

# ECONOMIC ZOOLOGY: HUMAN WELFARE AND ANIMALS

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# Economic Zoology: Human Welfare and Animals

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# Introduction to Economic Zoology

## 1.1 Meaning and Definition of Economic Zoology

Economic zoology is a specialized branch of zoology that deals with animals having direct or indirect economic importance to humans. It includes the study of beneficial animals that contribute to agriculture, industry, medicine, and environmental sustainability, as well as harmful animals that cause diseases, crop losses, and economic damage. The subject integrates biological knowledge with economic and social perspectives to understand how animal resources can be utilized sustainably for human welfare.

Different scholars have defined economic zoology in various ways:

According to classical zoologists, economic zoology is the study of animals that influence human economy positively or negatively.

Modern definitions emphasize sustainable utilization, conservation, and ethical management of animal resources.

Thus, Economic Zoology may be defined as: “The branch of zoology that studies animals of economic importance to humans, including their beneficial and harmful roles.”

Economic zoology is therefore an interdisciplinary subject connecting zoology, agriculture, veterinary science, fisheries, ecology, biotechnology, and economics.

## 1.2 Scope of Economic Zoology

Economic Zoology is a broad and applied branch of zoology that deals with the scientific study, management, and utilization of animals for the economic benefit of humankind. It encompasses all aspects of animal resources that contribute to food, clothing, shelter, medicine, industry, agriculture, and environmental sustainability. The scope of Economic Zoology is not limited to domesticated animals alone; it also includes wild animals, insects, aquatic organisms, parasites, and even microorganisms that influence human welfare either positively or negatively.

The various fields covered under the scope of Economic Zoology are described below in detail.

### **1.2.1 Animal Husbandry and Livestock Management**

Animal husbandry forms one of the most important branches of Economic Zoology. It involves the breeding, rearing, feeding, and healthcare of domestic animals for obtaining useful products such as milk, meat, wool, hides, and manure. Scientific methods are adopted to improve the quality and productivity of livestock.

Cattle and buffaloes are reared mainly for milk and dairy products, while sheep provide wool and mutton. Goats supply milk and meat and are often called the “poor man’s cow.” Pigs are important sources of pork and animal fat. Proper housing, balanced nutrition, vaccination, and disease control are essential components of livestock management. Improved breeds developed through selective breeding and artificial insemination have significantly increased production.

Thus, livestock farming provides employment, enhances rural income, and contributes to national food security.

### **1.2.2 Dairy Science**

Dairy science is a specialized area that deals with the production, processing, and distribution of milk and milk products. Milk is considered a complete food rich in proteins, fats, vitamins, and minerals. Economic Zoology includes knowledge of high-yielding breeds, clean milk production, and dairy technology.

Milk is processed into various products such as butter, cheese, curd, ghee, paneer, and milk powder. Dairy cooperatives and milk processing industries contribute significantly to the economy. In countries like India, the dairy industry plays a vital role in improving the socio-economic status of farmers.

### **1.2.3 Fisheries and Aquaculture**

Fisheries and aquaculture form another major area within the scope of Economic Zoology. Fish and other aquatic animals provide high-quality protein and are important sources of food for millions of people worldwide.

This field includes the study of:

- Inland fisheries (ponds, lakes, rivers)
- Marine fisheries (seas and oceans)
- Fish farming (carp culture, composite fish culture)
- Prawn and shrimp farming
- Pearl and oyster culture

Modern aquaculture techniques such as hatchery management, artificial breeding, and integrated fish farming increase productivity. Fisheries also contribute to export earnings and employment generation.

#### **1.2.4 Poultry Farming**

Poultry farming involves the rearing of birds such as chickens, ducks, turkeys, and quails for eggs and meat. It is one of the fastest-growing animal industries because it requires less space, less investment, and provides quick returns.

Economic Zoology includes the study of improved breeds, feeding practices, housing systems, and disease prevention. Broilers are raised for meat, while layers are reared for egg production. Poultry products are affordable sources of animal protein and help combat malnutrition.

#### **1.2.5 Apiculture (Bee Keeping)**

Apiculture refers to the scientific rearing and management of honey bees. Honey bees provide valuable products such as honey, beeswax, royal jelly, propolis, and bee venom. Honey is widely used as food and medicine, while beeswax is used in cosmetics, candles, and pharmaceuticals.

Bees also play a crucial ecological role in pollination, which increases crop yield and agricultural productivity. Thus, apiculture supports both agriculture and rural economy.

#### **1.2.6 Sericulture (Silkworm Rearing)**

Sericulture deals with the rearing of silkworms for the production of silk. Silk is a natural fiber used in the textile industry for making clothes, carpets, and decorative items. The main silkworm species, *Bombyx mori*, feeds on mulberry leaves.

The process involves egg production, larval rearing, cocoon formation, and reeling of silk threads. Sericulture provides employment to rural and tribal communities and is an important cottage industry.

### **1.2.7 Lac Culture and Other Insect Products**

Lac culture involves the rearing of lac insects that produce lac resin. Lac is processed into shellac and used in varnishes, polishes, toys, and electrical goods. Other insects produce commercially valuable substances such as cochineal dye and insect silk.

These industries demonstrate the economic importance of even small insects in human life.

### **1.2.8 Animals as a Source of Food and Nutrition**

Animals serve as major sources of high-quality food. Economic Zoology studies the production and utilization of animal-based foods such as meat, milk, eggs, fish, and honey. These foods are rich in proteins, essential amino acids, fats, and vitamins necessary for growth and health.

Proper management ensures hygienic production, processing, and preservation of food products. Thus, animals contribute directly to food security and nutritional balance.

### **1.2.9 Animals in Medicine and Research**

Animals play a vital role in medical science and research. Laboratory animals like rats, mice, rabbits, and guinea pigs are used for testing drugs, vaccines, and surgical techniques. They help in understanding disease mechanisms and developing treatments.

Many medicines are derived from animals, such as:

- Insulin from pancreas
- Antivenom from horse serum
- Hormones and enzymes
- Vaccines and sera

Hence, animals contribute significantly to healthcare and biomedical research.

### **1.2.10 Industrial and Commercial Products from Animals**

Several industries depend on animal products. Examples include:

- Leather from hides and skins
- Wool from sheep
- Silk from silkworms
- Ivory and bone crafts
- Gelatin and glue
- Cosmetics and pharmaceuticals

These products are used in clothing, manufacturing, and various commercial sectors, contributing to economic growth.

### **1.2.11 Harmful Animals and Pest Management**

Economic Zoology also deals with animals that cause economic losses. Many insects, rodents, and birds damage crops and stored grains. Mosquitoes and flies spread diseases, while rats destroy food supplies.

The study of their biology and life cycles helps in controlling them through chemical, biological, and integrated pest management methods. Effective control reduces losses and improves productivity.

### **1.2.12 Parasitology and Public Health**

Parasites infect humans and domestic animals, causing diseases and reducing productivity. Economic Zoology studies parasitic worms, protozoans, and ectoparasites along with their prevention and treatment.

Vector-borne diseases such as malaria, dengue, and filariasis have serious economic impacts. Understanding parasitology helps protect public health and livestock health.

### **1.2.13 Role of Animals in Agriculture and Ecosystem Services**

Animals contribute indirectly to agriculture by maintaining ecological balance. Earthworms improve soil fertility, bees pollinate crops, and birds and frogs control pests. These ecosystem services increase crop yield and reduce dependence on chemicals.

Thus, animals support sustainable agricultural practices.

### **1.2.14 Wildlife Conservation and Sustainable Utilization**

Wild animals are valuable natural resources. They maintain biodiversity, ecological stability, and tourism potential. Economic Zoology promotes wildlife conservation, habitat protection, and sustainable use to prevent extinction.

Eco-tourism and wildlife management generate revenue while preserving nature for future generations.

### **1.2.15 Modern Developments and Biotechnology**

Recent advances such as genetic engineering, artificial insemination, embryo transfer, disease diagnostics, and waste utilization have expanded the scope of Economic Zoology. These technologies improve productivity and sustainability.

Biogas production, biofertilizers, and value-added animal products are examples of modern innovations that enhance economic returns.

## **1.3 Historical Development of Economic Zoology**

Economic Zoology has evolved gradually with the progress of human civilization. From primitive dependence on wild animals to modern scientific management and biotechnology-based animal industries, the relationship between humans and animals has continuously developed. The historical growth of Economic Zoology can be understood through different stages, each representing increasing knowledge, utilization, and conservation of animal resources.

### **1.3.1 Prehistoric Period – Hunting and Food Gathering Stage**

In the earliest stage of human history, primitive humans depended entirely on nature for survival. Hunting wild animals and collecting fish were the primary sources of food, clothing, and shelter. Animal skins were used as clothing, bones were used for tools and weapons, and meat served as the main diet.

At this stage, there was no organized management of animals. Humans killed animals only to satisfy immediate needs. Although scientific knowledge was absent, this period marked the beginning of the economic relationship between humans and animals.

### **1.3.2 Domestication Period – Beginning of Animal Rearing**

With the development of agriculture and settled life, humans realized the advantage of domesticating animals instead of hunting them. This led to the domestication of animals such as dogs, cattle, sheep, goats, and pigs.

Domesticated animals provided:

- Milk
- Meat
- Wool
- Protection
- Draught power for farming

This period marked the foundation of animal husbandry. The control and care of animals improved food security and reduced dependence on wild hunting. Thus, domestication represented the first major step toward Economic Zoology.

### **1.3.3 Ancient Civilization Period**

During ancient civilizations such as those of India, Egypt, Mesopotamia, China, and Greece, animal rearing became more systematic. People practiced dairying, sheep rearing for wool, and fishing on a larger scale.

Historical records show:

- Egyptians practiced beekeeping
- Chinese developed sericulture (silk production)
- Indians practiced cattle rearing and dairy farming
- Horses and elephants were used for transport and warfare

Animals were not only sources of food but also played roles in trade, agriculture, and transportation. Thus, animal utilization expanded from subsistence to economic activity.

### **1.3.4 Medieval Period – Expansion of Animal-Based Occupations**

During the medieval period, various animal-based industries and occupations developed. Specialized groups of people were engaged in dairying, poultry farming, fishing, weaving silk, and leather processing.

This period witnessed:

- Growth of fisheries in coastal regions
- Development of wool and silk industries
- Use of bullocks and horses in agriculture and transport
- Traditional veterinary practices

Although scientific knowledge was limited, practical experience improved animal care and productivity.

### **1.3.5 Scientific Period – Beginning of Systematic Study**

The scientific revolution in the 17th and 18th centuries brought systematic study of animal biology. Zoology emerged as a separate branch of science, and researchers began studying animal anatomy, physiology, breeding, and diseases.

Important developments included:

- Classification of animals
- Understanding reproduction and heredity
- Discovery of microorganisms and parasites
- Beginning of veterinary science

Scientific knowledge helped improve livestock breeds and control diseases. This marked the transformation of traditional practices into scientific animal management.

### **1.3.6 Industrial Revolution – Commercialization of Animal Industries**

The Industrial Revolution greatly influenced Economic Zoology. Animal-based activities shifted from small-scale domestic practices to large-scale commercial industries.

Major changes included:

- Establishment of dairy farms and poultry farms
- Mechanized fishing
- Expansion of leather and wool industries
- Development of slaughterhouses and processing units
- Improved transportation of animal products

Mass production increased supply and profitability. Animals became important contributors to national and international trade.

### 1.3.7 Modern Period – Technological Advancement

The 20th century witnessed rapid technological advancement and modernization in animal-based industries. Scientific breeding, balanced feeding, and improved healthcare increased productivity significantly.

Key developments included:

- Artificial insemination
- Selective breeding
- Hatchery technology
- Vaccination and disease control
- Intensive poultry farming
- Scientific aquaculture

Animal husbandry and fisheries became organized sectors contributing greatly to the economy. Research institutions and universities began offering specialized courses in Economic Zoology.

### 1.3.8 Biotechnology Era – Recent Innovations

In recent decades, biotechnology has revolutionized Economic Zoology. Advanced techniques have improved both quality and quantity of animal production.

Modern innovations include:

- Genetic engineering
- Embryo transfer technology
- Cloning
- Molecular disease diagnostics
- Vaccine production
- Biofertilizer and biogas production from animal waste
- Value-added animal products

These technologies enhance efficiency while promoting sustainability and environmental protection.

### 1.3.9 Role of Economic Zoology in India

In India, Economic Zoology has special significance due to the large rural population depending on animal-based occupations.

Important milestones include:

- Operation Flood (White Revolution) in dairy sector
- Blue Revolution in fisheries
- Growth of poultry and egg production
- Development of sericulture and apiculture
- Government livestock improvement programs

These efforts have increased employment, nutrition, and economic stability in rural areas.

### **1.3.10 Present Status and Future Outlook**

Today, Economic Zoology is recognized as an applied and interdisciplinary science. It supports food production, healthcare, industry, and environmental conservation. Sustainable use of animal resources, ethical treatment, and biodiversity conservation are major concerns.

Future developments are expected in:

- Sustainable livestock farming
- Organic aquaculture
- Biological pest control
- Wildlife conservation
- Green technologies

Thus, the subject continues to evolve with changing human needs and scientific progress.

### **1.4 Relationship between Animals and Human Welfare**

Animals have shared a close and inseparable relationship with humans since the beginning of civilization. From primitive times to the modern scientific era, animals have supported human life by providing food, clothing, shelter, employment, medicine, and ecological stability. Human welfare largely depends upon the proper utilization and management of animal resources. Thus, animals are not only biological components of the ecosystem but also valuable economic assets that contribute directly and indirectly to social and economic development.

The relationship between animals and human welfare can be understood under the following subheadings:

#### **1.4.1 Animals as a Source of Food**

Animals provide highly nutritious food materials essential for human growth, development, and health. Animal products are rich in proteins, fats, vitamins, and minerals that are often lacking in plant-based diets.

Milk from cows, buffaloes, and goats is considered a complete food and is widely consumed by people of all age groups. Meat from cattle, sheep, goats, pigs, and poultry provides high-quality protein. Eggs are inexpensive sources of protein and vitamins. Fish and seafood are easily digestible and rich in omega-3 fatty acids. Honey produced by bees serves as both food and medicine.

Thus, animals play a vital role in ensuring food security and balanced nutrition for the growing population.

#### **1.4.2 Animals as a Source of Clothing and Materials**

Animals provide various raw materials used in the manufacture of clothing and other useful products. Wool obtained from sheep and goats is used to make warm garments. Silk produced by silkworms is used in the textile industry for making fine fabrics. Leather from hides and skins is used for shoes, belts, bags, and jackets. Fur and feathers are also used in clothing and decorative items.

These materials support large-scale textile and leather industries and contribute significantly to the economy.

#### **1.4.3 Animals in Agriculture and Farming**

Animals are closely associated with agricultural activities. They assist farmers in various ways and increase agricultural productivity. Bullocks, horses, camels, and buffaloes are traditionally used for ploughing fields, transporting goods, and irrigation work.

Animal dung serves as organic manure, improving soil fertility and crop yield. Earthworms help in soil aeration and vermicomposting. Honey bees promote pollination,

which increases fruit and seed production. Birds and frogs help in controlling harmful insects.

Thus, animals indirectly support crop production and sustainable agriculture.

#### **1.4.4 Animals as a Source of Employment and Income**

Animal-based occupations provide livelihood to millions of people worldwide, especially in rural areas. Activities such as dairy farming, poultry farming, fisheries, apiculture, sericulture, and livestock rearing generate regular income and employment.

Small-scale animal industries help reduce poverty and improve living standards. Dairy cooperatives, fish farms, and poultry units have become important sources of self-employment. Animal product processing industries also create jobs in transportation, marketing, and trade.

Therefore, animals contribute significantly to socio-economic development.

#### **1.4.5 Animals in Medicine and Healthcare**

Animals play a crucial role in the field of medicine and healthcare. Many life-saving drugs, vaccines, and hormones are obtained from animals. For example, insulin is prepared from animal pancreas, and antivenom is produced using horse serum. Cod liver oil, gelatin, and heparin are other medicinal products of animal origin.

Laboratory animals such as rats, mice, rabbits, and guinea pigs are used for medical research and testing new drugs. These studies help scientists understand diseases and develop treatments.

Hence, animals greatly contribute to human health and medical advancement.

#### **1.4.6 Animals in Industry and Commerce**

Several industries depend directly on animal products. The leather industry uses hides and skins. The wool and silk industries produce textiles. Fisheries and poultry industries supply processed food products. Beeswax, lac, bone, horns, and shells are used in handicrafts and manufacturing.

These industries promote trade and export, thereby increasing national income. Animal-based products are valuable commodities in both domestic and international markets.

#### **1.4.7 Animals in Transportation and Security**

Historically, animals were important means of transport. Horses, camels, donkeys, elephants, and bullocks were used for carrying goods and passengers. Even today, animals are used in hilly and rural areas where vehicles cannot reach.

Dogs are used for security, guarding homes, and assisting police and military forces. Sniffer dogs help detect explosives and narcotics. Thus, animals contribute to safety and transportation services.

#### **1.4.8 Animals in Recreation, Culture, and Companionship**

Animals also contribute to human welfare by providing emotional and recreational benefits. Pet animals such as dogs, cats, birds, and fish provide companionship and reduce stress. Zoos, aquariums, and wildlife parks serve educational and recreational purposes.

Animals are often part of cultural and religious traditions, festivals, and sports. This social connection further strengthens the human–animal relationship.

#### **1.4.9 Ecological and Environmental Services of Animals**

Animals help maintain ecological balance and environmental health. They participate in food chains, nutrient cycling, pollination, seed dispersal, and decomposition. Scavengers such as vultures and hyenas clean the environment by consuming dead animals. Earthworms improve soil structure, while bees increase biodiversity.

By maintaining ecosystem stability, animals indirectly support human survival and well-being.

#### **1.4.10 Ethical Responsibility and Animal Welfare**

While animals provide numerous benefits, humans also have a moral responsibility to treat them humanely. Proper care, nutrition, housing, and disease prevention are essential for their welfare. Cruelty and overexploitation should be avoided.

Modern Economic Zoology emphasizes sustainable use and conservation to ensure that animal resources remain available for future generations. Protecting animals ultimately protects human welfare.

### **1.5 Classification of Economically Important Animals**

Animals contribute to human welfare in numerous ways, either by providing direct benefits such as food, materials, and services or by causing damage and economic losses. For proper study and management, it is essential to classify animals according to their economic importance. Such classification helps in understanding their uses, improving productivity, controlling harmful species, and ensuring sustainable utilization.

Economically important animals are broadly classified into two main categories: Beneficial animals and Harmful animals. Each category can further be subdivided based on their functions and economic value.

#### **1.5.1 Beneficial Animals**

Beneficial animals are those that provide direct or indirect advantages to humans. They support human life by supplying food, raw materials, employment, ecological services, and industrial products.

These animals may be grouped into the following subcategories:

##### **(A) Food-Producing Animals**

These animals supply nutritious food essential for human health and survival. They form the backbone of food security and nutrition programs.

Examples:

- Cattle and buffalo – milk and dairy products
- Goat and sheep – meat (mutton/chevon)
- Poultry birds – eggs and chicken
- Fish and prawns – protein-rich seafood
- Bees – honey

These animals provide proteins, fats, vitamins, and minerals necessary for balanced diets. Their products are easily digestible and economically valuable.

### (B) Milk and Dairy Animals

Certain animals are specially reared for milk production. Milk is considered a complete food and is processed into several dairy products.

Examples:

- Cow
- Buffalo
- Goat
- Camel

Milk is used to prepare butter, ghee, cheese, curd, and milk powder. Dairy farming supports rural livelihoods and contributes significantly to national income.

### (C) Draught and Transport Animals

These animals help in agricultural operations and transportation of goods. They reduce human labor and are especially useful in rural and hilly regions.

Examples:

- Bullocks – ploughing and irrigation
- Horses – riding and transport
- Camels – desert transport
- Donkeys and mules – carrying loads
- Elephants – forest work

Such animals play an important role in traditional farming systems.

### (D) Fibre-Producing Animals

Some animals produce natural fibres that are used in the textile industry for making clothes and other products.

Examples:

- Sheep – wool
- Silkworm – silk
- Goat (Pashmina) – fine wool

- Yak and camel – hair

These fibres are used to prepare garments, carpets, blankets, and other materials of commercial value.

#### (E) Industrial Product–Yielding Animals

Many animals provide raw materials for industries and manufacturing processes. Their by-products are used commercially.

Examples:

- Bees – beeswax, royal jelly
- Lac insect – lac and shellac
- Cattle – hides and bones
- Oyster – pearls
- Fish – fish oil and fish meal

These products are used in cosmetics, medicines, polishes, varnishes, handicrafts, and other industries.

#### (F) Beneficial Insects

Certain insects are highly useful to humans and agriculture. They contribute both directly and indirectly.

Examples:

- Honey bees – honey and pollination
- Silkworm – silk
- Lac insect – lac
- Ladybird beetle – biological pest control

Pollination by insects increases crop yield and improves agricultural productivity.

#### (G) Animals Used in Medicine and Research

Some animals are essential in scientific research and pharmaceutical production. They help in developing drugs and vaccines.

Examples:

- Rats and mice – laboratory experiments
- Rabbits and guinea pigs – testing medicines
- Horses – antiserum production
- Snakes – venom for antivenom

These animals play an important role in advancing medical science and healthcare.

#### (H) Ecologically Useful Animals

Certain animals provide indirect benefits by maintaining environmental balance and supporting agriculture.

Examples:

- Earthworms – soil fertility and vermicomposting
- Birds and frogs – insect control
- Scavengers (vultures, hyenas) – cleaning environment
- Bees and butterflies – pollination

Such animals help sustain ecosystems and ensure long-term agricultural productivity.

### 1.5.2 Harmful Animals

Harmful animals are those that cause damage to crops, livestock, stored products, property, or human health. They result in significant economic losses and require control measures.

They may be classified into the following groups:

#### (A) Agricultural Pests

These animals destroy crops and reduce agricultural yield.

Examples:

- Locusts – destroy large crop areas
- Termites – damage plants and wood
- Caterpillars and beetles – feed on leaves
- Rats and wild boars – destroy fields

Such pests cause heavy financial losses to farmers.

#### (B) Stored Grain Pests

These pests damage stored food grains and food materials, reducing both quantity and quality.

Examples:

- Rice weevil
- Grain moth
- Flour beetle
- Rodents

They contaminate food and make it unsuitable for consumption.

#### (C) Disease-Carrying Animals (Vectors)

Some animals transmit diseases to humans and livestock, affecting public health and productivity.

Examples:

- Mosquito – malaria, dengue, filariasis
- Housefly – typhoid, cholera
- Tsetse fly – sleeping sickness
- Ticks and lice – various infections

Control of vectors is essential for preventing epidemics.

#### (D) Parasitic Animals

Parasites live inside or on the body of hosts and cause diseases and weakness.

Examples:

- Tapeworm, roundworm – intestinal diseases
- Liver fluke – liver infection in cattle
- Lice and mites – skin irritation
- Protozoans like Plasmodium – malaria

These parasites reduce productivity of humans and domestic animals.

### (E) Poisonous and Dangerous Animals

Some animals cause injury or death through bites, stings, or attacks.

Examples:

- Snakes
- Scorpions
- Spiders
- Wild carnivores

Though part of the ecosystem, they may pose threats to human safety.

### 1.5.3 Importance of Classification

The classification of economically important animals is essential because it:

- Helps in proper utilization of beneficial animals
- Assists in improving breeding and management
- Aids in controlling harmful animals
- Reduces economic losses
- Supports sustainable resource management
- Provides a systematic approach to study Economic Zoology

Thus, classification forms the foundation for effective planning and development of animal resources.

### 1.6 Importance of Economic Zoology

Economic Zoology plays a vital role in improving human life by providing scientific knowledge for the proper utilization, management, and conservation of animal resources. Animals contribute directly and indirectly to food production, employment, health, industry, and ecological balance. With increasing population pressure and limited natural resources, the efficient use of animals has become essential for sustainable development. Therefore, the study of Economic Zoology is not only academically important but also socially, economically, and environmentally significant.

The importance of Economic Zoology can be understood under the following subpoints:

#### 1.6.1 Ensuring Food Security

One of the primary contributions of Economic Zoology is the production of food. Animal products such as milk, meat, eggs, fish, and honey provide high-quality proteins and essential nutrients required for human growth and health.

Livestock farming, poultry farming, and fisheries increase food availability and help combat malnutrition. Fish and eggs provide affordable protein to economically weaker sections. Thus, animal resources are essential for meeting the dietary needs of the growing population.

### **1.6.2 Improvement of Nutrition and Public Health**

Animal-based foods contain essential amino acids, vitamins (A, D, B12), minerals, and fats that are often absent in plant-based diets. Regular consumption of milk, eggs, and fish improves immunity, growth, and mental development.

Moreover, animals contribute to medical research and the production of vaccines, drugs, hormones, and antivenoms. These medical contributions help control diseases and improve public health standards.

### **1.6.3 Employment Generation and Rural Development**

Animal husbandry and related activities provide employment to millions of people, especially in rural areas. Dairy farming, poultry farming, fisheries, sericulture, apiculture, and lac culture offer self-employment opportunities with low investment.

These activities:

- Increase rural income
- Reduce poverty
- Empower small farmers and women
- Promote cottage and small-scale industries

Thus, Economic Zoology supports socio-economic development and rural upliftment.

### **1.6.4 Contribution to National Economy**

Animal-based industries contribute significantly to the national income. Dairy, fisheries, poultry, leather, wool, silk, and honey industries generate large revenues and support export trade.

For example:

- Dairy industry contributes billions to the economy
- Fisheries earn foreign exchange through seafood export
- Silk and leather industries support manufacturing sectors

Therefore, animal resources play a major role in strengthening the country's economy.

#### **1.6.5 Support to Agriculture**

Animals are closely linked with agriculture. They provide draught power for ploughing, irrigation, and transport. Animal dung is used as organic manure, improving soil fertility and crop yield.

Beneficial animals like bees increase pollination, while birds and frogs control pests naturally. Earthworms enhance soil structure through vermicomposting. Thus, animals help maintain sustainable and eco-friendly farming practices.

#### **1.6.6 Supply of Industrial Raw Materials**

Many industries depend on animal products as raw materials. Wool, silk, leather, wax, lac, bone, horn, and fish oil are used in textile, cosmetic, pharmaceutical, and handicraft industries.

These materials are essential for manufacturing various consumer goods. Hence, Economic Zoology supports industrial growth and commercial development.

#### **1.6.7 Control of Harmful Animals and Pests**

Economic Zoology also helps identify and control harmful animals that cause damage to crops, livestock, and human health. Scientific knowledge of pest biology and life cycles enables effective pest management strategies.

Methods such as biological control, chemical control, and integrated pest management reduce economic losses and protect agriculture. Thus, the subject minimizes the negative impacts of harmful organisms.

#### **1.6.8 Advancement of Scientific Research**

Laboratory animals are essential tools in scientific and medical research. They help in studying physiology, genetics, pharmacology, and disease mechanisms. New drugs, vaccines, and surgical techniques are developed through animal experimentation.

Such research contributes to scientific progress and improves the quality of human life.

### **1.6.9 Conservation of Biodiversity and Wildlife**

Economic Zoology emphasizes the conservation and sustainable use of animal resources. Overexploitation of animals may lead to extinction and ecological imbalance. Wildlife conservation ensures the protection of endangered species and maintenance of biodiversity.

Wildlife tourism and eco-tourism also generate income while promoting environmental awareness. Conservation efforts secure animal resources for future generations.

### **1.6.10 Promotion of Sustainable Development**

Modern Economic Zoology focuses on the sustainable utilization of animal resources without harming the environment. Practices such as organic farming, integrated fish culture, vermicomposting, and waste recycling promote eco-friendly development.

Sustainable approaches ensure long-term benefits and prevent resource depletion. Hence, Economic Zoology supports the concept of “development with conservation.”

## **1.7 Principles of Economic Zoology**

Economic Zoology is based on certain fundamental principles that ensure the efficient, profitable, and sustainable utilization of animal resources. These principles guide the scientific management of animals so that maximum benefits can be obtained without causing harm to the environment or the animals themselves. Proper application of these principles helps increase productivity, reduce losses, maintain animal health, and promote long-term economic stability.

The important principles of Economic Zoology are described below:

### **1.7.1 Principle of Scientific Management**

Animals should be managed using scientific methods rather than traditional or unplanned practices. Scientific knowledge of anatomy, physiology, nutrition, reproduction, and behavior helps in proper care and management.

Scientific management includes:

- Proper housing
- Balanced feeding
- Clean environment
- Regular health monitoring

For example, well-designed cattle sheds and hygienic poultry houses reduce disease and increase productivity.

### **1.7.2 Principle of Selective Breeding and Genetic Improvement**

Improvement of animal breeds is essential to increase production. Selective breeding involves choosing superior animals for reproduction to obtain desirable traits such as high milk yield, fast growth, disease resistance, and better-quality products.

Modern techniques include:

- Cross-breeding
- Artificial insemination
- Embryo transfer
- Genetic selection

For instance, cross-bred cows produce more milk than local breeds. Thus, genetic improvement enhances economic returns.

### **1.7.3 Principle of Proper Nutrition**

Nutrition is the foundation of animal productivity. Animals must receive balanced diets containing carbohydrates, proteins, fats, vitamins, minerals, and water.

Proper feeding:

- Promotes growth
- Improves reproduction
- Increases resistance to diseases
- Enhances quality of products

For example, protein-rich feed increases egg production in poultry and milk yield in dairy cattle.

#### **1.7.4 Principle of Disease Prevention and Health Care**

Healthy animals are more productive and economically beneficial. Disease outbreaks can cause heavy losses. Therefore, prevention is better than cure.

Important health care measures include:

- Vaccination
- Deworming
- Regular veterinary check-ups
- Sanitation and hygiene
- Isolation of sick animals

For example, vaccination against foot-and-mouth disease protects cattle and prevents economic loss.

#### **1.7.5 Principle of Efficient Utilization of Animal Products**

All parts of animals should be utilized efficiently to avoid wastage and increase profitability. Besides primary products, by-products also have economic value.

Examples:

- Milk → butter, cheese, curd
- Hides → leather
- Bones → glue and fertilizers
- Fish waste → fish meal and manure

Complete utilization increases income and supports sustainable resource use.

#### **1.7.6 Principle of Pest and Parasite Control**

Harmful animals and parasites reduce productivity and cause economic damage. Their control is an important principle of Economic Zoology.

Control methods include:

- Chemical control (pesticides)
- Biological control (natural predators)

- Mechanical control (traps)
- Integrated pest management (IPM)

For example, introducing ladybird beetles helps control aphids in crops. Effective control minimizes losses and improves yield.

### **1.7.7 Principle of Conservation of Animal Resources**

Overexploitation of animals may lead to population decline or extinction. Conservation ensures sustainable use of animal resources for future generations.

Conservation measures include:

- Wildlife protection
- Habitat preservation
- Controlled hunting and fishing
- Breeding programs for endangered species

This principle maintains ecological balance and biodiversity.

### **1.7.8 Principle of Environmental Sustainability**

Animal production should not harm the environment. Waste products from farms and industries must be properly managed to avoid pollution.

Sustainable practices include:

- Biogas production from dung
- Vermicomposting
- Organic farming
- Recycling of animal waste

These practices reduce environmental damage and promote eco-friendly development.

### **1.7.9 Principle of Animal Welfare and Ethics**

Animals should be treated humanely and ethically. Cruelty, neglect, and unnecessary suffering must be avoided. Good welfare improves both productivity and public acceptance of animal industries.

Animal welfare includes:

- Proper food and water
- Comfortable shelter
- Freedom from stress and pain
- Veterinary care

Ethical treatment ensures responsible and sustainable use of animals.

#### **1.7.10 Principle of Economic Efficiency**

All animal-based activities should be economically viable. The cost of production must be lower than the income generated. Efficient planning, management, and marketing are essential.

This involves:

- Cost-benefit analysis
- Proper resource allocation
- Use of modern technology
- Reducing losses and wastage

Economic efficiency ensures profitability and long-term sustainability.

#### **1.7.11 Principle of Education and Extension Services**

Farmers and animal keepers must be educated about scientific methods and modern technologies. Training programs, veterinary services, and government extension schemes help disseminate knowledge.

Awareness and skill development improve productivity and management practices. Thus, education is an important foundation for successful Economic Zoology.

### **1.8 Role of Economic Zoology in Sustainable Development**

Sustainable development refers to meeting the needs of the present generation without compromising the ability of future generations to meet their own needs. It emphasizes the balanced use of natural resources while maintaining environmental stability and economic growth. Animals are important natural resources, and their scientific management is essential for sustainable development. Economic Zoology plays a key role in ensuring that animal resources are utilized efficiently, conserved properly, and protected from overexploitation.

### **1.8.1 Sustainable Food Production**

One of the primary goals of sustainable development is to provide adequate food for the growing population. Economic Zoology promotes scientific livestock farming, fisheries, poultry, and apiculture to increase food production without exhausting resources.

Improved breeds, balanced feeding, and modern management techniques increase productivity per animal, reducing pressure on land and water resources. For example, integrated fish farming produces more fish in limited space with minimal environmental impact. Thus, sustainable animal production ensures continuous food supply.

### **1.8.2 Conservation of Animal Biodiversity**

Biodiversity is essential for ecological stability and genetic resources. Overexploitation, hunting, habitat destruction, and pollution threaten many animal species with extinction. Economic Zoology emphasizes wildlife conservation, protection of endangered species, and maintenance of natural habitats. National parks, wildlife sanctuaries, and breeding programs help conserve valuable species. Conserving biodiversity ensures ecological balance and preserves genetic resources for future breeding and research.

### **1.8.3 Eco-friendly Agricultural Practices**

Animals contribute directly to sustainable agriculture. The use of animal dung as organic manure improves soil fertility without harmful chemicals. Vermicomposting by earthworms enhances soil structure and nutrient content.

Pollinators such as bees increase crop yield naturally, while birds and frogs help control pests biologically. These practices reduce dependence on chemical fertilizers and pesticides, promoting eco-friendly farming systems.

### **1.8.4 Waste Recycling and Resource Utilization**

Animal wastes, if unmanaged, can cause environmental pollution. Economic Zoology promotes proper recycling and utilization of animal by-products to reduce waste and increase efficiency.

Examples include:

- Biogas production from cattle dung
- Fish waste converted into fish meal or manure
- Bone and horn used for industrial products
- Compost preparation from farm waste

Recycling converts waste into useful products and supports a circular economy.

### **1.8.5 Reduction of Environmental Pollution**

Scientific animal management helps minimize pollution caused by animal farming. Proper disposal of waste, hygienic housing, and controlled feeding reduce contamination of soil, air, and water.

Techniques such as biogas plants and composting reduce greenhouse gas emissions and improve sanitation. Sustainable practices ensure that animal industries do not harm the environment.

### **1.8.6 Livelihood Security and Poverty Alleviation**

Sustainable development includes improving the economic condition of people, especially in rural areas. Animal-based activities such as dairy farming, poultry farming, fisheries, sericulture, and apiculture provide regular income and employment.

These activities require low investment and provide quick returns, making them suitable for small farmers and landless laborers. By generating employment, Economic Zoology helps reduce poverty and promotes social stability.

### **1.8.7 Promotion of Integrated Farming Systems**

Integrated farming combines crop production with livestock, poultry, and fisheries to maximize productivity and minimize waste. The by-products of one system are used as inputs for another.

- Animal dung used as fertilizer
- Pond water used for irrigation
- Crop residues used as animal feed

This integration reduces costs, improves efficiency, and ensures sustainable use of resources.

### **1.8.8 Development of Renewable Resources**

Animals provide renewable resources such as milk, eggs, wool, honey, and silk that can be produced continuously without destroying the animal. Proper management ensures a constant supply of these resources year after year.

Unlike non-renewable resources, renewable animal products support long-term sustainability and economic stability.

### **1.8.9 Ethical Use and Animal Welfare**

Sustainable development requires ethical treatment of animals. Healthy and stress-free animals show better productivity. Economic Zoology promotes humane care, proper housing, adequate nutrition, and disease prevention.

Animal welfare not only improves production but also ensures moral responsibility toward living organisms. Ethical practices contribute to sustainable and socially acceptable animal use.

### **1.8.10 Application of Modern Technology**

Modern technologies help improve efficiency while conserving resources. Techniques such as artificial insemination, genetic improvement, disease diagnostics, and scientific aquaculture enhance production with fewer inputs.

Biotechnology and modern management reduce resource wastage and increase output, supporting sustainable growth.

## **1.9 Modern Trends in Economic Zoology**

Economic Zoology has undergone remarkable transformation in recent decades due to rapid advances in science and technology. Traditional animal rearing methods have been replaced by modern, scientific, and technology-driven approaches that increase productivity, reduce losses, and ensure sustainability. The growing demand for food, medicine, and industrial raw materials has encouraged the development of improved techniques for efficient utilization of animal resources.

Modern Economic Zoology now integrates biotechnology, genetics, environmental science, veterinary medicine, and information technology to enhance both production and conservation. The important modern trends in Economic Zoology are described below:

### 1.9.1 Genetic Improvement and Selective Breeding

Selective breeding has become more scientific and precise with the help of genetics. High-yielding and disease-resistant breeds are developed to increase productivity.

Modern techniques include:

- Cross-breeding
- Hybridization
- Artificial insemination
- Embryo transfer technology
- Marker-assisted selection

These methods improve milk yield in cattle, egg production in poultry, growth rate in broilers, and disease resistance in livestock. Genetic improvement ensures better quality animals with higher economic returns.

### 1.9.2 Biotechnology and Genetic Engineering

Biotechnology has revolutionized animal production and healthcare. Genetic engineering helps modify animals for improved traits such as rapid growth, higher productivity, and disease resistance.

Applications include:

- Production of transgenic animals
- Vaccine development
- Hormone production
- Cloning
- Molecular diagnostics

For example, genetically improved fish grow faster in aquaculture systems. Biotechnology enhances efficiency and profitability in animal industries.

### 1.9.3 Scientific Dairy and Livestock Farming

Modern dairy and livestock farming now use advanced management systems. Automatic milking machines, balanced feed formulations, and computerized health monitoring improve production.

Practices include:

- Stall feeding
- Silage preparation
- Modern housing systems
- Disease surveillance
- Record keeping

These methods increase milk yield and reduce mortality. Scientific farming ensures hygienic and sustainable production.

#### **1.9.4 Advanced Poultry Production Systems**

Poultry farming has shifted from backyard rearing to commercial large-scale operations. Modern hatcheries, incubators, and controlled housing systems ensure high productivity.

Recent trends include:

- Broiler and layer specialization
- Vaccination schedules
- Nutrient-rich feed
- Climate-controlled sheds
- Automation of feeding and watering

These practices increase egg and meat production with minimum losses.

#### **1.9.5 Modern Fisheries and Aquaculture Techniques**

Aquaculture has expanded with the use of scientific methods and technologies. Fish farming is now carried out intensively to meet protein demand.

Modern practices include:

- Composite fish culture
- Cage and pen culture
- Integrated fish farming
- Biofloc technology
- Hatchery and seed production

These systems maximize production per unit area and promote sustainable fish farming.

### **1.9.6 Integrated Farming Systems**

Integrated farming is becoming popular as an eco-friendly and cost-effective method. It combines livestock, poultry, fisheries, and crop farming into one system.

- Fish ponds fertilized with animal dung
- Crop residues used as animal feed
- Poultry waste used as manure

This approach reduces waste, lowers input costs, and increases total farm income. It supports sustainable agriculture and efficient resource use.

### **1.9.7 Biological Pest Control and Integrated Pest Management (IPM)**

Chemical pesticides have harmful environmental effects. Modern Economic Zoology promotes biological pest control using natural predators and parasites.

Examples include:

- Ladybird beetles to control aphids
- Trichogramma wasps to destroy insect eggs
- Use of microbial pesticides

Integrated Pest Management combines biological, mechanical, and limited chemical methods to control pests safely. This reduces pollution and maintains ecological balance.

### **1.9.8 Value Addition and Processing of Animal Products**

Instead of selling raw products, modern industries process animal products to increase their value and shelf life.

- Milk → cheese, butter, yogurt, milk powder
- Fish → canned fish, fish oil, fish meal
- Meat → sausages, nuggets
- Honey → medicinal products

Value addition increases market demand, profit, and employment opportunities.

### **1.9.9 Waste Utilization and By-product Management**

Modern systems focus on zero waste and full utilization of animal by-products. Animal waste is converted into useful products.

- Biogas from dung
- Organic manure and compost
- Fish waste to fertilizers
- Bones and horns for handicrafts

Proper waste management reduces environmental pollution and increases economic efficiency.

#### **1.9.10 Wildlife Conservation and Eco-tourism**

Modern Economic Zoology emphasizes conservation along with utilization. Wildlife protection programs, breeding centers, and habitat restoration are important trends. Eco-tourism generates income while conserving biodiversity. National parks and wildlife sanctuaries promote both conservation and economic development.

#### **1.9.11 Digital Technology and Smart Farming**

Information technology has introduced precision farming and smart management systems.

- Sensors for animal health monitoring
- Automated feeding systems
- GPS tracking
- Data analysis for production records
- Online marketing of animal products

Digital tools improve efficiency, reduce labor, and increase profits.

# Economically Important Animals

## 1. Introduction

Animals have been closely associated with humans since ancient times and play a vital role in supporting human life and economic development. They provide food, clothing, medicines, labour, industrial raw materials, and ecological services. However, some animals also cause damage to agriculture, health, and property. Therefore, animals that directly or indirectly influence human economy are called economically important animals.

The study of economically important animals helps in their proper utilization, conservation, and control. By understanding their roles, humans can maximize benefits and minimize losses.

### Types of Economically Important Animals

Economically important animals are broadly divided into two main categories:

1. Beneficial Animals

2. Harmful Animals

1. Beneficial Animals

Beneficial animals contribute directly or indirectly to human welfare and economic growth. They support agriculture, industries, medicine, and nutrition.

### 1.1 Food-Producing Animals

These animals provide essential food products rich in proteins, fats, vitamins, and minerals necessary for human health.

- Cow and buffalo – milk
- Goat and sheep – meat
- Poultry – eggs and chicken

- Fish and prawns – seafood
- Honey bees – honey

Animal food improves nutrition and prevents protein deficiency diseases.

## **1.2 Dairy Animals**

Dairy animals are reared mainly for milk production. Milk is considered a complete food.

- Cow
- Buffalo
- Goat
- Camel

Milk is processed into curd, butter, ghee, cheese, and paneer, forming the basis of the dairy industry.

## **1.3 Draught and Transport Animals**

These animals help in agricultural operations and transportation.

- Bullocks – ploughing fields
- Horses – riding and transport
- Camels – desert transport
- Donkeys and mules – load carrying

They reduce manual labour and increase farm efficiency.

## **1.4 Fibre-Producing Animals**

Some animals produce fibres used in the textile industry.

- Sheep – wool

- Silkworm – silk
- Goat (Pashmina) – fine wool
- Camel and yak – hair

These fibres are used for making clothes, carpets, and blankets.

### **1.5 Industrial Product–Yielding Animals**

Many animals supply raw materials for industries.

- Bees – honey and beeswax
- Lac insect – lac and shellac
- Fish – fish oil and fish meal
- Cattle – leather and bones
- Oyster – pearls

These products are used in pharmaceuticals, cosmetics, paints, handicrafts, and other industries.

### **1.6 Beneficial Insects**

Certain insects are extremely useful to humans.

- Honey bees – pollination and honey production
- Silkworm – silk
- Lac insect – lac
- Ladybird beetle – biological pest control

Pollination by insects increases crop yield and agricultural productivity.

### **1.7 Animals Used in Medicine and Research**

Some animals are used for scientific experiments and drug testing.

- Rats and mice – laboratory studies
- Rabbits – vaccine testing
- Horses – antivenom production
- Frogs – physiological experiments

They help in the development of medicines and vaccines.

### **1.8 Ecological Service Animals**

These animals maintain environmental balance.

- Earthworms – soil fertility
- Birds and frogs – pest control
- Vultures – scavenging
- Bees – pollination

They support sustainable ecosystems and agriculture.

### **2. Harmful Animals**

Harmful animals cause damage to crops, stored food, livestock, and human health, leading to economic loss.

#### **2.1 Agricultural Pests**

These animals destroy crops and reduce yield.

- Locusts
- Caterpillars
- Termites
- Rats

They feed on plants, roots, and grains.

## 2.2 Stored Grain Pests

They attack stored food materials.

- Rice weevil
- Grain moth
- Flour beetle
- Rodents

They contaminate and spoil food.

## 2.3 Disease Vectors

These animals transmit diseases.

- Mosquito – malaria, dengue
- Housefly – cholera, typhoid
- Ticks – animal diseases
- Fleas – plague

They pose serious public health problems.

## 2.4 Parasitic Animals

Parasites live on or inside hosts and cause illness.

- Tapeworm
- Roundworm
- Liver fluke
- Lice

They reduce productivity and cause economic losses.

## 2.5 Poisonous and Dangerous Animals

These animals may cause injury or death.

- Snakes
- Scorpions
- Spiders
- Wild animals

They threaten human safety and livestock.

## 2.6 Economic Significance

Economically important animals contribute by:

- Providing food and nutrition
- Supporting agriculture
- Generating employment
- Supplying raw materials
- Maintaining ecological balance
- Assisting in research and medicine

At the same time, harmful animals require control measures to prevent economic loss.

## 2.7 Classification of Economically Important Animals

Economically important animals belong to different groups of the animal kingdom, ranging from simple invertebrates to highly developed vertebrates. Each group contributes to human welfare in different ways. Some provide food and industrial products, while others act as pests or parasites. Therefore, classifying these animals according to their zoological position helps in better scientific understanding, management, and utilization.

Broadly, economically important animals are divided into:

1. Invertebrates
2. Vertebrates

### 2.7.1 Economically Important Invertebrates

Invertebrates form the majority of animal species and contribute significantly to the economy. They provide products like silk, honey, lac, pearls, and also include many pests and parasites.

#### A. Beneficial Invertebrates

##### 1. Protozoa

Although many protozoans are harmful, some are useful in ecological balance and research.

- Paramecium and Amoeba – laboratory studies
- Protozoa in sewage treatment help in decomposition of organic matter

They help in nutrient recycling and environmental purification.

##### 2. Annelids (Earthworms)

Earthworms are called “farmer’s friends”.

Economic importance:

- Improve soil aeration
- Increase soil fertility
- Help in compost formation
- Used in vermiculture and vermicomposting

They enhance agricultural productivity.

##### 3. Molluscs

Several molluscs have food and industrial value.

- Oysters and mussels – edible seafood
- Pearl oyster – pearls
- Shells – lime and ornaments

Pearl culture is an important cottage industry.

#### 4. Crustaceans

Crustaceans contribute greatly to fisheries.

- Prawns
- Crabs
- Lobsters
- Shrimps

They are rich protein sources and have high market value.

#### 5. Insects

Insects are the most economically important group among invertebrates.

Beneficial insects:

- Honey bee – honey, wax, pollination
- Silkworm – silk
- Lac insect – lac
- Ladybird beetle – pest control

They support agriculture, textile, and forest industries.

#### B. Harmful Invertebrates

### 1. Agricultural pests

- Locusts
- Caterpillars
- Aphids
- Termites

They destroy crops and reduce yield.

### 2. Household pests

- Cockroaches
- Bed bugs
- Ants

They contaminate food and spread diseases.

### 3. Disease vectors

- Mosquito
- Housefly
- Flea
- Tick

They transmit malaria, dengue, plague, and other diseases.

### 4. Parasites

- Tapeworm
- Roundworm
- Liver fluke

They infect humans and domestic animals.

## 2.7.2 Economically Important Vertebrates

Vertebrates are highly developed animals and are directly associated with human life. They provide food, labour, medicine, and industrial products.

### A. Beneficial Vertebrates

#### 1. Fishes

Fishes form an important source of animal protein.

Economic uses:

- Food (fresh and dried fish)
- Fish oil
- Fish meal
- Fertilizer

Examples: Rohu, Catla, Hilsa, Tuna, Prawns

Fisheries support millions of livelihoods.

#### 2. Amphibians

Some amphibians are beneficial to agriculture.

- Frogs and toads – feed on insects

They control pests naturally and maintain ecological balance.

#### 3. Reptiles

Certain reptiles provide commercial products.

- Crocodile skin – leather
- Snake venom – medicines and antivenom

- Turtles – meat and shells

Some reptiles also control rodents.

#### 4. Birds

Birds contribute economically in many ways.

- Poultry birds – eggs and meat
- Ducks – eggs and meat
- Geese – feathers
- Owls and hawks – pest control

The poultry industry is one of the fastest-growing sectors.

#### 5. Mammals

Mammals are the most important economic animals.

Uses:

- Milk – cow, buffalo, goat
- Meat – goat, sheep, pig
- Wool – sheep
- Transport – horse, camel, donkey
- Leather – cattle skin
- Laboratory research – rats, rabbits

They provide maximum direct benefits to humans.

#### B. Harmful Vertebrates

Some vertebrates also cause economic loss.

- Rats – destroy crops and stored grains
- Wild boars – damage fields
- Monkeys – spoil fruits and crops
- Stray animals – accidents and property damage

Proper management is necessary to reduce losses.

## **2.8 Methods of Management and Utilization of Economically Important Animals**

The mere identification of economically important animals is not sufficient for achieving maximum benefits. Proper management, scientific utilization, and conservation are necessary to increase productivity and minimize losses. Efficient management practices ensure that beneficial animals provide maximum output, while harmful animals are effectively controlled.

Modern Economic Zoology emphasizes sustainable utilization of animal resources through improved breeding, feeding, healthcare, housing, and environmental management. These methods enhance production, maintain animal health, and protect ecological balance.

### **2.8.1 Selection of Suitable Species and Breeds**

Selection of high-quality breeds is the first step in animal management. Animals with superior genetic traits show better productivity and disease resistance.

Important criteria:

- High milk yield in dairy animals
- Fast growth rate in poultry and fish
- Disease resistance
- Good reproductive capacity
- Adaptability to local climate

- Gir and Sahiwal cows for dairy
- White Leghorn for eggs
- Broiler breeds for meat
- Rohu and Catla for fish culture

Proper selection increases economic returns and reduces maintenance costs.

### **2.8.2 Scientific Breeding Practices**

Breeding improves the genetic quality of animals and enhances productivity.

Methods:

- Selective breeding
- Cross-breeding
- Hybridization
- Artificial insemination
- Embryo transfer

Advantages:

- Higher yield
- Improved quality
- Faster growth
- Better disease resistance

Scientific breeding ensures continuous improvement of livestock and poultry populations.

### **2.8.3 Proper Feeding and Nutrition**

Balanced nutrition is essential for growth, reproduction, and production. Malnutrition reduces productivity and increases disease susceptibility.

Components of balanced feed:

- Carbohydrates
- Proteins
- Fats
- Vitamins
- Minerals
- Water

Examples:

- Green fodder and concentrates for cattle
- Protein-rich feed for poultry
- Supplementary feed in fish ponds

Adequate feeding improves milk yield, egg production, and body weight.

#### **2.8.4 Housing and Shelter Management**

Proper housing protects animals from extreme weather, predators, and diseases.

Features of good housing:

- Adequate space
- Proper ventilation
- Clean and dry floor
- Good drainage
- Protection from heat and cold

Well-designed shelters reduce stress, prevent infections, and improve productivity.

### **2.8.5 Health Care and Disease Control**

Diseases cause heavy economic losses by reducing production and causing mortality. Preventive healthcare is therefore essential.

Measures:

- Regular vaccination
- Deworming
- Periodic health check-ups
- Isolation of sick animals
- Hygienic surroundings

Healthy animals show better growth and production.

### **2.8.6 Hygienic and Sanitary Practices**

Cleanliness prevents the spread of pathogens and improves animal welfare.

Practices include:

- Cleaning sheds daily
- Proper disposal of waste
- Clean drinking water
- Disinfection of equipment
- Personal hygiene of workers

Sanitation reduces disease outbreaks and improves product quality.

### **2.8.7 Modern Farming Techniques**

Modern technologies increase efficiency and production.

- Automatic milking machines
- Hatchery incubators
- Biofloc fish culture
- Cage and pen culture
- Climate-controlled poultry sheds

These methods save labour, reduce losses, and increase profitability.

### **2.8.8 Processing and Value Addition of Animal Products**

Processing increases shelf life and market value of animal products.

- Milk → cheese, butter, ghee
- Meat → sausages, nuggets
- Fish → dried fish, fish oil
- Honey → medicinal products
- Hides → leather goods

Value addition generates higher income and employment opportunities.

### **2.8.9 Conservation and Sustainable Utilization**

Overexploitation of animals can cause depletion of natural resources and disturb ecological balance. Conservation helps ensure their long-term availability through measures such as wildlife protection, controlled hunting and fishing, breeding programs, habitat protection, and sustainable harvesting. These efforts help maintain biodiversity and ecological stability.

### **2.8.10 Control of Harmful Animals**

Harmful animals need to be properly managed to minimize economic losses and protect agriculture, livestock, and human health. Various control methods are used for this purpose. Mechanical methods include the use of traps, barriers, and nets to physically

prevent or capture pests. Chemical methods involve pesticides and other toxic substances that help in reducing pest populations quickly and effectively. Biological control focuses on using natural enemies such as predators, parasites, and pathogens to keep harmful animal populations under control in an eco-friendly way. In addition, Integrated Pest Management (IPM) combines multiple control strategies in a balanced manner to achieve long-term, sustainable pest control while minimizing environmental damage.

#### **2.8.11 Record Keeping and Farm Management**

Record keeping and farm management play a vital role in ensuring the efficiency, sustainability, and profitability of any farming enterprise. Maintaining accurate and systematic records helps farmers monitor productivity, identify strengths and weaknesses, and make informed decisions for future planning and improvement. Important records typically include production data to track output levels, breeding history to manage genetic quality and reproduction cycles, health records to monitor disease prevention and treatment, feed consumption logs to evaluate nutritional efficiency and costs, and financial accounts to assess overall economic performance. Proper documentation not only supports day-to-day farm operations but also aids in long-term strategic planning and resource management.

# Animal Husbandry and Human Welfare

## 3.1 Introduction

Animal husbandry is one of the oldest and most important occupations of humankind. Since ancient times, humans have domesticated animals for food, clothing, labour, and companionship. With the growth of civilization, animal rearing has developed into a scientific and organized activity aimed at improving the quality and productivity of domestic animals. Today, animal husbandry plays a crucial role in agriculture, rural development, nutrition, and the national economy.

Animal husbandry involves the scientific management of livestock such as cattle, buffalo, sheep, goats, pigs, and poultry for the production of milk, meat, eggs, wool, leather, and other useful products. It includes breeding, feeding, housing, healthcare, and proper utilization of animals. By adopting improved techniques and modern technologies, animal husbandry ensures higher production and better income for farmers.

In developing countries like India, where a large section of the population depends on agriculture, animal husbandry provides additional employment opportunities and serves as a supplementary source of income. It also helps in poverty alleviation, food security, and sustainable rural development. Thus, animal husbandry directly contributes to human welfare.

## 3.2 Meaning and Definition of Animal Husbandry

Animal husbandry refers to the systematic and scientific practice of rearing, breeding, feeding, and managing domesticated animals to obtain maximum economic benefits in the form of useful products and services. It involves proper care of animals from birth to maturity with special attention to their health, nutrition, housing, and reproduction.

In simple terms, animal husbandry is the art and science of managing animals so that they remain healthy, productive, and beneficial to humans. It plays an important role in agriculture by supplying food, raw materials, manure, draught power, and income to farmers.

Animal husbandry is not limited to livestock rearing alone but also includes allied activities such as dairy farming, poultry farming, sheep and goat rearing, piggery, and animal healthcare.

### Definition of Animal Husbandry

Animal husbandry has been defined by various authors and institutions in slightly different ways. Some commonly accepted definitions are:

1. Animal husbandry is the branch of agricultural science that deals with the breeding, feeding, care, and management of domestic animals for economic production and human welfare.

2. According to ICAR, Animal husbandry is the scientific management of livestock for obtaining maximum production of milk, meat, eggs, wool, and other animal products.

3. According to Banerjee (Textbook of Animal Husbandry), Animal husbandry is concerned with the principles and practices involved in the efficient management of domesticated animals.

4. According to FAO, Animal husbandry includes all practices related to the care, feeding, breeding, and health management of farm animals.

### 3.3 Objectives of Animal Husbandry

Animal husbandry is not merely the rearing of animals but a scientific and planned activity aimed at improving productivity, profitability, and sustainability. The main purpose of animal husbandry is to obtain maximum economic benefits while ensuring proper animal health and welfare. By adopting modern breeding, feeding, and management techniques, livestock production can be increased to meet the growing demands of food and raw materials for the human population.

The objectives of animal husbandry are discussed below:

#### 3.3.1 To Increase Production of Animal Products

One of the primary objectives of animal husbandry is to enhance the production of useful animal products such as:

- Milk
- Meat
- Eggs
- Wool
- Silk
- Honey
- Leather

Increased production ensures adequate supply of food and raw materials for the growing population. Higher yields improve the income of farmers and contribute to the national economy.

### **3.3.2 To Improve Breeds of Livestock**

Improvement of animal breeds is essential for obtaining better quality and higher productivity. Superior breeds show faster growth, higher yield, and greater resistance to diseases.

Methods include:

- Selective breeding
- Cross-breeding
- Hybridization
- Artificial insemination

Breed improvement results in animals that are more efficient and economically profitable.

### **3.3.3 To Provide Balanced Nutrition**

Proper feeding is necessary for healthy growth and productivity of animals. Malnourished animals show poor growth and low production.

Animal husbandry aims to:

- Provide balanced rations
- Supply essential nutrients
- Maintain proper feeding schedules
- Utilize fodder efficiently

Adequate nutrition improves milk yield, egg production, and weight gain.

### **3.3.4 To Maintain Good Health and Prevent Diseases**

Diseases reduce productivity and cause heavy economic losses. Therefore, maintaining animal health is an important objective.

Preventive measures:

- Vaccination
- Deworming
- Regular health check-ups
- Sanitation and hygiene
- Veterinary care

Healthy animals are more productive and have a longer lifespan.

### **3.3.5 To Provide Proper Housing and Management**

Animals require comfortable and safe living conditions. Proper housing protects them from harsh weather, predators, and infections.

Good housing should ensure:

- Adequate ventilation
- Cleanliness
- Proper drainage
- Sufficient space
- Protection from extreme temperatures

Scientific management reduces stress and increases productivity.

### **3.3.6 To Generate Employment Opportunities**

Animal husbandry provides employment to a large number of people, especially in rural areas.

Employment areas include:

- Dairy farming
- Poultry farming
- Sheep and goat rearing
- Fisheries
- Veterinary services

It promotes self-employment and improves rural livelihoods.

### **3.3.7 To Provide Supplementary Income to Farmers**

Livestock rearing acts as an additional source of income along with agriculture.

Farmers can earn regularly by selling:

- Milk
- Eggs
- Meat
- Wool
- Animal by-products

This reduces financial risk and ensures economic stability.

### **3.3.8 To Support Agricultural Activities**

Animals play an important role in farming operations.

- Draught power for ploughing and transport
- Dung for organic manure
- Biogas production
- Crop residue utilization

Thus, livestock and agriculture are closely interrelated.

### **3.3.9 To Supply Raw Materials for Industries**

Animal products serve as raw materials for many industries.

- Wool → textile industry
- Leather → footwear industry
- Bones → fertilizers
- Horns → handicrafts
- Fat → soap and cosmetics

These industries contribute significantly to economic development.

### **3.3.10 To Ensure Food Security and Nutritional Security**

Animal products are rich in high-quality proteins and essential nutrients. Animal husbandry aims to meet the nutritional needs of the population.

Milk, meat, eggs, and fish help:

- Prevent malnutrition
- Improve child growth
- Maintain public health

Thus, it supports food and nutritional security.

### **3.3.11 To Promote Sustainable and Scientific Utilization**

Modern animal husbandry emphasizes sustainable practices that do not harm the environment.

- Proper waste management
- Conservation of indigenous breeds
- Integrated farming systems
- Eco-friendly practices

These ensure long-term availability of animal resources.

## **3.4 Scope of Animal Husbandry**

### **Introduction**

Animal husbandry has a very wide scope in modern agriculture and rural development. It is not restricted only to the rearing of cattle and livestock but includes a variety of activities related to the production, management, improvement, and utilization of domestic animals and their products. With increasing population, rising demand for animal protein, and the need for employment opportunities, the scope of animal husbandry has expanded considerably.

Today, animal husbandry integrates scientific knowledge from zoology, veterinary science, genetics, nutrition, biotechnology, and management to ensure efficient and sustainable production. It contributes significantly to food security, economic growth, and human welfare.

The major areas included under the scope of animal husbandry are described below.

### **3.4.1 Dairy Farming**

Dairy farming deals with the breeding and management of cattle and buffaloes for milk production. It is one of the most important branches of animal husbandry.

Activities include:

- Selection of high-yielding breeds
- Feeding balanced rations
- Milking and milk processing
- Disease control and health care

Milk and milk products such as curd, butter, ghee, cheese, and paneer form an essential part of the human diet. The dairy industry provides regular income and employment to rural families.

### **3.4.2 Poultry Farming**

Poultry farming involves the rearing of domestic birds for eggs and meat. It is a fast-growing and profitable sector of animal husbandry.

- Hen
- Duck
- Turkey
- Quail

Poultry farming requires less space and investment and provides quick returns. Eggs and chicken meat are rich sources of protein and widely consumed.

### **3.4.3 Sheep and Goat Rearing**

Sheep and goat farming is suitable for dry and semi-arid regions. These animals require less maintenance and adapt well to harsh conditions.

- Meat
- Wool
- Milk
- Skin

Sheep and goats provide livelihood support to small and marginal farmers and contribute to the wool and meat industries.

### **3.4.4 Piggery Farming**

Piggery involves the rearing of pigs mainly for meat production. Pigs grow rapidly and efficiently convert feed into meat.

- High reproductive rate
- Fast growth
- Low investment
- High meat yield

Pork is an important source of animal protein in many countries. Piggery farming improves the economic status of farmers.

### **3.4.5 Fisheries and Aquaculture**

Fisheries include the capture and culture of fish and other aquatic organisms. Aquaculture involves scientific fish farming in ponds, tanks, or reservoirs.

- Fish
- Prawns
- Crabs
- Molluscs

Fish is a cheap and nutritious source of protein. Fisheries provide employment to millions of people and contribute significantly to the national economy.

### **3.4.6 Apiculture (Bee Keeping)**

Apiculture is the rearing and management of honey bees for honey and beeswax production.

Importance:

- Honey production
- Beeswax for industrial use
- Pollination of crops

Pollination increases agricultural yield and improves crop quality. Apiculture is a profitable cottage industry.

### **3.4.7 Sericulture (Silkworm Rearing)**

Sericulture involves the cultivation of silkworms for silk production.

- Rearing of silkworm larvae
- Feeding with mulberry leaves
- Collection of cocoons

- Silk extraction

Silk is an important textile fibre with high commercial value. Sericulture provides employment in rural areas.

#### **3.4.8 Veterinary Science and Animal Health Care**

Animal husbandry includes veterinary services for maintaining animal health and preventing diseases.

Services include:

- Vaccination
- Treatment of diseases
- Surgery
- Diagnostic tests
- Disease prevention programs

Healthy livestock ensures higher productivity and reduced mortality.

#### **3.4.9 Breeding and Genetic Improvement**

Modern animal husbandry focuses on genetic improvement of animals to enhance productivity.

Techniques:

- Selective breeding
- Cross-breeding
- Artificial insemination
- Embryo transfer

These methods produce superior breeds with better performance and disease resistance.

#### **3.4.10 Feed and Fodder Management**

Adequate feed supply is essential for livestock production. Feed and fodder management forms an important part of animal husbandry.

- Cultivation of fodder crops
- Preparation of silage and hay
- Balanced feed formulation

- Supplementary nutrition

Proper feeding increases growth and productivity.

#### **3.4.11 Processing and Marketing of Animal Products**

Animal husbandry also covers processing, preservation, and marketing of products.

Examples:

- Milk processing (dairy products)
- Meat processing
- Leather and wool industries
- Packaging and marketing

Value addition increases shelf life and profit.

#### **3.4.12 Waste Utilization and By-product Management**

Animal wastes are utilized effectively for environmental and economic benefits.

Examples:

- Dung → manure
- Biogas production
- Bone meal and blood meal
- Compost preparation

Waste utilization reduces pollution and promotes sustainable farming.

### **3.5 Importance of Animal Husbandry**

Animal husbandry plays a vital role in the economic, nutritional, and social development of human society. Since ancient times, domestic animals have served as a major source of food, labour, and livelihood. With the rapid growth of population and increasing demand for animal-based products, the importance of animal husbandry has increased tremendously. It is now considered one of the most essential components of agriculture and rural development.

Animal husbandry contributes not only to food production but also to employment, income generation, industrial growth, and environmental sustainability. Thus, it has a direct and positive impact on human welfare.

The importance of animal husbandry can be understood under the following aspects:

### **3.5.1 Source of Nutritious Food**

One of the primary importance of animal husbandry is the supply of high-quality, nutritious food products.

Animal foods include:

- Milk
- Meat
- Eggs
- Fish

These foods are rich in:

- Proteins
- Essential amino acids
- Vitamins
- Minerals
- Fats

Animal proteins are easily digestible and help in body growth, tissue repair, and disease resistance. Regular consumption prevents malnutrition and protein deficiency disorders.

### **3.5.2 Employment Generation**

Animal husbandry provides employment opportunities to millions of people, particularly in rural and semi-urban areas.

Employment sectors:

- Dairy farms
- Poultry farms
- Fisheries

- Sheep and goat rearing
- Veterinary services
- Processing industries

It promotes self-employment and supports landless labourers, women, and small farmers.

### **3.5.3 Supplementary Source of Income**

Livestock farming provides an additional and regular income to farmers along with crop production.

Income sources:

- Sale of milk
- Sale of eggs and meat
- Sale of wool and hides
- Sale of animal by-products

This reduces dependency on seasonal crops and ensures economic stability throughout the year.

### **3.5.4 Support to Agriculture**

Animal husbandry and agriculture are closely interrelated. Animals assist farming operations directly and indirectly.

Contributions:

- Draught power for ploughing and irrigation
- Transport of goods
- Organic manure from dung
- Biogas production
- Utilization of crop residues as feed

Thus, livestock farming strengthens agricultural productivity.

### **3.5.5 Industrial Development**

Many industries depend on animal products as raw materials.

Examples:

- Wool → textile industry
- Leather → footwear and bags
- Bones → fertilizers and glue
- Fat → soap and cosmetics
- Silk → silk industry

These industries generate employment and contribute to national income.

### **3.5.6 Export Earnings and National Economy**

Animal products are important export commodities that earn foreign exchange.

Exported products:

- Meat and meat products
- Dairy products
- Leather goods
- Wool and silk
- Fish and seafood

The livestock sector contributes significantly to the Gross Domestic Product (GDP) of many countries.

### **3.5.7 Utilization of Wastes**

Animal husbandry helps in converting agricultural wastes into useful products.

Examples:

- Crop residues → animal feed
- Dung → manure and biogas
- Slaughterhouse waste → fertilizers

This reduces environmental pollution and promotes sustainable farming practices.

### **3.5.8 Soil Fertility Improvement**

Animal dung and urine are rich in organic matter and nutrients. They are used as natural fertilizers.

Benefits:

- Improves soil structure

- Increases water-holding capacity
- Enhances crop yield
- Reduces chemical fertilizer use

Thus, livestock farming supports eco-friendly agriculture.

### **3.5.9 Social and Cultural Importance**

Animals have social, cultural, and emotional significance in human life.

Examples:

- Cows and bulls in rural households
- Horses and elephants in ceremonies
- Pets for companionship
- Animals used in sports and festivals

They contribute to human recreation and emotional well-being.

### **3.5.10 Women Empowerment and Rural Development**

Animal husbandry activities such as dairy, poultry, and goat rearing can be easily managed by women and small farmers.

Benefits:

- Home-based employment
- Financial independence
- Skill development
- Improvement in family income

Thus, it promotes gender equality and rural upliftment.

### **3.5.11 Ecological and Environmental Balance**

Livestock play an important role in maintaining ecological balance.

Roles:

- Recycling nutrients
- Maintaining biodiversity
- Supporting integrated farming systems
- Providing organic manure

Scientific animal husbandry promotes sustainable agriculture without harming the environment.

### **3.5.2 Employment Generation**

Animal husbandry provides employment to millions of people, especially in rural areas.

Activities include:

- Dairy farming
- Poultry farming
- Fish culture
- Wool and leather industries

It creates self-employment and reduces rural poverty.

### **3.5.3 Supplementary Income for Farmers**

Livestock farming provides additional income alongside crop farming. Even small and marginal farmers can maintain animals for economic support.

For example:

- Sale of milk daily
- Sale of eggs and meat
- Sale of wool and hides

Thus, it improves financial stability.

### **3.5.4 Support to Agriculture**

Animals assist agriculture directly and indirectly.

Contributions:

- Draught power for ploughing
- Transportation of goods
- Dung used as manure
- Biogas production

Animal manure improves soil fertility and crop yield.

### **3.5.5 Industrial Raw Materials**

Animals supply many industrial products.

Examples:

- Wool – textile industry
- Leather – footwear and bags
- Bones – fertilizers
- Horns – handicrafts

These materials support various industries and generate revenue.

### **3.5.6 Export and National Economy**

Animal products contribute significantly to national income through exports.

Examples:

- Meat products
- Leather goods
- Wool
- Silk
- Dairy products

Export of these products earns foreign exchange.

### **3.5.7 Social and Cultural Importance**

Animals are closely linked with human culture and traditions. They are used in festivals, sports, transport, and companionship.

Examples:

- Horses in ceremonies
- Cows in rural households
- Pets for emotional support

Thus, animals contribute to social well-being.

## **3.6 Livestock Management Practices**

Introduction

Efficient livestock production depends largely on proper management practices. Livestock management refers to the scientific care, supervision, and handling of domestic

animals to ensure their health, comfort, reproduction, and maximum productivity. Good management practices reduce mortality, prevent diseases, increase production, and improve the quality of animal products.

Modern livestock management integrates principles of zoology, veterinary science, nutrition, genetics, and environmental management. Scientific methods are essential for obtaining higher yields of milk, meat, eggs, wool, and other animal products while maintaining animal welfare.

The important livestock management practices are discussed below.

### **3.6.1 Selection of Breeds**

Breed selection is the first and most important step in livestock management. The productivity of animals largely depends on their genetic potential.

Criteria for selection:

- High milk or meat yield
- Fast growth rate
- Disease resistance
- Adaptability to local climate
- Good reproductive capacity

Example:

- Gir and Sahiwal cows for milk
- Leghorn hens for eggs
- Merino sheep for wool

Selection of superior breeds ensures better performance and profitability.

### **3.6.2 Housing Management**

Proper housing provides protection and comfort to animals. A well-designed shelter protects animals from extreme weather, predators, and diseases.

Characteristics of good housing:

- Adequate ventilation
- Sufficient light

- Clean and dry floor
- Proper drainage
- Enough space

Importance:

- Reduces stress
- Prevents infections
- Improves growth and production

Good housing enhances animal health and productivity.

### **3.6.3 Feeding and Nutrition Management**

Balanced feeding is essential for maintaining growth, reproduction, and production. Animals require adequate nutrients such as proteins, carbohydrates, fats, vitamins, minerals, and water.

Types of feed:

- Green fodder
- Dry fodder
- Concentrates
- Mineral supplements

Importance:

- Improves milk and meat production
- Enhances immunity
- Prevents nutritional disorders

Proper nutrition ensures efficient utilization of feed and better economic returns.

### **3.6.4 Breeding Management**

Breeding management aims at improving the genetic quality and productivity of livestock.

Methods:

- Natural mating
- Artificial insemination
- Cross-breeding

- Selective breeding
- Embryo transfer

Objectives:

- Produce superior offspring
- Increase yield
- Improve disease resistance

Scientific breeding helps in rapid genetic improvement of animals.

### **3.6.5 Health Care Management**

Healthy animals are more productive. Disease prevention and timely treatment are essential aspects of livestock management.

Health care measures:

- Regular vaccination
- Deworming
- Periodic health check-ups
- Isolation of sick animals
- Sanitation and hygiene

Benefits:

- Reduces mortality
- Increases productivity
- Prevents disease outbreaks

Veterinary care plays a crucial role in maintaining herd health.

### **3.6.6 Cleanliness and Sanitation**

Maintaining cleanliness in animal sheds and surroundings is essential for disease control.

Practices include:

- Daily cleaning of sheds
- Removal of dung and waste
- Disinfection of floors and equipment
- Clean water supply

Proper sanitation prevents the growth of harmful microorganisms and ensures a healthy environment.

### **3.6.7 Record Keeping**

Systematic record keeping helps in efficient farm management and decision-making.

Records maintained:

- Milk yield
- Growth rate
- Breeding history
- Vaccination schedule
- Feed consumption
- Disease records

These records help in identifying productive animals and improving farm efficiency.

### **3.6.8 Care of Young Animals**

Young animals require special attention for proper growth and development.

Care includes:

- Feeding colostrum after birth
- Balanced nutrition
- Vaccination
- Protection from cold and diseases

Proper care reduces mortality and ensures healthy future livestock.

### **3.6.9 Waste Management**

Animal wastes must be properly handled to maintain hygiene and environmental safety.

Utilization:

- Dung → manure
- Biogas production

- Compost preparation  
Waste management reduces pollution and generates additional income.

### **3.6.10 Marketing and Economic Management**

Efficient marketing ensures better profit from animal products.

Activities:

- Proper storage and preservation
- Transportation
- Value addition (processing milk/meat)
- Selling at competitive prices

Good marketing practices increase farmers' income and sustainability.

## **3.7 Dairy Farming**

Dairy farming is one of the most important branches of animal husbandry concerned with the rearing and management of milch animals for milk production. It plays a vital role in supplying nutritious food to the population and providing regular income and employment to farmers. Milk and milk products form an essential part of the human diet due to their high nutritive value.

In many countries, especially India, dairy farming is an integral component of rural life and agricultural economy. Scientific dairy farming practices help in increasing milk production, improving animal health, and enhancing the economic status of farmers. With the development of modern techniques such as artificial insemination, balanced feeding, and disease control, dairy farming has become more efficient and profitable.

### **3.7.1 Meaning of Dairy Farming**

Dairy farming refers to the scientific management of milch animals such as cows and buffaloes for the production, processing, and distribution of milk and milk products.

It includes:

- Selection of high-yielding breeds
- Proper feeding and housing
- Health care and disease control

- Hygienic milking
- Milk processing and marketing

Thus, dairy farming combines animal care with business management.

### 3.7.2 Importance of Dairy Farming

Dairy farming holds great importance in human welfare and the national economy.

Major importance:

#### 1. Nutritious food supply

Milk is considered a complete food because it contains:

- Proteins
- Fats
- Lactose
- Vitamins
- Minerals (Calcium, Phosphorus)

It is essential for children, pregnant women, and elderly people.

#### 2. Regular income

Milk can be sold daily, providing continuous income to farmers.

#### 3. Employment opportunities

It generates jobs in:

- Milk production
- Collection centers
- Processing plants
- Transportation
- Dairy industries

#### 4. Support to agriculture

- Dung used as manure
- Draught power (in some regions)
- Crop residues used as cattle feed

## 5. Industrial development

Milk is processed into:

- Butter
- Ghee
- Cheese
- Paneer
- Ice cream
- Milk powder

These products support dairy-based industries.

### 3.7.3 Milch Animals of Dairy Farming

Different animals are used for milk production depending on region and climate.

Common milch animals:

Cattle (Cows)

- Gir
- Sahiwal
- Red Sindhi
- Holstein Friesian
- Jersey

Buffaloes

- Murrah
- Mehsana
- Surti
- Jaffarabadi

Buffalo milk contains higher fat content, while cow milk is easily digestible.

### 3.7.4 Breed Selection in Dairy Farming

Selection of good breeds is essential for high milk yield.

Desirable characters:

- High milk production

- Regular calving
- Disease resistance
- Good body size
- Adaptability to climate

Cross-breeding of indigenous and exotic breeds is often practiced to improve productivity.

### **3.7.5 Housing Management in Dairy Farming**

Proper housing ensures comfort and protection to dairy animals.

Requirements:

- Clean and dry sheds
- Adequate ventilation
- Proper drainage
- Sufficient space
- Protection from heat, cold, and rain

Benefits:

- Reduces stress
- Prevents diseases
- Increases milk yield

Good housing promotes better health and productivity.

### **3.7.6 Feeding Management**

Balanced feeding is very important for milk production. Lactating animals require more nutrients.

Types of feed:

#### 1. Roughage

- Green fodder
- Dry straw
- Silage

#### 2. Concentrates

- Grains
- Oil cakes
- Bran
- Mineral mixture

### 3. Water

Clean drinking water must be available at all times.

Importance:

- Increases milk yield
- Improves health
- Prevents nutritional disorders

Proper feeding enhances both quality and quantity of milk.

### 3.7.7 Milking Management

Milking should be done hygienically and regularly.

Practices:

- Wash hands and udder before milking
- Use clean utensils
- Fixed milking time
- Gentle handling of animals

Methods:

- Hand milking
- Machine milking

Clean milking prevents contamination and ensures good quality milk.

### 3.7.8 Health Care and Disease Control

Disease prevention is essential for successful dairy farming.

Common diseases:

- Mastitis
- Foot and mouth disease
- Anthrax

- Black quarter

Preventive measures:

- Regular vaccination
- Deworming
- Clean environment
- Veterinary check-ups

Healthy animals produce more milk and reduce economic losses.

### **3.7.9 Milk Processing and Preservation**

Fresh milk is highly perishable, so it must be processed and preserved.

Methods:

- Pasteurization
- Refrigeration
- Sterilization
- Conversion into dairy products

Processing increases shelf life and market value.

### **3.7.10 Role of Dairy Farming in Rural Development**

Dairy farming plays a significant role in rural upliftment.

- Self-employment
- Women empowerment
- Poverty reduction
- Regular cash flow
- Improvement in living standards

Cooperative movements like dairy cooperatives help small farmers to market their milk efficiently.

Great — let us continue with the next section of Chapter 3 in the same detailed, textbook style.

## **3.8 Poultry Farming**

Poultry farming is an important branch of animal husbandry concerned with the rearing, breeding, and management of domestic birds for the production of eggs and meat.

It is one of the fastest-growing and most profitable livestock industries in the world. Poultry farming provides highly nutritious food at a low cost and requires comparatively less space, time, and investment than other livestock enterprises.

Due to rapid population growth and increasing demand for protein-rich food, poultry farming has gained great importance in both rural and urban areas. Scientific poultry management has led to improved breeds, better feeding practices, disease control, and higher productivity. Thus, poultry farming contributes significantly to food security, employment, and economic development.

### **3.8.1 Meaning of Poultry Farming**

Poultry farming refers to the scientific rearing and management of domestic birds for eggs, meat, feathers, and other products.

It includes:

- Breed selection
- Feeding and nutrition
- Housing
- Health care
- Egg production
- Meat processing
- Marketing

It is considered a quick-return and small-scale enterprise suitable for farmers and entrepreneurs.

### **3.8.2 Importance of Poultry Farming**

Poultry farming is important for several reasons related to nutrition, economy, and rural development.

Major importance:

#### **1. Source of nutritious food**

Eggs and poultry meat are rich in:

- High-quality proteins

- Vitamins (A, B-complex, D)
- Minerals
- Essential amino acids

Eggs are considered a complete and balanced food.

## 2. Quick income

Poultry birds grow rapidly and start laying eggs within a few months, giving fast returns.

## 3. Employment generation

It provides jobs in:

- Hatcheries
- Feed industries
- Poultry farms
- Processing units
- Marketing

## 4. Low investment

Requires:

- Less land
- Small capital
- Simple management

## 5. Utilization of waste

Poultry droppings are used as manure and fertilizer.

Thus, poultry farming improves the economic condition of small and marginal farmers.

### 3.8.3 Types of Poultry Birds

Different types of birds are reared for various purposes.

Common poultry birds:

1. Chicken (most common)

- For eggs and meat
    2. Ducks
  - For eggs and meat in wet areas
    3. Turkey
  - Mainly for meat
    4. Quail
  - For eggs and meat
    5. Goose
  - Meat and feathers
- Among these, chickens contribute the maximum production.

#### **3.8.4 Breeds of Poultry Birds**

Selection of improved breeds is essential for high productivity.

Layers (egg-type breeds)

- White Leghorn
- Minorca
- Rhode Island Red

Broilers (meat-type breeds)

- Cornish
- Plymouth Rock
- Broiler hybrids

Dual-purpose breeds

- New Hampshire
- Australorp

Layers are selected for egg production, broilers for meat, and dual-purpose breeds for both.

#### **3.8.5 Housing Management**

Proper housing protects birds from extreme weather, predators, and diseases.

Requirements of poultry house:

- Good ventilation
- Adequate light
- Proper drainage
- Clean floor
- Sufficient space

Systems of housing:

- Free-range system
- Semi-intensive system
- Deep litter system
- Cage system (battery system)

Good housing reduces stress and improves egg and meat production.

### **3.8.6 Feeding and Nutrition**

Balanced feeding is essential for rapid growth and high egg production.

Types of feed:

- Starter feed (for chicks)
- Grower feed
- Layer feed
- Broiler feed

Nutrients required:

- Proteins
- Carbohydrates
- Fats
- Vitamins
- Minerals
- Clean water

Proper feeding increases growth rate, egg number, and meat quality.

### **3.8.7 Breeding and Incubation**

Efficient breeding ensures a continuous supply of chicks.

Methods:

- Natural incubation (broody hens)
- Artificial incubation (incubators)

Artificial incubators maintain:

- Proper temperature
- Humidity
- Ventilation

They allow large-scale hatching of eggs and increase production efficiency.

### **3.8.8 Health Care and Disease Control**

Disease control is crucial because poultry diseases spread rapidly.

Common diseases:

- Ranikhet disease
- Fowl pox
- Coccidiosis
- Marek's disease
- Avian influenza

Preventive measures:

- Vaccination
- Sanitation
- Isolation of sick birds
- Proper ventilation
- Balanced diet

Healthy birds give better production and reduce economic losses.

### **3.8.9 Egg Production and Management**

Egg production is the primary goal in layer farming.

Practices:

- Regular feeding
- Adequate light exposure

- Clean nesting boxes
- Collection of eggs several times daily

Proper management improves both the number and quality of eggs.

### **3.8.10 Marketing and Processing**

After production, eggs and meat must be properly processed and marketed.

Includes:

- Cleaning and grading eggs
- Refrigeration
- Packaging
- Transportation
- Sale through markets or cooperatives

Processing increases shelf life and profit.

### **3.8.11 Advantages of Poultry Farming**

Advantages:

- Quick returns
- Low investment
- Less space required
- High feed conversion efficiency
- Easy management
- Regular income

Because of these benefits, poultry farming is ideal for rural youth and women entrepreneurs.

## **3.9 Sheep and Goat Farming**

Sheep and goat farming is an important branch of animal husbandry that involves the scientific rearing and management of sheep and goats for meat, milk, wool, skin, and manure. These animals are commonly referred to as “small ruminants” and play a vital role in the livelihood of small and marginal farmers, especially in rural, dry, and semi-arid regions.

Sheep and goats are hardy animals that can survive under harsh environmental conditions with minimal care and low investment. They efficiently convert poor-quality fodder and agricultural wastes into valuable animal products. Due to their adaptability, fast growth, and high reproductive rate, sheep and goat farming has become a profitable and sustainable livestock enterprise.

### **3.9.1 Meaning of Sheep and Goat Farming**

Sheep and goat farming refers to the scientific breeding, feeding, and management of sheep and goats to obtain useful products such as meat, wool, milk, skin, and manure.

It includes:

- Breed selection
- Feeding and grazing management
- Housing
- Health care
- Reproduction
- Marketing of products

It is also known as small ruminant farming.

### **3.9.2 Importance of Sheep and Goat Farming**

Sheep and goat farming has great economic and social importance, particularly in rural areas.

Major importance:

#### 1. Source of meat

- Mutton and chevon (goat meat) are highly nutritious and widely consumed.

#### 2. Source of wool

- Sheep provide wool used in the textile industry.

#### 3. Source of milk

- Goat milk is easily digestible and suitable for children and patients.

#### 4. Income generation

- Regular sale of animals and products provides steady income.

#### 5. Employment

Provides livelihood to shepherds, landless labourers, and tribal communities.

#### 6. Low investment

- Requires minimal capital and simple management.  
Thus, sheep and goat farming supports rural development and poverty reduction.

### 3.9.3 Characteristics of Sheep and Goats

#### Sheep

- Mainly reared for wool and meat
- Prefer grazing on grasses
- Adapted to cold and dry regions

#### Goats

- Known as “poor man’s cow”
- Reared for milk and meat
- Feed on leaves, shrubs, and weeds
- Highly adaptable to different climates

Both animals are hardy and resistant to diseases.

### 3.9.4 Important Breeds

Selection of suitable breeds is essential for better productivity.

#### Sheep breeds (India)

- Deccani
- Marwari
- Nellore
- Merino (exotic)

#### Goat breeds (India)

- Jamunapari
- Barbari
- Beetal

- Osmanabadi
- Black Bengal

Some breeds are known for meat, others for milk or wool production.

### 3.9.5 Housing Management

Proper housing protects animals from rain, cold, heat, and predators.

Requirements:

- Dry and well-drained floor
- Good ventilation
- Protection from dampness
- Adequate space
- Clean surroundings

Simple sheds or open shelters are generally sufficient.

Good housing reduces disease incidence and improves productivity.

### 3.9.6 Feeding and Grazing Management

Feeding plays an important role in growth and production.

Types of feeding:

- Grazing on pasture lands
- Green fodder
- Dry fodder
- Concentrates
- Mineral supplements

Importance:

- Improves body weight
- Enhances milk and wool production
- Maintains good health

Goats can utilize shrubs and bushes, making them suitable for wastelands.

### 3.9.7 Breeding Management

Small ruminants have high reproductive efficiency.

Features:

- Early maturity
- Short gestation period (about 5 months)
- Twinning common in goats
- High kidding and lambing rate

Practices:

- Selection of superior males
- Controlled breeding
- Timely mating

Good breeding management increases herd size and production.

### **3.9.8 Health Care and Disease Control**

Disease prevention is essential for profitable farming.

Common diseases:

- Foot and mouth disease
- Sheep pox
- Enterotoxaemia
- Parasites (worms, ticks)

Preventive measures:

- Regular vaccination
- Deworming
- Clean housing
- Isolation of sick animals
- Veterinary care

Healthy animals grow faster and give better yield.

### **3.9.9 Products Obtained**

Sheep and goats provide various useful products.

From sheep:

- Wool

- Mutton
- Skin
- Manure

From goats:

- Milk
- Meat (chevon)
- Skin
- Hair
- Manure

These products have high market demand.

### **3.9.10 Advantages of Sheep and Goat Farming**

Advantages:

- Low initial investment
- Less space required
- Easy management
- Fast reproduction
- Suitable for poor farmers
- Utilization of wastelands
- Quick returns

Because of these benefits, it is often called a “mini-livestock enterprise.”

### **3.9.11 Role in Rural Economy**

Sheep and goat farming contributes significantly to rural livelihoods.

- Income during crop failure
- Employment to women and landless people
- Supply of manure for fields
- Support to wool and meat industries

Thus, it plays a crucial role in sustainable agriculture and rural development.

### **3.10 Apiculture (Bee Keeping)**

Apiculture, or bee keeping, is the scientific management of honey bees for the production of honey, beeswax, pollen, propolis, and royal jelly. It is an important branch

of animal husbandry that contributes to human nutrition, rural employment, and agricultural productivity.

Honey is a natural sweetener rich in carbohydrates, vitamins, minerals, and antioxidants. Bee products are also used in medicine, cosmetics, and the food industry. Moreover, honey bees play a crucial role in pollination, which enhances crop yield, biodiversity, and the overall health of ecosystems.

Apiculture is especially suitable for small-scale farmers, women, and rural entrepreneurs, as it requires low investment, minimal space, and manageable labor.

### **3.10.1 Meaning of Apiculture**

Apiculture is the art and science of rearing honey bees for obtaining honey, wax, royal jelly, propolis, and pollen, along with enhancing pollination of crops.

Key components of apiculture include:

- Bee colony management
- Providing proper hives and shelter
- Feeding and health care
- Collection and processing of honey and other bee products

### **3.10.2 Importance of Apiculture**

#### **1. Nutritional Value**

Honey is a natural energy source, rich in carbohydrates, vitamins, and minerals.

Bee pollen is used as a dietary supplement due to its high protein content.

#### **2. Medicinal Uses**

Honey has antibacterial, anti-inflammatory, and antioxidant properties.

Propolis and royal jelly are used in traditional and modern medicines.

#### **3. Economic Benefits**

- Provides income for rural households and small entrepreneurs.
- Beekeeping requires low initial investment with high returns.

#### **4. Pollination Services**

Honey bees enhance the yield and quality of fruits, vegetables, and oilseed crops.

Important crops like apple, sunflower, cucumber, and mango benefit from bee pollination.

#### 5. Environmental Benefits

- Supports biodiversity by maintaining healthy plant populations.
- Helps in ecosystem balance through natural pollination.

#### 6. Industrial Applications

Honey, beeswax, and propolis are used in food, cosmetics, and pharmaceutical industries.

### 3.10.3 Types of Honey Bees

Honey bees are classified according to species and behavior.

#### 1. *Apis mellifera* (Western Honey Bee)

- Most common in commercial beekeeping.
- Introduced to India from Europe.
- Highly productive and docile.

#### 2. *Apis cerana indica* (Indian Honey Bee)

- Indigenous to India.
- Resistant to local diseases and adaptable to climate.

Produces less honey than *A. mellifera* but easier to manage in rural areas.

#### 3. *Apis dorsata* (Giant Honey Bee)

- Wild bee species nesting on cliffs or tall trees.
- Produces large amounts of honey.
- Difficult to domesticate.

#### 4. *Apis florea* (Dwarf Honey Bee)

- Small bees making exposed nests on shrubs or trees.
- Produces small quantities of honey.

### 3.10.4 Beekeeping Methods

### 1. Traditional Method

- Hives made from logs, clay pots, or bamboo baskets.
- Low investment and simple management.
- Low honey yield; colonies are prone to disturbance.

### 2. Modern Method (Scientific Beekeeping)

- Movable-frame hives allow inspection and management.
- High honey yield and easier disease management.
- Suitable for commercial production.

### 3. Intermediate Method

- Combines traditional hives with movable frames.
- Moderate investment and improved productivity.

#### **3.10.5 Hive Management**

Proper hive management ensures healthy colonies and high honey yield.

- Regular inspection of hives for health and population.
- Provide sugar syrup during nectar shortage.
- Keep hives clean and free from pests.
- Ensure adequate ventilation and sunlight.
- Protect colonies from predators like ants, wax moths, and birds.

#### **3.10.6 Feeding of Bees**

During nectar scarcity, supplemental feeding is necessary to maintain colony strength.

- Sugar syrup (1:1 ratio of sugar and water)
- Honey substitutes like jaggery solution
- Pollen substitutes for brood development

Proper feeding supports continuous honey production and colony survival.

#### **3.10.7 Diseases and Pest Control**

Honey bees are susceptible to diseases and pests, which can reduce productivity.

Common Diseases

- American Foulbrood: Bacterial infection killing larvae.
- European Foulbrood: Affects larvae, causing weak colonies.
- Chalkbrood: Fungal disease turning larvae into chalky masses.

#### Common Pests

- Wax moth (*Galleria mellonella*)
- Small hive beetle
- Ants and mites

#### Control Measures

- Maintain hygiene and clean hives regularly.
- Remove infected combs and weak colonies.
- Apply chemical or biological treatments as needed.

### 3.10.8 Collection and Processing of Honey

Honey collection must be careful to avoid harming bees.

#### Steps

1. Smoke the hive to calm bees.
2. Remove honey frames carefully.
3. Extract honey using centrifugal extractors.
4. Filter and store honey in sterilized containers.

Processed honey can be sold directly or used in food, medicine, or cosmetic industries.

### 3.10.9 Economic Importance of Apiculture

- Provides direct income from honey, wax, royal jelly, and pollen.
- Supports rural employment and women's self-help groups.
- Enhances agricultural productivity through pollination.

Supplies raw materials for industries such as cosmetics, pharmaceuticals, and food processing.

### 3.10.10 Role of Apiculture in Agriculture

Honey bees are vital pollinators for fruits, vegetables, and oilseeds.

- Increase seed set, fruit size, and crop yield.
- Help maintain biodiversity and ecological balance.

### **3.11 Sericulture (Silkworm Rearing)**

Sericulture is the art, science, and technology of rearing silkworms for the production of silk, a luxurious natural fibre widely used in the textile industry. It is one of the most important agro-based rural industries, combining agriculture (mulberry cultivation) with animal husbandry (silkworm rearing).

Silk is valued for its smooth texture, natural shine, strength, elasticity, and durability. From ancient times, silk has played an important role in trade, culture, and economy. India is one of the leading silk-producing countries in the world and produces different varieties such as mulberry silk, tasar silk, eri silk, and muga silk.

Sericulture requires low capital investment, less land, and family labor, making it highly suitable for small farmers, women, and rural households. Therefore, it contributes significantly to employment generation, poverty alleviation, and rural development.

#### **3.11.1 Meaning of Sericulture**

Sericulture refers to the scientific rearing of silkworms and processing of cocoons to obtain silk fibres.

It involves:

- Cultivation of host plants (mulberry)
- Rearing of silkworm larvae
- Collection of cocoons
- Reeling and processing of silk

Thus, sericulture integrates both crop production and insect rearing.

#### **3.11.2 Historical Background**

Silk production originated in China around 3000 BC and later spread to India, Japan, and other countries. India has a long tradition of silk weaving, especially in states like Karnataka, West Bengal, Assam, Tamil Nadu, and Andhra Pradesh.

Today, sericulture is recognized as an important cottage and small-scale industry, providing livelihood to millions of people.

### 3.11.3 Importance of Sericulture

#### 1. Economic Importance

- Generates regular income for rural families
- Requires small investment with high returns
- Encourages small-scale entrepreneurship

#### 2. Employment Generation

- Provides jobs in mulberry cultivation, silkworm rearing, reeling, spinning, and weaving

- Suitable for women and landless laborers

#### 3. Export Potential

- Silk and silk products earn valuable foreign exchange

#### 4. Eco-friendly Industry

- Non-polluting and sustainable
- By-products are biodegradable

#### 5. Cultural Importance

Silk garments are widely used in traditional, religious, and ceremonial functions

### 3.11.4 Types of Silk

India produces four major types of silk:

#### 1. Mulberry Silk

- Obtained from *Bombyx mori*
- Smooth, shiny, and most widely used
- Accounts for major silk production

#### 2. Tasar Silk

- Produced by wild silkworms
- Coarse but strong fibre
- Used for tribal textiles

#### 3. Eri Silk

- Also called “peace silk”
- Soft and warm
- Used for shawls and blankets

#### 4. Muga Silk

- Golden yellow silk
- Exclusive to Assam
- Very durable and expensive

#### 3.11.5 Silkworm Species

The most important silkworm species is:

*Bombyx mori* (Mulberry Silkworm)

- Completely domesticated
- Feeds exclusively on mulberry leaves
- Produces high-quality silk
- Easy to manage and suitable for commercial production

Other wild species include *Antheraea mylitta*, *Philosamia ricini*, and *Antheraea assamensis*.

#### 3.11.6 Life Cycle of Silkworm

The silkworm undergoes complete metamorphosis with four stages:

##### 1. Egg

- Female moth lays 400–500 eggs
- Eggs hatch within 10–14 days

##### 2. Larva (Caterpillar)

- Active feeding stage
- Feeds continuously on mulberry leaves
- Undergoes 4–5 moults
- Lasts about 20–25 days

##### 3. Pupa (Cocoon Stage)

- Larva spins silk around itself
- Forms a cocoon using continuous silk thread

- Lasts 10–12 days

#### 4. Adult Moth

- Emerges from cocoon
- Mates and lays eggs
- Does not feed

Total life cycle takes about 6–8 weeks.

### 3.11.7 Mulberry Cultivation

Mulberry leaves are the only food source for *Bombyx mori*, hence quality leaves are essential for good silk production.

#### Requirements

- Fertile, well-drained soil
- Warm climate (24–28°C)
- Adequate irrigation
- Organic manure and fertilizers

#### Practices

- Regular pruning
- Weed control
- Pest management

Healthy mulberry leaves directly influence larval growth, cocoon weight, and silk yield.

### 3.11.8 Silkworm Rearing Practices

Scientific rearing methods ensure maximum cocoon production.

#### Steps in Rearing

##### 1. Incubation

- Eggs kept at suitable temperature and humidity

##### 2. Feeding

- Tender leaves for young larvae
- Mature leaves for older larvae

- Feeding 4–5 times daily

### 3. Hygiene

- Regular cleaning of trays
- Removal of excreta and leftover leaves

### 4. Spacing

- Adequate space to avoid overcrowding

### 5. Environmental Control

- Temperature: 25–28°C
- Humidity: 70–85%

Proper care ensures healthy and uniform larval growth.

#### **3.11.9 Cocoon Formation and Harvesting**

After maturity, larvae stop feeding and begin spinning silk.

- Each larva secretes silk from silk glands
- Forms a cocoon using 300–900 meters of silk thread
- Cocoons are collected after 5–7 days

#### Harvesting

- Select healthy cocoons
- Remove defective ones
- Store carefully to prevent damage

Good quality cocoons produce better silk.

#### **3.11.10 Silk Reeling and Processing**

Reeling is the process of extracting silk filament from cocoons.

#### Steps

1. Boiling or steaming cocoons to soften sericin
2. Finding the filament end
3. Unwinding silk threads
4. Twisting several filaments to make yarn

## 5. Dyeing and weaving

This process converts raw cocoons into usable silk fibre.

### 3.11.11 Diseases and Pest Management

Silkworms are susceptible to diseases that reduce yield.

#### Common Diseases

- Pebrine (protozoan)
- Grasserie (viral)
- Flacherie (bacterial)
- Muscardine (fungal)

#### Control Measures

- Use disease-free eggs
- Maintain cleanliness
- Disinfect equipment
- Proper ventilation
- Regular monitoring

Prevention is more effective than treatment.

### 3.11.12 Economic Importance of Sericulture

- Provides employment to millions
- Generates supplementary income for farmers
- Supplies raw material to textile industry
- Promotes cottage and small-scale industries
- Enhances exports and foreign exchange

Sericulture significantly contributes to rural and national economy.

### 3.11.13 Role of Sericulture in Human Welfare

- Supports livelihoods of small farmers
- Encourages women participation
- Improves standard of living
- Reduces migration from rural areas
- Promotes sustainable agriculture

Thus, sericulture has both economic and social benefits.

### **3.12 Veterinary Science and Animal Health**

Veterinary science is the branch of applied biological science that deals with the prevention, diagnosis, and treatment of diseases in animals, as well as the maintenance of animal health and productivity. Healthy animals are essential for successful animal husbandry because diseases reduce growth, reproduction, milk yield, meat production, and working capacity.

Animal health management not only improves livestock productivity but also protects human health, since many diseases can be transmitted from animals to humans (zoonotic diseases). Thus, veterinary science plays a vital role in food security, public health, rural economy, and national development.

#### **3.12.1 Meaning of Veterinary Science**

Veterinary science may be defined as:

“The science concerned with the health care, medical treatment, disease prevention, and management of domestic and farm animals.”

It includes:

- Diagnosis of diseases
- Treatment and surgery
- Vaccination and preventive care
- Disease surveillance and control
- Public health protection

#### **3.12.2 Importance of Animal Health in Animal Husbandry**

Maintaining good animal health is essential because:

1. Increases Productivity
  - Healthy animals produce more milk, meat, eggs, and wool.
2. Improves Growth Rate
  - Proper health ensures better weight gain and development.

### 3. Reduces Mortality

- Prevents death of young and adult animals.

### 4. Enhances Reproduction

- Healthy animals show better fertility and breeding efficiency.

### 5. Prevents Economic Loss

- Reduces expenses on treatment and replacement of animals.

### 6. Protects Human Health

Prevents zoonotic diseases such as rabies, tuberculosis, and brucellosis.

### 3.12.3 Veterinary Services

Veterinary services include various facilities provided by government and private agencies to maintain animal health.

#### Major Services

- Veterinary hospitals and dispensaries
- Mobile veterinary clinics
- Vaccination programs
- Artificial insemination centers
- Diagnostic laboratories
- Disease surveillance and reporting

These services ensure timely treatment and preventive care for livestock.

### 3.12.4 Common Livestock Diseases

Livestock are affected by various bacterial, viral, fungal, and parasitic diseases.

#### 1. Bacterial Diseases

- Anthrax
- Brucellosis
- Mastitis
- Tuberculosis

#### 2. Viral Diseases

- Foot and Mouth Disease (FMD)
- Rabies
- Rinderpest
- Pox

### 3. Parasitic Diseases

- Roundworms and tapeworms
- Ticks and mites
- Liver flukes

### 4. Nutritional Deficiency Diseases

- Milk fever
- Rickets
- Anemia

These diseases reduce productivity and may even cause death if untreated.

#### **3.12.5 Disease Prevention and Control Measures**

Prevention is always better and cheaper than cure. Proper management practices can reduce disease incidence.

##### Preventive Measures

#### 1. Vaccination

- Regular immunization protects animals from infectious diseases
- Examples: FMD, rabies, HS vaccines

#### 2. Deworming

- Removal of internal parasites using anthelmintics
- Improves growth and feed efficiency

#### 3. Hygiene and Sanitation

- Clean sheds and equipment
- Proper disposal of dung and waste
- Disinfection of housing

#### 4. Balanced Nutrition

- Adequate feed with vitamins and minerals
- Prevents deficiency disorders

#### 5. Quarantine

- Isolation of sick or newly purchased animals
- Prevents spread of infection

#### 6. Regular Health Check-up

- Early diagnosis and timely treatment

### 3.12.6 Veterinary Public Health

Veterinary science also protects human health through control of zoonotic diseases.

#### Zoonotic Diseases

- Rabies
- Tuberculosis
- Brucellosis
- Anthrax

#### Public Health Measures

- Meat inspection
- Milk pasteurization
- Safe disposal of carcasses
- Control of stray animals

These measures ensure safe animal products for human consumption.

### 3.12.7 Role of Veterinarians

Veterinarians perform multiple functions:

- Diagnosis and treatment of diseases
- Surgical procedures
- Vaccination and preventive care
- Artificial insemination and breeding support
- Advising farmers on feeding and management
- Conducting awareness programs

- Monitoring disease outbreaks

They act as doctors, advisors, and educators for livestock farmers.

### **3.12.8 Modern Diagnostic and Treatment Technologies**

Recent advances have improved animal healthcare.

Technologies Include

- Blood and urine testing
- X-ray and ultrasound
- Rapid diagnostic kits
- Modern vaccines
- Antibiotics and antiparasitic drugs
- Tele-veterinary services

These technologies allow early detection and effective treatment.

### **3.12.9 Economic Importance of Veterinary Care**

Proper veterinary care:

- Reduces mortality and morbidity
- Improves production efficiency
- Increases farmers' income
- Ensures quality animal products
- Supports livestock-based industries

Thus, veterinary science directly contributes to economic development and food security.

### **3.12.10 Role in Human Welfare**

Veterinary science benefits society by:

- Providing safe milk, meat, and eggs
- Preventing zoonotic diseases
- Supporting rural livelihoods
- Ensuring sustainable livestock production
- Enhancing national health and nutrition

Hence, it forms a strong link between animal health and human welfare.

### **3.13 Role of Animal Husbandry in National Economy**

Animal husbandry plays a vital role in the national economy, especially in developing countries like India where agriculture and allied sectors form the backbone of economic growth. Livestock contributes significantly to food production, employment generation, industrial development, export earnings, and rural livelihood security.

Animal husbandry not only supplements agricultural income but also provides stability to farmers during crop failures. The sector includes dairy farming, poultry farming, sheep and goat rearing, piggery, apiculture, sericulture, and fisheries, all of which collectively strengthen the national economy.

#### **3.13.1 Contribution to Agricultural GDP**

Animal husbandry contributes a substantial share to the agricultural Gross Domestic Product (GDP).

Dairy farming alone accounts for a major portion of agricultural income.

Livestock acts as a moving asset that can be sold during emergencies, providing economic security to farmers.

#### **3.13.2 Food and Nutritional Security**

Supplies milk, meat, eggs, and fish, which are rich sources of animal protein, fats, vitamins, and minerals.

Helps in combating malnutrition, especially among children and pregnant women.

- Enhances national food availability and balanced diet.

#### **3.13.3 Employment Generation**

- Provides direct and indirect employment to millions of people.
- Generates jobs in:
  - Dairy and poultry farms
  - Meat processing units
  - Veterinary services
  - Feed and fodder industries
  - Transport and marketing

Women and landless labourers actively participate in livestock-related activities.

### 3.13.4 Support to Rural Economy

Serves as a major source of supplementary income for small and marginal farmers.

- Reduces rural poverty and unemployment.
  - Encourages self-employment and entrepreneurship in villages.
- Animal husbandry ensures inclusive growth and rural development.

### 3.13.5 Industrial Development

Animal husbandry supplies raw materials to various industries such as:

- Dairy industry – milk, butter, cheese, ghee
- Leather industry – hides and skins
- Textile industry – wool and silk
- Pharmaceutical industry – hormones, vaccines, enzymes
- Cosmetic industry – beeswax, fats, and oils

These industries contribute significantly to national industrial output.

### 3.13.6 Export and Foreign Exchange Earnings

- Animal products such as:
- Milk powder
- Ghee
- Meat and meat products
- Leather goods
- Wool and silk

are exported to various countries, earning valuable foreign exchange.

### 3.13.7 Role in Sustainable Agriculture

- Livestock provides organic manure, improving soil fertility.
- Animal power is used for ploughing, transportation, and irrigation.
- Crop residues are effectively utilized as animal feed, reducing waste.

This integration promotes sustainable and eco-friendly agriculture.

### 3.13.8 Women Empowerment and Social Development

- Livestock rearing is often managed by women in rural households.

- Encourages participation of women in economic activities.
- Improves family income, nutrition, and social status.

### **3.13.9 Poverty Alleviation and Livelihood Security**

- Provides continuous income throughout the year.
- Acts as insurance against crop failure and natural calamities.
- Helps in uplifting economically weaker sections of society.

### **3.13.10 Role in National Development**

- Strengthens the rural economy
- Supports food processing industries
- Reduces dependence on imports
- Contributes to balanced regional development

Thus, animal husbandry supports overall national growth and economic stability.

# Beneficial and Industrial Insects

## 4.1 Introduction

Insects are the most diverse and abundant group of animals on Earth, representing more than half of all known species. While many insects are recognized as pests due to their harmful effects on crops, stored products, livestock, or humans, a large number of insects are highly beneficial and play an essential role in human welfare, agriculture, and industry.

Beneficial insects contribute to human life in multiple ways — directly by producing valuable products like honey, silk, lac, wax, and dyes, and indirectly by performing crucial ecological functions such as pollination, biological control of pests, and nutrient recycling. Their role in natural ecosystems makes them indispensable for maintaining biodiversity and ecological balance.

### Importance of Beneficial Insects

#### 1. Economic Value

- Insects like honeybees, silkworms, and lac insects provide materials that support industries, handicrafts, and cottage enterprises.
- Products such as honey, beeswax, silk, shellac, and lac dyes are important sources of income for rural communities.

#### 2. Agricultural Importance

- Many insects act as pollinators, increasing the productivity and quality of crops.
- Predatory and parasitic insects help in biological control of pests, reducing dependency on chemical pesticides.

#### 3. Ecological Importance

- Certain insects, such as dung beetles and termites, play a key role in decomposition and nutrient recycling, which improves soil fertility and ecosystem health.

- They maintain ecological balance by controlling populations of other insects and decomposing organic matter.

#### 4. Food and Medicinal Resources

- Insects are a source of nutritious food (edible insects) for humans in many cultures.

- Bee products like honey, propolis, royal jelly, and venom are used in traditional and modern medicine for their antimicrobial, anti-inflammatory, and therapeutic properties.

#### 5. Environmental Indicators

- Beneficial insects, including certain species of butterflies and bees, serve as bioindicators for monitoring environmental health and habitat quality.

#### Direct and Indirect Benefits

##### Direct Benefits

- Production of commercially important substances:
- Honey, wax, and royal jelly from bees
- Silk from silkworms
- Lac from lac insects
- Materials for cosmetics, pharmaceuticals, and food industries

##### Indirect Benefits

- Pollination of fruits, vegetables, and oilseed crops
- Control of harmful pests naturally
- Recycling of organic matter to improve soil fertility
- Contribution to biodiversity and ecosystem stability

##### Role in Human Welfare

Beneficial insects significantly improve food security, nutrition, employment opportunities, and economic prosperity.

- Honey bees increase crop yields through pollination and provide honey and wax for nutrition and industry.
- Silkworms supply silk, creating jobs in rural and cottage industries.
- Lac insects provide shellac, which is used in varnishes, electrical insulation, and handicrafts.
- Predatory and parasitic insects protect crops and reduce pesticide costs.

Overall, these insects form a bridge between nature and human economy, supporting both rural livelihoods and national development.

## **4.2 Meaning of Beneficial Insects**

Beneficial insects are defined as those insects that provide economic, ecological, or social benefits to humans either directly or indirectly. Unlike pests, which cause damage to crops, animals, or stored products, beneficial insects contribute positively to human welfare, agricultural productivity, industrial development, and ecosystem stability.

They form an essential component of economic zoology, as they provide products, services, and ecological functions that are critical for sustaining life and improving human well-being.

### **4.2.1 Key Characteristics of Beneficial Insects**

#### **1. Economic Value**

- Produce commercially important substances such as honey, silk, beeswax, shellac, and dyes.
- Support industries including textiles, food, cosmetics, and pharmaceuticals.

#### **2. Agricultural Importance**

- Act as pollinators, enhancing the productivity and quality of crops.
- Serve as biological control agents, reducing pest populations naturally and minimizing pesticide use.

#### **3. Ecological Significance**

- Facilitate decomposition of organic matter, helping nutrient recycling.
- Maintain ecological balance by regulating other insect populations.
- Contribute to biodiversity and the stability of ecosystems.

#### 4. Medical and Nutritional Importance

- Provide products like honey, royal jelly, propolis, and bee venom with medicinal and therapeutic properties.

- Certain insects are a source of edible protein in traditional diets.

#### 5. Environmental Indicators

- Some beneficial insects, such as bees and butterflies, act as bioindicators, signaling the health of the environment.

#### 4.2.2 Direct and Indirect Benefits

##### Direct Benefits

- Production of food products: honey, royal jelly, edible insects
- Production of industrial materials: silk, lac, wax
- Medicinal and therapeutic applications of bee products

##### Indirect Benefits

- Enhancing crop yield via pollination
- Controlling agricultural pests naturally
- Maintaining soil fertility through decomposition
- Supporting biodiversity and ecological stability

#### 4.2.3 Importance in Economic Zoology

Insects classified as beneficial are integral to economic zoology, a branch of zoology concerned with animals that provide direct or indirect benefits to humans. Studying these insects helps in:

- Identifying economically valuable species
- Developing industries based on insect products
- Implementing biological pest control

- Ensuring sustainable agricultural and environmental practices

In short, beneficial insects form a bridge between nature and human welfare, linking ecological balance with economic development.

### 4.3 Classification of Beneficial Insects

Beneficial insects can be classified based on the type of benefit they provide to humans, whether for economic, agricultural, industrial, or ecological purposes. Classification helps in systematic study, management, and utilization of these insects in fields like apiculture, sericulture, lac culture, and biological pest control.

#### 4.3.1 Major Groups of Beneficial Insects

Beneficial insects are broadly divided into four main categories:

##### 1. Productive or Industrial Insects

These insects are reared or utilized to obtain valuable products for human use.

Economic Importance:

- Support cottage and small-scale industries
- Generate income and employment in rural areas
  - Provide raw materials for textiles, food, cosmetics, varnishes, and pharmaceuticals

##### 2. Pollinating Insects

Pollinating insects help in transfer of pollen from anther to stigma, which is essential for fertilization, seed formation, and fruit development.

Examples and Crops Pollinated:

Honey bees    Sunflower, apple, cucumber, watermelon

Butterflies    Mango, brinjal, mustard

Moths         Cotton, oilseed crops

Beetles        Cocoa, cashew, magnolia

Significance:

- Increase crop yield and quality
- Ensure food security
- Reduce dependence on artificial pollination

Pollinators play a crucial role in sustainable agriculture and horticulture.

### 3. Predators and Parasitoids (Biological Control Agents)

Some insects feed on harmful pests, acting as natural regulators in the ecosystem.

Predators:

- Ladybird beetles (*Coccinella septempunctata*) – feed on aphids and mealybugs

- Praying mantis – feeds on various insect pests
- Dragonflies – feed on mosquitoes and flies

Parasitoids:

- Parasitic wasps (*Trichogramma species*) – lay eggs inside pest larvae
- Ichneumon wasps – control caterpillars and beetle larvae

Importance:

- Reduce crop losses naturally
- Minimize pesticide usage
- Promote eco-friendly and sustainable pest management

### 4. Decomposer and Soil-Building Insects

Certain insects decompose organic matter, recycle nutrients, and improve soil fertility.

Examples:

- Dung beetles – decompose animal excreta
- Termites – break down plant litter and wood
- Ants – aerate soil and mix organic matter

Role in Ecosystem:

- Maintain nutrient cycling

- Improve soil structure and fertility
- Reduce environmental pollution from waste

#### 4.3.2 Other Classification Criteria

Apart from functional classification, beneficial insects can also be categorized based on:

##### 1. Habitat

- Terrestrial (bees, ants, ladybirds)
- Aquatic (water beetles controlling mosquito larvae)

##### 2. Mode of Action

- Direct product producers (honey, silk, lac)
  - Indirect service providers (pollination, pest control, decomposition)

##### 3. Economic Use

- Cottage industry support (lac, honey, silk)
- Agriculture support (pollinators, pest controllers)
- Environmental conservation (decomposers, bioindicators)

#### 4.3.3 Importance of Classification

- Helps in systematic study of beneficial insects
- Facilitates management and sustainable utilization
- Identifies potential species for economic exploitation
- Promotes awareness of ecological and agricultural value

#### 4.4 Apiculture (Honey Bees)

Apiculture, also known as beekeeping, is the art, science, and practice of rearing honey bees for the production of honey, beeswax, and other useful products. It is one of the oldest agro-based industries and is considered a highly rewarding and eco-friendly occupation.

Honey bees are not only valuable producers of food and industrial products, but they are also crucial pollinators that enhance the productivity of many agricultural crops. The practice of apiculture combines biology, agriculture, and management skills to obtain economic benefits while maintaining ecological balance.

#### 4.4.1 Meaning of Apiculture

“The scientific rearing and management of honey bees for the production of honey, wax, and other bee products, along with the utilization of their pollination services.”

It involves:

- Selecting suitable bee species
- Establishing hives and apiaries
- Providing proper feeding and care
- Harvesting honey and beeswax
- Using bees for crop pollination

#### 4.4.2 Importance of Apiculture

Economic Importance

- Honey and wax provide income for rural households.
- Beekeeping is a low-investment, high-return cottage industry.
  - Bee products are raw materials for food, cosmetics, and pharmaceutical industries.

Agricultural Importance

- Honey bees pollinate a wide variety of crops including apple, mustard, sunflower, and cucurbits.
- Pollination increases fruit set, seed production, and crop yield.

Ecological Importance

- Bees support biodiversity by aiding reproduction of flowering plants.
- Serve as bioindicators of environmental health.

#### 4.4.3 Species of Honey Bees

Several species of honey bees are used in apiculture. The most important species include:

Indian honey	<i>Apis cerana</i>	Native species, well-adapted to Indian bee
indica	climate	

European honey *Apis mellifera* High honey yield, introduced species, bee requires careful management

Giant honey *Apis dorsata* Wild species, migratory, produces bee high-quality honey

Dwarf honey *Apis florea* Small size, produces small quantities of bee honey, useful for pollination

#### 4.4.4 Products Obtained from Honey Bees

1. Honey – Nutritional and medicinal value; used as food and sweetener.
2. Beeswax – Used in cosmetics, candles, varnishes, and pharmaceuticals.
3. Royal Jelly – Nutritional and medicinal supplement; promotes health and longevity.
4. Propolis – Antimicrobial and therapeutic applications; used in medicine and cosmetics.
5. Bee Venom – Used in apitherapy for treatment of arthritis and other ailments.
6. Bee Pollen – Nutritional supplement rich in proteins, vitamins, and minerals.

#### 4.4.5 Apiary Establishment and Hive Management

##### 1. Site Selection

- Location with abundant flowering plants
- Well-drained, shady, and protected from wind
- Accessible for maintenance

##### 2. Hive Types

- Traditional hives – log hives, box hives
- Modern movable-frame hives – Langstroth hives, top-bar hives

##### 3. Bee Colony Management

- Maintain healthy bee population
- Monitor queen bee and brood development
- Provide supplementary feeding during dearth periods

- Prevent swarming and disease outbreaks

#### 4. Seasonal Management

- Ensure adequate forage throughout the year
- Adjust hive positions according to flowering seasons
- Harvest honey at the right time to prevent spoilage

#### 4.4.6 Pollination by Honey Bees

Honey bees are essential pollinators in agriculture:

- Visit flowers to collect nectar and pollen
- Transfer pollen from anther to stigma, facilitating fertilization

Crops like apple, mustard, sunflower, cucurbits, and guava benefit greatly

- Increase both yield and quality of crops

Pollination by honey bees is eco-friendly and cost-effective compared to artificial methods.

#### 4.4.7 Diseases and Pests of Honey Bees

Honey bee colonies are susceptible to several diseases and pests:

Diseases

- American foulbrood – bacterial disease affecting brood
- European foulbrood – bacterial infection of larvae
- Sacbrood virus – viral disease causing larval death

Pests

- Wax moth (*Galleria mellonella*) – destroys combs
- Ants – invade hives and disturb bees

Mites (*Varroa destructor*) – feed on bee haemolymph and weaken colonies

Management:

- Maintain hygiene and proper ventilation
- Regular inspection and removal of diseased combs
- Use of chemical or biological treatments for mites

#### 4.4.8 Economic Importance of Apiculture

- Provides employment and income to rural communities  
Produces marketable products for food, pharmaceutical, and cosmetic industries
- Supports crop productivity through pollination
- Promotes environmental conservation and biodiversity

#### **4.4.9 Role in Human Welfare**

Apiculture contributes to human welfare by:

- Supplying nutritious honey and other bee products
- Increasing agricultural productivity through pollination
- Providing livelihood opportunities for small farmers and women
- Encouraging eco-friendly, sustainable agricultural practices

Honey bees thus form a link between ecological health, rural economy, and human nutrition.

#### **4.5 Sericulture (Silkworms)**

Sericulture is the art, science, and practice of rearing silkworms for the production of silk. Silk, often called the “Queen of Fibres”, is a natural protein fibre with lustre, strength, and high economic value. Sericulture is a cottage and agro-based industry that provides employment to millions of rural people, generates foreign exchange, and supports textile and handicraft industries.

India is one of the major silk-producing countries in the world, and sericulture forms an important part of economic zoology due to its contribution to rural livelihoods and the national economy.

##### **4.5.1 Meaning of Sericulture**

“The scientific rearing of silkworms to produce silk yarn, along with proper management of mulberry plants and silkworm rearing facilities.”

It includes:

- Cultivation of mulberry or other host plants
- Rearing silkworms from egg to cocoon stage
- Harvesting cocoons

- Processing cocoons into silk threads

#### 4.5.2 Silkworm Species and Types of Silk

##### 1. Mulberry Silkworm

- Scientific Name: *Bombyx mori*
- Rears primarily on mulberry leaves (*Morus alba*)
- Produces mulberry silk, the finest and most lustrous silk
- Major species used in India and globally

##### 2. Non-Mulberry Silkworms

Tasar silkworms (*Antheraea mylitta*, *Antheraea proylei*) – feeds on teak, sal and arjuna trees

- Eri silkworms (*Samia ricini*) – feeds on castor leaves

Muga silkworms (*Antheraea assamensis*) – produces golden silk, endemic to Assam

#### 4.5.3 Life Cycle of Silkworms

The silkworm undergoes complete metamorphosis with four stages:

1. Egg Stage – Laid by female moths; hatches in 10–14 days.
2. Larval Stage (Caterpillar) – Feeds on host plant leaves; grows rapidly through four to five moults (instars).
3. Pupal Stage (Cocoon Formation) – Larvae spin silk cocoons using sericin to bind fibroin.
4. Adult Stage (Moth) – Emerges from cocoon, mates, and lays eggs to continue the cycle.

#### 4.5.4 Rearing of Silkworms

##### 1. Selection of Healthy Eggs

- Disease-free and high-yielding eggs
- Ensures good larval growth and cocoon quality

## 2. Preparation of Rearing House

- Clean and well-ventilated
- Controlled temperature (23–28°C) and humidity (70–85%)
- Protection from predators, pests, and diseases

## 3. Feeding

- Fresh mulberry leaves, washed and free from pesticides
- Feeding 4–5 times a day during peak larval growth
- Ensures healthy and uniform growth

## 4. Harvesting Cocoons

- Cocoons are harvested when silkworm pupae are fully matured
- Used for reeling silk yarn or processing

### 4.5.5 Diseases and Pest Management in Sericulture

Silkworms are susceptible to diseases that reduce silk yield:

#### Common Diseases

- Grasserie – viral infection causing swollen larvae
- Flacherie – bacterial infection leading to larval death
- Pebrine – protozoan disease affecting eggs and larvae

#### Management

- Regular cleaning and hygiene
- Disinfection of rearing trays and houses
- Use of disease-free eggs and resistant strains

### 4.5.6 Products Obtained from Sericulture

1. Silk Fibre – Raw silk used in textiles and handicrafts
2. Silkworm Pupae – Rich in protein, used as animal feed or for oil extraction
3. Sericin – Used in cosmetics, pharmaceuticals, and adhesives

### 4.5.7 Economic Importance of Sericulture

- Provides employment to millions in rural areas, especially women

- Generates foreign exchange through silk exports
- Supports textile and handicraft industries
- Enhances income of small farmers and cottage industry workers
- Promotes sustainable agro-based rural development

#### 4.5.8 Role in Human Welfare

- Provides luxurious silk fabric for clothing and decoration
- Offers livelihood opportunities in rural areas
- Supports cultural and traditional industries in India
  - Generates eco-friendly income, as silk production uses renewable mulberry leaves

#### 4.6 Lac Culture (Lac Insects)

Lac culture is the art and science of rearing lac insects to produce lac, a natural resin used in varnishes, dyes, wax, and shellac products. Lac is a valuable industrial product and forms an important cottage and agro-based industry in India, especially in tribal and rural areas.

Lac insects live on host trees, where they secrete resin that protects their bodies. This resin, known as raw lac, is harvested and processed into shellac, lac dye, and wax. The practice of lac culture provides employment, income, and raw materials for multiple industries, making it an important component of economic zoology.

##### 4.6.1 Meaning of Lac Culture

“The scientific rearing of lac insects on suitable host trees to obtain lac and its products for industrial, commercial, and economic purposes.”

It involves:

- Selection of host trees
- Inoculation with lac insects
- Proper management of colonies
- Harvesting and processing lac

##### 4.6.2 Lac Insect and Its Biology

- *Kerria lacca*

### Features

- Small, sap-sucking insect
- Lives on branches of host trees
- Secretes resin that protects the insect and forms lac encrustation

### Life Cycle

1. Egg Stage – Laid under lac encrustation
2. Nymph Stage (Crawler) – Mobile stage; settles on suitable branch
3. Adult Stage – Female secretes lac, males die after mating

#### 4.6.3 Host Trees for Lac Insects

Lac insects require suitable trees to feed and produce resin. Important host trees include:

Palas                      *Butea monosperma*

Ber                         *Ziziphus mauritiana*

Dhak                      *Butea frondosa*

Acacia                    *Acacia catechu*

The choice of host tree affects quality and quantity of lac produced.

#### 4.6.4 Methods of Lac Culture

##### 1. Plantation Selection

- Choose healthy trees with proper spacing
- Ensure availability of adequate sunlight

##### 2. Inoculation

- Introduce lac insects on branches (usually crawlers)
- Secure with twigs or special inoculation techniques

##### 3. Management of Colonies

- Monitor growth of lac colonies
- Protect from pests, birds, and environmental stress
- Ensure proper hygiene of plantation

#### 4. Harvesting

- Lac is ready for harvest in 3–6 months
- Scrape lac encrustation carefully from branches
- Separate resin from dead insects and debris

#### 4.6.5 Products Obtained from Lac Insects

1. Raw Lac – Unprocessed resin scraped from trees
2. Shellac – Purified lac used in varnishes, paints, and polishes
3. Lac Dye – Red or orange dye used in textiles and food
4. Lac Wax – Used in cosmetics, candles, and pharmaceuticals

#### 4.6.6 Economic Importance of Lac Culture

- Provides livelihood to rural and tribal communities
- Supports cottage and small-scale industries
- Generates raw materials for varnishes, paints, dyes, and cosmetics
- Provides employment for women and marginal farmers
- Contributes to export earnings

India is one of the largest producers of lac, supplying both domestic and international markets.

#### 4.6.7 Role in Human Welfare

Lac and its products are used in industries, crafts, and food coloring

- Provides income and employment in rural areas
  - Supports sustainable agroforestry practices
- Encourages eco-friendly income generation without harming the environment

#### 4.6.8 Conservation and Sustainable Practices

- Use host tree plantations for long-term lac production
- Avoid overharvesting to maintain insect populations

- Promote integrated pest management in lac plantations
- Educate farmers about scientific lac rearing techniques

Sustainable lac culture ensures continuous production, environmental conservation, and economic benefits.

#### 4.7 Pollinating Insects

Pollinating insects play a vital role in agriculture, horticulture, and natural ecosystems. Pollination is the process by which pollen grains are transferred from the anther to the stigma of flowers, leading to fertilization, seed formation, and fruit development. Although pollination can occur through wind and water, insects are the most efficient and reliable pollinating agents.

A large proportion of flowering plants and food crops depend on insects for pollination. Hence, pollinating insects are considered indispensable allies of humans, contributing significantly to food production, biodiversity, and economic stability.

##### 4.7.1 Meaning of Pollination

“The transfer of pollen grains from the male reproductive part (anther) to the female reproductive part (stigma) of a flower.”

When insects visit flowers to collect nectar or pollen, pollen grains stick to their body hairs and are transferred to other flowers, resulting in cross-pollination, which improves genetic diversity and crop yield.

##### 4.7.2 Major Groups of Pollinating Insects

Several insect groups participate in pollination:

###### 1. Honey Bees

- Most important pollinators worldwide
- Visit flowers frequently and systematically
- Responsible for pollination of a wide range of crops

Examples:

- *Apis cerana indica*
- *Apis mellifera*

## 2. Butterflies

- Pollinate brightly coloured flowers
- Possess long proboscis for nectar feeding
- Important pollinators of wild plants and garden crops

## 3. Moths

- Mostly nocturnal pollinators
- Pollinate night-blooming flowers
- Important for cotton and some oilseed crops

## 4. Beetles

- Known as primitive pollinators
- Pollinate flowers like magnolia and cocoa
- Feed on pollen and floral tissues

## 5. Flies and Wasps

- Pollinate small and simple flowers
- Important in cooler regions where bees are less active

### 4.7.3 Crops Benefited by Insect Pollination

Pollinating insects enhance both quantity and quality of agricultural produce.

Vegetable crops      Cucumber, pumpkin, tomato

Oilseed crops      Mustard, sunflower

Fibre crops      Cotton

Plantation crops      Coffee, cocoa

### 4.7.4 Importance of Pollinating Insects

#### 1. Agricultural Importance

- Increase crop yield
- Improve fruit size, shape, and quality
- Enhance seed viability

#### 2. Economic Importance

- Boost farmers' income
- Reduce need for artificial pollination
- Contribute indirectly to national economy

### 3. Ecological Importance

- Maintain plant diversity
- Support food chains and ecosystems
- Ensure survival of flowering plants

#### 4.7.5 Advantages of Insect Pollination

- More effective than wind pollination
- Promotes cross-pollination
- Increases genetic variability
- Environment-friendly and cost-effective

Insect pollination is essential for sustainable agriculture and biodiversity conservation.

#### 4.7.6 Threats to Pollinating Insects

Pollinating insects are declining due to:

- Excessive use of pesticides
- Habitat destruction
- Climate change
- Pollution
- Loss of flowering plants

This decline poses a serious threat to global food security.

#### 4.7.7 Conservation of Pollinating Insects

To protect pollinators:

- Promote organic farming
- Reduce chemical pesticide use
- Conserve natural habitats
- Encourage beekeeping
- Plant flowering plants and hedgerows

Conservation ensures long-term agricultural sustainability and ecological balance.

## 4.8 Insects as Biological Control Agents

Biological control is a natural method of managing agricultural pests using living organisms, particularly insects. Many insects act as natural enemies of harmful pests, helping to control their population without causing damage to crops or the environment. Such insects are known as biological control agents and are extremely important in economic zoology and sustainable agriculture.

The use of insects for biological control reduces dependence on chemical pesticides, thereby minimizing environmental pollution, health hazards, and pest resistance.

### 4.8.1 Meaning of Biological Control

“The regulation of pest populations by the use of their natural enemies such as predators, parasitoids, and pathogens.”

In this method, beneficial insects feed on or parasitize harmful insects, naturally keeping their numbers under control.

### 4.8.2 Types of Biological Control Insects

Biological control insects are mainly classified into predators and parasitoids.

#### 1. Predatory Insects

Predators are insects that attack, kill, and consume several prey insects during their lifetime.

##### Characteristics

- Free-living insects
- Consume large numbers of pests
- Both larval and adult stages may be predatory

##### Examples

Ladybird beetle (*Coccinella septempunctata*) Aphids, mealybugs

Praying mantis

Caterpillars, grasshoppers

Dragonfly

Mosquitoes and flies

Lacewing larvae (Chrysoperla)

Aphids, thrips

## 2. Parasitoid Insects

Parasitoids are insects that lay their eggs on or inside the body of a host insect. The developing larvae feed on the host and eventually kill it.

### Characteristics

- Host-specific
- Larvae develop inside host body
- Adult parasitoids are usually free-living

### Examples

			Parasitoid
Host	Pest	-----	Trichogramma
species	Eggs of moths and butterflies		
	Ichneumon wasps	Caterpillars	
	Braconid wasps	Aphids and beetle larvae -----	
	-----		

### 4.8.3 Importance of Insects as Biological Control Agents

#### Agricultural Importance

- Control insect pests naturally
- Reduce crop losses
- Maintain pest population below economic threshold

#### Environmental Importance

- Eco-friendly and non-polluting
- Preserve soil and water quality
- Protect non-target organisms

#### Economic Importance

- Low-cost pest management
- Reduces expenditure on pesticides

- Increases crop yield and farmer income

#### **4.8.4 Advantages of Biological Control**

1. Environmentally safe
2. No pesticide residue in food
3. Long-term pest control
4. Prevents pest resistance
5. Maintains ecological balance

#### **4.8.5 Limitations of Biological Control**

- Slower action compared to chemicals
- Effectiveness depends on environmental conditions
- Requires proper identification of pests and natural enemies

Despite limitations, biological control remains one of the safest pest management strategies.

#### **4.8.6 Biological Control in Integrated Pest Management (IPM)**

Biological control forms a key component of Integrated Pest Management (IPM), which combines:

- Biological methods
- Mechanical methods
- Cultural practices
- Limited chemical use

IPM ensures sustainable agriculture with minimal environmental impact.

### **4.9 Decomposer and Soil-Building Insects**

#### **Introduction**

Decomposer and soil-building insects play a crucial role in maintaining soil fertility and ecosystem balance. These insects feed on dead plants, animal remains, and organic wastes, breaking them down into simpler substances. Through their activities, nutrients are recycled back into the soil, making them available for plants.

In economic zoology, decomposer insects are considered indirectly beneficial to humans, as they improve soil structure, fertility, and agricultural productivity while also helping in waste disposal and environmental cleanliness.

#### 4.9.1 Meaning of Decomposer Insects

Decomposer insects are defined as:

“Insects that feed on dead and decaying organic matter and convert complex organic substances into simpler inorganic nutrients.”

Soil-building insects are those that improve soil structure through burrowing, mixing of soil, and addition of organic matter.

#### 4.9.2 Major Groups of Decomposer and Soil-Building Insects

##### 1. Dung Beetles

Dung beetles feed on animal excreta and play a major role in nutrient recycling.

Functions:

- Bury dung into soil
- Improve soil aeration
- Reduce breeding sites for flies and parasites

Economic Importance:

- Improve pasture quality
- Increase soil fertility
- Promote healthier livestock environment

##### 2. Termites

Termites feed on cellulose-rich materials such as wood and plant debris.

Functions:

- Decompose plant litter
- Mix organic matter with soil
- Improve soil porosity

Note: Though termites can be pests in buildings, they are ecologically beneficial in natural ecosystems.

### 3. Ants

Ants are important soil engineers.

Functions:

- Construct tunnels and nests
- Improve soil aeration and drainage
- Mix organic and mineral particles

Additional Benefits:

- Seed dispersal
- Predation on small insect pests

#### 4.9.3 Role in Soil Formation and Fertility

Decomposer and soil-building insects contribute to:

- Formation of humus
- Release of nutrients such as nitrogen, phosphorus, and potassium
- Improvement of soil texture and structure
- Enhanced water-holding capacity of soil

These activities directly support plant growth and agricultural productivity.

#### 4.9.4 Importance in Agriculture

- Improve crop yield indirectly
- Maintain long-term soil health
- Reduce dependency on chemical fertilizers
- Promote sustainable farming practices

Healthy soil created by insect activity leads to better root penetration and nutrient absorption in plants.

#### 4.9.5 Environmental Importance

- Decompose organic waste
- Prevent accumulation of dead matter

- Maintain ecological balance
- Support nutrient cycling in ecosystems

By cleaning the environment, these insects help maintain hygiene and ecosystem stability.

#### **4.9.6 Economic Importance**

Although decomposer insects do not produce direct marketable products, they provide valuable ecosystem services:

1. Enhanced soil fertility
2. Increased agricultural productivity
3. Reduced waste management costs
4. Sustainable nutrient recycling

These services contribute significantly to human welfare and national economy.

#### **4.9.7 Conservation of Decomposer Insects**

Threats include:

- Excessive pesticide use
- Habitat destruction
- Soil pollution

Conservation measures:

- Reduced chemical inputs
- Promotion of organic farming
- Protection of natural habitats

#### **4.10 Economic Importance of Beneficial and Industrial Insects**

Beneficial and industrial insects contribute enormously to the economic development of human society. They provide valuable products, support agriculture and industry, maintain ecological balance, and generate employment opportunities. Their contribution may be direct (production of goods) or indirect (ecosystem services).

### 4.10.1 Direct Economic Benefits

#### 1. Production of Commercial Products

Many insects produce valuable substances used in industries:

- Honey bees → honey, beeswax, royal jelly
- Silkworms → silk
- Lac insects → lac, shellac
- Cochineal insects → natural dyes

These products are widely used in:

- Textile industry
- Cosmetics
- Pharmaceuticals
- Food processing

#### 2. Employment Generation

Insect-based industries provide livelihoods to millions of people, especially in rural areas:

- Apiculture
- Sericulture
- Lac culture

These activities require low investment and offer high economic returns, making them ideal for small-scale farmers.

### 4.10.2 Indirect Economic Benefits

#### 1. Pollination Services

Pollinating insects like bees, butterflies, and beetles:

- Increase crop yield
- Improve fruit quality
- Enhance seed production

Pollination directly contributes to food security and agricultural economy.

## 2. Natural Pest Control

Predatory and parasitic insects help in:

- Controlling harmful pests
- Reducing pesticide use
- Promoting eco-friendly farming

This lowers crop losses and reduces production costs.

## 3. Soil Fertility and Waste Recycling

Insects such as termites, ants, and dung beetles:

- Improve soil structure
- Recycle nutrients
- Enhance agricultural sustainability

### 4.10.3 Contribution to Industries

Beneficial insects support multiple industries:

- Textile industry → silk
- Pharmaceutical industry → bee products
- Paint and varnish industry → shellac
- Food industry → honey

These industries contribute significantly to national income and exports.

### 4.10.4 Role in Sustainable Development

Beneficial insects promote:

- Organic farming
- Reduced chemical pollution
- Conservation of biodiversity
- Sustainable use of natural resources

They align closely with the goals of environmental conservation and green economy.

## 4.11 Conservation of Beneficial and Industrial Insects

Beneficial and industrial insects are vital for agriculture, industry, ecology, and human welfare. However, their populations are declining rapidly due to habitat loss, excessive pesticide use, climate change, and pollution. Conservation of these insects is essential to ensure sustainable development and ecological balance.

#### **4.11.1 Need for Conservation**

Conservation is necessary because beneficial insects:

- Support crop production through pollination
- Maintain soil fertility and nutrient cycling
- Provide economically valuable products
- Contribute to biodiversity and ecosystem stability

A decline in their population can lead to:

- Reduced agricultural yield
- Increased pest outbreaks
- Economic losses
- Ecological imbalance

#### **4.11.2 Threats to Beneficial and Industrial Insects**

##### **1. Habitat Destruction**

- Deforestation
- Urbanization
- Agricultural expansion

Loss of nesting and breeding sites affects bees, butterflies, and decomposer insects.

##### **2. Excessive Use of Pesticides**

- Kills both harmful and beneficial insects
- Disrupts food chains
- Causes long-term population decline

##### **3. Climate Change**

- Alters flowering seasons
- Affects insect life cycles
- Reduces availability of food sources

#### 4. Pollution

- Air, water, and soil pollution
- Industrial waste affecting insect survival

#### **4.11.3 Conservation Strategies**

##### 1. Habitat Protection

- Preservation of forests and grasslands
- Creating insect-friendly environments
- Maintaining hedgerows and flowering plants

##### 2. Promotion of Organic Farming

- Reduced chemical pesticide use
- Use of biological pest control
- Encouraging natural predators

##### 3. Integrated Pest Management (IPM)

- Combines biological, mechanical, and chemical methods
- Minimizes harm to beneficial insects

##### 4. Awareness and Education

- Farmer training programs
- Public awareness campaigns
- Inclusion in academic curriculum

#### **4.11.4 Role of Research and Technology**

- Development of eco-friendly pesticides
- Artificial breeding and mass rearing
- Monitoring insect populations
- Climate-resilient insect species research

# Harmful Insects and Economic Loss

## 5.1 Introduction

Insects form the largest and most diverse group of animals on Earth. While many insects are beneficial to humans, a significant number of species are considered harmful insects due to the economic losses they cause. Harmful insects adversely affect agriculture, stored products, forestry, livestock, and human health.

These insects damage crops at various stages of growth by feeding on leaves, stems, roots, flowers, and fruits. Some insects destroy stored grains and food materials, making them unfit for consumption. Others act as vectors of diseases, transmitting pathogens responsible for serious human and animal diseases such as malaria, dengue, plague and filariasis.

The activities of harmful insects result in reduced agricultural productivity, financial losses to farmers, increased food prices, and public health problems. Considerable expenditure is also required for pest control measures, which further adds to economic burden.

The study of harmful insects under Economic Zoology helps in understanding their biology, life cycles, mode of damage, and control methods. Scientific management of harmful insects is essential to minimize economic losses, ensure food security, and protect human welfare.

## 5.2 Classification of Harmful Insects

Harmful insects are classified on the basis of the area of infestation, nature of damage, and their economic significance. Such classification helps in understanding the extent of losses caused by insects and in planning suitable control and management strategies.

### 5.2.1 Agricultural Crop Pests

These insects attack field crops during different stages of growth and cause heavy yield loss.

Types of damage:

- Defoliation
- Stem boring
- Root cutting
- Sap sucking

Examples:

- Locust (*Schistocerca gregaria*) – causes large-scale destruction of crops

- Rice stem borer (*Scirpophaga incertulas*)
- Aphids (Aphis spp.) – transmit viral diseases

### 5.2.2 Stored Grain and Product Pests

Stored product pests infest stored grains, pulses, cereals, and processed food materials.

Damage caused:

- Reduction in weight and quality
- Contamination with excreta
- Loss of seed viability

Examples:

- Rice weevil (*Sitophilus oryzae*)
- Lesser grain borer (*Rhizopertha dominica*)
- Flour beetle (*Tribolium castaneum*)

### 5.2.3 Household Pests

Household pests cause nuisance, contamination of food, and damage to household goods.

- Cockroach (*Periplaneta americana*) – spreads disease-causing organisms

- Ants – spoil food
- Termites – destroy wooden furniture and buildings

### 5.2.4 Forest Pests

Forest pests damage forest trees and timber, leading to ecological and economic loss.

- Bark beetles – bore into tree bark
- Defoliating caterpillars – strip leaves of forest trees

### 5.2.5 Medical and Veterinary Pests

These insects directly affect human and animal health by acting as disease vectors.

- Mosquitoes – malaria, dengue, filariasis
- Fleas – plague
- Lice – typhus

### 5.2.6 Industrial and Textile Pests

These pests damage stored industrial materials such as wool, silk, and leather.

- Clothes moths
- Carpet beetles

## 5.3 Nature of Damage Caused by Harmful Insects

Harmful insects cause damage in various ways, depending on their feeding habits, life cycle, and habitat. The damage may be direct, by feeding on plants or materials, or indirect, by transmitting diseases. Understanding the nature of damage is essential for effective pest control and economic loss prevention.

### 5.3.1 Defoliation

Some insects feed on leaves, resulting in partial or complete defoliation.

Effects:

- Reduced photosynthesis
- Poor plant growth
- Lower crop yield

Examples:

- Caterpillars
- Locusts

### 5.3.2 Boring Damage

Boring insects attack stems, roots, fruits, and seeds.

Effects:

- Weakening of plant structure

- Wilting and lodging
- Reduced grain or fruit quality

Examples:

- Stem borers
- Fruit borers

### **5.3.3 Sap Sucking**

Sap-sucking insects feed on plant sap, depriving plants of essential nutrients.

Effects:

- Yellowing and curling of leaves
- Stunted growth
- Transmission of plant viruses

Examples:

- Aphids
- Whiteflies
- Leafhoppers

### **5.3.4 Root Feeding**

Some insects feed on plant roots, affecting water and nutrient absorption.

Effects:

- Wilting
- Reduced plant vigor
- Plant death in severe cases

Examples:

- Root grubs
- Termite larvae

### **5.3.5 Damage to Stored Products**

Stored product insects attack stored grains, pulses, flour, and processed food.

Effects:

- Loss of weight and quality
- Contamination with excreta

- Reduced germination capacity

Examples:

- Weevils
- Flour beetles

### **5.3.6 Transmission of Diseases**

Some insects act as vectors of pathogens.

Effects:

- Spread of human and animal diseases
- Increased healthcare expenditure

Examples:

- Mosquitoes – malaria, dengue
- Fleas – plague

### **5.3.7 Contamination and Nuisance**

Household pests contaminate food and surroundings.

Examples:

- Cockroaches
- Flies

## **5.4 Economic Losses Due to Harmful Insects**

Harmful insects cause significant economic losses by damaging crops, stored products, forests, livestock, and by affecting human health. These losses may be direct or indirect and have serious implications for food security and national economy.

### **5.4.1 Agricultural Losses**

Insect pests cause major losses in agriculture by:

- Reducing crop yield
- Lowering quality of produce
- Causing complete crop failure in severe infestations

It is estimated that 20–30% of agricultural production is lost annually due to insect pests in developing countries.

### **5.4.2 Losses to Stored Products**

Stored grain pests lead to:

- Weight loss of grains
- Contamination with insect fragments and excreta
- Reduced market value
- Loss of seed viability

These losses increase food scarcity and raise market prices.

#### **5.4.3 Losses in Forestry**

Forest pests cause:

- Destruction of timber
- Reduced forest productivity
- Ecological imbalance

This results in loss of raw materials for industries and affects biodiversity.

#### **5.4.4 Health-Related Economic Losses**

Medical and veterinary pests cause:

- Spread of diseases
- Increased healthcare expenses
- Loss of working days

Diseases such as malaria, dengue, and plague impose a heavy economic burden on society.

#### **5.4.5 Expenditure on Pest Control**

Considerable money is spent on:

- Insecticides
- Pest control equipment
- Labor and monitoring

Excessive chemical control also leads to environmental pollution and pesticide resistance, increasing long-term costs.

#### **5.4.6 Indirect Economic Losses**

Indirect losses include:

- Reduced export quality of agricultural products
- Environmental damage
- Loss of biodiversity

## **5.5 Major Harmful Insects of Economic Importance**

Certain insects are considered major pests due to the extensive damage they cause to agriculture, stored products, forests, and human health. These insects have high reproductive capacity and adaptability, leading to serious economic losses.

### **5.5.1 Locusts**

Scientific name: *Schistocerca gregaria*

Nature of damage:

- Feed on leaves, stems, flowers, and fruits
- Move in large swarms causing total crop destruction

Economic impact:

- Sudden and large-scale crop losses
- Food shortages and economic instability

### **5.5.2 Mosquitoes**

Examples: *Anopheles*, *Aedes*, *Culex*

Nature of damage:

- Blood-sucking insects
- Transmit diseases like malaria, dengue, filariasis

Economic impact:

- High healthcare costs
- Loss of working days

### **5.5.3 Termites**

Examples: *Odontotermes*, *Microtermes*

Nature of damage:

- Feed on cellulose
- Damage wooden structures, crops, and stored products

Economic impact:

- Structural damage to buildings
- Agricultural losses

#### **5.5.4 Aphids**

Scientific name: *Aphis* spp.

Nature of damage:

- Suck plant sap
- Transmit viral diseases

Economic impact:

- Reduced crop yield
- Poor quality produce

#### **5.5.5 Stem Borers**

Examples: *Scirpophaga* *incertulas*

Nature of damage:

- Bore into plant stems
- Cause dead heart and white ear formation

Economic impact:

- Significant reduction in cereal production

#### **5.5.6 Weevils**

Example: *Sitophilus oryzae*

Nature of damage:

- Damage stored grains

Economic impact:

- Loss of food grains during storage

### **5.6 Methods of Control of Harmful Insects**

Control of harmful insects is essential to reduce economic losses, protect crop yield, and safeguard human health. Different control methods are adopted based on the nature of pest, level of infestation, and environmental safety.

### 5.6.1 Cultural Control Methods

These are preventive measures aimed at reducing pest population by modifying farming practices.

Methods include:

- Crop rotation
- Timely sowing and harvesting
- Field sanitation
- Removal of infested plant parts

Advantages:

- Environment-friendly
- Economical
- Easy to adopt

### 5.6.2 Mechanical and Physical Control

These methods involve manual or physical removal of pests.

Examples:

- Handpicking of insects
- Use of traps (light traps, pheromone traps)
- Use of barriers and nets

### 5.6.3 Biological Control

This method uses natural enemies of pests.

Examples:

- Ladybird beetles against aphids
- Parasitoid wasps against caterpillars
- Predatory insects

Advantages:

- Eco-friendly
- Sustainable
- No chemical residue

### 5.6.4 Chemical Control

Use of insecticides to control pests.

Examples:

- Organochlorines
- Organophosphates
- Carbamates
- Pyrethroids

Limitations:

- Development of resistance
- Environmental pollution
- Harm to beneficial insects

### **5.6.5 Integrated Pest Management (IPM)**

IPM combines cultural, biological, mechanical, and chemical methods.

Benefits:

- Reduces pesticide use
- Maintains ecological balance
- Cost-effective and sustainable

### **5.7 Role of Economic Zoology in Pest Management**

Economic Zoology plays a vital role in understanding and managing harmful insects. It provides scientific knowledge about the identification, classification, life cycle, behavior, and ecology of insect pests. This understanding helps in developing effective and economical pest control strategies.

Economic zoology contributes by:

- Identifying harmful insect species accurately
- Studying their life cycles to target vulnerable stages
- Understanding pest–environment interactions
- Developing eco-friendly and sustainable control methods
- Minimizing economic losses while protecting beneficial organisms

Thus, Economic Zoology forms the scientific basis for Integrated Pest Management (IPM).

# Animals in Medicine and Industry

## 6.1 Introduction

Animals have played a significant role in the development of medicine and industry since ancient times. Humans have depended on animals not only as a source of food but also for therapeutic, diagnostic, and industrial purposes. The study of animals in medicine and industry forms an important branch of Economic Zoology, as it directly relates to human health, economic growth, and technological advancement.

In medicine, animals are extensively used as experimental models for understanding the structure and function of organs, studying diseases, and testing new drugs and vaccines. Many life-saving medicines, hormones, enzymes, antivenoms, and vaccines are produced with the help of animals. Laboratory animals such as rats, mice, rabbits, guinea pigs, and monkeys have contributed immensely to advances in medical research and treatment.

Animals also serve as sources of medicinal substances like insulin, heparin, hormones, and antibodies. Certain animal products have antimicrobial, anticoagulant, and therapeutic properties, making them valuable in modern healthcare systems. In addition, animals play an important role in the production of biological products such as antisera and vaccines.

In industry, animals provide a variety of raw materials used in textile, leather, pharmaceutical, cosmetic, and food industries. Products such as silk, wool, leather, bone meal, gelatin and shellac are derived from animals and contribute significantly to national and global economies. Animal-based industries also generate large-scale employment, especially in rural areas.

Thus, animals are indispensable in medicine and industry. Their judicious and ethical use, along with proper conservation and welfare measures, is essential to ensure sustainable development and human welfare.

## 6.2 Animals as Experimental Models

Animals are widely used as experimental models in medical and biological research. An experimental model is an organism used to study biological processes, disease mechanisms, and treatment methods that can be applied to humans. Animals are preferred because many of their physiological, anatomical, and genetic characteristics are similar to humans.

#### Common Laboratory Animals Used

- Rats (*Rattus norvegicus*) Used in studies of nutrition, physiology, pharmacology, and toxicology.
- Mice (*Mus musculus*) Widely used in genetic research, cancer studies, and immunology.
- Rabbits (*Oryctolagus cuniculus*) Used in antibody production, ophthalmic research, and skin testing.
- Guinea pigs (*Cavia porcellus*) Used in immunology and allergy research.
- Monkeys and other primates Used in neurological, behavioral and vaccine research.

#### Importance of Animal Models

- Help in understanding disease mechanisms
- Enable testing of drug safety and efficacy
- Assist in surgical and physiological research
- Provide reliable data before human trials

#### Ethical Considerations

Animals must be used only when alternatives are unavailable

- Follow the 3R principle:
- Replacement – use alternatives where possible

- Reduction – use minimum number of animals
- Refinement – minimize pain and distress

Animal experimentation is regulated by ethical committees and laws to ensure humane treatment and welfare.

### **6.3 Animals in Vaccine and Drug Development**

Animals play a crucial role in the development of vaccines and drugs. Before medicines are approved for human use, they must be tested for safety, potency, and side effects, and animal studies are a vital step in this process.

#### Role in Vaccine Development

- Testing the effectiveness of vaccines
- Studying immune responses
- Evaluating toxicity and side effects

#### Examples:

- Development of vaccines for rabies, polio, tuberculosis and COVID-19 involved animal testing.

- Horses are used for antivenom production.

#### Role in Drug Development

- Testing new drugs for toxicity and therapeutic value
- Determining proper dosage
- Studying long-term effects

Animals help in pharmacological studies related to:

- Antibiotics
- Analgesics

- Anticancer drugs
- Hormones

#### Antisera and Antivenom Production

- Large animals like horses are injected with small doses of toxins
- Antibodies formed are collected as antisera
- Used in treating snake bites and scorpion stings

#### Limitations

- Ethical concerns
- High cost
- Differences between animal and human responses

### 6.4 Medicinal Products of Animal Origin

Many important medicines and therapeutic substances are obtained from animals. These products have been used in modern medicine for treating various diseases and disorders.

#### 6.4.1 Insulin

- Originally extracted from the pancreas of pigs and cattle
- Used in the treatment of diabetes mellitus
- Regulates blood glucose levels

#### 6.4.2 Heparin

- Obtained from the liver and lungs of animals
- Acts as an anticoagulant
- Prevents blood clot formation during surgeries

### **6.4.3 Hormones**

- Thyroxine, adrenaline, and other hormones
- Used in treating endocrine disorders

### **6.4.4 Antibodies and Antisera**

- Produced in animals like horses and rabbits
- Used to treat infections and toxin exposure

### **6.4.5 Enzymes and Other Products**

- Trypsin, pepsin, and pancreatin
- Used in digestive disorders

## **6.5 Animals in Traditional and Modern Medicine**

Animals have been used in traditional medical systems since ancient times and continue to play an important role in modern healthcare.

### **6.5.1 Traditional Medicine**

- Ayurveda uses animal products such as milk, honey, ghee
- Traditional remedies involve animal-derived substances

### **6.5.2 Modern Medicine**

- Use of animal models for disease research
- Production of vaccines and pharmaceuticals
- Organ transplantation and surgical research

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## **6.6 Industrial Products Obtained from Animals**

Animals are important sources of raw materials for many industries. These animal-based products contribute significantly to the national economy and provide employment to millions of people.

### **6.6.1 Leather**

- Obtained from the skin of cattle, buffalo, goats, and sheep
- Used in footwear, bags, belts, and garments

### **6.6.2 Wool**

- Obtained from sheep, goats, and camels
- Used in textile industries for making clothes, blankets, and carpets

### **6.6.3 Silk**

- Produced by silkworm (*Bombyx mori*)
- Used in the textile industry for making luxury fabrics

### **6.6.4 Bone and Horn Products**

- Bone meal used as fertilizer
- Horns used in buttons, ornaments, and handicrafts

### **6.6.5 Gelatin and Glue**

- Obtained from bones and connective tissues
- Used in food, pharmaceutical, and photographic industries

## **6.7 Animals in Biotechnology**

Biotechnology has expanded the role of animals in modern medicine and industry.

### **6.7.1 Transgenic Animals**

- Animals with altered genetic material
- Used for producing therapeutic proteins

### **6.7.2 Monoclonal Antibodies**

- Produced using animals
- Used in cancer diagnosis and treatment

### **6.7.3 Xenotransplantation**

- Transplantation of animal organs into humans
- Pigs are commonly used for research

## **6.8 Ethical Issues and Animal Welfare in Medicine**

The use of animals in medicine and industry raises important ethical concerns. While animals contribute significantly to scientific progress, their welfare must be protected.

### Ethical Issues

- Pain and suffering during experiments
- Overuse of animals in research
- Moral responsibility towards living beings

### Animal Welfare Measures

- Following the 3R Principle:
- Replacement – use alternatives where possible
- Reduction – minimize the number of animals used
- Refinement – reduce pain and stress
- Use of anesthesia and proper care
- Monitoring by ethical committees
- Legal regulations and guidelines

Ethical use ensures humane treatment and sustainable scientific development.

### **6.9 Economic Importance of Animals in Medicine and Industry**

Animals contribute greatly to the economy through:

- Pharmaceutical industries
- Biotechnology and research sectors
- Textile and leather industries
- Employment generation in rural and urban areas

Animal-based industries help in:

- Export earnings
- Industrial growth
- Technological advancement

### **6.10 Summary**

Animals play an indispensable role in medicine and industry. They serve as experimental models, sources of medicinal products, and raw materials for various industries. Advances in biotechnology have further increased their importance. Ethical use and animal welfare are essential to ensure sustainable benefits for human society.

# Harmful and Parasitic Animals

## 7.1 Introduction

Animals play a vital role in maintaining ecological balance; however, certain animals adversely affect human health, agriculture, livestock, and the economy. Such animals are known as harmful and parasitic animals. They cause damage either directly, by attacking or poisoning humans and animals, or indirectly, by acting as carriers of disease-causing pathogens.

Parasitic animals live in or on another organism (host) and obtain nourishment at the expense of the host, leading to malnutrition, disease, and reduced productivity. The study of harmful and parasitic animals is an important component of Economic Zoology, as it provides knowledge for prevention, control, and management of diseases, thereby improving public health and economic stability.

## 7.2 Harmful Animals

Harmful animals are those animals that cause injury, disease, discomfort, or economic loss to humans, livestock, crops, and property. These animals may harm directly by biting, stinging, poisoning, or attacking, or indirectly by transmitting disease-causing organisms. The impact of harmful animals is significant in public health, agriculture, and animal husbandry, making their study an important part of Economic Zoology.

### 7.2.1 Venomous Animals

Venomous animals possess specialized venom glands that produce toxic substances. These toxins are injected into the body of the victim through fangs, stingers, or spines.

- Snakes – Cobra, Krait, Russell’s viper
- Scorpions
- Spiders

Effects of Venom

- Paralysis of muscles and nerves

- Excessive bleeding and clotting disorders
- Severe pain and tissue damage
- In some cases, death

#### Economic and Health Impact

- High medical treatment costs
- Loss of working days
- Mortality in rural and agricultural areas

### 7.2.2 Nuisance and Household Animals

These animals commonly live in human dwellings and surroundings and cause discomfort and disease by contaminating food and water.

#### Examples

- Housefly (*Musca domestica*) – spreads cholera, typhoid, dysentery
- Cockroach (*Periplaneta americana*) – spreads bacteria and allergens
- Mosquitoes – cause malaria, dengue, filariasis

#### Harmful Effects

- Mechanical transmission of pathogens
- Food spoilage and contamination
- Allergic reactions and infections

### 7.2.3 Agricultural Pests

These animals cause serious damage to crops and stored agricultural products, leading to economic loss.

#### Examples

- Rodents (rats and mice) – destroy standing crops and stored grains
- Locusts – cause large-scale crop destruction
- Weevils and beetles – damage stored cereals

#### Economic Loss

- Reduced crop yield

- Food scarcity
- Increased pest control expenditure

#### **7.2.4 Livestock Pests**

Livestock pests affect domestic animals by sucking blood, spreading diseases, or damaging skin, resulting in reduced productivity.

##### Examples

- Ticks – transmit bacterial and viral diseases
- Lice – cause itching and hair loss
- Mites – cause mange

##### Effects

- Reduced milk, meat, and wool production
- Anemia and weakness in animals
- Increased veterinary expenses

#### **7.2.5 Harmful Aquatic Animals**

Certain aquatic animals cause harm to humans and fisheries.

##### Examples

- Puffer fish – contains tetrodotoxin
- Jellyfish – cause painful stings
- Predatory fish – reduce fish stock

##### Importance of Studying Harmful Animals

- Helps in disease prevention and control
- Reduces economic losses
- Promotes public health and safety
- Supports sustainable agriculture and animal husbandry

#### **7.3 Parasitic Animals**

A parasite is an organism that lives in or on another organism called the host, deriving nourishment while causing harm.

### Characteristics of Parasites

- Dependence on host
- Structural adaptations
- High reproductive capacity

## 7.4 Types of Parasites

### 7.4.1 Based on Habitat

- Ectoparasites – live on the host surface
- Endoparasites – live inside the host body

### 7.4.2 Based on Duration

- Temporary parasites
- Permanent parasites

## 7.5 Ectoparasites

### 7.5.1 Lice (*Pediculus humanus*)

- Cause itching and hair loss
- Transmit typhus fever

### 7.5.2 Fleas (*Xenopsylla cheopis*)

- Cause irritation and anemia
- Vector of plague

### 7.5.3 Ticks

- Suck blood from livestock
- Transmit bacterial and viral diseases

## 7.6 Endoparasites

### 7.6.1 Protozoan Parasites

#### *Plasmodium*

- Causes malaria
- Transmitted by female Anopheles mosquito

#### *Entamoeba histolytica*

- Causes amoebic dysentery

### 7.6.2 Helminth Parasites

#### *Ascaris lumbricoides*

- Causes ascariasis
  - Leads to intestinal obstruction
- Taenia solium*
- Causes taeniasis
  - Associated with undercooked pork
- Wuchereria bancrofti*
- Causes filariasis
  - Leads to elephantiasis

### 7.7 Life Cycles of Important Parasites

Understanding life cycles helps in effective control and prevention.

- Direct life cycle – Ascaris
- Indirect life cycle – Plasmodium, Taenia

### 7.8 Economic Impact of Harmful and Parasitic Animals

- Loss of man-days
- Decreased agricultural productivity
- Increased medical expenses
- Poor livestock health

### 7.9 Prevention and Control Measures

#### 7.10.1 Environmental Control

- Sanitation
- Proper waste disposal

#### 7.10.2 Chemical Control

- Insecticides
- Antiparasitic drugs

#### 7.10.3 Biological Control

- Natural predators
- Genetic control

#### 7.10.4 Public Health Measures

- Awareness programs
- Vaccination
- Early diagnosis

### 7.11 Role of Economic Zoology

Economic zoology contributes to:

- Identification of harmful animals
- Disease control strategies
- Livestock health management
- Public health planning

### **7.12 Summary**

Harmful and parasitic animals pose a major threat to human health, agriculture, and economy. Scientific understanding of their biology, life cycles, and control methods is essential for sustainable development and improved quality of life.

# Wildlife Conservation and Animal Welfare

## 8.1 Introduction

Wildlife conservation and animal welfare have emerged as critical global concerns in the present century due to the rapid decline in biodiversity and increasing anthropogenic pressures on natural ecosystems. Wildlife includes all free-living, non-domesticated animals inhabiting natural environments such as forests, grasslands, wetlands, deserts, and marine ecosystems. These animals play a vital role in maintaining ecological balance by participating in food chains, nutrient cycling, pollination, seed dispersal, and regulation of populations.

Over the past few decades, human activities such as deforestation, industrialization, agricultural expansion, urbanization, mining, and infrastructure development have resulted in habitat destruction and fragmentation. Along with this, climate change, pollution, invasive species, and illegal hunting have further accelerated the extinction of many wildlife species. According to global estimates, a large number of animal species are currently threatened or endangered, making conservation efforts more urgent than ever.

Wildlife conservation primarily focuses on the protection, management, and restoration of animal populations and their natural habitats to ensure their long-term survival. It adopts a scientific and ecosystem-based approach, emphasizing species conservation, habitat preservation, and sustainable use of natural resources. In contrast, animal welfare is concerned with the ethical treatment and well-being of individual animals, ensuring that they are free from unnecessary suffering, pain, stress, and cruelty, whether in the wild, captivity, agriculture, research, or companionship.

Although wildlife conservation and animal welfare were once considered separate disciplines, modern environmental science recognizes them as interrelated and complementary. Effective conservation cannot be achieved without addressing animal

welfare, particularly in captive breeding programs, wildlife rescue and rehabilitation, zoos, research institutions, and during human–wildlife conflict management. Similarly, long-term animal welfare depends on healthy ecosystems and stable wildlife populations.

In countries like India, which are rich in biodiversity and home to numerous endemic and endangered species, wildlife conservation and animal welfare hold special significance. Legal frameworks, protected area networks, species-specific conservation projects, and growing public awareness have contributed to conservation success; however, continuous efforts are needed to balance developmental needs with ecological and ethical responsibilities. This chapter provides an overview of the principles, methods, challenges, and importance of wildlife conservation and animal welfare in ensuring sustainable coexistence between humans and animals.

## **8.2 Concept of Wildlife Conservation**

Wildlife conservation is a scientific and ethical approach aimed at protecting wild animal species and their natural habitats to maintain ecological stability and biodiversity. It recognizes wildlife as an integral component of ecosystems that supports life on Earth. Conservation involves planned management of wildlife populations, protection of critical habitats, regulation of exploitation, and restoration of degraded ecosystems.

The concept of wildlife conservation has evolved from mere protection of game animals to a holistic ecosystem-based approach. Earlier conservation efforts focused mainly on preventing overhunting of economically important species. Modern conservation biology, however, emphasizes the protection of entire ecosystems, landscape-level planning, and the conservation of genetic diversity. It integrates ecological principles with social, economic, and cultural factors.

Wildlife conservation also promotes sustainable utilization of wildlife resources so that present needs are met without compromising the ability of future generations to meet their own needs. Community participation, indigenous knowledge, and international cooperation play a crucial role in successful conservation programs.

### **Objectives of Wildlife Conservation**

- Protection of endangered and threatened species: Preventing extinction by safeguarding vulnerable populations and improving their survival prospects.
- Maintenance of ecological balance: Ensuring stable food chains, predator–prey relationships, and ecosystem functioning.
- Preservation of genetic diversity: Conserving genetic variability within species to enhance adaptability and resilience.
- Sustainable use of natural resources: Regulating utilization of wildlife to prevent overexploitation.
- Protection of habitats and ecosystems: Conserving forests, wetlands, grasslands, marine ecosystems, and other critical habitats.

### **8.3 Threats to Wildlife**

Wildlife populations across the globe are declining due to a wide range of natural and human-induced threats. These threats not only reduce population sizes but also disrupt ecological interactions and ecosystem services.

- Habitat loss and fragmentation: Large-scale deforestation, agricultural expansion, mining, dam construction, and urban development destroy and fragment natural habitats. Fragmentation isolates populations, restricts movement, and reduces genetic exchange.
- Poaching and illegal wildlife trade: Illegal hunting for meat, fur, skin, ivory, horns, bones, and traditional medicines poses a serious threat to many species such as tigers, elephants, rhinos, pangolins, and reptiles.
- Climate change: Rising temperatures, altered rainfall patterns, melting glaciers, and sea-level rise affect breeding cycles, migration routes, food availability, and habitat suitability.
- Pollution: Industrial effluents, pesticides, plastics, oil spills, and heavy metals contaminate air, water, and soil, leading to poisoning, reproductive failure, and mortality of wildlife.

- Human–wildlife conflict: Expansion of human settlements into wildlife habitats leads to crop damage, livestock predation, and human casualties, often resulting in retaliatory killing of animals.

#### **8.4 Wildlife Conservation Methods**

Wildlife conservation employs a combination of in-situ and ex-situ strategies to protect species and ecosystems effectively.

##### **In-situ Conservation**

In-situ conservation involves the protection and management of wildlife within their natural habitats. This method allows species to evolve naturally and maintain ecological interactions. Protected areas are established and managed to minimize human disturbance.

- National Parks: Strictly protected areas aimed at conserving entire ecosystems with minimal human interference.

- Wildlife Sanctuaries: Areas where wildlife is protected, but limited human activities may be permitted.

- Biosphere Reserves: Large areas that include core, buffer, and transition zones for conservation, research, and sustainable development.

- Conservation and Community Reserves: Areas managed with the participation of local communities to promote conservation and livelihoods.

##### **Ex-situ Conservation**

Ex-situ conservation involves conserving species outside their natural habitats when in-situ measures are insufficient.

- Zoological parks: Provide safe environments for conservation breeding, education, and research.

- Botanical gardens: Conserve plant species essential for animal survival.

- Captive breeding programs: Breed endangered species under controlled conditions for reintroduction into the wild.
- Gene banks and cryopreservation: Preserve genetic material such as seeds, sperms, ova, and embryos for future use.

### **8.5 Animal Welfare: Concept and Principles**

Animal welfare is a multidisciplinary concept concerned with the physical, mental, and emotional well-being of animals. It emphasizes that animals are sentient beings capable of experiencing pain, fear, stress, and pleasure. Ensuring animal welfare is a moral obligation of humans in all situations involving animals, including wildlife management, farming, research, entertainment, and companionship.

The widely accepted Five Freedoms of Animal Welfare provide a framework for assessing animal welfare:

1. Freedom from hunger and thirst: Access to fresh water and a balanced diet.
2. Freedom from discomfort: Provision of appropriate shelter and resting areas.
3. Freedom from pain, injury, and disease: Prevention, rapid diagnosis, and treatment.
4. Freedom to express normal behavior: Adequate space and social interaction.
5. Freedom from fear and distress: Conditions that prevent mental suffering.

### **8.6 Importance of Animal Welfare**

Animal welfare is essential for ethical, ecological, and economic reasons. Humane treatment of animals reflects societal values and promotes sustainability.

- Ensures humane treatment of animals: Prevents cruelty, neglect, and unnecessary suffering.
- Enhances productivity: Healthy and stress-free animals show better growth, reproduction, and performance.

- Reduces stress and disease incidence: Proper care improves immunity and lowers mortality.
- Promotes ethical research practices: Ensures responsible use of animals in scientific studies.
- Improves conservation outcomes: Welfare-oriented management enhances survival and breeding success of captive wildlife.

### **8.7 Wildlife Conservation in India**

India is one of the world's megadiverse countries, supporting a vast array of ecosystems and wildlife species. Conservation efforts in India combine legal protection, species-specific programs, and community involvement.

- Wildlife (Protection) Act, 1972: Provides legal protection to wildlife and establishes protected areas.
- Project Tiger (1973): Aims to conserve tiger populations and their habitats.
- Project Elephant (1992): Focuses on elephant conservation and mitigation of human–elephant conflict.
- Protected area network: Includes national parks, sanctuaries, biosphere reserves, and conservation reserves.
- Community-based conservation: Involves local communities in conservation planning and benefit-sharing.

### **8.8 Role of Zoological Parks and Rescue Centers**

Modern zoological parks and wildlife rescue centers have shifted from entertainment-based institutions to conservation-oriented facilities.

They play a vital role in:

- Conservation breeding: Maintaining genetically viable populations of endangered species.

- Education and awareness: Sensitizing the public about wildlife conservation and animal welfare.
- Research and veterinary care: Supporting scientific studies and providing advanced medical treatment.
- Rescue and rehabilitation: Treating injured, orphaned, or confiscated animals and, where possible, releasing them back into the wild.

### **8.9 Ethical Issues in Wildlife Conservation**

Wildlife conservation involves several ethical dilemmas that require careful consideration and balanced decision-making.

- Captivity vs. freedom: Ethical concerns regarding keeping wild animals in captivity for conservation or education.
- Human displacement: Relocation of indigenous and local communities for protected area creation.
- Use of animals in research and tourism: Ensuring minimal harm and maximum welfare.
- Development vs. conservation: Balancing economic growth with protection of biodiversity.

### **8.10 Role of Public Awareness and Education**

Public awareness and education are crucial components of successful wildlife conservation and animal welfare programs. Informed citizens are more likely to support conservation initiatives and adopt sustainable lifestyles.

Environmental education in schools and colleges, mass media campaigns, nature clubs, eco-tourism, and involvement of non-governmental organizations help spread awareness. Participation of local communities in conservation decision-making fosters a sense of ownership and responsibility, reducing conflicts and illegal activities..

## **8.11 Conclusion**

Wildlife conservation and animal welfare are essential for maintaining ecological balance and ensuring ethical coexistence between humans and animals. Effective conservation requires integrated efforts involving scientific management, strict law enforcement, ethical responsibility, and public participation. Protecting wildlife today ensures a healthier planet for future generations.



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