Swa Education

HAND BOOK
of
FOOD SAFETY OFFICER
(MADHYA PRADESH)
VOLUME- I

HANDBOOK
Of
FOOD SAFETY
OFFICER
(Madhya Pradesh)

Preface

*I am pleased to launch 1st edition of "**Handbook of Food safety Officer Vol. 01**". This book has been developed keep in mind the Food Safety officer and food related Exams.*

*This book has been thoughtfully developed with the needs of future Food Safety Officers in mind. It is especially designed to assist candidates preparing for the **State Food Safety Officer examination in Madhya Pradesh**, offering focused content aligned with the examination pattern and syllabus.*

*The handbook encompasses a wide range of essential topics, including **Basic Food Science, Food and Nutrition, Food Preservation, Packaging and Storage, Indian Farming Systems**, and **Food Processing Technology**. These subjects are critical for building a strong foundation and understanding of food safety standards, practices, and technologies.*

Food Safety Officers play a pivotal role as frontline guardians of public health, ensuring that food businesses comply with safety regulations and that consumers have access to safe and wholesome food. This book aims to empower aspirants with the knowledge and confidence required to take on this important responsibility.

It is my hope that this handbook proves to be a valuable companion in your journey towards becoming a skilled and responsible Food Safety Officer.

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Chapter 01

History of Food and Its Preservation

HISTORY OF FOOD

Historical Perspective of Food

a) Prehistoric Era:

- Early humans relied on hunting, fishing, and gathering.
- **Tools:** Stone tools for hunting and basic food preparation.
- **Diet:** Raw fruits, nuts, roots, and animal meat.
- Discovery of fire (~1.7 million years ago) led to the cooking of food, improving safety, digestibility, and flavour.

b) Agricultural Revolution (10,000 BCE):

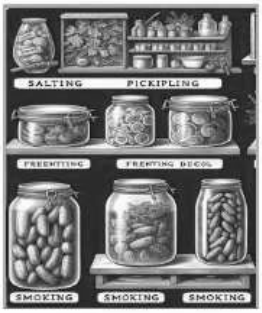
- Shift from nomadic to settled lifestyles.
- Development of farming practices (cultivation of wheat, barley, rice, etc.).
- Domestication of animals (e.g., cattle, goats, pigs).
- Surplus food production enabled the growth of civilizations.

c) Ancient Civilizations:

- **Egyptians:** Use of salt for meat and fish preservation; fermentation (bread, beer).
- **Mesopotamians:** Storage of grains in granaries; use of honey as a natural preservative.
- **Chinese:** Development of fermentation techniques (soy sauce, wine).
- **Indians:** Use of spices like turmeric and salt for preservation and flavouring.

d) Medieval Period:

- Use of drying, salting, smoking, and pickling to preserve meat and fish.
- Monasteries became hubs for the development of fermentation (e.g., cheese, beer, wine).
- Trade routes introduced new preservation techniques like sugar-based preservation (jam and candied fruits).



e) **Early Drying Techniques:** Grains and nuts were dried using sunlight and air.

- By the late 1700s, mechanical drying methods were developed.
- Dried foods gained popularity due to their compactness, light weight nature, and extended shelf life.

i. **Cheese-making:** This method for prolonging milk's shelf life was an accidental discovery but became widely adopted.

ii. **Canning:** Nicolas Appert, a French confectioner, pioneered the canning process in the 1809 by applying heat to food in sealed glass bottles, preventing deterioration.

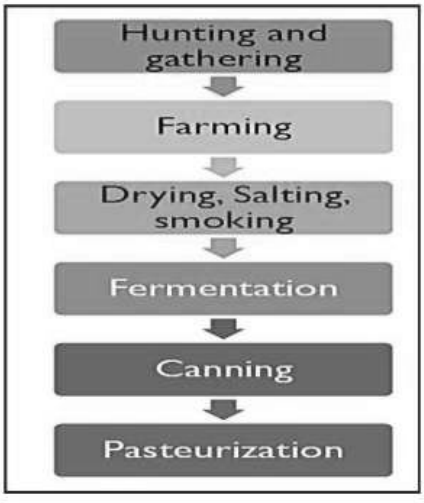
- ❖ This discovery was in centivized by NapoleonI, who awarded Appert 12,000 Francs forits potential to supply food to distant military forces.
- ❖ Appert's methods were tested successfully by the French Navy, preserving foods like meat, vegetables, fruits, and milk.

iii. **Pasteur's Contributions:** Before 1860, food spoilage was attributed to spontaneous generation.

- ❖ Louis Pasteur demonstrated that microorganisms (ferments, molds, and forms of putrefaction) were the primary causes of spoilage.
- ❖ He established that food preservation relies on creating condition sun favourable for microbial growth.

Evolution of Food Processing

- **8000-7000 B.C.:** The transition from hunting and gathering to farming, with crops and livestock as primary food sources.
- **4000 B.C.:** Development of preservation techniques such as salting, smoking, drying, and usings now and ice to store food.
- **3000 B.C.:** Use of yeast to produce alcoholic beverages via fermentation.
- **200 A.D.:** Fermentation processes expanded to include the production of yogurt using bacteria.
- **1809:** Nicolas Appert's discovery of food preservation in sealed containers laid the foundation for the canning industry.
- 1864 Louis Pasteur's invention of pasteurization to kill harmful microbes in wine and beer
- 1920s Clarence Birdseye introduced the quick-freezing method, revolutionizing food storage and quality preservation.



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Chapter 03

Role of Food Fortification

What is Food Fortification

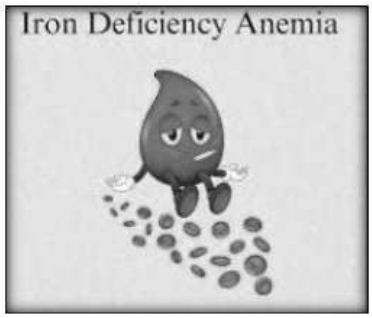
- Food fortification is the process of adding essential vitamins and minerals, such as Iron, Iodine, Zinc, and Vitamins A & D, to staple foods like rice, wheat, oil, milk, and salt to enhance their nutritional value.

Why is Food Fortification Needed?

- Micronutrient deficiencies, often referred to as **"hidden hunger,"** pose significant health risks. The lack of access to a balanced diet, dietary variety, or availability of nutritious food results in inadequate micronutrient intake.
- Additionally, food processing can lead to nutrient losses. Fortification serves as an effective strategy to combat these issues alongside dietary diversification and supplementation.

Prevalence of Micronutrient Deficiencies in India

- India has a high burden of micronutrient deficiencies, particularly related to Vitamin A, Iodine, Iron, and Folic Acid. These can cause serious health conditions like Night Blindness, Goitre, Anaemia, and birth defects.
- According to the **National Family Health Survey (NFHS)**:
  - ❖ **58.4%** of children (6-59 months) are anaemic.
  - ❖ **53.1%** of women in the reproductive age group are anaemic.
  - ❖ **35.7%** of children under 5 years are underweight.
- Fortification is a globally recognized intervention to mitigate these widespread nutritional deficiencies.



Benefits of Food Fortification

- Food fortification presents a **cost-effective and impactful** solution to improve public health.
- The **Copenhagen Consensus** estimates that every **1 Rupee** spent on fortification yields **9 Rupees** in economic benefits.
- Though initial investments are required for equipment and vitamin/mineral premix, the overall cost of fortification remains minimal, with a price increase of only **1-2%**, which is **less than standard market fluctuations**.

Key Benefits of Food Fortification

Wide Reach & Impact

- Staple foods are commonly consumed by the majority of the population, making fortification an efficient method to enhance public health at scale.

Safe & Regulated

- The addition of micronutrients follows strict guidelines to ensure safety, staying well within **Recommended Daily Allowances (RDA)**.

Cost-Effective & Sustainable

- Fortification is an economical intervention that does not necessitate changes in dietary habits or consumption patterns.

Preserves Food Characteristics

- It does not alter the taste, aroma, or texture of the food, ensuring consumer acceptance.

FORTIFY HEALTH

Iodised Salt

- As per the directions dated **24th August 2018**, iodised salt when fortified with iodine is **exempted** from the mandatory requirement of using the **+F logo** for fortified foods under the **FSS Regulations 2018**.
- **Iodine fortification** is **mandatory** for **common salt** only.
- **Rock salt, pink salt, black salt**, etc., are **not required** to be mandatorily iodised.

Component	Level of nutrient	Source of nutrient
Iodine	15-30 ppm on dry weight basis	Potassium iodate

Iron and Iodine Fortified Salt

Double Fortified Salt (DFS)

- DFS formulations generally provide **100%** of the daily dietary iodine requirement and approximately **30-60%** of the daily dietary iron requirement.
- The dual fortification of salt with iodine and iron presents a **sustainable approach** to combat iodine and iron deficiencies.

Declaration

- People with **thalassemia** may take it under **medical supervision**.

Component	Level of nutrient	Source of nutrient
Iodine	15-30 ppm on dry weight basis	Potassium iodate
Iron	850-1100 ppm	Ferrous sulphate or ferrous fumarate

Fortified Atta & Maida

- Atta, when fortified, shall contain added Iron, Folic Acid, and Vitamin B-12 at the levels in given Tables:

Nutrients/Source	Level of nutrient per litre
Iron Ferrous citrate or Ferrous lactate or Ferrous sulphate or Ferric pyro phosphate or electrolytic iron or Ferrous fumarate or Ferrous Bis Glycinate;	28 mg-42.5 mg *
Or Sodium Iron (III) Ethylene diamine tetra Acetate Trihydrate (Sodium feredetate-Na Fe EDTA);	14 mg-21.25 mg
Folic acid	75 µg-125 µg
Vitamin B12-Cyanocobalamine or Hydroxy cobalamine;	0.75 µg-1.25 µg

In addition, atta may also be fortified with following micronutrients, singly or in combination, at the level in the table:

Nutrients/Source	Level of nutrient per kg
Zinc-Zinc Sulphate;	10 mg-15 mg
Vitamin A-Retinyl acetate or Retinyl Palmitate;	500 µg RE-750 µg RE
Thiamine (Vitamin B1)-Thiamine hydrochloride or Thiamine mononitrate;	1.25 mg-1.75 mg
Riboflavin (Vitamin B2)-Riboflavin or Riboflavin 5'-phosphate sodium;	0.75 µg-1.25 µg
Niacin (VitaminB3) -Nicotinamide or Nicotinic acid;	12.5 mg-20 mg
Pyridoxine (Vitamin B6)-Pyridoxine hydrochloride;	1.5 mg-2.5 mg

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Chapter 04 Aspects of Eat Right Challenges in India

Introduction

- The **Eat Right India (ERI)** movement has been launched by the **Food Safety and Standards Authority of India (FSSAI)** to protect the health of people and the planet by transforming the country's food ecosystem through a **systems approach**.
- It is based on three key themes:
  - **Eat Safe:** Ensuring **food safety** through stringent regulations and monitoring.
  - **Eat Healthy:** Promoting the consumption of **balanced and nutritious diets**.
  - **Eat Sustainable:** Encouraging **environmentally friendly food practices**.

  - This movement aligns with **preventive and promotive healthcare initiatives** like **Ayushman Bharat** and **POSHAN Abhiyaan**.
  - It integrates a **whole-of-government approach**, linking food-related mandates across various ministries (**Agriculture, Health, Environment**, etc.).
  - Additionally, it adopts a **whole-of-society approach**, engaging stakeholders including **consumers**, **community organizations**, and **academia**.
- **FSSAI's core regulatory functions focus on:**
  - **Strengthening food safety** through **science-based standards**.
  - **Enforcing compliance** through **risk-based inspections**, **audits**, and **surveillance**.

- **Enhancing food testing capacities** through **public-private partnerships**.
- **Promoting self-compliance** through **training and certification programs**.
- Despite its significance, several challenges hinder the effective implementation of the **Eat Right India (ERI)** movement in India. These challenges can be categorized into **policy**, **implementation**, **infrastructure**, **awareness**, **behavioural**, **economic**, and **environmental** aspects.

- **Night blindness:** It is attributed to the functional failure of the retina in the proper regeneration of visual purple (rhodopsin).
- **Xeropthalmia:** Vit A deficiency can lead to keratinization of the cornea, resulting in xeropthalmia. This is an important cause of blindness in poorly fed childrens in developing countries like India.
- **Xeroderma:** Vit A deficiency results in the skin becoming dry, scaly, and rough.

b. Vitamin D: Calciferol

- Vitamin D is represented by Ergocalciferol (Vit D 2) and Cholecalciferol (Vit D3)
- **Ergosterol:** It is a plant sterol. By the action of U.V. radiation ergosterol is converted into ergocalciferol (Vit D2).
- **7- dehydrocholesterol:** It is an animal sterol. By the action of U.V. radiation it is converted into Cholecalciferol (Vit D3).
- Vitamin D is remarkably stable and preparations of food containing it can be warmed or kept for long periods without its deterioration. Storage processing and cooking not affects it.

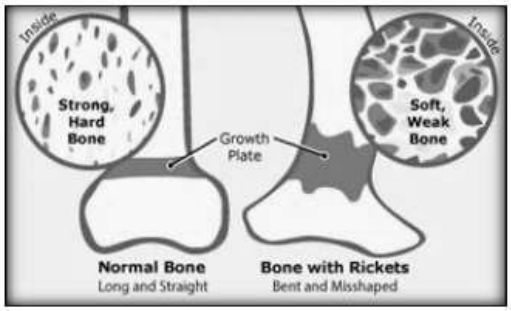
Functions

- Like other fat-soluble vitamins, Vitamin D can be stored in the body to a large extent.
- It promotes growth and **mineralization of the bones and teeth**.
- Vit D increases intestinal **absorption of calcium, phosphate transport** in intestine, maintains proper calcium and phosphorus levels in serum and increases the **reabsorption of calcium** by kidney.

Deficiency

- **Rickets:** the deficiency of Vitamin D in children during the period of active skeletal growth causes rickets, which results from the defective mineralization of the ends of growing bones.

  As a result the ends remain abnormally pliable and eventually assume a bent form resulting in bowlegs, enlargement of bones around the joints and narrow distorted chest with beading of the ribs.
- **Osteomalacia:** deficiency of Vit D in adults. Osteomalacia leads to defective mineralization. In this case there is decalcification of bone shafts and the tendency is for fractures rather than bending.



c. Vitamin E: Tocopherol

- It is the most widely available vitamin in common foods. Wheat germ oil is the richest source of the vitamin. It is also present in other cereals, green plants, egg yolk, milk fat, butter, meat, nuts and vegetable oils.
- **α-tocopherol** is the **most active form** of Vitamin E.

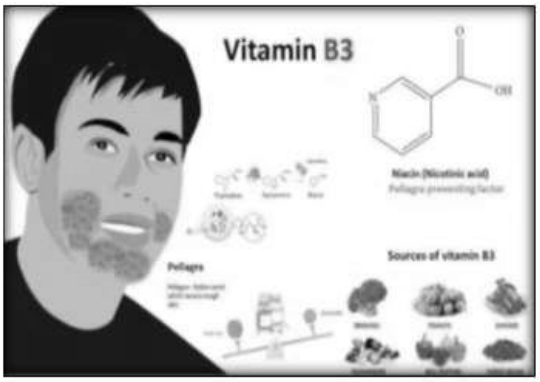
- Niacin can be synthesized by the bacteria of the intestinal flora and is formed in the tissues from the amino acid tryptophan, e.g. milk and egg, have a far greater niacin potency.
- Niacin is one of the most stable vitamins being relatively resistant to heat, light, acids and alkalis.

Functions:

- Form the active part of coenzymes that play an important part in biological oxidation.
- Nicotinamide is the component of two coenzymes- Nicotinamide adenine dinucleotide (NAD), and nicotinamide adenine dinucleotide phosphate (NADP).

Deficiency:

- Weakness, indigestion, ulcerated mouth and tongue.
- **Pellagra:** caused due to prolonged deficiency of niacin.
- This results in **Diarrhoea, dementia (depression) and dermatitis**. Skin lesions are aggravated by exposure to sunlight, neurological symptoms and mental changes occur in more advanced cases.



iv. Pantothenic acid: (Vitamin B5):

- It is widely distributed in foods and is particularly abundant in animal tissues, whole grain cereals and pulses. It also occurs in lesser amount in milk vegetables and fruits.
- It is reported to be synthesised by intestinal microflora.
- Pantothenic acid is more stable in solution than in the dry form.
- It is stable in pH range 4-7.
- It is decomposed by alkali and dry heat.
- It is stable in moist heat in neutral solutions.

Function

- Component of coenzyme A, which is involved in reactions which play important role in release of energy from carbohydrates and glucose synthesis.

Deficiency

- Burning feet syndrome: burning sensation and numbness in feet.
- Pain and sensation in arms and legs, loss of appetite, nausea, and indigestion.
- Pulse rise, fainting attacks, and increase in susceptibility to infection have also been observed.

- Symptoms of phosphorus deficiency may include:
- **Weakness and Fatigue:** Since phosphorus is involved in energy metabolism, a deficiency can lead to feelings of weakness and fatigue.
- **Loss of Appetite:** Phosphorus deficiency may result in a reduced appetite.
- **Bone and Joint Pain:** In severe cases, deficiency may contribute to bone and joint pain.
- **RDA:** 1000 mg/day

Sources

- Dairy Products, Meat and Poultry, Seafood, Eggs, Legumes, Nuts and Seeds, Whole Grains, Vegetables, Dried Fruits.

Magnesium

- **Energy Production:** Magnesium is a cofactor for enzymes involved in ATP (adenosine triphosphate) production, the primary energy currency of cells. It is essential for various metabolic reactions, including glycolysis and the Krebs cycle.
- **Muscle Function:** Magnesium is involved in muscle contraction and relaxation. It helps regulate the function of neuromuscular impulses and supports the proper functioning of muscles.
- **Nervous System Regulation:** Magnesium plays a role in **neurotransmitter release and helps regulate the excitability of neurons.** It contributes to the overall function of the nervous system.
- **RDA:** 385 mg/day

Mineral	Metabolism	Physiologic function	Clinical application	Food source
Sodium	Readily absorbed, excretion chiefly by kidney, controlled by aldosterone.	Major cation in extra cellular fluid, water and acid base balance, cell membrane permeability, absorption of glucose	Fatigue & weakness Headache, losses during diarrhea & excessive sweating.	NaCl, cheese, meat, spinach, celery, RDA: 2000 mg/day
Potassium	Readily absorbed secreted and reabsorbed in GI circulation, excretion chiefly by kidney	Major cation in intra cellular fluid, water and acid base balance, glycogen formation, protein synthesis.	Hypokalemia, muscle disorders, irregular hear beats.	Fruits, vegetables, legume, nuts, whole grain meat. RDA: 3500 mg/day
Chlorine	Readily absorbed excretion controlled by kidney	Major anion in extra cellular fluid, water and acid base balance, gastric HCl production.	Diarrhoea, vomiting, Hypochloremic alkalosis.	RDA 1800-2300 mg/day NaCl is source of chlorine
Sulphur	Elemental form absorbed as such, split from amino acid sources (methionine, and cystein in digestion and absorbed into portal circulation	Essential constituent of protein structure, enzyme activity and energy metabolism	Cysteine renal calculi, cystinuria	Meat, egg, milk, cheese, legumes, nuts, garlic, onion.

Success

Chapter 04 Programme of Nutrition and Health in India (MDMP, ICDS, National Food Security Mission)

MDMP: Introduction

- The **Mid-Day Meal Scheme** started on **August 15, 1995**, to help more children **go to school, attend regularly, and stay healthy** by giving them free food.
- In the beginning, children got **100 grams of food grains** each school day.
- In **2001**, the Supreme Court said the food should be **cooked** and provide at least **300 calories and 8–12 grams of protein** for children in **classes 1 to 5**.
- In **2008-09**, it was extended to **classes 1 to 8**.
- The scheme was renamed as the **National Programme of Mid-Day Meal**, also called the **Mid-Day Meal Scheme**.
- In **September 2021**, the scheme was update d and renamed as **Pradhan Mantri Poshan Shakti Nirman (PM POSHAN)**.
- It provides **one hot cooked meal** to children in **government and aided schools**, **special training centers**, **Madarsas**, and **Maqtabs**.
- It covers around **11.80 crore children in 11.20 lakh schools** (2021–22 data).
- In the **2024–25 budget**, the government gave **₹12,467.39 crore (around US$1.5 billion)** to run the scheme.

Objectives of PM POSHAN (Simplified)

- The **PM POSHAN** scheme is run by the **Ministry of Education** to give **nutritious meals** to all children in:
- **Bal Vatika** (pre-primary)
- **Classes 1 to 8**
- In **government and government-aided schools**
- It is for **every child**, no matter their **gender or social background**, to help make sure **every child gets basic education**.

Main Goals

- **Fight hunger** and **support education**.
- **Improve the nutrition** of school-going children.
- **Encourage poor and disadvantaged children** to attend school regularly and focus better in class.
- **Support children in drought or disaster-hit areas**, even during summer vacations.

Food and Nutrition norms under the scheme

- Following are the norms as per National Food Security Act (NFSA), 2013.

Success

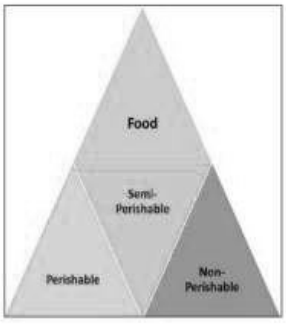
Chapter 01

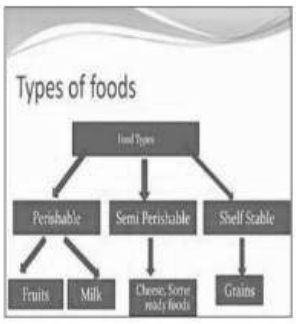
Food Preservation, Principles and Its Methods

FOOD PRESERVATION

- Food preservation is the process of preventing or delaying the spoilage of food, thus extending its shelf life and maintaining its nutritional value, flavor, and safety.
- It is essential to preserve food to ensure its availability during times of scarcity and to prevent foodborne illnesses caused by microbial contamination.

Types of food





▪ **Perishable:** Last for less time 2 days to 1 week. E.g.: milk, fruit, meat.
▪ **Semi perishable:** Last for around 2 months and are processed. E.g.: ice cream, cheese, bread
▪ **Shelf stable** Has longer shelf life more than 6 months. E.g.: food grains

Why to preserve food?

1. **Extended Shelf Life**: Preservation methods help extend the shelf life of food, allowing it to be stored and consumed over a more extended period. This is particularly crucial in situations where food availability is limited, such as during seasons of crop scarcity or in areas with limited access to fresh food.
2. **Minimizing Food Waste**: Food preservation reduces food waste by preventing spoilage and decay. By preserving food, we can utilize and consume it before it goes bad, reducing the amount of food that ends up discarded in landfills.
3. **Availability of Nutritious Food**: Preservation methods allow us to store and access nutritious food even when it is out of season. By preserving fruits, vegetables, and other perishable items, we can ensure a continuous supply of essential nutrients throughout the year, promoting a balanced diet.
4. **Cost Savings**: Preserving food can result in cost savings by allowing bulk purchases of seasonal or discounted items. By preserving and storing food for longer periods, we can take advantage of sales, reduce the frequency of shopping trips, and save money in the long run.
5. **Food Security**: Food preservation plays a vital role in ensuring food security, especially in areas prone to natural disasters or regions with limited agricultural resources. Preserved food can be a valuable resource during emergencies or times of crisis when access to fresh food is disrupted.
6. **Convenience and Accessibility**: Preserved foods offer convenience and accessibility. They can be easily transported, stored, and prepared, making them suitable for situations

Success

Chapter 02

Thermal and Non-thermal Food Preservation Technology

THERMAL METHOD

- Heat kills microorganisms by changing the physical and chemical properties of their proteins. When **heat** is used to preserve foods, the number of microorganisms present, the **microbial load**, is an important consideration.
- Various types of microorganisms must also be considered because different levels of resistance exist. For example, bacterial spores are much more difficult to kill than vegetative bacilli. In addition, increasing acidity enhances the killing process in food preservation.

Pasteurization

- **Pasteurization** is a heat treatment process designed to reduce harmful microorganisms and extend the shelf life of food products, typically liquids.
- It involves heating food to a specific temperature below its boiling point for a set duration, followed by rapid cooling. The process aims to kill most heat-resistant, non-spore-forming pathogens like *Mycobacterium tuberculosis* and *Coxiella burnetti*.

Purpose

- liminate pathogens, reduce spoilage microorganisms, inactivate enzymes, and maintain food quality.

Types

- **LTLT (Low Temperature Long Time)**: 62.8°C for 30 minutes.
- **HTST (High Temperature Short Time)**: 71.7°C for 15 seconds.
- **UHT (Ultra High Temperature)**: 135°C for 2-5 seconds (e.g., shelf-stable milk and juices).

Applications

- Milk, juices, beer, and liquid eggs.

Limitations

- Does not kill all microorganisms and may require refrigeration for some products like milk.

Canning

- The process of sealing fruits and vegetables or any other *foodstuffs hermetically (air tight) in containers and sterilizing them by heat for long storage is known as canning*. In 1904, Nicholas Appert of France invented this process and he is called as Father of Canning.
- The process of canning is also known as *Appertization*. Fruits and vegetables are canned in the season when the raw material is available in plenty. The canned products are sold in off-season and give better returns to the grower.

Metal and Metal Alloys intended to come in contact with food products

SI. No	List of Standards
1	Cold-reduced Electrolytic Tinplate – IS 1993/ISO 11949
2	Cold reduced Electrolytic Chromium or Chromium Oxide – Coated Steel - IS 12591/ISO 11950
3	Wrought Aluminium and Aluminium Alloy Sheet and Strip for General Engineering – IS 737
4	Aluminium and Aluminium Alloy Bare Foil for Food Packaging – IS 15392
5	Specification for Crown Closures – IS 1994
6	Specification for Round Open Top Sanitary Cans for Foods and Drinks – IS 9396 (Part 1)
7	Specification for Round Open Top Sanitary cans for Foods and Drinks – IS 9396 (Part 2)

Plastic Materials intended to come in contact with food products.

1. **Polyethylene (PE):**
- **Types**: Includes Low-Density Polyethylene (LDPE) and High-Density Polyethylene (HDPE).
- **Properties**: PE is versatile, with LDPE being flexible and HDPE being more rigid. Both types have excellent moisture barrier properties.
- **Applications**: LDPE is used in bread bags and squeeze bottles, while HDPE is used in milk jugs and detergent bottles.
- **Why Used**: PE's moisture resistance, flexibility, and strength make it suitable for a variety of packaging applications, from soft bags to rigid containers.

2. **Polystyrene (PS)**:
- **Properties**: PS is rigid, lightweight, and can be either transparent or opaque. It has poor barrier properties and can be brittle unless modified.
- **Applications**: Used in disposable cups, plates, foam food trays, and takeout containers.
- **Why Used**: PS is inexpensive, easy to mold, and provides a good balance between rigidity and lightweight, making it ideal for single-use packaging.

3. **Polyvinyl Chloride (PVC):**
- **Properties**: PVC is flexible, transparent, and has good resistance to grease and oil. It can be made softer with plasticizers.
- **Applications**: Commonly used in cling films and some food wraps.
- **Why Used**: PVC's flexibility and clarity make it ideal for packaging fresh foods that require close contact with the packaging material.

4. **Polypropylene (PP):**
- **Properties**: PP has a high melting point, is resistant to chemicals, and is flexible yet tough. It also has good barrier properties for moisture.
- **Applications**: Used in yogurt containers, margarine tubs, and microwaveable food trays.
- **Why Used**: PP's ability to withstand high temperatures makes it ideal for hot-fill packaging and microwave-safe containers.

5. **Ionomer Resins:**
- **Properties**: Ionomers are tough, clear, and have excellent clarity and sealability. They are resistant to punctures and have good barrier properties.
- **Applications**: Used in packaging for sharp or irregularly shaped foods like meat and cheese.
- **Why Used**: Ionomer resins are chosen for their strength and ability to form strong seals, making them ideal for packaging that needs to be durable and leak-proof.

6. **Ethylene Acrylic Acid (EAA):**
- **Properties**: EAA copolymers offer excellent adhesion to a wide range of substrates, and they provide good toughness and seal strength.
- **Applications**: Used in food packaging laminates and coatings.
- **Why Used**: EAA's adhesion properties make it ideal for multi-layer packaging, where different materials need to bond together effectively.

7. **Polyalkylene Terephthalates (e.g., PET):**
- **Properties**: These are strong, lightweight, and have excellent barrier properties against moisture and gases. PET is also highly transparent.

Success

Chapter 01

Status of Agriculture in India (2024 - 2025)

Land Use Pattern as per Nine-Fold Classification All India Agriculture

Classification of Land	Area (Thousand Hectares)
Reporting area for land utilization statistics (1 to 9)	306650
1. Forests	72021
2. Area put to non-agricultural uses	27845
3. Barren & unculturable land	16554
4. Permanent pastures & other grazing lands	10248
5. Land under Misc. tree Crops	2992
6. Culturable Wasteland	11659
7. Fallow Land Other than Current Fallows	11128
8. Current Fallow	13498
9. Net Area Sown	140705
Agricultural Land (5+6+7+8+9)	179982
Cultivated Land (8+9)	154203
Cropping Intensity (% of Total cropped Area over Net Area Sown)	155.9

Source-Wise Irrigated Area All India

Irrigated Area (in thousand Hectares)	
1. Government Canals	17959
2. Private Canals	165
3. Total Canals (1+2)	18124
4. Tanks	2235
5. Tube-wells	39134
6. Other wells	10672
7. Other Sources	9147
Net Irrigated Area (3+4+5+6+7)	79312
Gross Irrigated Area	122294
% of Gross Irrigated Area over Gross Cropped Area	55.8
% of Net Irrigated Area over Net Area Sown	56.4

Source: Land Use Statistics (MoA & FW), DA & FW Economics Statistics September 2024, GOI

Key Highlights from the Economic Survey 2024-25

Agriculture and Allied Sectors

- **Agricultural Income Growth**: Increased at **5.23% annually** over the past decade.
- **Allied Sectors as Growth Drivers**: Livestock, fisheries, and horticulture have significantly contributed to overall **agriculture sector growth**.
- **Kharif Foodgrain Production (2024)**: Estimated at **1,647.05 Lakh Metric Tonnes (LMT)**.

Agriculture's Contribution 2024

Food Exports and Processing

- **India's Agri-Food Exports**: Constituted **11.7% of total exports** in FY24.
- **Seafood Export Growth**: Increased by **29.70% from FY20 to FY24**.

Success

Chapter 02 Types of Traditional & Modern Farming System

Importance of Farming in India

- Farming is a crucial part of the Indian economy, contributing significantly to GDP.
- Agriculture remains the primary livelihood for 58% of India's population.

Traditional vs. Modern Farming

- Traditional farming relies on organic fertilizers, outdated tools, and local expertise.
- Modern farming incorporates advanced machinery, technology, and capital-intensive methods.
- The shift from traditional to modern farming impacts biodiversity and local farming cultures.
- Modernization has led to the dominance of large agribusinesses, reducing the role of small farmers.

Impact on Biodiversity and Sustainability

- Traditional farming supports biodiversity and cultural diversity, making agriculture more resilient.
- A balance between modernization and conservation is necessary to ensure food security and environmental sustainability.

Agriculture and Economic Growth

- India has a strong agrarian history dating back to the Vedic era.
- The Government of India aims to boost agricultural exports beyond $60 billion.
- The Indian food industry is the 6th largest globally, with food processing covering 32% of the sector.

Future of Indian Agriculture

- Both traditional and commercial farming play significant roles in India's agricultural landscape.
- Sustainable practices and conservation efforts are essential for maintaining agricultural growth while preserving biodiversity.

Traditional Farming

- Traditional farming is defined as a primitive way of farming that involves the use of labour-intensive, traditional knowledge, tools, natural resources, organic fertilizer, and old customs and cultural beliefs of the farmers.

i. **Deforestation:**

- Deforestation is the process of cutting down trees for agricultural and productive activities.
- It is the process of removing a forest or a stand of trees from a piece of land to convert it into farms, pastures, or urban usage.
- Tropical rainforests have the highest concentration of deforestation.

PIG FARMING / PIGGERY

- Pig farming, also known as **swine farming** or **piggery**, is the practice of raising and breeding domestic pigs for meat production (pork).
- It is a branch of animal husbandry that involves the care, feeding, and management of pigs to ensure healthy growth and high-quality meat yield.

Advantages of Pig Farming

- Fast growth rate and high reproduction ability.
- Requires less space compared to other livestock.
- High demand for pork worldwide.
- Can utilize kitchen and farm waste as feed.

Key Aspects of Pig Farming

i. **Breeds Selection** – Choosing suitable pig breeds like Yorkshire, Landrace, Duroc, and Berkshire for better growth and meat production.

ii. **Housing & Management** – Providing proper shelter, ventilation, and hygiene to maintain a disease-free environment.

iii. **Feeding & Nutrition** – Ensuring a balanced diet rich in protein, carbohydrates, vitamins, and minerals to promote healthy weight gain.

iv. **Health & Disease Control** – Regular vaccinations, deworming, and sanitation to prevent infections and diseases.

v. **Breeding & Reproduction** – Managing breeding programs to improve piglet survival rates and productivity.

vi. **Marketing & Processing** – Selling pigs for pork production and ensuring good market strategies for profit.

Housing provides shelter and protection. For maximum productivity the following points needs to be considered-

i. Pig shed should be constructed on North-South direction on dry and raised ground at communicable place.

ii. The height of the roof should be 8-10ft.

iii. The sidewalls (upto 4ft from ground) of the shed should be constructed with brick and cement plastered and polished. The remaining height (upper 4-6ft.) can be made up of wire/bamboo net.

iv. The floor should be hard or pucca, non-slippery and sloped (3 cm. slope).

v. Feeding and water troughs should be constructed in the pen and the corners of the walls, troughs and drain should be rounded for easy cleaning.

vi. Provision for creep box should be made in farrowing pen.

vii. Provision for adequate open space for exercise, sufficient water and facility for proper disposal of faeces should be created.

viii. The individual pens should be of uniform size (80-100 sq ft).

FARMING SYSTEM OF PIG

- Three different systems of farming – Intensive, Semi-intensive and Scavenging systems are practiced by farmers depending on the type of pig, facilities and personal choice.

1. Intensive System:

i. Expensive to create facilities.
ii. Applicable for large commercial Farm.
iii. All Scientific approach are possible in this System for production of safe food (pork).
iv. Pigs are confined to the pigsties and no access to outside.
v. Reproductivity and productivity of pigs are more because of the high quality management, proper breeding, health care and quality feed.

2. Semi- intensive System:

i. This system of pig rearing is adopted in rural areas where pig rearing is considered as livelihood.
ii. This system of rearing is a modified way of Scavenging system.
iii. Pigs are generally kept in strong enclosures either made of wood or strong fencing materials.
iv. Requires a large area for free movement of pigs. Sometime small wooden houses are also provided within the enclosure as shelter.
v. Generally pigs are allowed for grazing, small quantity of balanced ration is provided.
vi. Locally available feed components like Colocasia,Tapioca ,Kitchen / Hotel / Market waste etc. are used as major feed.
vii. Sows are shifted to other places to avoid mortality of piglets during farrowing.
viii. Scientific system of rearing is lacking in respect of breeding, management and health care.

3. Scavenging System:

i. It is the traditional pig keeping procedure and is the primitive method of pig rearing.
ii. Under this system, pigs are let loose to feed on scavenging materials.
iii. The pigs in group move one place to other.
iv. Does not require any effort on management.
v. The pigs under this system results poor growth and occurrence of disease.
vi. Smaller litter size at birth and at weaning.

Sanitation & Hygiene

i. The floor should be maintained dry.
ii. The feeder should be cleaned daily with clean water.
iii. The feeder could be sanitized using 5% KMnO4 (Potassium Permanganate).
iv. The floor & walls shall be cleaned daily with $KMnO_4$ (Potassium Permanganate) (2.5 gm per litre of water).
v. Visit of outside persons shall be strictly prohibited near the pigsty.
vi. The area around the pigsty (i.e. road/path) must also be sanitized regularly with $KMnO_4$ solution.
vii. Keep the clothes separate while working with the animals & don't mix them with other ones.

FEEDING

- Feed plays a very important role in successful pig production.
- Feed alone represents about 70-75 percent of the total cost of producing hogs.
- The productivity and reproductivity of pig farm depends on the quality as well as quantity of feed supplied to the pigs.

Success

Chapter 4.5 Livestock: Duckery System

Duckery Systems

- Ducks can be raised in different ways, depending on the available space and management system. The two common systems are the **semi-intensive system** and the **intensive system**. Each system has specific requirements to ensure the ducks grow well and stay healthy.

i. **Semi-Intensive System:**

- In a semi-intensive system, **ducklings should be kept indoors for the first four weeks** to protect them from harsh weather and predators. Once they are about **4 weeks old**, they can be allowed to go outside.
- Ducks should not be overcrowded, as it can lead to stress, diseases, and slow growth. To prevent this, the recommended number of ducks per hectare is **5000 ducks**.
- However, it is better to **keep them in smaller groups of about 200 ducks** for easier management. Smaller groups make it easier to provide proper care, including feeding, watering, and protection from diseases.

ii. **Intensive System:**

- In an intensive system, ducks are **kept indoors all the time**. This method allows for **better control over their environment**, including temperature, cleanliness, and protection from predators.
- Ducks can be raised on **different types of flooring**, such as soft bedding made of straw (**litter system**), wooden or plastic slatted floors (**slat floor system**), or a combination of both.
- Ducks need **a lot of clean drinking water** because water helps them digest food properly and keeps them healthy.
- The **water containers** should be deep enough so that ducks can **dip their entire bill into the water**. This helps them **clean their nostrils and prevent infections**. A good depth for water containers is **13-15 cm**.

iii. **Free-Range Duck Farming:**

- In free-range systems, ducks are allowed to roam freely in open fields or near water bodies. This method is **cheaper and more natural**, but it requires proper land management.

- The number of ducks kept in a free-range system depends on the availability of food sources like **grass, insects, and aquatic plants**.

Stocking Rate

- A farmer can keep **1000 ducks per 0.405 hectare (1 acre)**, but this number may change depending on the **amount of green plants available** for the ducks to eat.

Housing and Space Requirements

- Ducks need enough space to grow well and stay comfortable. If they do not have enough room, they may **fight, get sick, or lay fewer eggs**.

a) For Ducks in the Intensive System:

- When ducks are kept indoors full-time, each duck needs **4 to 5 square feet of space** inside the shelter. This ensures they have enough room to move around and stay stress-free.

b) For Ducks in the Semi-Intensive System:

- In the **night shelter** (where ducks sleep at night), **each duck should have at least 3 square feet of space**.
- During the day, ducks need **10 to 15 square feet of outdoor space per bird**. This allows them to **walk, forage, and exercise freely**.

Integrated Aquaculture or Fish Farming

- Culture of fishes along with agriculture or animal husbandry or salt industry.
- Eg: Rearing of fishes in paddy fields, Rearing of cow near a fish pond.

Advantages

- Single labour, double income
- No need for artificial feeding
- No need for additional fertilizer
- Recycling of wastes
- Maximum utilization of natural resources
- No additional cost

Agriculture Cum Fish

Paddy cum fish culture

i. Synchronous or mixed farming or simultaneous- west Bengal.
ii. Alternate or rotational e.g. Kerala- culture of fishes in pokkali fields.
iii. Relay – fish farming extended after harvest.

Animal husbandry cum fish culture

i. Poultry cum fish culture
ii. Dairy cum fish culture
iii. Pig cum fish culture
iv. Duck cum fish culture

Management In Fisheries / Aquaculture

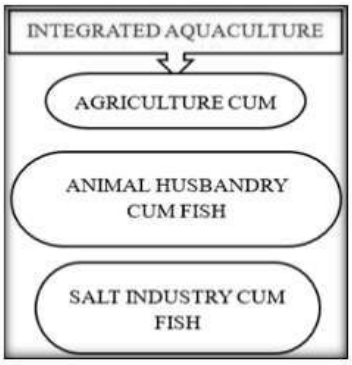
Feeding in Fisheries

- Feeding is a crucial aspect of fish farming, directly influencing growth, health, and production efficiency. Proper feeding techniques and balanced nutrition ensure optimal fish yield and profitability.

Types of Fish Feed

Natural Feed

- *Phytoplankton* and *zooplankton.*
- Aquatic plants (*Ipomoea aquatica*, *Azolla spp., Salvinia spp., Hydrilla spp. and Pistia stratiotes*).
- Insects and detritus.

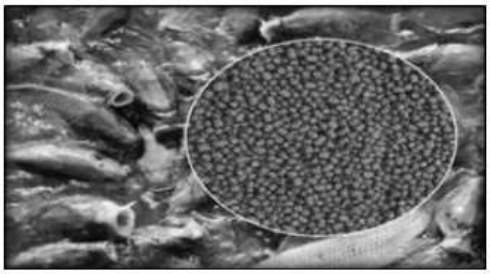


Supplementary Feed

- Rice bran, Oil cakes (mustard, groundnut, coconut, and linseed cake)
- Wheat bran and broken rice

Artificial (Formulated) Feed

- Pelletized or extruded feed containing proteins, fats, vitamins, and minerals
- Ingredients include fish meal, soybean meal, cereal grains, vitamins, and mineral supplements



Feeding Strategies

Feeding Frequency

i. **Fry:** 4–6 times/day
ii. **Fingerlings:** 2–4 times/day
iii. **Adult fish:** 1–2 times/day

Success

Chapter 06

Small, Medium and Large Enterprises Including Value Chains and Secondary Enterprises as Livelihood Component for Farmers

Small, Medium and Large Enterprises in Agriculture

- Small, Medium and Large Enterprises in Agricultural Value Chains: A Livelihood Perspective for Farmers

Introduction

- Small, medium, and large enterprises (SMEs and larger businesses) play an essential role in agricultural value chains, contributing significantly to farmer livelihoods.
- These enterprises influence agricultural productivity, market access, income generation, and employment opportunities.
- Each type of enterprise — **small, medium, or large** —has a distinct function in strengthening agricultural ecosystems.

1. Small Enterprises (SEs):

Description:

- Small enterprises in agriculture are typically family-owned or community-based.
- Operated by farmers or small business owners within local markets.
- Examples include local produce markets, small-scale food processors, and agricultural cooperatives.

Role in Agricultural Value Chains

Processing and Packaging

- Small enterprises often engage in fundamental processing like sorting, cleaning, drying, and packaging of produce.
- This helps in adding value to raw agricultural products and improving shelf life.
- Local branding and direct-to-consumer sales can enhance the profitability of small-scale processing.

Local Distribution and Direct Selling

- Small enterprises supply local and regional markets, reducing logistics complexities.
- Encourages farm-to-table models, increasing profits for farmers.
- Enables direct consumer interaction, reducing reliance on intermediaries.

Secondary Businesses

- Small businesses include organic fertilizer production, seedling nurseries, and tool repair services.
- These enterprises help farmers reduce costs and dependency on external suppliers.
- Community-based shared resources such as irrigation services and cooperative storage facilities enhance sustainability.

Livelihood Impact

Income Diversification

- Provides alternative revenue streams to farmers, reducing dependence on seasonal crops.
- Strengthens resilience against market volatility and weather-related uncertainties.

Skill Development and Entrepreneurship

- Helps farmers develop expertise in agribusiness management, marketing, and quality assurance.
- Encourages financial literacy and self-sufficiency in farming communities.

Community Economic Strengthening

- Small enterprises build cooperative networks and enhance local economic growth.
- Strengthens bargaining power and ensures fair pricing for agricultural products.

2. Medium Enterprises (MEs):

Description

- More structured than small enterprises with dedicated management teams and formalized operations.

Major Functions

- Loans up to Rs. 5 lakh at 7% interest annually.
- Additional 3% subvention for timely repayment reduces interest to 4%.
- Includes post-harvest loans and natural calamity-related loans.
- **Achievements:** The amount under operative **Kisan Credit Card (KCC)** accounts has more than doubled from **₹4.26 lakh crore** in March 2014 to **₹10.05 lakh crore** in December 2024.

5. Agriculture Infrastructure Fund (AIF):

Launch Date: FY 2020-21

- **Vision:** Mobilize investment in agricultural infrastructure.

Major Functions

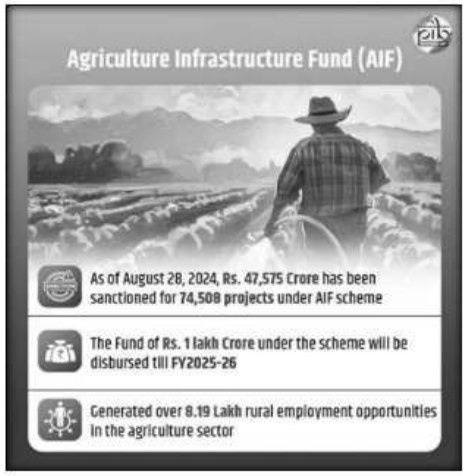
- Rs. 1 lakh crore loan facility from FY 2020-21 to FY 2025-26.
- Interest subvention of 3% per annum; credit guarantee up to Rs. 2 crore.
- **Achievements:** Rs. 47,575 crore sanctioned for 74,508 projects.

6. Formation and Promotion of 10,000 FPOs:

- **Launch Date:** 2020
- **Vision:** Promote Farmer Producer Organizations (FPOs).

Major Functions

- Financial assistance of up to Rs. 18 lakh per FPO for three years.
- Credit guarantee of up to Rs. 2 crore per FPO.
- **Achievements:** 7,774 FPOs registered; onboarded on e-NAM for better pricing.



7. National Beekeeping and Honey Mission (NBHM) 'Sweet Revolution':

- **Launch Date:** 2020
- **Vision:** Promote scientific beekeeping and achieve the "Sweet Revolution."

Major Functions

- Development of honey testing labs and Madhukranti portal.
- **Achievements:** 23 lakh bee colonies registered; 88 honey FPOs formed; 160 projects sanctioned worth Rs. 202 crore.

8. Market Intervention Scheme and Price Support Scheme (MIS-PSS):

- **Vision:** Protect growers from distress sales during bumper crop seasons.

Major Functions

- Procurement of pulses, oilseeds, and perishable agricultural commodities.

9. Namo Drone Didi:

- **Launch Period:** 2024-25 to 2025-26
- **Vision:** Provide drones to Women SHGs for agriculture services.

FIELD CROPS (CEREALS)				
Common Name (India)	**English Name**	**Botanical Name**	**Family**	**Chromosome Number**
गेहूं (Gehu)	Wheat	*Triticum aestivum*	Poaceae	2n = 42
धान (Dhaan)	Rice	*Oryza sativa*	Poaceae	2n = 24
मक्का (Makka)	Maize/Corn	*Zea mays*	Poaceae	2n = 20
जौ (Jau)	Barley	*Hordeum vulgare*	Poaceae	2n = 14
बाजरा (Bajra)	Pearl Millet	*Pennisetum glaucum*	Poaceae	2n = 14
ज्वार (Jowar)	Sorghum	*Sorghum bicolor*	Poaceae	2n = 20
रागी (Ragi)	Finger Millet	*Eleusine coracana*	Poaceae	2n = 36
कोदो (Kodo)	Kodo Millet	*Paspalum scrobiculatum*	Poaceae	2n = 40
कुटकी (Kutki)	Little Millet	*Panicum sumatrense*	Poaceae	2n = 36
सामा (Sama)	Barnyard Millet	*Echinochloa frumentacea*	Poaceae	2n = 36, 54
फॉक्सटेल मिलेट (Kangni)	Foxtail Millet	*Setaria italica*	Poaceae	2n = 18
चिन्ना (Chinna)	Proso Millet	*Panicum miliaceum*	Poaceae	2n = 36
बकव्हीट (Kuttu)	Buckwheat	*Fagopyrum esculentum*	Polygonaceae	2n = 16
अमरंथ (Rajgira)	Amaranth	*Amaranthus caudatus*	Amaranthaceae	2n = 32
ट्रिटिकेल (Triticale)	Triticale (Wheat × Rye Hybrid)	× *Triticosecale*	Poaceae	2n = 42, 56
डूरम गेहूं (Durum Gehu)	Durum Wheat	*Triticum durum*	Poaceae	2n = 28
ओट्स (Jai)	Oats	*Avena sativa*	Poaceae	2n = 42
राई (Rye)	Rye	*Secale cereale*	Poaceae	2n = 14
चीनी चावल (Chinese Rice)	Chinese Rice	*Oryza rufipogon*	Poaceae	2n = 24
जंगली धान (Wild Rice)	Wild Rice	*Zizania palustris*	Poaceae	2n = 30

VEGETABLE CROPS				
Common Name (India)	**English Name**	**Botanical Name**	**Family**	**Chromosome Number**
आलू (Aloo)	Potato	*Solanum tuberosum*	Solanaceae	2n = 48
प्याज (Pyaaz)	Onion	*Allium cepa*	Amaryllidaceae	2n = 16
टमाटर (Tamatar)	Tomato	*Solanum lycopersicum*	Solanaceae	2n = 24
बैंगन (Baingan)	Brinjal / Eggplant	*Solanum melongena*	Solanaceae	2n = 24
गोभी (Phool Gobhi)	Cauliflower	*Brassica oleracea var. botrytis*	Brassicaceae	2n = 18
पत्ता गोभी (Patta Gobhi)	Cabbage	*Brassica oleracea var. capitata*	Brassicaceae	2n = 18

46	ICAR-National Institute of Veterinary Epidemiology and Disease Informatics	Bengaluru, Karnataka
47	ICAR-Sugarcane Breeding Institute	Coimbatore, Tamil Nadu
48	ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan	Almora, Uttarakhand
49	ICAR-Central Institute for Research on Cattle	Meerut, Uttar Pradesh
50	ICAR-National Institute of High Security Animal Diseases	Bhopal, Madhya Pradesh
51	ICAR-Indian Institute of Maize Research	Ludhiana, Punjab
52	ICAR-Central Agroforestry Research Institute	Jhansi, Uttar Pradesh
53	ICAR-National Institute of Agricultural Economics and Policy Research	New Delhi
54	ICAR-Indian Institute of Wheat and Barley Research	Karnal, Haryana
55	ICAR-Indian Institute of Farming Systems Research	Modipuram, Uttar Pradesh
56	ICAR-Indian Institute of Millets Research	Hyderabad, Telangana
57	ICAR-Indian Institute of Oilseeds Research	Hyderabad, Telangana
58	ICAR-Indian Institute of Oil Palm Research	Pedavegi, Andhra Pradesh
59	ICAR-Indian Institute of Water Management	Bhubaneswar, Odisha
60	ICAR-Indian Institute of Rice Research	Hyderabad, Telangana
61	ICAR-Central Institute for Women in Agriculture	Bhubaneswar, Odisha
62	ICAR-Central Citrus Research Institute	Nagpur, Maharashtra
63	ICAR-Indian Institute of Seed Research	Mau, Uttar Pradesh
64	ICAR-Indian Agricultural Research Institute	Hazaribag, Jharkhand

NATIONAL AND STATE LIVESTOCK INSTITUTIONS IN INDIA

Abbreviation	Full Name	Headquarters	Establishment Year
NDRI	ICAR-National Dairy Research Institute	Karnal, Haryana	**1923**
IVRI	ICAR-Indian Veterinary Research Institute	Izatnagar, Bareilly, Uttar Pradesh	**1889**
CARI	ICAR-Central Avian Research Institute	Bareilly, Uttar Pradesh	**1979**
CIRB	ICAR-Central Institute for Research on Buffaloes	Hisar, Haryana	**1985**
CIRC	ICAR-Central Institute for Research on Cattle	Meerut, Uttar Pradesh	**1987**
CIRG	ICAR-Central Institute for Research on Goats	Makhdoom, Mathura, Uttar Pradesh	**1979**
CSWRI	ICAR-Central Sheep and Wool Research Institute	Avikanagar, Rajasthan	**1962**
NIANP	ICAR-National Institute of Animal Nutrition and Physiology	Bengaluru, Karnataka	**1995**
NIHSAD	ICAR-National Institute of High Security Animal Diseases	Bhopal, Madhya Pradesh	**2013**
NIVEDI	ICAR-National Institute of Veterinary Epidemiology and Disease Informatics	Hebbal, Bengaluru, Karnataka	**2013**
NMRI	ICAR-National Meat Research Institute	Chengicherla, Hyderabad, Telangana	**1999**
NIFMD	ICAR-National Institute of Foot and Mouth Disease	Arugul, Bhubaneswar, Odisha	**2008**
NBAGR	ICAR-National Bureau of Animal Genetic Resources	Karnal, Haryana	**1984**
NRCC	ICAR-National Research Centre on Camel	Bikaner, Rajasthan	**1984**
NRCE	ICAR-National Research Centre on Equines	Hisar, Haryana	**1986**

Success

Chapter 05 Innovative Thermal Technologies

INNOVATIVE THERMAL METHOD

OHMIC HEATING

- Ohmic Heating is a thermal processing method where **electric current** is passed through food to heat it.
- Food acts as an **electrical resistor**, generating heat internally.
- Also known as:
  - **Electrical Resistance Heating.**
  - **Joule Heating.**
  - **Electro heating.**

Principle Behind Ohmic Heating

- Foods containing **water and ionic salts** conduct electricity but also resist it — this resistance produces heat.
- **Heat is generated uniformly** within the food material.
- Requires **good electrical conductivity** for efficient heating.

Current and Safety in Ohmic Heating

- Voltage (**V**) and Resistance (**R**) determine **Current (I)**:

$$I = V / R$$

- Every product has a **critical current density** — exceeding this causes **arcing or flash-over**.

Application of Ohmic Heating in Food Processing

- Depends on the **rate of heat generation** within the food system.
- Suitable for **liquid foods with large particulates**:
- Soups, stews, fruit slices in syrup, sauces.
- Ideal for heat-sensitive liquids and protein-rich food:
- Minimizes protein denaturation and coagulation.
- Used in **juice processing** to inactivate enzymes without affecting flavor.

Factors Influencing Heating Rate

a) Relative electrical conductivities of solid and liquid phases.

b) Volume proportion of each phase in the mixture.

Advantages of Ohmic Heating

- **Efficient energy usage** – optimized investment.
- **Instant system shutdown**.
- **Low maintenance** – no moving parts.
- **Simultaneous heating** of particles and liquid prevents over-processing.
- Helps in **preserving nutrients and flavor** by avoiding overheating.

Electroporation Effect

- Occurs at **low frequencies (50–60 Hz)** and **high field strengths (>100 V/cm)**.
- Electric field causes **charge buildup** across the cell membrane.
- Results in **formation of pores** (membrane disruption).
- Related to **lipid content** of the membrane acting as an insulator.

Disadvantages of Ohmic Heating Systems

High Initial Investment

- Commercial ohmic heating systems can cost over **$9 million USD**, including installation.

Dependency on Electrical Conductivity

- System efficiency is highly influenced by the **electrical properties** of the food.
- **As temperature increases**, electrical conductivity also increases — may cause **non-uniform heating**.

Risk of Electrical Arcing

- Inadequate cleaning leads to **protein deposits** on electrodes.
- This can result in **electrical arcing** and system failure.

About the Book

This book serves as a encompasses a wide range of essential topics, including **Basic Food Science, Food and Nutrition, Food Preservation, Packaging and Storage, Indian Farming Systems**, and **Food Processing Technology**. These subjects are critical for building a strong foundation and understanding of food safety standards, practices, and technologies.

About the Author

Mr. Arpit Singh holds a B.Tech degree in Biotechnology from Dr. A.P.J. Abdul Kalam Technical University, Lucknow. Worked for 3 years in the biotech industry, gaining practical experience in the field. Founded "Swa Education." Swa Education plays a crucial role in preparing students for exams related to food safety regulations in India. Swa Education dedicated to offering coaching services in the field of food safety exams.

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