or cooked.
- Prepare the meat on a surface that's separate from all other cooking materials.
- Keep vegetables and other ingredients away from meat, especially if you aren't cooking them together in the same dish.
- Try to use separate cutting boards, clean all cooking utensils after they touch raw meat, and use different utensils to serve food after have prepared it.

Storing of meat:

- Uncured, raw meat generally lasts safely for around three days in the refrigerator. If once plan to keep uncooked meat longer, freezing it is best bet.
- Seal the meat in an airtight package before freezing. Then, it can usually be frozen for at least several months.
- Safe freezing and refrigeration time also depends on the storage temperature.
- Keep freezer as close to 0°F (-17.8°C) as possible. This helps retain nutrients and keep food fresh.
- Keep refrigerator at around 34°F (1.1°C), just above freezing, to effectively prolong the shelf life of foods.

Below the general guidelines for how long basic meats can be kept safely if they're stored properly.

Type of meat	Safe storage times (in the refrigerator)	Safe storage times (in the freezer)
Uncooked poultry	1–2 days	9 months (pieces) to 1 year (whole)
Uncooked ground meat	1–2 days	3–4 months
Uncooked steaks or chops	3–4 days	4–12 months, depending on the item
Cooked poultry meat	3–4 days	2–6 months

Cooking temperature and food safety:

Cooking temperature affects both the taste and safety of food.

The rare to well-done spectrum refers to the temperature at the center of the meat, which is best checked using a meat thermometer. These can be found at kitchen supply stores and in most grocery stores.

Typical cooking temperatures are:

- Rare: 120–125°F (48.9–51.7°C)
- Medium: 140–145°F (60–62.8°C)
- Well-done: 165°F (73.9°C) or higher

From a safety perspective, hotter temperatures at the center of the meat are safer. However, safe cooking temperatures vary for different types of meat.

Safe cooking temperatures for different meats are:

i) Poultry: 165°F (73.9°C) for whole or ground poultry. Poultry should never be eaten rare. Undercooked poultry can spread salmonella and other diseases. You should always cook it thoroughly.

ii) Ground meats: 160°F (71.1°C) for ground meats such as beef, mutton and lamb. While whole cuts of meat typically have most bacteria on their surfaces, ground meats may have bacteria mixed throughout. Therefore, they must be cooked to a higher temperature than whole cuts of meat.

iii) Whole meat: 145°F (62.8°C), and the meat should be allowed to rest for at least three minutes before eating. The resting time gives the heat more time to kill any bacteria.

- Beef has a wider safety range, but lovers of rare meat are safer sticking to steaks, roasts, and chops.

Freezing of meat:

Freezing of meat in industrial abattoirs is normally carried out in so-called ‘freezing tunnels’ with air at temperatures of between -20 and -40°C , a relative humidity of 95–100% and a circulation of 2–4 m/s. These rooms must have effective insulation from the outside environment, and walls/doors made of appropriate materials to withstand freezing. Due to associated occupational health and safety risks, appropriate security measures are necessary in these rooms, including an appropriate locking system and door heaters which preventing their freeze-blockage in the shut position.

Meat freezes (cryoscopy points) at temperatures of between -1.5 and -1.8°C (muscle tissue) or -2.2°C (fatty tissue). Only the water in meat is actually frozen, and initially only a proportion of it. The concentration of various compounds dissolved in the water increases in the remaining unfrozen water which, in turn, decreases its freezing point. Consequently, approximately only 75% of water in meat is frozen at -5°C , around 90% at -30°C and 100% at -60°C .

Control the Temperature:

Meat products need to be stored at 5°C or colder to stay as fresh as possible. It needs to be monitored throughout the journey using a temperature measuring device that can be fitted into refrigerated freight, like a thermograph, an electronic data logger or a thermometer. To always get right readings, calibrate the device to an accuracy of $\pm 1^{\circ}\text{C}$.

If the journey will be short and it is transporting chilled meat products, store them in insulated and lidded containers so they stay cold. Remember, only precooled food can be kept in such containers. But if it is transporting frozen meat products, won’t need such containers. Just make sure they stay frozen throughout the journey.

Protect Meat Products from Contamination:

A lot of things can contaminate meat products during shipment if anybody is not careful. Good thing there are many ways to prevent this:

- Practice good personal hygiene—always wash hands before and after handling the meat products.
- Always wear clean clothing.
- Don’t handle the meat products if you’re sick.
- Cover any wounds you might have with waterproof bandages.
- Don’t smoke anywhere near the meat products.
- Immediately place chilled meat products in insulated and lidded containers.
- Keep the packaging intact.
- Keep ready-to-eat meat products and raw meat products separate.
- Separate, remove or discard contaminated or damaged meat products.
- Always check for pests or vermin.
- Don’t allow animals to go near the meat products or your refrigerated freight.
- Don’t keep chemicals near the meat products.
- Keep your refrigerated freight in good condition.
- Regularly check refrigerated freight for damages.
- If find any damages, have the refrigerated freight repaired right way.
- Make sure the inside of your refrigerated freight is sturdy, smooth, corrosion- resistant, nontoxic, doesn’t transfer odour or taste and can put up with repeated cleaning and sanitising.

Transportation of meat:

Meat should be transported in a correct manner, to make sure no contamination takes place nor bacteria can grow on the product. There are three types of meat products produced as a result of slaughter:

- fresh meat products
- processed meat products
- frozen meat products

The transportation of each of these products has different guidelines. Frozen meat products for example can be transported all over the world. Fresh meat products have a limited shelf life and therefore have to be in the supermarket within two days. Fresh meat products are therefore not transported long distances typically. Processed meat products can either be fresh or frozen. With this being said, trucks are therefore the most common transportation method, especially concerning fresh meats.

Fresh meat products are transported with trucks from the slaughterhouse to the retailers and the super market. If a product is processed, the meat is transported from the slaughterhouse to the meat processing manufacturer and then to retailers and super markets.

To guarantee a healthy fresh product, the time of transportation from producer to consumer must be as short as possible. Not only time is important to guarantee a fresh product.

The following actions are further taken to ensure food safety during the transportation of fresh meat products:

- Before transportation poultry meat should be and kept at temperatures below 4°C or 40°F.
- The meat and meat products should be packaged and checked for leakers, temperature, packaging, etc. before transportation.
- Meat is put in packages, boxes or crates when transported.
- Human contact should be limited with the products.

When transporting the meat once it has been taken home from the grocery store, depending on the travel time make sure the product is frozen. This will ensure its freshness for longer and will keep the product from reaching above 40° F. Wrap the product in newspaper as an insulator, place the meat in a cooler, wrap the cooler in blanket covering all cracks to keep the product as cold as possible and preventing spoilage and bacterial growth.

Preservation/Storage of Milk:

Milk is almost sterile when secreted from a healthy udder. The natural inhibitors in milk (e.g., lactoferrin and lactoperoxidase) prevent significant rises in bacterial numbers for the first three to four hours after milking, at ambient temperatures. Cooling to 4 °C within this period maintains the original quality of the milk and is the method of choice for ensuring good-quality milk for

processing and consumption. Cooling can be achieved by mechanical refrigeration or cooling tanks. Cooling facilities are expensive for small-scale producers in developing countries and can usually be afforded by only large-scale dairy enterprises. However, in areas with high concentrations of small-scale dairy operations, milk cooling centres can represent a valid solution for cooperatives of small-scale producers.

In some parts of developing countries, refrigeration is not feasible because of the high initial investment and running costs and technical problems, including the lack or unreliability of an electricity supply. Options for lowering temperature and/or retarding the growth of spoilage organisms include boiling the milk immediately after milking, partially immersing the milk containers in cool water (e.g., streams), and using the lactoperoxidase system. This last option is a Codex Alimentarius-approved safe and natural system of raw milk preservation. Lactoperoxidase is an enzyme that is found naturally in milk and that acts as a natural antibacterial agent. It is recommended that only trained people at collection points use the lactoperoxidase system; it is not intended for use by milk producers and should not replace pasteurization. The lactoperoxidase system of milk preservation extends the shelf-life of raw milk by seven to eight hours at 30 °C.

When the milk can be cooled to between 15 and 20 °C, the lactoperoxidase system allows overnight preservation of the evening milk, and thus the collection of milk only once per day, which reduces milk losses related to collection logistics and collection costs.

Pasteurization:

Pasteurization is a process of heating a food, which is usually a liquid(milk), to a specific temperature for a predefined length of time and then immediately cooling it after it is removed from the heat. This process slows spoilage caused by microbial growth in the food.

Methods of Pasteurization:

- 1) High Temperature, Short Time (HTST method)
- 2) Ultra High Temperature Pasteurization (UHT method)
- 3) Vat Pasteurization

1) The HTST pasteurization standard was designed to achieve a five-log reduction, killing 99.999% of the number of viable micro-organisms in milk. This method requires that the milk be held at 161 degrees for 16 seconds. This process, also referred to as continuous flow pasteurization, requires the milk to be forced through metal pipes that are heated from the outside.

2) The UHT produces a product that has a stable shelf life of up to two months. UHT processing holds the milk at a temperature of 138°C (280°F) for a minimum of two seconds.

3) The Vat Pasteurization is the most gentle type of pasteurization. The milk is held in a heated vat at 145 degrees for 30 minutes. It is then quickly cooled to 39 degrees.

Transportation of Milk:

Milk being perishable commodity, it becomes necessary to transport the fresh raw milk to the consumer or the chilling/processing plant within 4 hours of its production. Thus, transportation becomes an integral part of milk collection system. An efficient and suitable facility is selected on the basis of the raw milk collection as well as regional requirements.

Milk can be transported in milk cans or bulk tankers, which should be suitable for effective cleaning and sanitization. Generally, milk from small-scale milk producers is transported in milk cans by the producers themselves or by milk collectors (informal traders and intermediaries). Milk collectors usually collect milk cans from several producers and then transport them – by bicycle, animal, vehicle or foot – to local/urban markets, family shops, stands, canteens or small-scale processing plants. Milk in cans is uncooled or barely cooled, so the duration of transport is of primary importance in ensuring the delivery of good-quality milk. An advantage of using milk cans is that the milk from different producers is not mixed, avoiding the risk of spoiling good milk with low-quality batches. The milk produced in large-scale commercial dairy operations is usually transported in bulk tankers. As milk tankers are insulated, the milk is still cool when it arrives at its destination and unlikely to turn sour before reaching a distant processing plant or market.

Methods of milk transport:

Generally following methods are being used in dairy industry:

Head load: Generally, producers carry milk on their head to nearby collection/chilling/processing point. This is being practiced in villages to carry small quantity (3 to 25 litres) of milk for short distances (3-8 km) to the collection point, specially in hilly areas where there is no development of road.

i) Shoulder sling: Use is restricted to hilly areas or other areas where no other means of transport is easily available. When the milk is slightly more (20 to 40 liters) and conveniently cannot be carried on head, for little more distance (5 to 10 Km), this method is practiced.

ii) Bicycles: Bicycles are commonly and conveniently used to carry milk to the collection centres, pick-up points and chilling/processing points. It is also used to carry milk in unorganized sector by middlemen/agents/vendors to sell milk in the accessible urban area. It is faster, more convenient and easily accessible to milk producers/consumers home. About 40 litres (l) of milk for a distance of about 10-15 Km can easily be transported.

iii) Motor Cycle: Still heavier duty than bicycle can be taken to cover more than 15 Km and carry more than 100Kg of milk in very short time. Tricycle or cycle rickshaw: It can carry more load than cycle.

iv) Auto rickshaw: It can carry more load than cycle, rickshaw/motor cycle.

v) Boat: Boat is used to cross-river. Normally, small boats carry about 200 l of milk for short distances.

vi) Motor trucks: Motor trucks carry milk in cans and bulk tanks to a load of 0.5 to 3.5 tons for more than 100 Km. With the improvement in road facilities and construction of all season roads, motor trucks have been found most effective means of transportation.

vii) Railway wagon: Railway wagons are most dependable and economical for long distance but less popular means of milk transportation. Railway wagon can carry 10 to 12 tons of load for more than 100 Km.

viii) Road tanker: Insulated stainless steel tanks are mounted on road truck chassis for bulk handling (3000 – 12000 l) and for long distance (100 to 1000 Km.) transportation. The tanker may be divided into 2 to 3 equal capacity compartments with separate outlets.

ix) Rail tanker: Insulated and/or refrigerated stainless steel tanks are mounted on rail truck/chassis of the capacity in the range of 10,000 to 50,000 l to transport milk for a long distance 500 to 3000 Km or more.

The extent, structure, distance of the collection area and form of collection, determine the selection of mode of transportation.

Preservation/Storage of Eggs:

The storage of shell eggs during the main laying season, in order to conserve them for consumption when they are scarce, has been practised for many centuries.

For the successful storage of eggs, the following conditions must be met.

- The eggs placed in storage must be clean; they must not be washed or wet.
- Packaging material used should be new, clean and odourless.
- Loss of water due to evaporation should be reduced to a minimum.
- The storage room must be free from tainting products and materials and should be cleaned regularly with odourless detergent sanitizers.
- The storage room must be kept at a constant temperature and humidity must be checked.
- There should be air circulation in the storage room.
- Eggs should be stored so that they are allowed to breathe.
- As far as possible, interior quality should be monitored; there should be a good proportion of thick white, the yolk should stand up well, and the flavour of white and yolk should be good.

Cold storage of eggs:

In the tropics, eggs can deteriorate very quickly unless they are stored at low temperatures. The ideal temperature for storage in such climates is 13°C or lower (usually between 10° and 13° C). Here refrigeration is a necessity for successful commercial storage; however, it may be unavailable or the costs too high. The most important factors in successful cold storage are as follows:

- The selection and packaging of eggs.
- The equipment and preparation of the cold store.
- Proper temperature, humidity and air circulation.
- Periodic testing for quality.
- The gradual adjustment of eggs to higher temperatures when removed from storage.

Transport of Eggs:

For the successful transport of shell eggs three essential requirements must be met.

1. The containers and packaging materials must be such that the eggs are well protected against mechanical damage.
2. Care should be taken at all stages of handling and transport. Workers handling eggs should be instructed so that they appreciate the need for careful handling. The provision of convenient loading platforms at packing stations, loading depots and raiing stations, and handling aids, such as hand trucks and lifts, are of great help.
3. The eggs must be protected at all times against exposure to temperatures that cause deterioration in quality as well as contamination, especially tainting.

The permissible range of temperatures during loading and transport depends on the local climatic conditions and the duration of the journey. Table below shows recommended temperatures for transport and loading.

Care is needed to avoid excessive shaking, especially where roads are bad. Egg containers should be stacked tightly and tied down securely to minimize movement. Covers should be used to protect them from the heat of the sun, rain and extreme cold where applicable. Where bicycles are used, a device such as a special carrier suspended on springs may be helpful.

Recommended temperatures for loading and transport:

Loading & transport	Transport over 2 or 3 days	Transport over 5 or 6 days
Maximum on loading	+6° C	+3° C
Recommended for transport	-1° to + 3° C	-1° to + 1° C
Acceptable for transport	1° to + 6° C	1° to + 3° C

A basic prerequisite for all long-distance transport is that arrangements be made for proper reception, handling and storage at the end of the journey. This is especially important where large lots are delivered to a relatively small market. Without access to suitable storage facilities, the eggs may have to be marketed quickly under adverse climatic conditions, which may cause substantial quality deterioration and price losses.

Delivery of high quality eggs over long distances, especially in hot climates, generally calls for refrigeration. Requirements for the successful operation of refrigerated transport equipment are rather rigid especially as regards the following factors:

- Efficiency and durability of insulation;
- Adequacy and reliability of the cooling mechanism; and
- Adequate circulation of air within the vehicle or container so that variations of temperature are slight.

Topic-12: Role of disease prevention & control of livestock for ensuring food safety

Background:

Food safety has emerged as an important global issue due to international trade and public health implications. Despite advances in hygiene, consumer's knowledge, food treatment and processing, food borne diseases still represent a significant threat to public health, worldwide. The term food borne diseases (frequently referred as food poisoning) covers illness acquired through consumption of contaminated food and includes foodborne intoxication, foodborne infections. Globally, WHO estimated approximately 3-5 billion episodes of diarrhoea and more than 1.8 billion death in children under 5 years of age where significant proportion of resulted due to consumption of animal origin food contaminated with pathogens or toxins. In underdeveloped and developing countries food borne pathogens as well as food safety issues are neglected issues. But with the time and economic development consumers concern regarding food safety has been increased.

The potential impact of animal diseases on food safety:

Public concerns over food safety are heightened during outbreaks of any disease in food-producing animals. Some of these diseases, however, have few or no implications for the human food chain. Others may carry a potential risk of foodborne transmission, but their impact on human health can be minimized through a combination of animal health control measures and food hygiene practices.

A range of infectious agents or pathogens may be involved, including bacteria, viruses, toxins, parasites and other unconventional agents, such as the prion protein that is thought to be responsible for bovine spongiform encephalopathy (BSE) in cattle. Although humans may acquire zoonoses through a number of different routes, infections that are transmitted in food and water are of particular concern, and are an important cause of illness in both developing and developed countries.

Monitoring animal health and preventing animal disease outbreaks is vital to the economy and safety of the country's food supply. Production of healthy livestock helps to ensure a safe food supply and keep consumer prices stable. Animal disease outbreaks can cost the country millions of dollars due to animal slaughters, trade halts, and subsequent disease eradication efforts.

The impact of unsafe food costs low- and middle-income countries economics about US\$110 billion in lost productivity and medical expenses each year (WB).

Animal diseases with human health implications can adversely impact public health, global trade, and the stability of the agricultural segment of the economy. Healthy animals are more likely to result in:

- Safer food supplies.
- Higher farm productivity (including increased numbers of offspring).
- Reduced environmental impacts.
- Reduced use of antibiotics.
- Improved animal well-being.

Food contamination with pathogens:

Food may be contaminated with pathogens in a number of ways. If an animal is affected by a particular disease, tissues from the animal, including its meat or milk, are a potential source of human infection if allowed to enter the food chain.

More commonly, however, animals can be infected with zoonotic pathogens but show little or no signs of clinical disease. These 'carrier' animals are more difficult to detect either on the farm or at the slaughterhouse, so eradication is more of a problem. Many of these organisms live in the intestinal tract of healthy animals and can spread to humans through faecal contamination of the environment or of products such as milk during milking or eggs during laying. In addition, small amounts of intestinal contents may contaminate the carcass after slaughter and be present on raw meat.

Cross-contamination of other foods can occur if they come into contact with a contaminated product either directly, during storage or preparation, or indirectly via humans, work surfaces, utensils or other objects.

Major Foodborne Pathogens:

Bacteria	<i>Campylobacter, Salmonella, Listeria, Pathogenic Escherichia coli (E. coli), Yersinia</i>
Bacterial toxins	Toxins of <i>Staphylococcus aureus, Clostridium perfringens, Clostridium botulinum</i> and <i>Bacillus cereus</i>
Viruses	<i>Calicivirus</i> (including norovirus), <i>rotavirus</i> , hepatitis A virus, hepatitis E virus
Parasites	<i>Trichinella, Toxoplasma, Cryptosporidium, Giardia</i>

Some other pathogens that are important cause of zoonotic foodborne illness are shown in figure below;

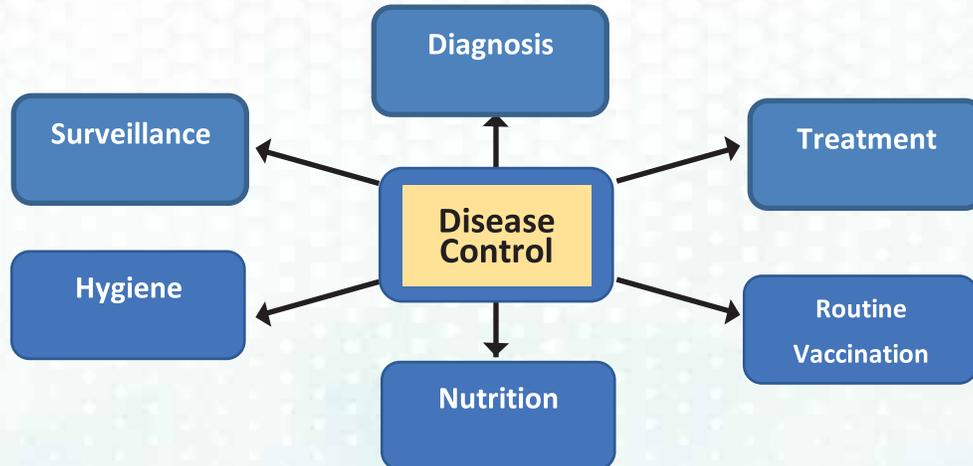
OTHER PATHOGENS

<u>DISEASE</u>	<u>PATHOGEN</u>
Anthrax	Bacillus anthrax
Diphtheria	Corynebacterium diphtheriae
Tuberculosis	Microbacterium tuberculosis
Scarlet/Rheumatic fever-	Streptococcus pyogenes
Cholera	Vibrio cholerae
Gonorrhoea	Neisseria gonorrhoea
Plaque	Yersinia pestis

Control measures:

In developed countries, potential risks associated with foodborne pathogens are minimised through stringent animal health control measures. These are aimed at eradication of zoonotic diseases within the animal population and at ensuring food safety through the prevention of contamination at all stages of the food supply chain.

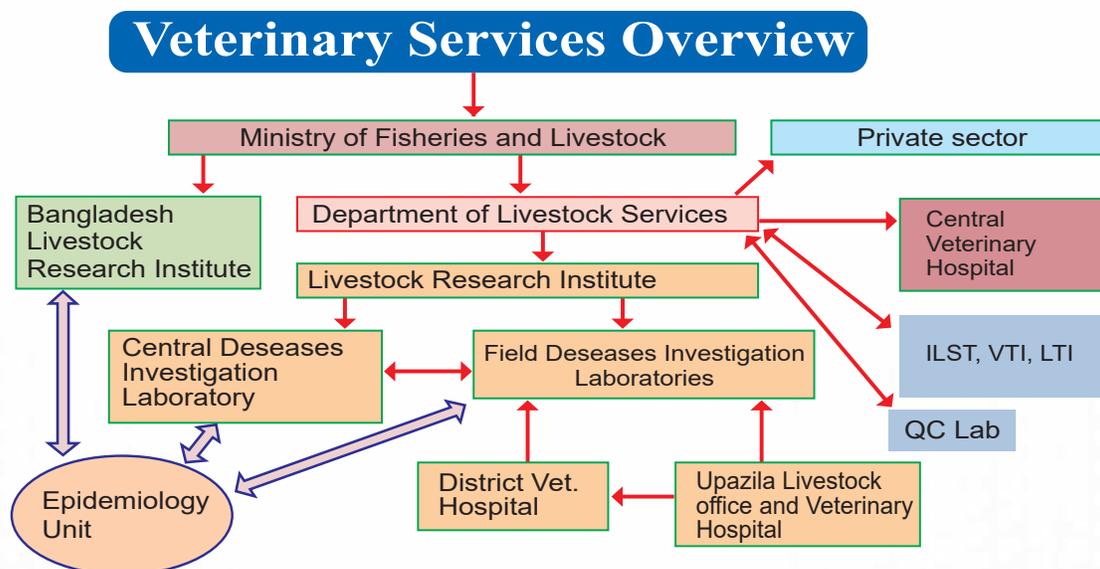
Measures to preventing and controlling animal diseases:



Disease control Activities:

Department of livestock Services has a setup of veterinary services up to the sub-district level for Disease diagnosis, surveillance, risk analysis, control strategy development and implementation of disease control strategy to control animal disease that contributes in food safety. The Veterinary services are shown in figure below;

The Veterinary services are shown in figure below;



Disease control activities at farm level:

- Play a key role in ensuring that animals are kept under hygienic conditions;
- Early detection of diseases;
- Surveillance and treatment of animal diseases, including conditions of public health significance;
- Provide livestock producers with information, advice and training on-how to avoid, eliminate or control food safety hazards e.g. drug and pesticide residues, mycotoxins, environmental contaminants, in primary production, including through animal feed. Producers' organizations, particularly those with veterinary advisors, can provide awareness and training as they are in regular contact with farmers and understand their priorities;
- Aware producer on biosecurity;
- Veterinary Services plays a central role in ensuring the responsible and prudent use of biological products and veterinary drugs, including antimicrobials, in animal husbandry. This helps to reduce the risk of developing antimicrobial resistance and unsafe levels of veterinary drug residues in foods of animal origin;
- Conduct disease investigations for emerging and re-emerging trans boundary diseases that may pose threat to food safety;
- Conducts surveillance for antimicrobial resistant organisms;
- Vaccination for the prevention of animal and poultry diseases that contributes in food safety. Department of livestock services produces 17 types of Bacterial and Viral vaccines, distribute to the sub-district where vaccination is conferred to the animals and poultry to control diseases. Furthermore, DLS also give NOC for vaccine import in Bangladesh. Based on this NOC the Drug administration of Bangladesh permit the import of necessary vaccines of animal uses. In Bangladesh there are systemic vaccination, routine vaccination and emergency ring vaccination. Vaccination has proved its capacity to help prevent, control and eradicate several diseases in addition to or as alternative to stamping-out policy. It reduces the chance of spreading of diseases of different types including food borne pathogens. For some vaccines, DLS conduct vaccine matching and efficacy testing through vaccination

monitoring, efficacy trial and immunogenicity study with the help of Disease investigation lab, research institute and academic institutes;

- Veterinary services also provide training and education for the veterinarians, paraprofessionals, producers on disease control;
- Although the livestock rearing in Bangladesh is complex in nature, mostly small-scale farming, DLS is trying to develop animal tracing mechanisms with the help of Livestock and Dairy development project. This will help to trace animal movement, movement of products of animal origin and will contribute in withdraw of animal products, if there is any foodborne disease outbreak;

Activities at processing site:

- Meat inspection at slaughter houses with a view to control and/or reduction of biological hazards of animal and public health concern by ante- and post-mortem meat inspection which is a core responsibility of the Veterinary Services;
- Conduct meat inspection in slaughter houses at central level, municipality level, district level and also at sub-district level for the control of biological hazards of animal and public health importance through ante- and post-mortem meat inspection. Although the slaughter system in Bangladesh is not organized enough, DLS is trying to develop an organized systems for slaughter with help from different agencies and development projects;
- Train manpower involved in slaughter and processing of animal and poultry originated food;
- Providing certification of products for international trade using laboratory link, especially the Central Disease Investigation laboratory and QC lab. of the DLS;
- Providing health certification to international trading partners attesting that exported products meet both animal health and food safety standards is another important role of the Veterinary Services;
- Certification in relation to animal diseases, including zoonoses, and meat hygiene;

Role of Animal vaccination in Food safety:

Veterinary vaccines are important for animal health, animal welfare, food production, and public health. They are a cost-effective method to prevent animal disease, enhance the efficiency of food production, and reduce or prevent transmission of zoonotic and foodborne infections to people. Safe and effective animal vaccines are essential to modern society. Animal vaccines plays a key role in protecting animal health and contribute to public health through a safer food supply. They also help to reduce the need for antibiotics by preventing diseases that might otherwise require antibiotic treatment.

The use of vaccinations over the last century has prevented death and disease in millions of animals. An example of a vaccine victory on the animal health side occurred in 2011. The World Organization for Animal Health (OIE) declared an ancient and deadly disease among cattle (rinderpest, also known as “cattle plague”) officially eradicated throughout the world thanks primarily to vaccinations.

Vaccines support an animal's immune system. At best, a vaccine prevents an animal from getting a particular disease. At a minimum, it lessens the impact of the disease. In any case, vaccinations help to keep animals healthy and food safe. How do they impact the safety of food? Vaccines, for example, may decrease the incidence of salmonella in chickens, which can make the eggs we eat safer, and contribute to a safer food supply.

Vaccines can also help reduce the need for antibiotics by preventing diseases that might otherwise require antibiotic treatment. A shared goal throughout the agricultural community is to reduce the need for antibiotics, while ensuring they are available when needed to responsibly address animal suffering. Vaccines help to achieve this goal. Preventing sickness or lessening its impact on animals by administering vaccines is the ethical thing to do. In essence, vaccines are an important tool to improve animal health, and they contribute to food safety.

Importance of livestock vaccines:

livestock vaccines are used in livestock and poultry to maintain animal health and to improve overall production. More efficient animal production and better access to high-quality protein are essential to feed the growing population.

Vaccines as alternatives to antibiotics:

A variety of studies have demonstrated that the use of various bacterial as well as viral vaccines in animal populations can result in a significant reduction in antibiotic consumption. The use of vaccines has also reduced the need for antimicrobial use in commercial poultry production.

Topic-13: Feed & Foods sample Collection and Transportation for quality test

Introduction:

A systematic approach to sample collection is one of the facet of the laboratory testing program. The condition and adequacy of sample is prime need for proper analysis. If the samples are not collected properly the laboratory test result will be meaningless. A sampling protocol should be clearly defined.

Why Sampling is done:

- To obtain a representative sample of the whole feed/food lot.
- For result accuracy and appropriate interpretation of laboratory analyses.

Major Sources of errors in sampling

Sources	Examples	Precaution
Food sample identification	Poor labelling of samples	Maintenance of documentation throughout sampling and analytical process
Nature of sample	Samples do not conform to the sampling protocol	Explicit instructions I sampling protocol, training of sample staff
Transport and handling	Samples contaminated or degraded during transport	Protocol specifies condition to be maintained, supervision
Analytical sample preparation	Incorrect mixing or homogenization	Proper supervision in laboratory quality assurance
Analytical sample storage	Incorrect storage of samples	Proper laboratory techniques and supervision

General Consideration during sample collection:

- Sample should be collected aseptically (using sterile technique).
- Avoid contamination from lot to lot or environment.
- The sampling equipment and sample containing container or bags should be clean, dry and free from microbial/ chemical contamination/ foreign odors.
- Use containers that are clean, dry, leak-proof, wide mouthed, sterile, and of a size suitable for samples of the product
- During shipment of the sample filled submission form should be sent.
- Samples should be transported to the laboratory as early as possible with the original conditions maintained as nearly as possible.
- During transportation proper temperature should be maintained.
- Sample containers should be checked for integrity (broken, leaking, etc.) before sending and after receiving the sample.
- Sample bags prior to sampling should be labelled.
- After sampling, squeeze excess air from bags prior to sealing to reduce shipping volume. 123

Collection of Sample:

The samples should be collected in a random manner, whenever possible during the loading or unloading of the lot. The composition and nature of each lot affects the homogeneity and uniformity of the total sample mass. The proper statistical sampling procedure, according to whether the food is solid, semisolid, viscous, or liquid, must be determined. The number of units that comprise a representative sample from a designated lot of a food product must be statistically significant. It would be relevant to have at least 5 to 8 samples randomly picked up for reconfirmation and have some statistical inferences.

Sample should be collected in sterile sampling equipment like stainless steel spoon, forceps, spatulas, scissors as well as sampling personnel should use sterile gloves, sealed sterilized bags, cans, and jars (wherever microbiological tests are applicable).

In case of collecting liquid sample an additional sample should be taken as a temperature control. Dry and canned food are collected in ambient temperature and frozen foods in a pre-chilled container.

Sample description, sample collecting time, date, place, and temperature of the sample at the time of collection, reasons for testing should be recorded.

Handling of sample:

Proper handling is needed to protect the sample from changes in composition and contamination. Handle all samples as if they are infectious.

Sample Size and selection of sample:

Sample selection and sample size vary depending on the product, the required analysis and the lab methodology.

Labelling of Samples

Each sample should be individually labelled and include at least the following information:

- Date of sample collection
- ID number, name and type of the sample that is linked to the submission form.
- Name of preservatives.

Preservation of Sample:

Appropriate preservatives should be used according to the type of sample and the required test (microbial test or analytical test). If the samples are not properly preserved the analytical/ microbial test results may be inaccurate due to loss by volatilization and/or degradation.

Packaging and shipment:

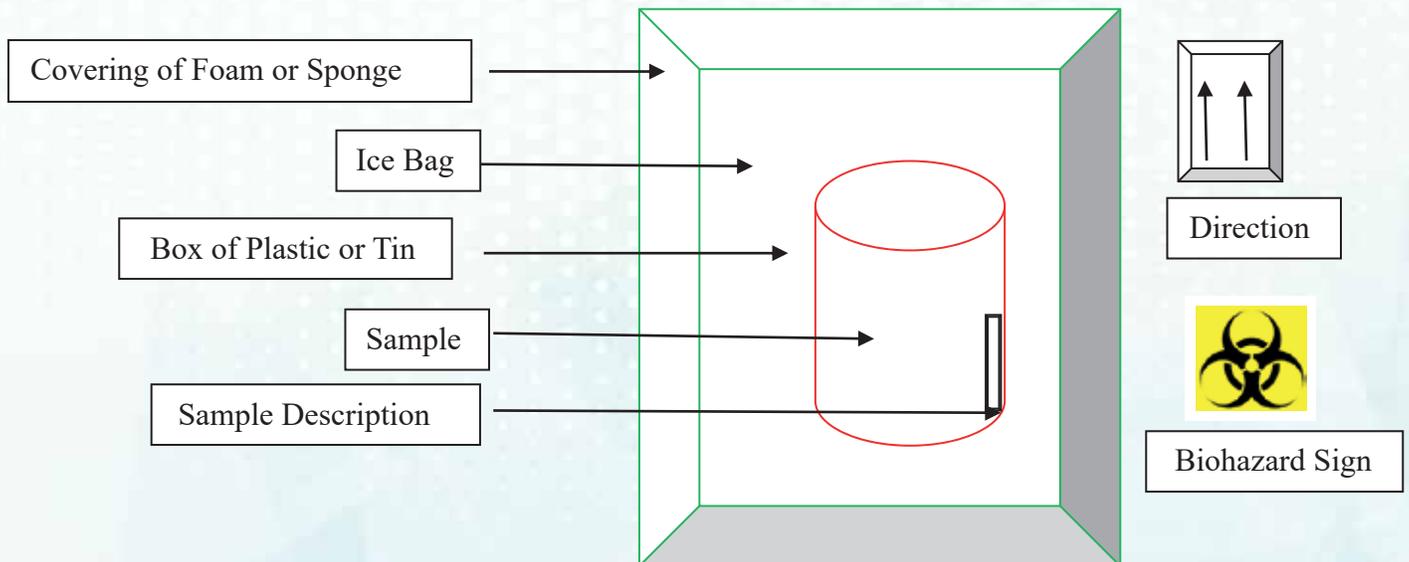
Inspector or collecting official/analyst/stakeholder is responsible for the packaging and shipment of a sample. Samples must be packaged and shipped in a way which maintains their integrity. The container containing sample can be placed in a plastic bag and sealed with a lead seal or metal clasp. In case of rigid containers such as glass jars should be sealed with sealing wax.

For the shipment of perishable samples under refrigeration, either wet ice or a commercial "Ice Gel" pack may be used. If there is a chance of container ruptures during shipment. Insulated containers or chests should be used. Upon arrival the temperature should be observed and recorded. The container should be marked as "Perishable frozen Product" and shipped the same day of collection. Frozen and refrigerated food product should be transported in ice at 0-4°C in an insulated container of rigid construction with a tight-fitting cover to keep them unchanged until arrival at the laboratory.

Dry, non-perishable samples should be packed in a sturdy cardboard box with appropriate packing material to prevent breakage during shipment. Shipment of non-perishable products do not need refrigeration.

Samples of fresh meat: Samples of fresh meat must be packed in such a manner as to maintain the sample temperature between 0 and 5°C during transport to the laboratory. Samples should be dispatched on the day of collection and analysis commenced on the day following collection and no later than on the second day following collection

Samples of frozen meat: Frozen meat samples should be maintained frozen for up to 7-days after collection. Held frozen during transport or transported at 0-5°C to allow thawing during transportation. Frozen samples must not be re-frozen once thawed or transported at 0-5°C.



Sample storage and disposal:

Between the time of arrival at the laboratory and initiation of analysis, refrigerated unfrozen perishable samples must be maintained between 0 and 4 °C, and frozen food must be kept frozen. All perishable and frozen samples should be examined within 36 hours of collection. Perishable samples that cannot be examined within 36 hours after being sampled should be frozen. However, freezing refrigerated microbiology samples may cause microbial cell injury and even death. Thus, this practice should be performed only as a last resort and not routinely.

Refrigerated unfrozen perishable sample should be examined within 6 hours after collection. Samples held at 0-4 °C for more than 24 hours should not be examined. Canned or dry, nonperishable foods may be stored at room temperature before analysis.

After the test portions have been removed from the sample, the rest of the sample should be returned to storage. Samples should be stored depending upon their type.

Reserve portions of microbiology samples containing pathogenic microorganisms and/or microbial toxins should be stored with special precaution and should be autoclaved before disposal.

Effects of sample storage and preparation on nutrient content and precautions required to minimize them

Effects	Potential Changes	Nutrients Affected	Precaution
Drying out	Loss of water	All nutrients	Design of protocol, Keep samples sealed, weigh food at start and during preservation
Absorption	Gain of water	All nutrients	Design of protocol, keep samples in sealed container
Microbial activity	Degradation/ autolysis/ synthesis	Loss of CHO, proteins, gain in thiamin, Vit B6	Storage at low temperature, pasteurization or addition of inhibitors
Oxidation	Destruction of unsaturated fatty acids, loss of vitamins	Alterations in profile of fats	Store at -30C in sealed containers under nitrogen. Add antioxidants, bacteriostatic agents
Acid	Hydrolysis	Loss of sucrose and higher oligosaccharides	Store at low temperatures Neutralize acids
Alkaline	Destruction	Loss of thiamine	Avoid alkaline conditions and SO ₂
Light	Photo degradation	Loss of riboflavin	Protect from light
Contamination during sampling	From cooking vessels, soil, dust	Increase inorganic nutrients	Design protocol to minimize contamination, gently rinse with distilled water
Contamination from metallic blades, glassware	Increase in inorganic nutrients	Increase in major trace elements	Select apparatus with care Clean all utensils Store in plastic bags
Separation	Separation of fats	Changes in compositional Alteration in fiber content	Avoid over vigorous mixing and thaw/freeze cycles

Sample Acceptability and rejection:

Samples received after holding times have expired, in inappropriate containers or lacking appropriate preservatives and lack of information according to the laboratory demand should not be accepted for testing. When all information/ criteria is fulfilled then the sample will be accepted for further processing.

When rejecting a sample, it is important to:

- Promptly inform the authorized person that the sample is unsuitable for testing.
- Request another sample that should be maintained proper procedures.

Sample register:

The laboratory should keep a register (log) of all incoming samples.

- Date and time of collection
- Date and time the sample was received in the laboratory
- Sample type
- Address of the owner who sent the sample
- Laboratory assigned identification
- Tests to be performed.

Type of sample for Quality control Laboratory:

- Livestock feed and ingredients.
- Livestock inputs (Vitamins, minerals, premix)
- Animal originated food and its food products (meat, milk, egg and their product etc.)