Unit-I

- Livestock production systems of different agroclimatic zones.
- Important breeds of domestic animals.
- Body conformation and identification, dentition and ageing of animals.
- Transport of animals by different means.
- Common farm management practices.
- Common vices of animals, their prevention and care.
- livestock resources and their management.
- Organic livestock production.
- Housing for various livestock species.
- Important breeds of domestic animals.
- General management and feeding of farm animals.
- Importance of grassland, pastures and fodders in livestock production.
- Rabbit farming, its scope and care as well as management practices involved.
- present scenario of indian poultry industry.
- Common breeds of poultry. Poultry farm management and concept of intesive poultry production.
- Commercial poultry production and Hatchery management.
- Backyard poultry production and concept of self local market.
- Marketing of animals and avian products including value addition.
- Milk Industry in India.
- Composition, nutritive value and Physico-chemical properties of Milk. Milk processing plant and its management.
- Organic milk products.
- Legal and BIS standards of Milk and Milk products. Management of abattoirs, BIS Standards on organization and layout of abattoirs.
- Ante-mortem, Post- mortem examination, dressing, evaluation, grading and fabrication of dressed carcass. HACCP concept in abattoir management.
- Introduction to wool, fur, pelt and speciality fibers processing.
- Retrospect and prospect of meat industry in India. Nutritive value of meat, fraudulent substitution of meat, preservation of meat and aquatic foods.
- Formulation and development of meat and sea foods.
- Physico- chemical and microbiological quality of meat, aquatic food and food products.
- Laws governing national, international trade of meat and meat products.

Important term related to Livestock Production Systems for Quick Review

Livestock: Glossary

Term	Definition
Abomasum	The fourth compartment, or true stomach, of the ruminant animal.
Abort	To expel the fetus prematurely.
Afterbirth	Membranes expelled after the birth of the fetus.

Animal management	The art and science of managing animals to produce a worthwhile product.
Anthelmintic	A chemical compound used for treating internal worms in animals.
Antibiotic	A chemical agent that prevents the growth of bacteria.
Antimicrobial	A substance that can destroy or inhibit the growth of microorganisms.
Antiseptic	A substance used to kill harmful organisms on the skin surface.
Anus	The opening at the end of the digestive system through which feces are expelled.
Apparel wool	Fine wool used in making clothing.
Arsenical	A drug containing arsenic.
Artificial insemination	Placing of sperm in the female reproductive tract by non-natural means.
Bitch	An adult female dog.
Boar	An uncastrated male pig used for breeding.
Bobby calf	A male calf about one week old.
Bos indicus	Humped cattle found in tropical countries.
Bos taurus	Domestic cattle originating from the Aurochs or Celtic shorthorn.
Bovine	A generic term for cattle.
Brand	A marking placed on an animal using extreme heat, cold, paint, or caustic materials.
Breed	A group of animals with distinct characteristics that produce similar offspring.
Breeding Bull or Stud Bull	An adult male used for breeding.
Broken-mouth	A mouth with missing teeth, commonly seen in old sheep or goats.
Browse	Shoots, twigs, and leaves of brush plants used as fodder for livestock.
Buck	A male goat, deer, or rabbit; an intact, mature male goat.
Buckling	An immature male goat.
Buffalo bull calf	A male young buffalo.
Buffalo calf	A young buffalo of either sex.
Buffalo heifer calf	A female young buffalo.
Bull	A male bovine of any age that has not been castrated.
Bull calf	A male bovine under one year of age.
Buller	A female that is constantly in heat.

Bulling	A term describing a cow in heat or the act of service by a male.
Bullock or Steer	An adult castrated male used for carting and tillage.
Burdizzo	An instrument used for bloodless castration.
Calf	A beef animal under one year of age.
Calving	The act of giving birth to a calf.
Calving interval	The length of time between one calving and the next.
Cannibalism	The act of eating another member of the same species, seen in poultry and swine.
Capon	A male chicken whose reproductive organs have been removed or rendered inactive.
Carbohydrate	An organic compound containing carbon, hydrogen, and oxygen.
Carcass	The dressed body of an animal after slaughter.
Carpet wool	Coarse wool used for making carpets.
Carrying capacity	The number of animals that can be grazed on a pasture during a grazing season.
Cast	To make the animal fall to the ground.
Castrate	To remove the testes of the male or render them inactive.
Cattle	Animals of the family bovine, genus Bos.
Chevon	The meat from goats.
Clip	To cut hair from animals; also refers to the total wool shorn from a flock.
Colostrum	The first milk produced after parturition, rich in antibodies.
Concentrate	Feed containing less than 18% crude fiber when dry.
Conception rate	The percentage of animals that become pregnant when bred.
Corral	A small, fenced yard for confining livestock.
Cow	A mature female bovine that has had one or more calves.
Creep	An enclosure for feeding young animals separately from adults.
Creep feed	Special feed provided for young animals in a creep enclosure.
Crisscrossing	Mating crossbred females with a sire of one of the parent breeds; also called backcrossing.
Crone	An old, broken-mouthed ewe retained for breeding due to excellent performance.
Crutch	To remove soiled wool from between a sheep's hind legs.
Cud	In ruminants, a ball of feed brought up from the stomach to be rechewed.
Cull	To dispose of poorer animals in a herd or flock.
Dam	The mother of an animal.

Deadweight	The weight of an animal after slaughter, minus offal, head, and hide.
Dehorn	To remove the horns of livestock, either chemically or mechanically.
Dewlap	A hanging fold of skin under the neck, especially in cattle and goats.
Digestible energy (DE)	The gross energy of feed minus the energy remaining in the feces after digestion.
Digestible protein (DP)	The portion of crude protein in feed that can be utilized by an animal.
Disbud	To remove or prevent the growth of horn buds in young livestock.
Disinfectant	A substance used to kill harmful organisms on non-living surfaces.
Dock	To remove all or part of the tail.
Doe	A female goat, deer, or rabbit.
Domesticate	To adapt the behavior of an animal to fit the needs of people.
Double rig	A condition where both testicles are retained in the abdomen (cryptorchidism).
Draft animal	An animal used for pulling loads.
Drench	A liquid medicine administered orally to animals.
Elastrator	An instrument used to place rubber bands over the scrotum or tail for castration or docking.
Electrolyte	A solution containing salts and energy sources used to treat young animals with scours.
Environment	The external conditions and influences that affect an organism's life and development.
Estrus	The period during which a female is receptive to mating (in heat).
Ewe	A female sheep or lamb.
Feed efficiency	The ratio of feed units required for one unit of production.
Feeder calf	A weaned calf under one year old, sold for further feeding.
Fertilization	The union of a sperm cell with an egg cell.
Fleece	The total wool coat of a sheep.
Flock	A group of animals (e.g., sheep, goats, birds).
Flush	To increase the feed level of females prior to breeding.
Free martin	A sterile female calf born as a twin to a male calf.
Gimmer	A female sheep between 1 and 2 years old.
Goat	A common gender term for a goat.

Goatling	A female goat over 1 year but not exceeding 2 years of age.
Grease	Impurities present in fleece.
Haylage	Low-moisture grass silage.
Heifer	A female bovine that has not had a calf.
Hermaphrodite	An animal with both male and female reproductive organs.
Heterosis	Improvement in offspring due to hybrid vigor.
Inbreeding	The mating of related animals.
Kidding	The act of giving birth to a goat.
Lambing	The act of giving birth to a lamb.
Legume	A plant in the Leguminosae family, like peanuts or alfalfa, that fixes nitrogen.
Livestock	Domestic animals raised for production purposes.
Mineral	An inorganic substance required in small amounts for proper nutrition.
Mohair	The fleece of an Angora goat.
Ovulation	The release of an egg cell from the ovary.
Phenotype	The physical appearance of an animal.
Placenta	The structure in mammals that nourishes the fetus in the uterus.
Polled	An animal that naturally lacks horns.
Protein	An organic compound made up of amino acids, necessary for growth and repair.
Rumen	The first and largest compartment of the ruminant stomach.
Semen	A mixture of seminal fluid and sperm.
Udder	The milk-producing gland of mammals like cows and goats.
Vitamin	An organic compound needed in small amounts for proper nutrition.
Wether	A castrated male sheep or goat.
Yearling	An animal between one and two years old.
Yeld or Eild	A barren or non-lactating animal.

Classification of domestic animal

Animal	Order	Sub-Order	Family	Genus
Cattle	Ungulata	Artiodactyla	Bovidae	Bos
Buffalo	Ungulata	Artiodactyla	Bovidae	Bubalus
Sheep	Ungulata	Artiodactyla	Ovidae	Ovis
Goat	Ungulata	Artiodactyla	Capridae	Capra

Camel	Ungulata	Artiodactyla	Camilidae	Camelus
Horse	Ungulata	Perissodactyla	Equidae	Equus
Donkey	Ungulata	Perissodactyla	Equidae	Equus
Dog	Carnivora	—	Canidae	Canis
Cat	Carnivora	—	Felidae	Felis
Rabbit	Lagomorpha	—	Leporidae	Oryctolagus

Term	Definition
Animal Husbandry	Management and care of farm animals for profit, enhancing genetic qualities and behavior advantageous to humans.
Type	A standard combining characteristics essential for a particular purpose (e.g., milk, meat, wool, or work).
Breed	A group of domestic animals of a species with homogeneous, distinguishable characteristics.
Species	A group of individuals with common characteristics that distinguish them from other groups.
Sire	The male parent of the calf.
Dam	The female parent of the calf.
Bull	Adult uncastrated male cattle used for breeding.
Cow	Adult female cattle that has calved once or more.
Calf	Young cattle of either sex below six months of age.
Bull calf	Male calf under one year of age.
Heifer calf	Female calf under one year of age.
Heifer	Female cattle above one year that has not calved.
Bullock	Castrated male cattle used for work.
Steer	Castrated male cattle used for meat production.
Buller	A female cattle constantly in heat (estrus); also known as a nymphomaniac animal.
Teaser	A vasectomized bull used to detect heat or estrus in female cows.
Foetus	Developing young during the last quarter of pregnancy.
Fertility	The ability of an animal to produce large numbers of living offspring.
Sterility	The inability to produce offspring.
Calving	The process of giving birth.
Prolificacy	Ability to produce large numbers of offspring; prolific animals.
Fecundity	The potential capacity of a female to produce functional ova.
Free Martin	A sterile heifer born as a twin with a male.
Cryptorchids	Failure of testes to descend into the scrotum; if both are retained in the abdominal cavity, sterility results.
Service	The act of a male covering a female in heat to deposit sperm in the female genital tract.
Conception	The successful union of male and female gametes and implantation of the zygote.
Gestation	The condition of a female carrying a developing fetus in the uterus.
Gestation Period	The period from conception to parturition (e.g., cows: 279-283 days; buffalo: 310 days; sheep: 148-152 days; goat: 150-152 days).
Parturition	The act of giving birth.
Lactation Period	The period after parturition during which the animal produces milk.
Dry Period	The period after lactation when the animal does not produce milk.

Calving Interval	The period between two successive calvings.
Average	The sum of production divided by the number of animals.
Wet Average (W.A.)	Average daily milk yield of a lactating cow.
Herd Average (H.A.)	Average daily milk yield of milking animals in a herd.
Environment	The sum of all external influences to which an individual is exposed.

Sheep Terminology

Term	Definition
Sheep	Common gender.
Ram or Tup	Adult uncastrated male sheep used for breeding.
Ewe	Adult female sheep that has given birth.
Lamb	Young sheep of either sex.
Ram lamb	Male young sheep.
Ewe lamb	Female young sheep.
Wedder or Wether	Castrated male sheep.
Crone	Old ewe with excellent breeding performance, retained in the breeding flock.
Gimmer	Female sheep between 1 and 2 shearing.
Seggy	Ram castrated after service.
Yeld or Eild	A barren or non-lactating animal.
Shearing	The removal of wool.
Lambing	The act of giving birth to a lamb.

Goat Terminology

Term	Definition
Goat	Common gender.
Buck or He-goat	Adult male goat used for breeding.
Doe	Adult female goat that has given birth at least once.
Buckling	Male goat over 1 year but not exceeding 2 years of age.
Goatling	Female goat over 1 year but not exceeding 2 years of age.
Kid	Young goat of either sex.
Kidding	The act of giving birth to a kid.

Pig Terminology

Term	Definition
Farrowing	The act of giving birth to piglets.
Boar	Adult uncastrated male pig used for breeding.
Sow	Adult female pig used for breeding.
Stag or Hog or Barrow	Castrated male pig.
Gilt	Young female pig kept for breeding.
Open Gilt	Young female pig that has not been served.

Closed Gilt	Young female pig that has become pregnant.
Store Pig	Pigs between weaning and fattening, usually between 8 and 15 weeks old.
Runt	The smallest and weakest piglet in a litter.

Dog Terminology

Term	Definition
Dog	Common gender; also refers to an adult male dog.
Bitch	Adult female dog.
Pup	Young dog of either sex.
Whelping	The act of giving birth to puppies.

Cat Terminology

Term	Definition
Cat	Common gender.
Tom Cat	Adult uncastrated male cat.
Queen Cat	Adult female cat.
Neuter	Castrated cat.
Kitten	Young cat of either sex.
Queening	The act of giving birth to kittens.

Rabbit Terminology

Term	Definition
Buck	Adult male rabbit used for breeding.
Doe	Adult female rabbit.
Bunny	Young rabbit of either sex.
Kindling	The act of giving birth to young rabbits.

Meat Terminology

Animal	Meat
Cattle	Beef
Buffalo	Carabeef
Calf	Veal
Sheep	Mutton
Goat	Chevon
Pigs	Pork
Rabbit and Poultry	White meat

Act of Mating

Animal	Act of Mating
Cattle and Buffalo	Serving

Sheep	Tupping
Goat	Serving
Pigs	Coupling
Horse	Covering

House of Animals

Animal	House
Cattle and Buffalo	Shed / Byre / Barn
Sheep and Goat	Pen
Pigs	Sty
Dogs	Kennel
Horse	Stable
Rabbit	Hutch

Group of Animals

Differences between Cattle and Buffalo

Cattle	Buffalo
Dewlap present	Dewlap absent
Rounded and conical horns	Broad and flat horns
Weaker legs, smaller hooves	Stronger legs, larger hooves
More functional sweat glands	Fewer functional sweat glands
Dense hair growth	Sparse hair growth

Details	Cattle	Buffalo	Sheep	Goat	Pig	Horse
Species	Bovine	Bovine or Bubaline	Ovine	Caprine	Swine	Equine
Groups of animals	Herd	Herd	Flock	Flock or band	Drove or herd or stock	Pack
Adult male	Bull	Buffalo bull	Ram or tup	Buck	Boar	Stallion
Adult female	Cow	She buffalo or buffalo cow	Ewe	Doe	Sow	Mare
Young male	Bull calf	Buffalo bull calf	Ram lamb or Tup lamb	Buckling or male kid	Boarling	Colt
Young female	Heifer calf	Buffalo heifer calf	Ewe lamb or gimmer lamb	Goatling	Gilt	Filly
New born	Calf	Buffalo calf	Lamb	Kid	Piglet or pigling	Foal
Castrated male	Bullock or steer	Buffalo bullock	Wether or wedder	Castrated	Hog or stag or barrow	Gelding or geld
Sterilized female	Spayed	Spayed	Spayed	Spayed	Spayed	Spayed
Female with its offspring	Calf at foot	Calf at foot	Suckling	Suckling	Suckling	Foal at foot
Act of parturition	Calving	Calving	Lambing	Kidding	Farrowing	Foaling
Act of mating	Serving	Serving	Tupping	Serving	Coupling	Covering
Cry	Bellowing	Bellowing	Bleating	Bleating	Grunting	Neighing

Chromosome number	60	50	58	60	38	64

Differences between Sheep and Goat

Sheep	Goat
Usually gives birth to one	Twins or triplets often born
Short stature	Taller stature
Females without horns	Both sexes have horns (not twisted)
No wattles or beards	Wattles and beards present
Dense wool growth	Moderate hair growth
Short tail	Longer tail
Rounded body conformation	Angular and laterally flattened body conformation

Gestation period in different spp.	
Dog	2 months ± 2 days
Pig	3 months ± 3 weeks ± 3 days (114 days)
Sheep/ Goat	5 months ± 5 days
Cattle	9 months ± 9 days
Buffalo	10 months ± 10 days
Horse	11 months ± 11 days
Elephant	2 years (22 months)

Dentition of domestic animal

Cattle Dentition

Dental Formula

- **Temporary Dentition**: 0/4, 0/0, 3/3, 0/0
- **Permanent Dentition**: 0/4, 0/0, 3/3, 3/3

Stages of Dentition in Cattle

- **At birth**: 8 incisors and 3 pre-molars (temporary dentition) palpable below the gums.

- **1 month**: 8 temporary incisors prominent, 3 temporary molars well up and wearing.
- **6 months**: Teeth are well-placed in the jaw.
- **1 year**: Significant wear on temporary incisors.
- **2 years**: First pair of permanent central incisors replace temporaries, first and second molars emerge.
- **2 ½ - 3 years**: Second pair of permanent medial incisors replace temporaries.
- **3 - 3 ½ years**: Third pair of permanent lateral incisors replace temporaries.
- **4 years**: Last pair of permanent corner incisors replace temporaries.
- **4-5 years**: Teeth slightly worn along cutting edges.
- **6 years**: Wear reaches halfway across the upper surface, part of the root is exposed.
- **10 years**: Most of the crown is worn, small enamel cup remains.
- **12-14 years**: Only tooth stumps remain.

Age Estimation by Teeth in Cattle

- **Under 2 years**: No permanent teeth.
- **2 years 3 months**: 2 permanent teeth.
- **3 years**: 4 permanent teeth.
- **3 years 6 months**: 6 permanent teeth.
- **4 years**: 8 permanent teeth.
- **Over 4 years**: Old animal, more than 8 permanent teeth.

Buffalo Dentition

Stages of Dentition in Buffalo

- **Under 3 years**: No permanent teeth.
- **2 years 6 months**: 2 permanent teeth.
- **3 years 6 months**: 4 permanent teeth.
- **4 years 6 months**: 6 permanent teeth.
- **5-6 years**: 8 permanent teeth.
- **Over 6 years**: Old animal, more than 8 permanent teeth.

Sheep and Goat Dentition

Dental Formula

- **Temporary Dentition**: 0/4, 0/0, 3/3, 0/0
- **Permanent Dentition**: 0/4, 0/0, 3/3, 3/3

Stages of Dentition in Sheep and Goat

- **Birth to 1 year**: Temporary incisors in use, lamb teeth well worn, first pair of permanent central incisors may be cutting.
- **14-18 months (Two Tooth)**: First pair of permanent central incisors replace temporaries.
- **20-24 months (Four Tooth)**: Second pair of permanent medial incisors replace temporaries.
- **26-30 months (Six Tooth)**: Third pair of permanent lateral incisors replace temporaries.
- **32-36 months (Full Mouth)**: Fourth pair of permanent corner incisors replace temporaries.

Age Estimation by Teeth in Sheep and Goats

- **Under 1 year**: No permanent teeth.
- **1 year**: 2 permanent teeth.
- **2 years**: 4 permanent teeth.
- **2 ½ years**: 6 permanent teeth.
- **3 years**: 8 permanent teeth.
- **Over 4 years**: Old animal, more than 8 permanent teeth.

Species	Deciduous Teeth (Formula)	Permanent Teeth (Formula)
Horse	*Di* 3/3, *Dc* 0/0, *Dp* 3/3	*I* 3/3, *C* 1/1 (a), *P* 3/3 (b), *M* 3/3
Cow	*Di* 0/4, *Dc* 0/0, *Dp* 3/3	*I* 0/4 (c), *C* 0/0 (c), *P* 3/3, *M* 3/3
Sheep	*Di* 0/4, *Dc* 0/0, *Dp* 3/3	*I* 0/4 (c), *C* 0/0 (c), *P* 3/3, *M* 3/3
Goat	*Di* 0/4, *Dc* 0/0, *Dp* 3/3	*I* 0/4 (c), *C* 0/0 (c), *P* 3/3, *M* 3/3
Pig	*Di* 3/3, *Dc* 1/1, *Dp* 3/3	*I* 3/3, *C* 1/1, *P* 4/4, *M* 3/3
Dog	*Di* 3/3, *Dc* 1/1, *Dp* 3/3	*I* 3/3, *C* 1/1, *P* 4/4, *M* 2/3
Cat	*Di* 3/3, *Dc* 1/1, *Dp* 3/2	*I* 3/3, *C* 1/1, *P* 3/2, *M* 1/1 (d)

Footnotes:

- **(a)**: Canine teeth usually appear only in male horses; they are regressed or absent in mares.
- **(b)**: Small premolars (wolf teeth) may be present, particularly in the upper jaw, and may be unilateral or bilateral.
- **(c)**: The canine tooth of domestic ruminants is commonly counted as a fourth incisor.
- **(d)**: The maxillary second premolar and first molar can be absent in some cats.

Key:

- **Di**: Deciduous Incisor
- **Dc**: Deciduous Canine
- **Dp**: Deciduous Premolar
- **I**: Incisor
- **C**: Canine
- **P**: Premolar
- **M**: Molar

Cattle and buffalo breeds

Milch Cattle Breeds

S.No	Breed	Origin	Salient Characteristics	Performance Parameters
1	Gir	Gir Forests, Gujarat	Broad convex forehead, pendulous ears folded like a leaf, horns curved in a "**half moon**" appearance, red or chocolate-brown patches.	Milk yield: 1200-1800 kg; Age at first calving: 45-54 months; Inter-calving period: 515-600 days.
2	Red Sindhi	Karachi and Hyderabad, Pakistan	Red color with shades from dark to light, horns thick at the base and curve upward, well-developed hump, compact frame.	Milk yield: 1100-2600 kg; Age at first calving: 39-50 months; Inter-calving period: 425-540 days.
3	Sahiwal	Montgomery District, Pakistan	Symmetrical body, reddish dun or pale red, short and stumpy horns, large dewlap, long tail with black switch.	Milk yield: 2725-3175 kg in a 300-day lactation period; Some cows yield up to 4535 kg.
4	Deoni	Marathwada, Maharashtra	Spotted black and white, drooping ears, prominent forehead, thick skin, moderately developed udder.	Milk yield: 636-1230 kg; Age at first calving: 894-1540 days; Inter-calving period: 447 days.

Draught Cattle Breeds

S.No	Breed	Origin	Salient Characteristics	Performance Parameters
5	Nagori	Rajasthan	Short-horned, white or light grey color, coffin-shaped skull, slightly convex profile.	Known for its strength and speed, particularly suitable for plowing and carting in sandy terrain.
6	Kenketha	North India	Lyre-horned, grey color, wide forehead, prominent orbital arches, flat dished profile.	Suitable for hard draught work; adaptable to semi-arid conditions.
7	Hallikar	Karnataka	Grey color, compact, muscular, medium-sized animal, horns emerge close at the poll and curve backward and forward.	Known for excellent trotting ability; used in wars for carrying cannons during Tipu Sultan's reign.
8	Amritmahal	Karnataka	Grey cattle, narrow bulging forehead with a furrow, long	Known for fast trotting and endurance; also used

			horns close together, tapering head.	in wars for carrying cannons by Tipu Sultan.
9	Khillari	Maharashtra	Grey-white color, quick gait, long convex forehead with a central groove, horns close together, curving backward and forward.	Fast trotting breed, especially useful for heavy agricultural work and transportation.
10	Kangayam	Tamil Nadu	Grey or white, strong hooves, spread-apart horns, dark prominent eyes with black rings, stout legs.	Well-known for draught power; used for plowing and carting in the plains of Tamil Nadu.
11	Bargur	Erode, Tamil Nadu	Brown with white markings, medium-sized, moderate muzzle, light brown horns with sharp tips curving backward and upward.	Active and strong, particularly suited for work in hilly terrains.

Dual-purpose Cattle Breeds

S.No	Breed	Origin	Salient Characteristics	Performance Parameters
12	Tharparkar	Tharparkar District, Pakistan	White or light grey, wide-set horns curving upward and outward.	Milk yield: 1800-2600 kg; Age at first calving: 38-42 months; Inter-calving period: 430-460 days.
13	Hariana	Haryana (Rohtak, Hisar, Gurgaon)	White or light grey, bulls darker on fore and hind quarters, small horns, long narrow face, flat forehead.	Milk yield: 600-800 kg per lactation; Age at first calving: 40-60 months; Inter-calving period: 425-540 days.
14	Kankrej	Gujarat and Rajasthan	Silver-grey to iron-grey, lyre-shaped horns, smooth gait, broad forehead, upturned nose.	Milk yield: 1360 kg; Known for fast, powerful draught ability; used for plowing and carting.
15	Ongole	Andhra Pradesh (Guntur District)	Glossy coat, dark grey markings on males, short stumpy horns, fan-shaped dewlap.	Milk yield: 1000 kg; Age at first calving: 38-45 months; Inter-calving period: 470 days.

16	Krishna Valley	Karnataka (Black Cotton Soil Watershed)	Grey-white color, massive frame, deep body, distinct bulging forehead, small curved horns.	Milk yield: 916 kg; Powerful animals useful for slow ploughing, valued for their good working abilities.

Exotic Cattle Breeds

S.No	Breed	Origin	Salient Characteristics	Performance Parameters
1	Jersey	Jersey Island, UK	- Smallest of dairy types, reddish fawn color, dished forehead, compact and angular body.	- Milk yield: 5000-6000 kg/lactation. - Fat content: 5.3%. - SNF (Solids-Not-Fat): 7%.
2	Holstein-Friesian	Netherlands (Friesland)	- Largest dairy breed, black and white markings, large udder, ruggedly built.	- Milk yield: 6000-7000 kg/lactation. - Fat content: 3.45%.
3	Brown Swiss	Switzerland	- Rugged, less refined, docile, brown color with light stripe along the back, long life, well-adapted to high altitudes.	- Milk yield: 4000-5000 kg/lactation. - Fat content: 4%.
4	Guernsey	Guernsey Island (France)	- Fawn and white color, medium size, less rugged than Holstein, more rugged than Jersey, high butterfat content, symmetrical udders.	- Milk yield: 4000-4500 kg/lactation. - Fat content: 5%.
5	Ayrshire	Scotland	- Beautiful dairy breed, red color ranging from orange to dark brown, active but hard to manage.	- Milk yield: 4000-5000 kg/lactation. - Fat content: 4%.
6	Red Dane	Denmark	- Red to reddish-brown color, strong and robust, heavy breed	- Milk yield: 3000-4000 kg/lactation.

			with bulls weighing up to 950 kg and females around 600 kg.	- Fat content: 4% and above.
7	Shorthorn	England	- Red, roan, or white in color, dual-purpose breed (milk and meat), docile, medium to large size.	- Milk yield: 3000-4000 kg/lactation. - Fat content: 3.8%-4.2%.
8	Red Poll	England	- Dark red color, known for dual-purpose qualities (milk and meat), polled (no horns), medium-sized.	- Milk yield: 3500-4500 kg/lactation. - Fat content: 3.5%-4%.
9	Fleckvieh	Germany (Bavaria)	- Dual-purpose breed, spotted color pattern, strong, well-muscled, and good temperament.	- Milk yield: 4000-5000 kg/lactation. - Fat content: 3.8%-4%.
10	Montbeliarde	France	- Red pied (red and white) breed, medium to large size, robust with strong legs, good health and fertility traits.	- Milk yield: 5000-6500 kg/lactation. - Fat content: 3.9%.
11	Simmental	Switzerland	- Dual-purpose breed (milk and meat), red and white, strong, well-adapted to rough terrain and large frame size.	- Milk yield: 4500-6000 kg/lactation. - Fat content: 4%-4.2%.
12	Normande	France	- Dual-purpose breed, white and brown, good grazing ability, well-muscled, high fertility.	- Milk yield: 4000-4500 kg/lactation. - Fat content: 4%.
13	Milking Shorthorn	England	- Dual-purpose (milk and meat), red, white, or roan in color, medium size, hardy and adaptable.	- Milk yield: 3000-4000 kg/lactation. - Fat content: 3.8%.

Breed	Alternative Names	Place of Origin	Color	Horn Type	Salient Characteristics
Murrah	Delhi, Kundi, Kali	Haryana, Punjab	Jet black, sometimes with white markings on tail and face	Tightly curved	Massive body, long head and neck, broad hips, drooping fore and hind quarters, efficient milk and butterfat producer.
Nili-Ravi	Ravi Buffalo	Punjab (India and Pakistan)	Black with white markings on face, legs, and tail	Small, tightly coiled	Elongated head, wall eyes, medium-sized frame, fine muzzle, white markings are desirable in females.
Bhadawari	-	Uttar Pradesh, Madhya Pradesh	Light or copper-colored	Curled outward, downward, then backward	Small body, short legs, higher hindquarters, two white "Chevron" lines on the neck, high butterfat efficiency.
Jaffarabadi	Gir Buffalo	Gujarat (Gir forests, Kutch)	Black	Drooping, heavy, slightly less curved than Murrah	Massive head and neck, broad forehead, used for ploughing and carting, maintained by traditional Maldhari breeders.
Surti	Dekhani, Gujarati, Charotar	Gujarat (Kaira and Baroda districts)	Rusty brown to silver-grey	Sickle-shaped	Medium-sized, wedge-shaped body, two white collars (on jaw and brisket), known for high-fat milk.
Mehsana	-	Gujarat (Mehsana town)	Black or black-brown	Long, less curved than Murrah, irregular shapes	Cross between Surti and Murrah, longer body, heavy head, horns less curved at the ends, good persistency in milk production.
Nagpuri	Ellichpuri, Barari	Maharashtra (Nagpur, Akola, Amravati districts)	Black with white patches on face, legs, and tail	Long, flat, sward-shaped	Long, thin face, backward-bending sward-shaped horns, suited for forest

					grazing, strong for draught work.
Godavari	-	Andhra Pradesh (Godavari, Krishna delta)	Predominantly black with sparse brown hair	Curved	Crossbreed with Murrah, medium stature, compact body, known for high-fat milk and shorter calving intervals.
Toda	Nilgiri Buffalo	Tamil Nadu (Nilgiri hills)	Fawn or ash-grey	Inward, outward, and forward	Indigenous to Nilgiris, long body, deep chest, thick hair coat, strong legs, well-developed horns.
Pandharpuri	-	Maharashtra (Kolhapur, Solapur districts)	Light black to deep black	Very long, curved backward and outward, twisted	Narrow face, long nasal bone, distinctive long horns extending beyond shoulder blade, suited for dry regions.

Key Notes:

- **Jersey:** Known for its high butterfat content and smaller size, making it ideal for crossbreeding with Zebu cattle in India.
- **Holstein-Friesian:** The largest and most productive dairy breed in terms of milk yield, but with lower fat content in milk.
- **Brown Swiss:** Known for its adaptability to rugged conditions and long life. It has high milk yield with moderate fat content.
- **Guernsey:** Famous for its high butterfat and protein content, making it a great breed for quality milk production.
- **Ayrshire:** Beautiful but hard-to-manage breed, ideal for milk production in rough terrains.
- **Red Dane:** A heavy breed, often used for both milk and meat, with excellent adaptability to a wide range of climates.
- **Shorthorn and Red Poll:** Dual-purpose breeds, known for their balanced performance in both milk and meat production.
- **Fleckvieh and Simmental:** Known for their **excellent muscling,** these dual-purpose breeds are widely used **for both dairy and beef production.**

- **Montbeliarde and Normande:** Well-adapted to grazing systems, these dual-purpose breeds provide good milk and meat yields with excellent health and fertility **Buffalo Breeds with Detailed Characteristics (Including Alternative Names)**

Key Characteristics by Breed:

- **Murrah (Delhi, Kundi, Kali):** Tightly curved horns, massive build, highly efficient in milk and butterfat production. Predominantly found in Haryana and Punjab.
- **Nili-Ravi (Ravi Buffalo):** Known for white markings on face and legs, tight coiled horns, "wall eyes" characteristic, bred around the Ravi river in Punjab.
- **Bhadawari:** Light copper coloration, distinctive two "**Chevron" lines on the neck,** excellent converter of coarse feed into high butterfat milk, common in Uttar Pradesh and Madhya Pradesh.
- **Jaffarabadi (Gir Buffalo):** Large and powerful with drooping horns, valued for draught work, found primarily in Gujarat's Gir forests and maintained by Maldharis.
- **Surti (Dekhani, Gujarati, Charotar):** Medium-sized with sickle-shaped horns and two white collars around the jaw and brisket, known for its high fat percentage in milk, found in Gujarat.
- **Mehsana: A crossbreed between Surti and Murrah,** with longer, irregularly shaped horns, known for high milk persistency, found in Mehsana, Gujarat.
- **Nagpuri (Ellichpuri, Barari):** Sward-shaped horns, black with white patches, suited for forest grazing and strong draught capabilities, found in Maharashtra.
- **Godavari:** Crossbred with Murrah, known for its high-fat milk and compact body, commonly found in the delta regions of Godavari and Krishna rivers.
- **Toda (Nilgiri Buffalo):** Indigenous to the Nilgiri hills, with inward-curved horns and a thick coat of hair, known for its adaptability to high altitudes.
- **Pandharpuri:** Recognized for its exceptionally **long, twisted horns, suited for draught work in dry regions** of Maharashtra.

Crossbred Cattle Breeds in India

Breed	Cross/Origin	Place of Origin	Inheritance/Genetics	Salient Characteristics
Taylor	Cross between Ayrshire bulls (UK) and local cows	Patna, Bihar	Ayrshire Bulls x Local Cows	Developed by Dr. Taylor near Patna. Aimed at improving milk production

				through crossbreeding.
Jersind	Cross between Red Sindhi and Jersey	Various regions in India	3/8 Red Sindhi x 5/8 Jersey	Small body size with better adaptability to Indian conditions, particularly hot and humid climates.
Brown-Sind	Cross between Brown Swiss and Red Sindhi	Various regions in India	3/8 to 5/8 Brown Swiss x Red Sindhi	Aimed at combining the hardiness of Red Sindhi with the high milk yield of Brown Swiss.
Karan Swiss	Cross between American Brown Swiss and Sahiwal/Red Sindhi	NDRI, Karnal (Haryana)	50% Brown Swiss, 50% Indigenous	Resembles Sahiwal in appearance, high milk yield with 4.2-4.4% fat, average age at first calving is 32 months.
Karan Fries	Cross between Tharparkar and Holstein Friesian	NDRI, Karnal (Haryana)	50% Holstein Friesian	Black patches, occasionally fully black with white markings, average yield 3700 kg with 3.8-4.0% fat.
Sunandini	Cross between Brown Swiss and local non-descript cows	Indo-Swiss project, Kerala	62.5% Brown Swiss	Synthesized breed under Indo-Swiss project, average lactation yield of 4351 kg in 305 days.

Frieswal	Cross between Friesian and Sahiwal	Military farms in India	Friesian inheritance between 3/8 and 5/8	High milk yield with Friesian characteristics, average lactation yield 2729 kg.

sheep breeds

categorizes sheep breeds based on their utility and agro-ecological regions in India:

Category	Breeds
Apparel Wool Breeds	Hissardale, Nilgiri, Kashmir Merino, Avivastra, Bharat Merino, Pattanwadi, Tibetan, Bonpala, Gaddi, Rampur Bushair, Changthangi, Karnah, Gurez
Superior Carpet Wool Breeds	Chokla, Nali, Marwari, Magra, Jaisalmeri, Pugal, Sonadi, Jalauni, Muzzafarnagri, Bellary, Deccani, Coimbatore, Chottanagpuri, Balangir, Ganjam, Shahabadi
Coarse Carpet Wool Breeds	Malpura, Sonadi, Jalauni, Muzzafarnagri, Mandya, Vembur, Kilakarsal, Kenguri, Bhakarwal, Poonchi, Changthangi, Bonpala
Hairy Meat Breeds	Nellore, Mecheri, Hassan, Bellary, Deccani, Mandya, Trichy Black, Karnah, Shahabadi, Vembur, Madras Red, Ramnad White, Kilakarsal, Kenguri, Coimbatore

Classification of Sheep Breeds Based on Agro-Ecological Regions in India

Region	Breeds
Northern Temperate Region	Gaddi, Rampur Bushair, Bhakarwal, Poonchi, Tibetan Sheep, Kashmir Merino, Changthangi, Karnah, Gurez
North-Western, Central Arid, and Semi-Arid Region	Chokla, Nali, Marwari, Magra, Jaisalmeri, Pugal, Malpura, Sonadi, Muzzafarnagri, Munjal
Southern Region (Semi-Arid & Coastal)	Deccani (Bellary), Nellore, Hassan, Mecheri, Mandya, Kilakarsal, Vembur, Madras Red, Trichy Black, Kenguri, Coimbatore

Eastern Region	Chottanagpuri, Balangir, Ganjam, Bonpala, Garole, Shahabadi

Exotic Breeds

Type	Breeds
Fine Wool Breeds	Merino, Rambouillet
Mutton Breeds	Suffolk, Southdown, Dorset
Dual Purpose Breeds	Corriedale, Polworth
Pelt Breeds	Karakul

North-Western, Central Arid, Semi-Arid Region

Breed	Region	Key Characteristics
Chokla	Rajasthan	Good quality carpet wool, medium-sized, white with black/brown patches, 2-3 kg wool yield/year.
Magra	Rajasthan	Coarse carpet wool, white, larger-sized, highly adaptable.
Nali	Rajasthan, Haryana	Medium-sized, white, produces good carpet wool, polled.
Pugal	Rajasthan	Medium-sized, white, good quality carpet wool, yields around 1-1.5 kg wool/year.
Marwari	Rajasthan, Gujarat	Medium-sized, black or brown, hardy breed, wool yields around 1.5-2 kg/year.
Malpura	Rajasthan	Coarse and hairy wool, mainly kept for mutton, produces very little wool.
Sonadi	Rajasthan	Coarse wool, produces milk as well, white with patches, horned.
Jaisalmeri	Rajasthan	Medium-sized, white, good wool production, drought-resistant.

Pattanwadi	Gujarat	Medium quality wool, dual-purpose (wool and mutton), produces around 1-1.5 kg wool/year.
Muzzaffanagri	Uttar Pradesh	Large-sized, good carpet wool, white with patches, yields 1.5-2 kg wool/year.
Jalauni	Uttar Pradesh	Medium-sized, used for wool and mutton, produces coarse wool.
Hissardale	Haryana, Hissar & Kulu	Crossbred with Bikaneri and Merino, good quality wool, white with brown patches, wool yield around 2-3 kg/year, polled.

Southern Region

Breed	Region	Key Characteristics
Deccani	Maharashtra, Andhra Pradesh, Karnataka	Medium-sized, black with white markings, coarse hairy wool, mainly for blankets, adaptable to semi-arid regions.
Nellore	Andhra Pradesh (Nellore, Prakasam, Ongole)	Tall breed, little hair except at brisket, withers, and breech, rams horned, ewes polled, wattled, mainly for mutton.
Bellary	Karnataka (Bellary)	Medium-sized, color ranges from white to black combinations, fleece is extremely coarse and open, primarily for mutton.
Hassan	Karnataka (Hassan)	Small, white with brown or black spots, coarse and open fleece, 39% of males horned, primarily for mutton.
Mandya	Karnataka (Mandya)	Small, white with light brown face, compact body, U-shaped conformation, best mutton type in India, both sexes polled.

Mecheri	Tamil Nadu (Salem, Namakkal, Coimbatore)	Medium-sized, light brown, both sexes polled, covered with short hairs, mainly for mutton.
Kilakarsal	Tamil Nadu (Ramnad, Madurai, Tanjore)	Brown/dark tan with black spots, medium-sized, males have twisted horns, primarily used for mutton.
Vembur	Tamil Nadu (Tirunelveli)	Tall, dark tan with black spots, drooping ears, males horned, covered with short hairs, primarily for mutton.
Coimbatore	Tamil Nadu (Coimbatore, Salem)	Medium-sized, white with black or brown spots, hairy fleece, primarily for mutton.
Ramnad White	Tamil Nadu (Ramnad, Sivagangai)	Medium-sized, white, males have twisted horns, short thin tail, primarily for mutton.
Madras Red	Tamil Nadu (Chennai, Kancheepuram)	Brown varying from light tan to dark, short thin tail, rams have twisted horns, both sexes covered in short hairs, used for mutton.
Trichy Black	Tamil Nadu (Trichy, Dharmapuri)	Small, black body, males horned, ewes polled, fleece is coarse and hairy, used for mutton.
Kenguri	Karnataka (Raichur)	Medium-sized, dark brown color, males horned, ewes polled, primarily for mutton.

Eastern Region

Breed	Region	Key Characteristics	Purpose	Adaptability
Shahabadi	Bihar	Medium-sized breed, produces coarse wool suitable for carpets, blankets, and local uses. Usually white in color with	Primarily for mutton and wool	Adapted to hot, humid climates of Bihar, moderately drought-resistant.

		occasional brown or black patches.		
Chhottanagpuri	West Bengal, Bihar, Odisha	Small-sized sheep with hardy nature, produces coarse wool, known for good quality carpets and blankets. Slightly curved horns in males, ewes are usually polled.	Wool and mutton	Well-suited for the hot, humid climates of Eastern India, thrives on minimal feed.
Ganjam	Odisha	Medium-sized, coarse wool-producing breed. The wool is usually used for making carpets and kumblies. Predominantly white with drooping ears.	Mainly mutton, some wool	Tolerant to hot, humid climates. Highly adaptable to the difficult terrain of Odisha and low-input farming.
Balangir	Odisha	Small-sized breed producing coarse wool, known for its use in carpets. Body color usually white with black patches.	Mutton and wool production	Suited to hot and humid regions with low rainfall; good foragers.
Bonpala	West Bengal, Sikkim	Medium-sized breed known for producing good quality wool and meat. White body with occasional black patches. Both polled and horned individuals are found.	Wool and mutton	Adapted to the cold, hilly regions of West Bengal and Sikkim. Tolerates harsh climates.
Tibetan	Arunachal Pradesh, Sikkim	lium-sized breed with hardy nature. Produces coarse wool, well adapted to cold, mountainous regions. Often used by local	Wool and pelt production	Suited for high-altitude regions with extreme weather conditions.

		communities for wool and pelt production.		

Northern Temperate Region

Breed	Region	Key Characteristics	Purpose	Adaptability
Rampur Bushair	Himachal Pradesh, Jammu	Medium to large-sized breed. Known for fine wool production, used for making high-quality woolen products. Well adapted to hilly and cold climates.	Wool and mutton production	Adapted to cold and mountainous regions. Highly resilient and thrives in harsh weather conditions.
Gaddi	Himachal Pradesh, Uttar Pradesh	Medium-sized breed, producing good quality wool, primarily dual-purpose (wool and mutton). White with black or brown markings.	Wool and mutton production	Well-suited for temperate climates and high-altitude grazing.
Gurez	Jammu and Kashmir	Medium-sized breed, produces medium wool. Known for its dual-purpose nature, wool for apparel and meat for local consumption.	Wool and mutton	Adapted to the hilly, cold regions of Jammu & Kashmir, especially suited for nomadic herding practices.
Karnah	Jammu and Kashmir	Medium-sized breed producing medium-quality wool. Well adapted to mountainous regions, known for its resilience in extreme cold.	Wool and mutton	Thrives in the cold, harsh climates of Jammu and Kashmir.
Poonchi	Jammu and Kashmir	Medium-sized breed, primarily known for wool production, good	Wool and mutton	Adapted to cold climates, thrives in the

		adaptability to cold weather. Produces medium wool, suited for apparel.		high-altitude regions of Kashmir.
Changthangi	Ladakh, Jammu & Kashmir	breed known for producing the famous **Pashmina wool**. Extremely resilient to cold and adapted to high-altitude grazing in barren, cold desert areas.	Pashmina wool and mutton	Best suited for extremely cold, high-altitude regions. Adaptable to low nutrition and scarce vegetation.

Exotic Breeds

Category	Breed	Key Characteristics	Purpose	Adaptability
Fine Wool Breeds	**Merino**	Origin: Spain. Known for excellent wool quality, hardiness, and longevity. Rams are horned, ewes polled. Skin folds contribute to fleece production.	Wool production (superior quality)	Adapted to a wide range of climates, originally from temperate zones, but can thrive in arid regions.
	Rambouillet	Origin: France. Large, rugged, fast-growing sheep, renowned for wool and mutton production. Rams have horns, ewes are polled.	Wool and mutton production	Performs well in temperate to semi-arid conditions. Hardy and resilient, well-suited for large-scale sheep farming.

Category	Breed	Key Characteristics	Purpose	Adaptability
	Polworth	Origin: UK. Developed from Lincoln and Merino. Produces good quality wool comparable to Merino. Horned and polled strains exist.	Wool and mutton production	Suited for temperate climates, thrives well in pastures and grazing systems.
Mutton Breeds	**Suffolk**	Origin: UK. Large breed with black face, ears, and legs. Known for rapid growth and excellent meat quality. Wool yield: 2-3 kg/year.	Mutton production	Perform s well under a wide range of climates, including temperate and hot conditions.
	Dorset	Origin: UK. Available in both polled and horned varieties. Hardy breed producing superior quality mutton. Wool yield: 2.75-3.25 kg/year.	Mutton and wool production	Adaptable to various environments, performs well in temperate and semi-arid climates.
	Southdown	rigin: UK. Known for excellent mutton conformation and meat quality. Low-set, compact animals, light brown face and legs.	Mutton production	Best suited to temperate climates with access to high-quality pasture. Thrives in well-managed farms with a focus on meat production.
Dual-Purpose Breeds	**Corriedale**	Origin: New Zealand. Developed from Merino and Lincoln crosses.	Wool and mutton	Adapted to temperate and semi-arid

Category	Breed	Key Characteristics	Purpose	Adaptability
		Known for both mutton and wool production. Fleece yield: 4.5-5.5 kg/year.	producti on	climates. Performs well on pasture-based farming systems.
Pelt Breeds	**Karakul**	Origin: Central Asia. Primarily raised for lamb pelts used in garment production. Coarse wool, poor mutton quality.	Pelt production	Adapted to extreme climates, including arid, desert-like conditions with sparse vegetation.

.Breeds of Goats in India

India has a diverse range of indigenous goat breeds that are adapted to various agro-climatic conditions. These breeds are primarily used for meat, milk, skin, and hair production. They are generally hardy animals, capable of surviving in harsh conditions with limited nutrition and water. Below is a detailed classification of goat breeds based on their utility, agro-ecological regions, and some specific characteristics of prominent breeds.

1. Classification of Indian Goat Breeds Based on Utility

Utility	Breeds
Meat & Skin	Black Bengal, Ganjam, Tellicherry (Malabari), Kanni Adu, Osmanabadi, Khasi, Kodi Aadu, Salem Black
Meat, Milk & Skin	Jamnapari (Etawah), Beetal, Barbari, Sirohi, Surti, Mehsana, Jhakhrana
Meat, Hair & Skin	Bakharwal, Gaddi, Marwari, Kutchi, Zalawadi

Utility	Breeds
Meat, Pashmina & Skin	Changthangi, Chegu
Milk, Meat & Skin	Beetal, Jamnapari, Surti, Mehsana, Gohilwadi, Sangamneri

2. Classification of Goat Breeds Based on Agro-Ecological Regions

Region	Breeds
Northern Temperate Region	Gaddi, Changthangi, Chegu
North-western, Central Arid	Sirohi, Marwari, Beetal, Barbari, Kutchi, Zalawadi
Southern Region	Tellicherry (Malabari), Osmanabadi, Jamnapari, Kanni Adu, Salem Black, Kodi Adu
Eastern Region	Black Bengal, Ganjam, Khasi

Detailed Breed Descriptions

1. Jamnapari (Etawah)

- **Region**: Uttar Pradesh
- **Purpose**: Milk, Meat & Skin
- **Description**: Largest and most elegant of the long-legged goats of India with white coat and tan/black markings. The nose is Roman-shaped, giving it a parrot-like appearance.
- **Body Size**: Bucks weigh about 75 kg; does weigh around 55 kg.
- **Milk Production**: Average yield is 280 kg in 274 days; can yield up to 4 kg/day with a total lactation yield of 575 kg.
- **Kidding**: Mostly once a year with a possibility of twins.
- **Other Features**: Large udders and high-quality skin.

Beetal

- **Region**: Punjab, Haryana

- **Purpose**: Meat, Milk & Skin
- **Description**: Resembling the Jamnapari but smaller, the Beetal is predominantly black but can have red, tan, or spotted variations.
- **Body Size**: Bucks weigh around 70 kg, and does weigh around 46 kg.
- **Milk Production**: Average lactation yield of 150 kg; peak production recorded at 5.2 kg/day.
- **Other Features**: High-quality meat and prolific breeders.

Sirohi

- **Region**: Rajasthan
- **Purpose**: Meat & Milk
- **Description**: Medium-sized goats, predominantly brown, white, or an admixture of both, with coarse short hair and upward-curving horns.
- **Body Size**: Bucks weigh about 50 kg, and does weigh around 23 kg.
- **Milk Production**: Average lactation yield of 71 kg in 175 days.
- **Other Features**: Good for meat production with good adaptability to arid conditions.

Black Bengal

- **Region**: West Bengal, Assam
- **Purpose**: Meat & Skin
- **Description**: Small-sized, predominantly black, short-haired goats with excellent quality chevon (meat) and premium skins for leather.
- **Body Size**: Bucks weigh around 15 kg, and does weigh around 12 kg.
- **Kidding**: Highly prolific, capable of producing 2-3 kids per kidding.
- **Milk Production**: Limited to kid nourishment; average lactation yield is about 53 kg.
- **Other Features**: Famous for high-quality skins used for leather goods.

Tellicherry (Malabari)

- **Region**: Kerala
- **Purpose**: Meat & Milk
- **Description**: Medium-sized goats with a wide variety of coat colors (white, black, brown, and combinations). Known for good reproductive capacity.
- **Body Size**: Bucks weigh around 39 kg, and does weigh around 31 kg.
- **Milk Production**: Average milk yield is around 65 kg in 172 days.
- **Other Features**: Good adaptability to coastal and humid climates.

Gaddi (Chamba)

- **Region**: Himachal Pradesh
- **Purpose**: Meat & Hair
- **Description**: Sturdy, medium-sized goats with long, lustrous hair, mainly used for producing coarse wool and meat. Horned with a Roman nose.
- **Body Size**: Bucks weigh about 27 kg, and does weigh around 25 kg.

- **Other Features**: Known for their high-quality coarse wool used for making ropes, rugs, and snow boots.

Chegu

- **Region**: Himachal Pradesh
- **Purpose**: Pashmina (Cashmere) Wool
- **Description**: Medium-sized, hardy goats producing high-quality cashmere (Pashmina). Coat colors range from white to greyish-red.
- **Body Size**: Bucks weigh about 39 kg, and does weigh around 26 kg.
- **Other Features**: High-quality pashmina wool used in luxury textiles, along with pack-carrying ability for transportation in hilly terrains.

Kanni Adu

- **Region**: Tamil Nadu
- **Purpose**: Meat & Skin
- **Description**: Tall, predominantly black goats with some white markings. Known for good quality meat production.
- **Body Size**: Bucks weigh about 36 kg, and does weigh around 29 kg.
- **Kidding**: High reproductive rates with twins or single births common.
- **Other Features**: Hardy breed suited for southern regions.

Exotic Goat Breeds in India

1. Saanen

- **Origin**: Switzerland
- **Purpose**: Milk Production
- **Description**: White or cream-colored goats, known for high milk production. Graceful and usually polled.
- **Body Size**: Bucks weigh 95 kg, and does weigh 65 kg.
- **Milk Production**: Average yield of 2-5 kg/day with a lactation period of 8-10 months. High butter-fat content of 3.5%.

Toggenberg

- **Origin**: Switzerland
- **Purpose**: Milk Production
- **Description**: Hardy breed, brown with white facial stripes, and erect ears. High milk production capacity.
- **Body Size**: Does weigh over 80 kg.
- **Milk Production**: Average milk yield of 5.5 kg/day with 3.4% butter-fat content.

Boer

- **Origin**: South Africa

- **Purpose**: Meat Production
- **Description**: Large, long-legged goat, white with a reddish-brown head. Known for its fast growth and excellent meat quality.
- **Body Size**: Bucks weigh between 80-90 kg, and does weigh 50-70 kg.
- **Other Features**: Adaptable to various climates and efficient in meat production.

Breeds of pig

Breed	Origin	Color	Key Characteristics	Mature Boar Weight	Mature Sow Weight
Large White Yorkshire	England	Solid white, occasional freckles	Prolific breeder, excellent mother, good carcass quality, bacon type, good for crossbreeding	300-400 kg	230-320 kg
Middle White Yorkshire	England	White, no wrinkles or spots	High lean meat-to-bone ratio, upturned dished face, short snout, hardy, grows rapidly	250-340 kg	180-270 kg
Berkshire	England	Black with six white points	Dished face, erect ears, long arched back, good pork quality, used in upgrading programs	270-380 kg	200-290 kg
Landrace	Denmark	White, occasional freckles	Long body, lop ears, less back fat, high feed efficiency, known for prolificacy	270-360 kg	200-320 kg
Hampshire	USA (Kentucky)	Black with white belt	Upright ears, dished snout, excellent carcass quality, leaner meat	320 kg	280 kg
Duroc	USA (New York, New Jersey)	Cherry red (light to rich)	Two-thirds ear lop, arched back, excellent mother,	400 kg	350 kg

Breed	Origin	Color	Key Characteristics	Mature Boar Weight	Mature Sow Weight
			large size, fast growth rate		
Tamworth	England	Golden red	Long snout, large erect ears, good bacon type, prolific and careful mothers, excellent foragers	350 kg	250-300 kg
Chester White	USA (Pennsylvania)	White, bluish spots	Good growth rate, prolific breeder, used for bacon production	-	-
Hereford	USA (Missouri)	Two-thirds red, white face	Similar to Hereford cattle, good meat quality, white must appear on feet and extend above hoof	-	-
Poland China	USA (Ohio)	Black with six white points	Quiet temperament, good carcass quality, drooping ears, large size, criticized for smaller litter size	-	-

- ✓ **Large White Yorkshire**: Most extensively used exotic breed in India, excellent for crossbreeding.
- ✓ **Middle White Yorkshire**: Known for high lean meat-to-bone ratio, medium size, upturned snout.
- ✓ **Berkshire**: Originated from Berkshire, England, known for its six white points and dished face.
- ✓ **Landrace**: Noted for prolificacy and feed efficiency, less back fat, characterized by lop ears.
- ✓ **Hampshire**: Known for excellent carcass quality, black with white belt.
- ✓ **Duroc**: Large frame, cherry red color, excellent mothering ability, fast growth.
- ✓ **Tamworth**: Golden red, good bacon type, long snout and erect ears, prolific breeders.
- ✓ **Chester White**: White with bluish spots, good for bacon production.
- ✓ **Hereford**: Two-thirds red in color with a white face, similar to Hereford cattle.
- ✓ **Poland China**: Black with six white points, good carcass quality, large in size, drooping ears.

Breeds of Horse

In India, there are **6 well-known distinct breeds** of horses and **3 additional breeds** recognized by the FAO. These breeds have specific breeding tracts in various parts of the country. **ICAR-National Bureau of Animal Genetic Resources, Karnal,** registered 1 new indigenous breeds, **Bhimthadi horse of** Maharashtra now total registered breeds of horses and pony will be **8.**

Indian Horse Breeds

1. **Marwari**: Found in Rajasthan, known for pace and speed, mainly used for riding, sports, and safari.
2. **Kathiawari**: Originates from Gujarat, primarily used for pace and speed.
3. **Spiti**: From Himachal Pradesh, used for hill purposes, known for their strength and ability to thrive in harsh environments.
4. **Zanskari**: Found in Jammu & Kashmir, used for hill purposes, capable of working at high altitudes.
5. **Manipuri**: From Manipur, used for polo, speed, and sports.
6. **Bhutia**: Found in the Himalayan regions, used for pack and hill work.

Additional FAO-recognized breeds include:

1. **Chummarti**: From Tibet and found in Himachal Pradesh.
2. **Deccani**:
3. **Sikang**:

Indian Horse Breeds & Classification of Horses

Breed	Location	Purpose
Kathiawari	Gujarat	Pace & Speed
Marwari	Rajasthan	Pace & Speed
Bhutia	Himalayan Ranges	Hill purpose
Manipuri	Manipur	Speed, Polo, and Sports
Spiti	Himachal Pradesh	Hill purpose
Zanskari	Jammu & Kashmir	Hill purpose

Classification of Horses

Character	Light Horse	Draught Horse	Ponies
Height (M)	1.47 to 1.52	1.47 to 1.52	< 1.47
Weight (Kg)	400 to 600	600 and above	200 to 400
Uses	Riding and pack	Riding & Heavy work	Pack work

Breed Descriptions

Marwari Horse

- Origin: Marwar and Mewar region, Rajasthan.
- Height: 142-169 cm.
- Distinctive Features: Long ears (16 cm), ears can rotate 180º, inward-curved tips like a sickle.
- Coat Colors: Chestnut, liver chestnut, black, brown, piebald, skewbald.
- Uses: Riding, sports, safari.
- Known for endurance and adaptability under harsh conditions.

Kathiawari Horse

- Origin: Gujarat (Saurashtra region).
- Believed to have evolved from wild horses and Arabian breeds.
- Common Colors: Chestnut, bay, grey, dun.
- Ears: Shorter and smaller compared to Marwari, capable of rotating 180º.
- Height: 130-150 cm.
- Uses: Pace and speed.

Spiti Horse

- Origin: Tibet, found in Himachal Pradesh.
- Height: 120-122 cm.
- Colors: Gray, black, brown, dun.
- Adapted to cold desert regions and used for riding and as pack animals.

Zanskari Horse

- Found in Laddakh, Jammu & Kashmir.
- Height: 132-147 cm.
- Common Colors: Gray, black, copper.
- Used for riding, draught, and transport in high-altitude areas.

Manipuri Horse

- Found in Manipur and Assam.
- Height: 112-132 cm.
- Common Colors: Bay, brown, gray, chestnut.
- Known for their speed, beauty, and used in polo and sports.

Bhutia Horse

- Found in Sikkim and Darjeeling.

- Height: 130-132 cm.
- Common Colors: Gray, bay.
- Strong legs and long hair on neck and tail; used for pack and riding purposes.

Chummarti Horse

- Found in the Chummarti valley, Tibet.
- Similar to Spiti breed.
- Height: 127-129 cm.

Exotic Horse Breeds

Thoroughbred Horses

- Origin: Cross between warm-blooded Arabian horses and cold-blooded European horses(**hot-blooded**, meaning they are high**-spirited and energetic. cold-blooded**, meaning they are **calm and even-tempered.).**
- Maintained by private breeders in India and registered under the Stud Book Authority of India.
- Used for racing, Indian Army, and paramilitary forces.
- Features: Long forearm, strong hindquarters, highly muscular.

Arabian Horse

- Distinctive Features: Small, triangular head with wide-set eyes, arched neck, tail raised above croup when walking or trotting.
- Known for endurance and agility.

Pony Breeds

- **Welsh Pony**: Ideal for young children as play and pet animals.
- **Connemara Pony**: Largest of the pony breeds.
- **Miniature Horse**: Maximum height for registration is 32 inches (e.g., Tom Thumb: 23 inches).

Topic 3. Common Farm Management Practices: Disinfection, Isolation, Quarantine, and Disposal of Carcasses

I. Disinfection

Disinfection refers to the process of destroying pathogenic microorganisms from surfaces, equipment, or areas to prevent the spread of infection. This can be achieved through the use of **physical**, **chemical**, and **gaseous** agents.

1. Physical Disinfectants:

- **Heat**:

- **Mechanism**: Destroys microorganisms by denaturing their proteins and oxidizing cellular components.
- **Forms**:
  - **Dry Heat**: Applied in the form of a flame (300°C) for sterilizing surfaces such as floors, walls, and equipment.
  - **Moist Heat**: More effective than dry heat, commonly used as **steam** for disinfecting equipment and utensils. Steam is particularly useful in eliminating bacterial spores and heat-resistant pathogens.

- **Radiation**:
  - **Ultraviolet (UV) radiation**: UV light from the sun is a natural disinfectant. Artificial UV lamps can also be used in enclosed spaces like veterinary clinics or barns to disinfect surfaces and air. Pathogens like **Brucella** can be destroyed by exposure to sunlight for 4-5 hours.
- **Filtration**:
  - **Application**: Used in air-conditioning systems, water purification, and in the processing of biological materials to remove microbial contaminants.
- **Desiccation**:
  - **Effect**: Dehydration removes moisture from microorganisms, rendering them inactive. This method is effective for some pathogens, though others, like bacterial spores, may resist drying.

2. Chemical Disinfectants:

Chemical disinfectants are widely used in veterinary practices because they are easy to prepare, cost-effective, and have broad-spectrum activity. They are available in different forms like liquids, powders, and gases.

- **Acids and Alkalis**:
  - **Examples**: Boric acid (4-6%) and sodium hydroxide (1-5%) solutions.
  - **Application**: Used for disinfecting animal houses, barns, and equipment. **Calcium hydroxide** (slaked lime) is also used for whitewashing walls and disinfecting areas.
- **Aldehydes**:
  - **Examples**: Formaldehyde (5-10%) for disinfecting floors, and **Glutaraldehyde (2%)** for sterilizing surgical instruments.
  - **Action**: These compounds act by cross-linking microbial proteins, rendering them inactive.

- **Detergents and Soaps**:
  - **Function**: Used mainly for cleaning surfaces by removing grease, dirt, and organic matter, which interfere with the efficacy of disinfectants. **Quaternary ammonium compounds** (e.g., Cetavlon, Savlon) are widely used.
- **Halogens**:
  - **Examples**: Chlorine and iodine.
  - **Action**: These agents kill pathogens by causing oxidation. Common forms include **bleaching powder** (calcium hypochlorite) and **organic chloramines**.
- **Metallic Compounds**:
  - **Examples**: **Copper sulfate** (5 mg/lit) used for disinfecting water systems.
- **Oxidizing Agents**:
  - **Examples**: **Potassium permanganate** (1-2 mg/lit), which is used to oxidize organic matter and kill microorganisms.
- **Phenols**:
  - **Examples**: Cresol (3-5%), Lysol (3-5%), thymol, and tar acids. These are commonly used for disinfecting farm buildings and barns.
- **Bleaching Powder**:
  - A mixture of calcium hydroxide and chlorine, it is used as a disinfectant and deodorant. A common solution is 1 kg of bleaching powder dissolved in 25 liters of water.
- **Sodium Hypochlorite**:
  - Similar to bleaching powder, this is a powerful germicide, particularly in the absence of organic matter.
- **Quick Lime (Calcium Oxide)**:
  - Used for disinfecting burial pits and carcasses, it is highly effective in destroying organic material.
- **Calcium Hydroxide (Slaked Lime)**:
  - Used in whitewashing walls and acts as a disinfectant. It is sometimes combined with 5% phenol for enhanced disinfection.

3. Gaseous Disinfectants:

- **Formalin Gas**: Used for fumigating enclosed spaces.
- **Ozone Gas**: An effective oxidizing agent that kills microorganisms.

- **Cresol Gas**: Sometimes used in veterinary practices for air disinfection.

II. Quarantine

Quarantine

It is the practice of isolating apparently healthy animals that have been exposed to infectious agents or that are newly introduced into a herd or country to prevent the possible spread of diseases.

- **Purpose**: Quarantine prevents potential outbreaks by segregating exposed animals for a specified period until the risk of infection is eliminated.
- **Quarantine Period**: Typically lasts for 30 to 40 days, depending on the disease's incubation period. For diseases like rabies, this period can extend up to 6 months.
- **Quarantine Procedures**:
    - Animals are screened for **internal parasites** by conducting a fecal examination.
    - **Deworming** is carried out around the 23rd/24th day if necessary.
    - Animals are treated for **ectoparasites** by dipping or spraying on the 25th/26th day.
    - **Regular monitoring** for signs of illness or infection.

III. Isolation

Isolation refers to the segregation of infected or potentially infected animals from healthy ones during an outbreak of a contagious disease.

- **Purpose**: To prevent the spread of infectious diseases to healthy animals.
- **Isolation Procedures**:
    - Infected animals should be housed in a **separate isolation shed**, far from the main herd.
    - If a separate shed is unavailable, the sick animals should be tied at one end of the existing shed, as far from healthy animals as possible.
    - **Separate attendants** and **equipment** should be used to care for isolated animals. If shared, attendants should tend to healthy animals first, and the equipment should be disinfected after each use.
    - Attendants should **wash their hands and disinfect their footwear** and clothing after handling sick animals.
    - Isolated animals should only be returned to the herd after full recovery and a confirmed absence of infection.

IV. Disposal of Carcasses

Safe disposal of carcasses is critical to preventing the spread of diseases to other animals or humans. The primary methods of disposal include **burial** and **incineration**.

1. Burial of Carcasses:

- **Procedure**:
    - Select a site far from wells or watercourses.
    - Ensure a **burial depth of 6 feet**, allowing enough soil to cover the carcass.
    - **Quicklime** or other disinfectants are spread over the carcass before burial to accelerate decomposition and prevent scavengers from accessing the site.
    - Carcasses should be buried with their skin intact, except in the case of **anthrax**, where the skin should not be slashed.
    - The burial area should be disinfected with coal tar to deter animals like foxes and dogs.

2. Incineration/Cremation of Carcasses:

- **Methods**:
    1. **Pit Method**:
        - A pit is dug (7 feet long, 4 feet wide, 18 inches deep) with ventilation trenches to provide airflow for burning.
        - Straw soaked with paraffin is placed in the trench to facilitate lighting.
        - Wood and coal are added to create a steady burn.
    2. **Surface Burning Method**:
        - Carcasses are burned on the ground, especially in areas where the soil is waterlogged or unsuitable for pits.
        - Trenches are dug to improve ventilation, and the carcass is placed over them.
        - Straw soaked with paraffin is used to ignite the fire.
    3. **Flame Gun Method**:
        - A flame gun directs a powerful flame at the carcass, reducing it to ashes.
        - This method does not require digging pits and is faster depending on the number of flame guns used.

Routine Farm Operations

I. Castration

Castration is the removal or deactivation of the testicles to prevent reproduction.

- **Purpose**:
    1. To render animals more docile.
    2. To promote faster weight gain and improve meat quality.
    3. To control indiscriminate breeding.
    4. To prevent genital diseases.
    5. To facilitate easier yoking for work animals by producing leaner necks.
- **Optimum Age**:
    1. **Young animals**: Within 3 months (surgical or elastrator method).
    2. **Adult animals**: Before 1 year of age (Burdizzo method).
- **Methods**:
    1. **Burdizzo Method** (Bloodless Castration): A Burdizzo castrator is used to crush the spermatic cord, cutting off blood supply to the testicles.
    2. **Open Surgical Method**: The scrotum is opened, and the testicles are surgically removed.
    3. **Rubber Ring/Elastrator Method**: A tight rubber ring is applied around the scrotum to cut off blood flow, causing the testicles to atrophy.

II. Dehorning

Dehorning is the removal of horns in adult cattle, while **disbudding** prevents the development of horns at an early age.

- **Purpose**:
    1. Reduces the space required for housing animals.
    2. Prevents injury to other animals and handlers.
    3. Dehorned animals are easier to manage.
    4. Prevents **horn cancer** in certain breeds.
- **Optimum Age**: 15 to 20 days for disbudding.
- **Methods**:

1. **Hot Iron Method**: An electric dehorner is used to burn and destroy horn tissue in calves.
2. **Elastrator**: Rubber bands are placed around the base of the horn, cutting off circulation, causing the horn to fall off.
3. **Chemical Method**: Caustic potash or soda is applied to the horn buds to stop growth.
4. **Dehorning Saw/Clippers**: Used for older cattle, the horns are sawed off, and the main horn artery is tied to prevent excessive bleeding.

III. Extra Teat Removal

Extra teat removal is the process of removing supernumerary teats, which may be blind or leaky.

- **Procedure**:
  - The area is cleaned, and extra teats are clipped off with scissors.
  - Tincture iodine is applied to disinfect the wound.
  - In older animals, sutures may be applied to arrest bleeding.
  - The procedure is best performed before the calf reaches 6 months of age.

Methods of Drug Administration

Drugs can be administered in two primary ways: **Oral Administration** and **Parenteral Administration**.

I. Oral Administration

Oral administration involves administering medicines through the mouth. Medicines can be given in **liquid**, **solid**, or **semi-solid** forms.

1. Drenches

- Drenches are liquid medicines administered orally.
- **Methods**:
  - **Horses**: Drenches are given using a **stomach tube**, which is preferred over a drenching bottle or bit.
  - **Cattle**: A metal drencher or stomach tube can be used. The tube can be passed through the nostril or, with the help of a probang gag, through the mouth.

- **Sheep and Goat**: Drenching cups or stomach tubes are used, but the nostrils are too small for tube insertion. A mouth gag may be required to prevent the tube from being chewed.

2. Bolus and Pills

- These are solid forms of medication, typically large pills or tablets.
- **Methods**:
  - **Horses**: The operator holds the tongue between the jaws, inserts the bolus into the left side of the horse's mouth, and drops it at the back of the throat.
  - **Cattle**: The bolus is deposited on the back of the tongue by hand or with a balling gun.
  - **Sheep and Goat**: The bolus is placed on the back of the tongue using a balling gun.

3. Electuaries

- These are semi-solid medications, often prepared with **treacle and applied to the back of the tongue.**
- **Usage**: Commonly given to treat respiratory complaints or when swallowing is difficult.
- **Methods**:
  - **Cattle**: The operator opens the animal's mouth, and the electuary is smeared on the tongue.
  - **Sheep and Goat**: The animal is restrained similarly to drenching, and the electuary is applied on the tongue.

II. Parenteral Administration

Parenteral administration refers to any method of drug administration that does not involve the oral route. This includes **injections** and **infusions** into various parts of the body.

1. Hypodermic or Subcutaneous Injections

- Injections made under the skin with a hypodermic needle.
- **Site of Injection**:
  - **Horse and Cattle**: Neck region.
  - **Sheep and Goat**: Flank region.
- **Absorption Rate**: Slower than intramuscular and intravenous injections.

2. Intramuscular Injections

- Medicines are injected directly into the muscles when subcutaneous administration is unsuitable.
- **Site of Injection**:
    - **Horse, Cattle, Sheep, and Goat**: Muscles of the breast, neck, triceps, or buttock.

3. Intravenous Injections

- Medicines are injected directly into the bloodstream for rapid effect.
- **Site of Injection**:
    - **Cattle**: Jugular vein or mammary vein.
    - **Sheep and Goat**: Jugular vein.

4. Intraperitoneal Injections

- Medicines are injected into the peritoneal cavity, usually using a trocar and canula.
- **Usage**: Often for large animals, but a hypodermic syringe is used for small animals.

5. Intratracheal Injections

- Drugs are injected into the trachea, commonly used in conditions like parasitic bronchitis in cattle and sheep.

6. Intra-mammary Infusions

- Antibiotics or medications are infused into the teat canal to treat conditions like mastitis.
- **Method**: The udder is emptied of milk, and a special syringe or teat syphon is used for infusion.

7. Intra-uterine Irrigation

- Antiseptic solutions are injected into the uterus to clean and irrigate the uterine cavity.
- **Methods**: A two-way catheter for cows, a rubber tube and pump for mares, or a syringe for smaller animals.

8. Intra-ruminal Injections

- Medicines are administered directly into the rumen, often using a trocar and canula, particularly for anti-parasitic drugs.

III. Pessaries

- Solid forms of medicines inserted into the uterus or vagina of large animals.

IV. Inhalation

- Vapors from medicated boiling water are inhaled by the animal, usually for treating respiratory diseases.
- **Application**: Useful for all animals suffering from respiratory ailments.

V. Enema

- Given to evacuate the bowel or provide nutrition to animals unable to take nourishment orally.

VI. Poultices

- Semi-solid substances like **glycerine and kaolin** mixed with **turpentine** are applied externally to affected parts of the body.
- **Usage**: Commonly used to treat localized infections or inflammation.

VII. Fomentation

- A first aid treatment for sprains, typically using hot or cold applications to reduce inflammation and relieve pain.
- **Types**: Hot fomentation or cold fomentation (ice packs).

VIII. Baths

- Animals suffering from hoof diseases, such as foot rot in sheep, are driven through a shallow foot bath containing antiseptics.
- **Usage**: Foot baths are a preventive and therapeutic measure for hoof infections.

Summary of Drug Administration Routes:

Route	Method	Primary Usage
Oral	Drenches, Bolus, Pills, Electuaries	Common for treating digestive, respiratory issues.
Subcutaneous (SC)	Hypodermic injection	Slow absorption of medicine under the skin.

Intramuscular (IM)	Injection into muscle	Faster absorption, useful for antibiotics, vaccines.
Intravenous (IV)	Injection into the bloodstream	Rapid effect, ideal for emergencies.
Intraperitoneal (IP)	Injection into the peritoneal cavity	Large animals, emergency rehydration.
Intratracheal	Injection into the trachea	For respiratory diseases in young cattle and sheep.
Intra-mammary	Infusion into the teat canal	Mastitis treatment in dairy animals.
Intra-uterine	Injection into the uterus	Cleaning and irrigating the uterus after infections.
Intra-ruminal	Injection into the rumen via trocar and canula	Administer anti-parasitic and other medicines.
Pessaries	Solid medicines for uterus or vagina	Large animal reproductive treatments.
Inhalation	Vapors of medicated boiling water	For respiratory diseases in all animals.
Enema	Administer via rectum	For bowel evacuation or nutrition in sick animals.
Poultices	External application of glycerine, kaolin, and turpentine	Local treatment for infections or inflammation.
Fomentation	Hot or cold compresses	First aid for sprains, swelling, and inflammation.
Baths	Antiseptic foot baths	Treatment of hoof diseases like foot rot.

Common Vices of Animals (Cattle, Sheep, and Goat) and Their Prevention and Care

Vices are abnormal behaviors or bad habits exhibited by animals, which can result from various factors such as confinement, poor management, or genetic predispositions. Addressing these vices is essential to maintain animal health, productivity, and welfare.

Vices in Dairy Animals (Cattle)

1. **Eye Rolling**:
    - Eyes are moved around in the orbit without any visible object.
    - **Cause**: Common in calves confined in crates for long periods.
    - **Prevention**: Allow free movement and provide a less restrictive environment.
2. **Tongue Rolling**:
    - The tongue curls and uncurls inside or outside the mouth without the presence of food or solid objects.
    - **Affected Animals**: Seen in young adult cattle, especially breeds like **Brown Swiss**.
    - **Causes**: Hereditary factors, continuous confinement, and low roughage diets.
    - **Prevention**: Insertion of a metal ring through the frenulum of the tongue, dietary inclusion of salt mixtures, and ensuring free movement.
3. **Licking and Eating Own Hair**:
    - Young calves housed in individual crates lick and consume their hair, leading to hairballs (bezoars) in the rumen.
    - **Prevention**: Early weaning, housing in group pens, and providing roughage to occupy the calves.
4. **Sucking and Eating Solid Objects**:
    - Recently weaned calves lick and suck on solid objects like walls or bars.
    - **Prevention**: Paint wood surfaces with **creosote** and provide high-quality roughage and concentrates.
5. **Intersucking by Calves**:
    - Calves separated from their mothers may suck on their own bodies or other calves, focusing on the navel, prepuce, scrotum, udder, and ears.
    - **Prevention**: Proper management of calf separation and grouping, including providing adequate feeding.
6. **Milk Sucking by Adult Animals**:
    - Adult cows or bulls suck milk from the udder of other cows, reducing milk production and causing damage to the teats.

- **Prevention**: Close monitoring of herd behavior and ensuring proper feeding and supervision.

Vices in Sheep and Goats

1. **Wool Pulling and Wool Eating**:
   - Sheep confined in restrictive environments may pull and eat wool, leading to health issues.
   - **Cause**: Overcrowding and lack of roughage in the diet.
   - **Prevention**: Provide adequate space, access to roughage, and proper diet.
2. **Stealing Young/Lamb Stealing**:
   - Pre-parturient ewes, cows, or mares may adopt the newborns of other animals, reducing maternal care for their own offspring.
   - **Effect**: Leads to the foster mother rejecting her own young and may result in the death of lambs due to lack of colostrum.
   - **Prevention**: Separate the pregnant animals from the group before and after parturition to avoid confusion and lamb stealing.

. Livestock Production Systems of Different Agro-Climatic Zones

Livestock production systems are part of farming systems and are classified based on integration with crops, land use, and the agro-ecological zone.

Types of Livestock Production Systems

1. **Solely Livestock Production Systems**:
   - These systems rely almost entirely on feed from **rangelands**, **pastures**, or **purchased feeds**. Less than 10% of the total value of production comes from non-livestock farming activities.

a. **Landless Livestock Production Systems**:

- Less than 10% of the dry matter fed to animals is produced on the farm. Stocking rates exceed 10 livestock units (LU) per hectare of agricultural land.

b. **Grassland-Based Systems**:

- More than 10% of the dry matter fed to animals is farm-produced. Stocking rates are below 10 LU per hectare of agricultural land.

2. **Mixed-Farming Systems**:

- Livestock systems where more than 10% of the dry matter comes from **crop by-products**, **stubble**, or where more than 10% of the total value of production comes from non-livestock farming activities.

a. **Rain-fed Mixed-Farming Systems**:

- More than 90% of the non-livestock farm production comes from **rain-fed land**.

b. **Irrigated Mixed-Farming Systems**:

- More than 10% of the non-livestock farm production comes from **irrigated land use**.

Intensive, Semi-Intensive, and Extensive Systems

1. **Intensive System**:
   - All operations, including feeding, watering, and housing, are confined to one place, with restricted animal movement.
   - **Suitable For**: Poultry, pigs, and rabbits. Dairy farming is also conducted intensively in developed countries.
   - **Benefits**: Facilitates mechanization and control of production processes.
2. **Semi-Intensive System**:
   - Animals are confined for part of the day and allowed to graze during the day. Concentrates are fed during confinement.
   - **Suitable For**: Dairy cattle, goats, and sheep.
   - **Benefits**: Combines the advantages of controlled feeding with natural grazing.
3. **Extensive System**:
   - Animals are kept on **grassland** with minimal confinement. They roam freely, with small shelters provided for young animals during extreme weather conditions.
   - **Suitable For**: Large flocks of sheep, goats, and cattle raised in open grazing systems.

Tethering as a Livestock Management System

- **Tethering**: Animals are tied in place and allowed to graze near inhabited areas, usually practiced by small-scale or subsistence farmers. It is common in humid areas where land space is limited.
- **Method**: Animals graze on kitchen remnants, crop residues, and nearby vegetation.

Migratory Livestock Production Systems

In migratory systems, sheep and goat farmers move their flocks seasonally to access different pastures. This practice is common in **mountainous regions** and **semi-arid/arid regions** where grazing availability fluctuates with seasons and rainfall.

1. **Summer Grazing**: Flocks are moved to highlands where pasture is available.
2. **Winter Grazing**: Flocks are brought down to lowlands to avoid harsh winter conditions.

.Goat Production Systems in the Tropics

Goat production systems in tropical regions are divided into **extensive**, **semi-intensive**, and **intensive** systems based on grazing methods, movement, and management.

1. Extensive Systems

These systems involve open grazing on natural pastures with minimal intervention. They are common in regions with large areas of pasture and are characterized by low labor and capital investment.

- **Nomadic Systems**:
  - Involves continuous movement of both the flock and its owners in search of grazing land.
  - **Challenges**: Difficult to improve due to the inability to segregate animals by age, sex, or reproductive stage. Supplementary feeding is also difficult.
  - **Management**: Nomads rely on their knowledge of the best pasture and water sources at different seasons.
  - **Region**: Arid areas with sparse or seasonal grazing.
- **Transhumant Systems**:
  - Goats graze near a permanent village base for part of the year and move to distant pastures during other parts of the year, usually in different ecological zones.
  - **Management**: Women, children, and the elderly often remain in the village, taking care of pregnant or newly kidded goats. This allows selective breeding and controlled kidding.
  - **Feeding**: Crop wastes, tree leaves, and tethering are common feeding methods.
- **Sedentary Systems**:
  - These systems range from fully extensive to zero-grazing. Sedentary farmers have more control over goat production and may integrate grazing with cultivated pasture.
  - **Application**: Suitable in areas with large pastures and minimal labor input.

2. Semi-Intensive Systems

- **Tethering**:
    - Goats are tethered to prevent them from straying, with the tether attached to a stationary or movable post.
    - **Precautions**: Care must be taken to avoid strangulation, ensure shade and access to water, and move goats daily to fresh grazing areas.
    - **Advanced Method**: A "running wire" system uses a sliding metal ring on a wire stretched between two posts, allowing goats to graze a larger area.
    - **Suitability**: An excellent and cost-effective system for smallholders.

3. Intensive Systems

- **Zero-Grazing**:
    - **Description**: Goats are kept in enclosures, and feed is brought to them, often from cultivated pastures. Stocking density is high, and goats do not graze on open land.
    - **Challenges**: Fencing goats is expensive and difficult as goats are adept at finding weaknesses in fences.
    - **Management**: Requires strong, high fences (at least 1.5 meters) made from wire netting or wooden rails.
    - **Application**: Suitable for areas where land is limited and labor-intensive management is possible.

Housing of Sheep and Goats

Proper housing is essential for the optimal productivity of sheep and goats, especially for protection against extreme weather. Below are key aspects of housing management for sheep and goats, as outlined in various research and management studies.

1. Housing Requirements

Basic Protection: Minimum housing is needed to protect animals from sun, rain, and winds.

Simple Structures: Sheds can be built using materials like asbestos sheets, bamboos, thatched materials, and steel supports.

Adaptability to Climate: Sheep and goats are adapted to a wide range of climatic conditions across India, from the Western Himalayas to the trans-Gangetic plains.

2. Orientation and Ventilation

Shed Orientation:

- **East-West orientation**: Cooler, but North-South keeps the shed dry and promotes sanitation.

- **North-East to South-West orientation**: Provides maximum comfort in hot, arid climates.

Ventilation: Adequate ventilation is crucial to prevent humidity and ensure airflow. Open sides above 1 meter from the floor in hot conditions are recommended.

Winter Considerations: Sides may be closed during the winter to reduce heat loss, but cross-ventilation must be maintained.

3. Roof Design

Roof Height:

- A height of **3 to 3.5 meters** is recommended to ensure proper ventilation.
- Lower roofs can limit ventilation, while 'A' shaped roofs help reduce heat gain from direct sunlight.
- **Double Roofs**: These reduce heat, but are costly and may not be necessary in all situations.

4. Floor and Space Requirements

- **Flooring**: The floor should be comfortable, clean, and dry to prevent diseases and injuries. Straw bedding works well in cold periods but should be thin in hot weather.
- **Space Requirements**: Adequate space prevents huddling and ensures proper heat dissipation.

Animal Type	Space per Animal (m^2)
Ram or buck in groups	1.8
Ram or buck individual	3.2
Lambs or kids in group	0.4
Weaner in groups	0.8
Yearling or goatlings	0.9
Ewe or doe in groups	1.0
Ewe with lambs	1.5

5. Types of Sheds

Ewe/Doe Shed: 15 m x 4 m x 3 m high, accommodating 60 ewes or does.

Ram/Buck Shed: 4 m x 2.5 m x 3 m high, housing up to 3 rams.

Lambing/Kidding Shed: 1.5 m x 1.2 m x 3 m high, designed for maternity care.

Lamb/Kid Shed: 7.5 m x 4 m x 3 m high, partitioned for weaned and unweaned lambs.

Sick Animal Shed: 3 m x 2 m x 3 m high, for segregating sick animals.

Shearing/Store Room: 6 m x 3.5 m x 3 m, divided into storage for wool, shearing equipment, feed, and medicines.

Attendant's Room: For caretakers, located at a convenient spot on the farm.

6. Essential Appliances

Feeders: Use rectangular or hexagonal feeders to reduce wastage. For goats, stall feeding at an elevated level helps minimize contamination and wastage.

Water Troughs: Clean, covered troughs are necessary to prevent infections. The recommended trough length is **3-4 cm per goat** for group housing.

7. Shed Hygiene

General Maintenance: Regular cleaning, disinfection, and seasonal repairs are essential for shed hygiene.

Pest Control: Seasonal spraying helps control ectoparasites. Disinfect with carbolic acid to prevent snake infestations and annual whitewashing with lime before winter is advised.

Ventilation Adjustments: Use thatch panels during summer and winter to control airflow.

8. Housing for Dairy Goats

Sheds: Sheds should have individual stalls for milking does, with a passage in between the rows of stalls. Each stall should measure **1.2 m x 1.4 m**.

Milk Room: This room stores milk for disposal.

Store Room: A storage area for feed and other materials.

Construction Details:

Floor: Cement or wooden platform with a **45 cm** elevation and proper drainage.

Walls: Built with brick up to **1.2 m** in height, topped with wire-netting for ventilation.

Roof: Asbestos or galvanized steel sheets, or thatch in areas with low rainfall.

Partitions: Dividers between stalls made from wood or galvanized steel.

Manger: Raised wooden or metal mangers, 45 to 60 cm from the ground, to hold feed.

kids, reduce the incidence of infections, and improve overall health.

Housing for Calves

Calf housing should provide an environment that minimizes disease, promotes growth, and reduces the need for veterinary care.

Fundamental Requirements:

- **Dry Bedding**: Keeps the calf warm and reduces heat loss.
- **Ventilation**: Ensures fresh air circulation and removes harmful gases like ammonia and methane.
- **Air Capacity**: Proper air volume per calf reduces disease transmission.
- **Draught-Free Environment**: Essential for young calves, especially during winter.

Types of Calf Housing:

1. **Individual Pens**: Used for the first 1-3 months to prevent disease transmission and ensure proper monitoring.
2. **Group Pens**: After three months, calves are moved to group pens of **3-5 calves per pen**. By six months, they are usually housed individually again.

Floor Space Requirements for Calves:

Age of Calves (months)	Covered Area (m^2)	Open Area (m^2)	Number of Calves per Pen
0-3 months	1.0	2.0	24
3-6 months	1.5	3.0	16
6-12 months	2.0	4.0	12

Housing of Bulls

Bulls contribute significantly to the genetic improvement of the herd by providing half of the offspring's genotype. Proper housing for bulls, especially in hot climates, is essential to maintain semen quality and breeding efficiency. Bulls are usually housed individually in pen and yard systems, either in single-row or double-row layouts.

Purpose of Bull Housing

1. Shields bulls from inclement weather and ensures safety and ease of handling.
2. Provides space for bulls to exercise, essential for maintaining physical health.
3. Well-housed bulls maintain higher semen quality, improving reproductive outcomes.

Floor Space Requirements for Bulls

- **Covered Area**: Minimum 12 m^2 per bull.
- **Open Exercise Yard**: Minimum 120 m^2 per bull.
- If an open yard is not available, a bull exerciser should be provided.

Construction Principles for Bull Housing

1. **Walls**:
    - Solid walls up to 1.5 meters in height.
    - Above this, 2-3 horizontal tubular rods with gaps of 20-30 cm are installed to allow ventilation and visibility.
2. **Flooring**:
    - Rough cement concrete with a gradient slope of 1/40 to 1/60 for proper drainage.
    - The floor should provide good traction and help prevent hoof problems.
    - In hot climates, the floor should remain cool, and vitrified paving bricks may be used to prevent slipping.
3. **Roof**:
    - **Gable or Monitor Roof**: Eaves height of 2.5 – 3 m, and ridge height of 3.2 – 3.5 m.
    - **Roofing Material**: Insulating materials like asbestos or galvanized iron sheets are used to reduce heat absorption in hot regions.

Fitting and Facilities

1. **Manger**:
    - Cement concrete manger with dimensions: **60 cm width, 40 cm depth, and 50 cm height**.
    - Equipped with yoke or tubular stanchions to secure the bull during feeding.
2. **Water Trough**:
    - A trough with a length of 60-75 cm should be provided, and an automatic water bowl is recommended for ease of watering.
3. **Doorway**:
    - Each bull pen should have a **half-door** main entrance, **4 feet wide and 7 feet high**.
    - Two strong bars should be placed across the upper opening to prevent the bull from jumping the lower door when open.
4. **Yard**:
    - The yard should be **120 m²**, enclosed by a 0.3 m solid wall, and tubular rods up to 1.2 m height.
    - The floor should be made of cement concrete, grooved, and roughened for better grip, with drainage access.

5. **Service Crate**:
    - The exercise yard should have access to a service crate for handling and semen collection.
    - The semen collection area should be located near the bull housing for efficiency.

Protection Against Hot Climatic Conditions

The semen quality and libido of bulls can decrease during hot weather. To minimize thermal stress, the following measures should be taken:

- **Cool and Well-Ventilated Shed**: Bulls should be housed in sheds that provide proper ventilation and cooling.
- **Showering/Splashing Cold Water**: Bulls should be showered 2-3 times during the hottest part of the day to cool them down.
- **Exercise During Cooler Hours**: Bulls should be taken for exercise in the early morning or late evening to avoid heat stress.
- **Planting Trees for Shade**: Quick-growing, tall trees should be planted around the bull shed to provide natural shade.
- **Roof Insulation**: Straw can be spread over the roof, and the roof can be painted white on the outside to reflect heat, while the inside is painted black to absorb and dissipate heat.

Isolation and Quarantine Sheds

- **Isolation Shed**: Used to separate sick animals from healthy stock to prevent disease transmission. It should be located at the **farthest corner of the farm.**
- **Quarantine Shed**: New animals entering the farm are housed here for **30 to 40 days** to monitor for any diseases before integrating them with the main herd.

Store Room

- A store room should be fully enclosed with rat-proofing measures.
- Feed mixing units should be located at a distant place, with a smaller feed store near the milking parlor for easy access.

Milk Room

- Essential for milk storage and cooling in larger dairies with production capacities ranging from **400 to 700 liters**.
- Room size: **3.7 m x 5 m**. For smaller dairies producing less than 100 liters, a room of **3.75 m x 3 m** is sufficient.

Hay or Straw Shed

- An adult animal consumes **5-10 kg of hay or straw per day**, while younger stock consumes **2-5 kg per day**.
- The space requirement for hay storage can be calculated based on annual consumption needs.

Dimensions of Milking Barn

Component	Dimensions
Length of standing space	1.5 – 1.7 m
Width of standing space	1.05 – 1.2 m
Width of central passage	1.5 – 1.8 m
Width of feed alley	0.75 m
Width of gutter	0.30 m
Overhang	0.75 m

Floor Space Requirements

Type of Animal	Covered Area (m^2)	Open Area (m^2)	Max Number of Animals per Pen	Shed Height
Bulls	12.0	24.0	1	175 cm (rainy areas), 220 cm (dry areas)
Cows	3.5	7.0	50	
Buffaloes	4.0	8.0	50	
Down-Calver	12.0	12.0	1	
Young Calves	1.0	2.0	30	
Old Calves	2.0	4.0	30	

Feeding and Watering Space Requirements

Type of Animal	Space per Animal (cm)	Total Manger Length for 100 Animals (cm)	Total Water Tank Length for 100 Animals (cm)
Adult Cattle & Buffaloes	60 – 75	6000 – 7500	600 – 750
Calves	40 – 50	4000 – 5000	400 – 500

Dimensions of Feed Manger

Type of Animal	Width (cm)	Depth (cm)	Height of Inner Wall (cm)
Adult Cattle & Buffaloes	60	40	50
Calves	40	15	20

Livestock Production Systems of Different Agro-Climatic Zones

Livestock production systems are part of farming systems and are classified based on integration with crops, land use, and the agro-ecological zone.

Types of Livestock Production Systems

3. **Solely Livestock Production Systems**:
    - These systems rely almost entirely on feed from **rangelands**, **pastures**, or **purchased feeds**. Less than 10% of the total value of production comes from non-livestock farming activities.

a. **Landless Livestock Production Systems**:

- Less than 10% of the dry matter fed to animals is produced on the farm. Stocking rates exceed 10 livestock units (LU) per hectare of agricultural land.

b. **Grassland-Based Systems**:

- More than 10% of the dry matter fed to animals is farm-produced. Stocking rates are below 10 LU per hectare of agricultural land.

4. **Mixed-Farming Systems**:

- Livestock systems where more than 10% of the dry matter comes from **crop by-products**, **stubble**, or where more than 10% of the total value of production comes from non-livestock farming activities.

a. **Rain-fed Mixed-Farming Systems**:

- More than 90% of the non-livestock farm production comes from **rain-fed land**.

b. **Irrigated Mixed-Farming Systems**:

- More than 10% of the non-livestock farm production comes from **irrigated land use**.

Intensive, Semi-Intensive, and Extensive Systems

4. **Intensive System**:
   - All operations, including feeding, watering, and housing, are confined to one place, with restricted animal movement.
   - **Suitable For**: Poultry, pigs, and rabbits. Dairy farming is also conducted intensively in developed countries.
   - **Benefits**: Facilitates mechanization and control of production processes.
5. **Semi-Intensive System**:
   - Animals are confined for part of the day and allowed to graze during the day. Concentrates are fed during confinement.
   - **Suitable For**: Dairy cattle, goats, and sheep.
   - **Benefits**: Combines the advantages of controlled feeding with natural grazing.
6. **Extensive System**:
   - Animals are kept on **grassland** with minimal confinement. They roam freely, with small shelters provided for young animals during extreme weather conditions.
   - **Suitable For**: Large flocks of sheep, goats, and cattle raised in open grazing systems.

Tethering as a Livestock Management System

- **Tethering**: Animals are tied in place and allowed to graze near inhabited areas, usually practiced by small-scale or subsistence farmers. It is common in humid areas where land space is limited.
- **Method**: Animals graze on kitchen remnants, crop residues, and nearby vegetation.

Migratory Livestock Production Systems

In migratory systems, sheep and goat farmers move their flocks seasonally to access different pastures. This practice is common in **mountainous regions** and **semi-arid/arid regions** where grazing availability fluctuates with seasons and rainfall.

3. **Summer Grazing**: Flocks are moved to highlands where pasture is available.
4. **Winter Grazing**: Flocks are brought down to lowlands to avoid harsh winter conditions.

Goat Production Systems in the Tropics

Goat production systems in tropical regions are divided into **extensive**, **semi-intensive**, and **intensive** systems based on grazing methods, movement, and management.

1. Extensive Systems

These systems involve open grazing on natural pastures with minimal intervention. They are common in regions with large areas of pasture and are characterized by low labor and capital investment.

- **Nomadic Systems**:
  - Involves continuous movement of both the flock and its owners in search of grazing land.
  - **Challenges**: Difficult to improve due to the inability to segregate animals by age, sex, or reproductive stage. Supplementary feeding is also difficult.
  - **Management**: Nomads rely on their knowledge of the best pasture and water sources at different seasons.
  - **Region**: Arid areas with sparse or seasonal grazing.
- **Transhumant Systems**:
  - Goats graze near a permanent village base for part of the year and move to distant pastures during other parts of the year, usually in different ecological zones.
  - **Management**: Women, children, and the elderly often remain in the village, taking care of pregnant or newly kidded goats. This allows selective breeding and controlled kidding.
  - **Feeding**: Crop wastes, tree leaves, and tethering are common feeding methods.
- **Sedentary Systems**:
  - These systems range from fully extensive to zero-grazing. Sedentary farmers have more control over goat production and may integrate grazing with cultivated pasture.
  - **Application**: Suitable in areas with large pastures and minimal labor input.

2. Semi-Intensive Systems

- **Tethering**:
    - Goats are tethered to prevent them from straying, with the tether attached to a stationary or movable post.
    - **Precautions**: Care must be taken to avoid strangulation, ensure shade and access to water, and move goats daily to fresh grazing areas.
    - **Advanced Method**: A "running wire" system uses a sliding metal ring on a wire stretched between two posts, allowing goats to graze a larger area.
    - **Suitability**: An excellent and cost-effective system for smallholders.

3. Intensive Systems

- **Zero-Grazing**:
    - **Description**: Goats are kept in enclosures, and feed is brought to them, often from cultivated pastures. Stocking density is high, and goats do not graze on open land.
    - **Challenges**: Fencing goats is expensive and difficult as goats are adept at finding weaknesses in fences.
    - **Management**: Requires strong, high fences (at least 1.5 meters) made from wire netting or wooden rails.
    - **Application**: Suitable for areas where land is limited and labor-intensive management is possible.

. General Management and Feeding Practices

1.1 Calf Management

- **Calf replacement rate:** 20-30% of the herd for production efficiency.
- **Calving Management:**
    - Transfer to **calving pen** 1-2 weeks before calving.
    - **Size:** 3m × 4m (12m²), well-ventilated.
    - **Hygiene:** Sterilize with antiseptic; provide clean bedding.
- **Signs of Approaching Parturition:**
    - Udder distension, vulva swelling, relaxation of pelvic ligaments.
- **Stages of Parturition:**
    - **Preparatory Stage** – Cervical dilation.
    - **Expulsion Stage** – Delivery of the calf.
    - **Fetal Membrane Expulsion** – Placenta expelled within 12 hours.

- **Post-Calving Care:**
    - **Udder cleaning** with antiseptic water.
    - Immediate **colostrum feeding**.
    - Monitor for **milk fever, ketosis, grass tetany**.

1.2 Care of Newborn Calf

- **Stimulating respiration:** Licking by the mother or manual massage.
- **Clearing mucus:** By lifting the calf by the hock or using a dry towel.
- **Umbilical Cord Care:** Tie and disinfect with **tincture iodine**.
- **Neonatal Deworming:** 10g **piperazine adepate** in the first week.

1.3 Colostrum Feeding

- **Importance:**
    - Provides **passive immunity** through gamma globulins.
    - Acts as **laxative** for meconium passage.
- **Optimal Feeding Time:** Within **first 1-2 hours** of birth.
- **Gut Closure:** Occurs within **24 hours** after birth.
- **Colostrum Composition vs. Milk:**

Constituent	Cow Colostrum (%)	Buffalo Colostrum (%)	Milk (%)
Total Solids	28.3	31.0	12.86
Protein	21.32	23.8	3.34
Fat	0.15-1.2	4.0	4.0

- **Feeding Schedule:**
    - **First 30 mins:** 5-8% of body weight.
    - **10-12 hours later:** Another 5-8%.
    - **2nd & 3rd day:** 10% of body weight.

1.4 Calf Weaning and Feeding

- **Weaning Age:** 90 days.
- **Weaning Methods:** Early weaning (bucket-fed), Nurse-Cow Method (allowed to suckle).
- **Milk Replacer Composition:**
    - **50% skim milk powder, 10% fat, minerals, vitamins.**
    - **Milk replacer to water ratio:** 1:8.

2. Breeding Management of Cattle

2.1 Puberty & Mating

- **Puberty Age:** 8-12 months (varies with breed).
- **Breeding age:** At **75% of adult body weight**.
- **First Service:** 18 months for crossbred heifers.

2.2 Estrous Cycle & Heat Detection

- **Estrous cycle length: 21±3 days**.
- **Estrus Duration:** 12-18 hours; ovulation occurs 12-16 hours later.
- **Signs of Heat:**
    - **Standing heat** (accepts mounting) – most reliable.
    - **Mucous discharge, restlessness, drop in milk yield**.
- **Silent Heat:** Common in buffaloes; **use teaser bulls, pedometers**.

2.3 Artificial Insemination & Mating

- **Optimal AI Timing:**
    - **Morning estrus → AI in evening.**
    - **Evening estrus → AI next morning.**
- **Repeat Breeders:** If not pregnant after **multiple AI cycles**, check for reproductive disorders.

2.4 Pregnancy Diagnosis & Calving Interval

- **Pregnancy test:** 6-8 weeks post-insemination.
- **Ideal calving interval: 365 days**.
- **First AI post-calving: 50-75 days postpartum**.

3. Feeding Strategies for Different Livestock

Animal	Feeding Practice
Calves	Colostrum (first 3 days), milk replacers, starter ration at 2 weeks.
Heifers	Balanced diet with adequate protein and minerals to maintain growth.
Pregnant Animals	**Last trimester** – Increased **energy, protein, calcium** for fetal growth.
Lactating Cows	**High-energy diet**, green fodder, mineral supplements.
Dry Cows	**Restricted feeding** to avoid excessive fat deposition.

Bulls	**High-protein diet, mineral mix, exercise** to maintain libido and fertility.
Draft Animals	**Carbohydrate-rich diet** for stamina, adequate hydration.

4. Farm Records and Maintenance

- **Types of Records:**
  - **Production Records** (milk yield, growth rates).
  - **Breeding Records** (heat detection, AI dates, pregnancy status).
  - **Health Records** (vaccination, deworming, disease outbreaks).
- **Benefits of Record-Keeping:**
  - **Efficient culling and breeding management.**
  - **Identifies high-yielding and problem animals.**

Management of Sheep and Goats

1. Reproductive Parameters

Parameter	Sheep (Ewe)	Goat (Doe)
Estrous Cycle	16-19 days (avg. 17)	19-21 days (avg. 20)
Estrus Duration	6-48 hrs (avg. 24 hrs)	34-38 hrs
Ovulation	24-30 hrs after estrus onset	Mid to late estrus
Gestation Period	144-152 days (avg. 147)	146-155 days (avg. 150)

2. Breeding Season

- **Tropical Sheep:** Breed year-round, with peak mating from **July to October** (post-monsoon).
- **Temperate Sheep:** Breed with decreasing daylight (August-November).
- **Indigenous Rams:** Produce quality semen year-round, while temperate rams may have reduced fertility in hot weather.

3. Preparation for Breeding

Practice	Purpose

Flushing	Extra feeding (3-4 weeks before breeding) increases ovulation and twinning rates.
Tagging	Shearing wool from the dock to facilitate mating.
Ringing	Removing wool from ram's neck/belly for efficient mating.
Crutching	Removing wool from perineum of ewes for cleaner mating.
Marking Rams	Using dyes on rams' brisket to track mated ewes.

4. Selection of Breeding Stock

Selection Criteria	Ewe	Ram
Age	18-24 months	12-24 months
Body Weight	≥ 70% of adult weight	Strong, well-fed
Health	Good udder, mothering ability	No physical defects, good libido
Disqualifications	Poor teeth, blind teats, meaty udders	Cryptorchidism, weak legs

- **Sex Ratio:**
    - **Temperate Regions:** 1 ram per 40 ewes.
    - **Tropical Regions:** 2-3 rams per 100 ewes.

5. Estrous Detection

- **Signs:** Vulva reddening, tail wagging, mounting, standing reflex, frequent bleating.
- **Detection Methods:**
    - **Intact Ram:** Allowed into the flock for heat detection.
    - **Aproned Male:** Used for heat detection without mating.
    - **Vasectomized Ram:** Used for detecting estrus.

6. Mating Systems

System	Description
Hand Mating	Ewes/does detected in heat are mated individually.
Pen Mating	20-25 ewes/does are placed with rams at night.
Flock Mating	Rams run with ewes for entire season (risk of exhaustion).
Artificial Insemination (AI)	Fresh or frozen semen is used.

Embryo Transfer (ET)	Genetic advancement but expensive and requires surgery.

7. Estrous Synchronization

Method	Description
Ram Effect	Introducing rams suddenly to stimulate estrus.
Telescoping	Keeping rams away for 2-3 months, then introducing them.
Hormonal Synchronization	Progesterone implants or prostaglandin injections induce estrus.

8. Pregnancy & Parturition Management

Care During Pregnancy

✅ **Separate ewes in late pregnancy** for special care.
✅ **Extra feeding (last 3-4 weeks)** improves lamb birth weight.
✅ **Avoid rough handling** to prevent abortions.
✅ **Lambing shed:** Provide soft bedding, protection from cold.

Care at Parturition

✅ **Signs of labor:** Restlessness, swollen udder, vulva flushing.
✅ **Assistance in difficult births** (dystocia cases).
✅ **Ensure colostrum feeding** within the first hour.
✅ **Protect from cold and rain** (use lambing pens).

Post-Partum Care

✅ **Clean and dress umbilical cord** with antiseptic.
✅ **Check udder for mastitis** or blocked teats.
✅ **Monitor lambs/kids behavior** (proper bonding with mother

9. Feeding Management

Feeding of Breeding Ewes

- **Flushing Diet:**
    - Grass pasture + 150g wheat bran/day.
    - Green fodder + 200g concentrate/day.
- **Pregnancy Feeding:**
    - **Early/Mid Pregnancy:** Pasture grazing, **legume hay supplement** if pasture is poor.
    - **Late Pregnancy:**

        - 225g grains (barley/maize/oats) + 7kg green fodder/day.
        - 600g legume hay or 300g concentrate with **12-14% DCP**.
- **Lactation Feeding:**
    - **High-protein diet** to support milk production.
    - **Free-choice clean water.**

10. Feeding of Rams

✅ **300-500g concentrate mixture** (3 parts oats/barley, 1 part maize, 1 part wheat).
✅ **Avoid overfeeding** to prevent obesity (reduces fertility).

11. Lamb/Kid Feeding

Age	Milk Feeding	Concentrate	Forage
0-3 days	Colostrum	-	-
10 days	Milk + creep feed	100g/day	Introduce forage
30 days	Milk + grains	200g/day	Green fodder
60 days	Weaning	225-450g/day	Full pasture access

✅ **Creep feeding** improves growth rates.
✅ **Orphan lambs:** Hand-fed **milk replacers** and legume hay.

12. Housing of Sheep and Goats

Type	Space Requirement (m^2)
Ram/Buck (individual)	3.2
Ram/Buck (group)	1.8
Ewes/Does (group)	1.0
Ewe with lambs	1.5
Lamb/Kid pen	0.4

✅ **Ventilation:** Open sides above 1m in hot climates.
✅ **Roof:** 3-3.5m height for airflow, thatch for insulation.
✅ **Feeders:** Elevated feeders for goats prevent contamination.
✅ **Water troughs: 3-4cm per goat** in group housing.

13. Shearing of Wool

Shearing Method	Description
Hand Shearing	Slow, uneven cuts, stress on sheep.
Machine Shearing	Fast, even cuts, minimizes wool loss.
Chemical Shearing	Cyclophosphamide (24 mg/kg), removes wool in 3 days but has **residual toxicity risks**.

✅ **Twice a year (March-April, Sept-Oct).**
✅ **Avoid yellowing (canary stain) by early shearing.**

14. Culling of Livestock

Type	Criteria
Policy Culling	Poor productivity, genetic defects, old age.
Veterinary Culling	Disease, injury, or poor health.
Emergency Culling	Accidents, contagious diseases like TB.

✅ **Cattle Culling Age:** After **5 calvings or 12 years**.
✅ **Sheep/Goat Culling Age:** 6 years or **broken mouth**.

Key Takeaways

✅ **Flushing & flushing diet** improves fertility.
✅ **Estrous detection is crucial** for AI and natural breeding.
✅ **Proper lamb/kid care** ensures higher survival rates.
✅ **Good housing, nutrition, and disease control** improve productivity.
✅ **Shearing should be timely** to avoid wool defects.
✅ **Culling should be done strategically** to maintain herd health.

Management in Swine and Piglet Care

1. Selection of Breeding Stock

Boar Selection (Male Pigs)

✅ **Age:** 18-24 months.
✅ **Weight:** 300-400 kg (breed-dependent).

✅ **Criteria:** Strong libido, disease-free, fast growth, good muscle conformation.
✅ **Boar-to-Sow Ratio:** 1 boar per 10 sows.

Sow Selection (Female Pigs)

✅ **Age:** 8-11 months (gilts).
✅ **Weight:** 90-110 kg at first breeding.
✅ **Criteria:** High litter size, good milk production, strong maternal instinct.

2. Reproductive Management

Parameter	Details
Estrous Cycle	21 days
Heat Duration	2-3 days (peak fertility on the 2nd day)
Heat Signs	Swollen/red vulva, restlessness, frequent urination, vocalization, standing heat
Gestation Period	111-114 days (3 months, 3 weeks, 3 days)
Mating	Natural mating (gilts - 1st day, sows - 2nd day) or AI
AI Semen Volume	200-500 ml

3. Pregnancy and Farrowing Management

Signs of Pregnancy

✅ Swollen abdomen, increased appetite, udder development, nesting behavior.

Pre-Farrowing Preparation

✅ **Signs of Labor:** Restlessness, milk secretion, nesting.
✅ **Pen Preparation:** Clean, disinfect, add soft bedding.
✅ **Feed & Water:** Fresh water, balanced diet, laxative feed.

Farrowing & Postpartum Care

✅ **Farrowing Monitoring:** Watch for dystocia (difficult birth).
✅ **Piglet Care:** Ensure breathing, remove membranes, assist with nursing.
✅ **Sow Care:** Prevent uterine infections, check for mastitis, maintain hydration.

4. Piglet Management

Management Practice	Details
Navel Care	Disinfect umbilical cord after birth

Needle Teeth Clipping	1-3 days post-birth (prevent injury to sow's udder)
Iron Supplementation	150-200 mg injection (first 3-4 days) to prevent anemia
Castration	4-8 weeks (prevent boar taint, unwanted breeding)
Temperature Control	30-35°C (use heat lamps, heating pads)
Weaning	6-8 weeks, gradual transition to solid feed

5. Fertility & Litter Size

✅ **Larger Litters = Higher Profitability:** Raising 10 piglets is as cost-effective as raising 6.
✅ **Optimal Mating Age:** Gilts should farrow at **12-14 months** and weigh **100 kg** before breeding.

6. Mating & Breeding Systems

System	Details
Hand Mating	Individual mating when sow is in heat (ensures accuracy).
Pen Mating	Multiple sows housed with a boar (less controlled).
Pasture Mating	Boars freely mate with 15-20 sows (risk of exhaustion).
Artificial Insemination (AI)	Efficient, reduces disease risk, allows genetic improvement.

✅ **Double Mating:** Two services (12-14 hours apart) improve conception rates.

7. Estrous Synchronization

✅ **Ram Effect:** Sudden introduction of a boar induces heat.
✅ **Hormonal Synchronization:** Prostaglandin injections or progesterone implants.

8. Culling of Sows & Boars

Criteria for Culling	Sows	Boars
Age	>6 litters	>5 years
Reproductive Issues	Small litters, failed conception	Infertility, low libido
Defects	Teat defects, small vulva	Weak limbs, cryptorchidism
Temperament	Nervous, irritable	Aggressive, overweight

9. Housing for Swine

Category	Covered Area (m²)	Open Yard Area (m²)
Boar	6.25 – 7.5	8.8 – 12.0
Farrowing Sow	7.5 – 9.0	8.8 – 12.0
Weaners	0.96 – 1.8	8.8 – 12.0
Dry Sow/Gilt	1.8 – 2.7	1.4 – 1.8

✅ **Farrowing Pens:** Guardrails to prevent piglet crushing.
✅ **Wallowing Tank:** 2.5 m × 1.2 m × 0.15 m (essential for heat regulation).

10. Feeding Management

Stage	Crude Protein (%)	Feed Consumption
Pre-Starter (2-5 kg)	24%	1.5-2 kg per piglet
Starter (5-15 kg)	20-22%	9-11 kg total
Grower (15-35 kg)	18%	50-60 kg total
Finisher (35-60+ kg)	13%	Varies, marketed at 70-75 kg
Lactating Sows	13-15%	4-7 kg daily + 14-23 L water

✅ **Flushing Diet (Pre-Breeding):** Increased feeding 2 weeks before mating improves fertility.
✅ **Creep Feeding:** Introduce at **3 weeks** for early piglet growth.

11. Nutritional Deficiencies & Symptoms

Symptom	Cause
Slow Growth	Protein, vitamin/mineral deficiency
Poor Appetite	Calcium, phosphorus, iron, B-vitamin deficiency
Lameness	Deficiency in calcium, phosphorus, vitamin A/D
Diarrhea (Scours)	Poor diet, bacterial infection
Weak Piglets	Vitamin A, iodine deficiency
Piglet Anemia	Iron deficiency (requires supplementation)

✅ **Iron Supplementation:** Injection at 3 days of age prevents anemia.

12. Water & Supplementation

Stage	Water Requirement (L/day)
Lactating Sow	14-23 L
Finishing Pig	6-10 L
Weaner Pig	2-5 L

✅ **Mineral Mixture:** Calcium, phosphorus, zinc, iron.
✅ **Vitamin A, D, B-Complex:** Essential for immunity and growth.

13. Feeding Systems

✅ **Swill Feeding:** Economical but must be **boiled** to prevent disease.
✅ **Feed Formulation:**

- **Energy:** Maize, wheat, sorghum.
- **Protein:** Groundnut cake, fish meal.
- **Minerals:** Bone meal, dicalcium phosphate.

Key Takeaways

✓ Heat detection is crucial for successful breeding.
✓ Flushing improves ovulation and conception rates.
✓ Creep feeding at 3 weeks ensures early growth.
✓ Piglets require iron supplementation to prevent anemia.
✓ Proper housing and ventilation prevent disease outbreaks.
✓ Controlled mating systems (AI, hand mating) improve productivity.
✓ Feed efficiency is key—protein and energy balance impacts growth.

Housing, Feeding, and Breeding Management of Horses

1. Housing Management of Horses

Stable Design

✅ **Stall Arrangement:**

- Single-row or double-row system.
- **Passage width:**
    - **Single-row:** 1.5 - 2 m.
    - **Double-row:** 2.5 - 3 m (horses should not face each other to reduce stress).

✅ **Roof Height:**

- **Flat roof: 4 m** from floor to roof.
- **Gabled roof: 3 m** from floor to tie beam.

Stall Dimensions

Size of Horse	Length (m)	Width (m)	Height (m)
Small horse	3.0	2.5	1.9
Light/medium	3.5	3.0	1.9
Large horse	4.0	3.5	1.9

Manger Design

✅ **Three-part manger**: Separate sections for **grain, hay, and water**.
✅ **Material:** Reinforced concrete with **chinrest** to prevent crib-biting.
✅ **Hay Rack Placement:** Below horse's head.

Dimension	Size (cm)
Top width	45
Bottom width	22
Length	75
Depth	30
Bottom height from floor	75

Stud Design & Special Accommodations

✅ **Stallion Boxes: 4.27 × 4.27 m** (14 ft × 14 ft), cement floor, good ventilation.
✅ **Mare Boxes: 3.66 × 4.27 m** (12 ft × 14 ft) for visiting mares & foals.
✅ **Foaling Boxes: 4.27 × 5.50 m** (14 ft × 16 ft), minimal fittings, heat lamps.
✅ **Young Stock Yard:** Safe, spacious area with proper fencing.

✅ **Paddocks:** Dry paddocks with **shade trees & water troughs**.

2. Feeding Management of Horses

Principles of Feeding

✓ **Feed Hygiene:** Free from mold, dust, and contaminants.
✓ **Consistent Schedule:** Feed at fixed times daily.

✓ **Water & Salt:** Fresh water available at all times; salt/mineral blocks for mineral needs.
✓ **Exercise:** Avoid excessive grain for idle horses to prevent "Monday Morning Sickness" (Azoturia).
✓ **Roughage:** Essential to prevent colic and wood-chewing behavior.
✓ **Teeth Checkups:** Dental health ensures proper chewing.

Feeding Schedule

Feed/Fodder	Morning	Noon	Night
Hay	25%	25%	50%
Grain/Concentrate	33%	33%	33%

Cereal Grains for Horses

Grain	Properties
Oats	High fiber, low density, safest grain for horses
Barley	Higher starch, must be **rolled/cracked** before feeding
Corn	High energy, should be **cracked**, useful in winter
Sorghum	Must be **processed (rolled/cracked)**, should be mixed with bulky feeds
Wheat	**Rarely used** due to gluten content causing digestive issues

Feeding Brood Mares

✅ **Critical Period:** Last **90 days of gestation** (60-65% fetal growth occurs).
✅ **Lactation Peak:** First **12 weeks - high energy & protein needed**.

Nutritional Requirements During Lactation

Nutrient	Requirement
Protein	12-16%
Calcium	1.2 gm/kg of milk
Phosphorus	0.75 gm/kg of milk
Energy	792 Kcal DE/kg of milk

✅ **Colostrum:** Critical for **foal immunity** in the first 12-15 hours.

Concentrate Formula for Pregnant/Lactating Mares

Ingredient	Percentage (%)
Oats	30%

Corn	10%
Barley	13%
Wheat Bran	10%
Soybean Meal	11.5%
Linseed Meal	4%
Alfalfa Meal	10%
Dicalcium Phosphate	2%
Limestone	0.5%
Salt & Vitamin Supplement	1%

Feeding Foals & Weanlings

✓ **Creep Feeding:** Starts at **1-2 weeks** after birth.
✓ **Daily creep feed intake: 0.5 - 0.75% of body weight** by 5-6 weeks.

✅ **Weaning Age:** 6 months (diet must be **high in protein** (16-18%)).

Ingredient (Weanlings)	Percentage (%)
Oats	25%
Corn	31%
Soybean Meal	23%
Dicalcium Phosphate	2%
Limestone	0.25%
Molasses	5%

Racehorse Nutrition

✅ **Concentrates up to 60% of diet** during peak training.

Ingredient	Percentage (%)
Oats	30%
Corn	10.75%
Barley	9.5%
Soybean Meal	23%

Molasses	7%
Dicalcium Phosphate	2%
Salt & Vitamins	1%

3. Breeding Management of Horses

Age & Sex Ratio

✓ **Sex Ratio: 1 stallion covers 30-40 mares per season**.
✓ **Stallion Puberty: 12-15 months**, but not used for breeding until **3-4 years**.
✓ **Mare Puberty: 12-15 months**, but first mating at **2.5-3 years** (300-350 kg weight).

Reproductive Cycle

Parameter	Details
Estrous Cycle	21-23 days
Estrus Duration	4-6 days
Ovulation	On **3rd-4th day of estrus**
Optimal Mating Time	2-3 days after estrus begins
Gestation	335-345 days
Foal Heat	9-11 days postpartum
Weaning	4-6 months

Selection of Stallions

✅ **Breeding Soundness Evaluation:**
✓ **Semen Volume: 50-150 ml/ejaculate**.
✓ **Sperm Concentration: 50-200 million/ml**.
✓ **Reaction Time: 1-5 min** to detect heat.

✅ **Service Frequency:**

Age	Services per week
2 years	2 mares
3 years	6 mares
Mature Stallion	Daily, with rest every 7-8 days

4. Management of In-Foal Mares & Foaling

✅ **Exercise:** Liberty grazing preferred, light riding allowed in early pregnancy.
✅ **Tetanus Booster: 30 days before foaling**.
✅ **Foaling Box:** Move mare **3 weeks before due date**.
✅ **Foaling Kit:** Soap, antiseptic, iodine, bandages, obstetrical sleeves.

✅ **Signs of Foaling:** Waxing on teats, sweating, pelvic relaxation, restlessness.

✅ **Colostrum Intake:** Critical in **first 12-15 hours** for immunity.

Rabbit farming Management

Introduction to Rabbit Farming

Rabbits are primarily raised for **meat**, **fur**, and **wool production**. They have a remarkable ability to convert various feeds into high-quality products useful for human consumption. All domestic rabbit breeds are descendants of the European wild rabbit, **Oryctolagus cuniculus**. The first recorded instance of rabbit husbandry dates back to Roman times, where they were kept in rabbit gardens. Rabbits were domesticated relatively recently, with most breeds developed over the last 200-300 years. Initially, rabbits were used primarily for research until the 1950s.

Biological Data for Rabbits

- **Scientific Name:** Oryctolagus cuniculus
- **Body Temperature:** 38.3-39.5ºC
- **Sexual Maturity:** 4-5 months
- **Oestrous Cycle:** Continuous
- **Gestation Period:** 30-32 days
- **Litter Size:** 6-8 kits
- **Weaning Age:** 4-6 weeks

Anatomy of Rabbits

- Rabbits are not closely related to rodents, despite some superficial resemblance.
- Their incisor teeth, like rodents, grow continuously, but they also have a smaller second pair.
- Rabbits possess a large caecum and well-developed appendix for digesting cellulose.
- There are various breeds classified into small, medium, and large categories, commonly used for experimental purposes:
    - **Small:** Polish (1-1.5 kg), Netherland Dwarf (1.5 kg)
    - **Medium:** Dutch (1.5-2.5 kg)
    - **Large:** Flemish Giant (6 kg), New Zealand White (5 kg), Californian (4.5 kg)

Differences Between Rabbits and Hares

- **Rabbits** (chromosome number **44)** are **altricial**, meaning their young are born blind and hairless. They typically live in burrows or warrens and are kept as domestic pets.
- **Hares** (chromosome number **48**) are **precocial**, born with hair and the ability to see. They live in simple nests above ground, do not live in groups, and are larger with longer ears. The Indian Hare, or Black-naped Hare, is common in South Asia.

Advantages of Rabbit Breeding

- **Non-competitive with Human Food:** Rabbits can be raised on high-forage, low-grain diets.
- **High Feed Conversion Efficiency:** Feed-to-meat conversion ratios range from **2.5-3.0** on grain-based diets to **3.5-4.0** on forage-based diets.
- **High Growth Rate:** Rabbits can reach a market weight of **2 kg** in just **12 weeks**.
- **Reproductive Efficiency:** Rabbits can be bred within **24 hours** of kindling, making them highly efficient for continuous reproduction.
- **Efficient Forage-to-Meat Conversion:** Rabbits produce about **five times** as much meat from alfalfa as cattle.

Comparative Efficacy of Rabbit as Meat Producer

Animal	Young per Year	Total Carcass Weight (kg)	Carcass Weight/ Dam Weight
Cattle	0.9	173	0.35
Sheep	1.0	25	0.42
Goat	1.5	24	1.0-1.5
Pig	20	3200	16
Rabbit (intensive)	30-48	72-117	18-29

Rabbits are prolific, producing **10-15 times** their own body weight in meat annually. They are ideal for small-scale and large-scale commercial production.

Comparative Nutritive Value of Rabbit Meat

Animal	Protein %	Fat %	Moisture %	Calories/ 400g	Cholesterol (mg/kg)
Rabbit	20.8	10.2	27.9	795	50
Chicken	20.0	11.2	67.0	810	60
Veal	18.8	14.0	66.0	910	100
Lamb	15.7	27.7	55.0	1420	-
Pork	11.9	45.0	42.0	2050	105

Rabbit meat is high in **protein** and **vitamins**, with lower fat content compared to other meats. It is well-suited for both **backyard** and **commercial production**.

Constraints in Rabbit Farming

- **Lack of Germplasm:** There is a shortage of high-quality breeding stock.
- **Lack of Technical Knowledge:** Many farmers are unaware of proper rabbit farming techniques.
- **Market Challenges:** There is no organized market for rabbit meat, and consumers often perceive rabbits as pets rather than livestock.
- **Unsteady Supply:** The availability of wild rabbits also limits organized rabbit farming efforts.
- **Low Consumer Demand:** Rabbit meat is not widely promoted, leading to competition with other meats and poorly developed market channels.

Identification of Rabbits

- **Ear Tattoos:** The most reliable identification method for most breeds, although it can be problematic for dark breeds.
- **Ear Tags/Leg Bands:** These are alternatives, but leg bands must be properly sized to avoid discomfort as the rabbit grows

Breeds of Rabbit

Rabbits are categorized into different breeds based on their body size: **small**, **medium**, and **large**. These breeds are commonly used for both experimental and commercial purposes. Below is a classification of rabbit breeds based on their size:

Heavy Breeds

1. **Flemish Giant:**
    - Origin: Belgium
    - Weight: Over 6 kg
    - Characteristics: Comes in different colors; known for its large size.
2. **White Giant:**
    - Characteristics: White-colored rabbit, known for fast growth and prolific breeding.
    - Use: Primarily bred for meat and fur.
3. **Grey Giant:**
    - Origin: U.S.S.R.
    - Weight: 4.5 to 5.0 kg
    - Characteristics: Resembles a hare, often mistaken for one; bred for meat and fur production.

Average Breeds

1. **New Zealand White:**
    - Origin: England

- Weight: 4.5 to 5.0 kg
- Characteristics: Albino with red eyes; one of the most widely used breeds for meat production.
- Use: Meat and fur.

2. **Californian (Synthetic American):**
   - Weight: 3 to 4.5 kg
   - Characteristics: White fur with black tips on the nose, ears, feet, and tail.
   - Use: Second most popular breed for meat production.
3. **New Zealand Red:**
   - Weight: 3 to 4.5 kg
   - Characteristics: Red variant of the New Zealand White breed; less intensively selected for meat production.

Lightweight Breeds

1. **Soviet Chinchilla:**
   - Weight: 3 to 4.5 kg
   - Characteristics: Blue-grey fur with a white belly and a distinctive "dewlap" (skin fold around the chest).
   - Use: Meat production; fur is popular in fur crafts.
2. **Dutch:**
   - Weight: 2.5 to 3.5 kg
   - Characteristics: White band around the shoulders, a white stripe on the face, and white front and back feet.
   - Use: Bred for both meat and as pets.
3. **Himalayan:**
   - Origin: Thought to be from China
   - Characteristics: White with black extremities (ears, nose, feet).
   - Use: Bred for meat and fur.

Fur / Wool Breeds

1. **Angora Rabbit:**
   - Origin: Ankara (historically known as Angora), Turkey
   - Characteristics: Bred for its long, soft wool. Angora wool is harvested through shearing, combing, or plucking.
   - Use: Wool production.

Crossbreeds

- Crossbreeds between the above-mentioned breeds and local rabbits have been developed, particularly in regions like Kerala, India. These rabbits are adaptable to local conditions and typically weigh 4.0 to 4.5 kg.

Rabbit Farming in India

Rabbits were introduced to India in **1978**. Here's a brief history of their introduction:

- **March 1978:** The first batch of **60 New Zealand White rabbits** (10 males and 50 females) was imported from the UK by the **Central Sheep and Wool Research Institute (CSWRI)**.
- **November 1979:** Another batch of **Soviet Chinchilla**, **Grey Giant**, and **White Giant** rabbits (25 males and 100 females) was received from the USSR under an Indo-USSR agricultural development protocol.
- These rabbits were initially reared at **NTRS Garsa** and later shifted to **Avikanagar** and **Mannavanur** to study their adaptability to India's diverse agro-climatic conditions.

Reproduction in Rabbits

Sex Ratio:

- 1 male for 10 females.

Age at First Breeding:

- Small breeds (e.g., Polish, Dutch): 4 months.
- Medium breeds (e.g., New Zealand White, Chinchilla): 5-6 months.

Oestrous Cycle and Signs of Heat:

- Rabbits do not have a well-defined oestrous cycle but exhibit rhythmic sexual receptivity.
- **Signs of heat:**
    - Restlessness, rubbing the chin on cage sides.
    - Lying in a mating posture with the tail lifted.
    - Vulva appears congested, purple, and moist.

Reproductive Details:

- Puberty occurs between 4 to 9 months, with smaller breeds maturing earlier.
- Rabbits are induced ovulators, meaning ovulation occurs as a result of mating.
- Follicles develop in waves, with estrogen levels fluctuating based on follicular development.
- Ovulation occurs approximately 10 hours post-mating, induced by mechanical or sexual stimulation.

Selection for Breeding

- Select the heaviest animals, considering age differences.

- Choose rabbits from the largest litter.
- Ensure the selected animals are healthy, with alert behavior, a smooth coat, and a curiosity for their environment.
- Male rabbits should have descended testicles by 12 weeks.

Estrous Cycle and Behavior

- Rabbits do not have a traditional estrous cycle; they ovulate spontaneously.
- A doe in heat will show **lordosis** (arched back with raised hindquarters).
- If a doe is in dioestrus, she may refuse the male and crouch or show aggression.

Types of Reproduction Cycles

- **Extensive Reproduction:**
  - Mating occurs after weaning, every 2½ months. Best suited for tropical climates.
- **Semi-Intensive Reproduction:**
  - Doe is mated 10 to 20 days after kindling, with weaning at 4-5 weeks.
- **Intensive Reproduction:**
  - Doe is mated immediately after kindling, with weaning at 4 weeks.

Choosing Reproduction Rates

- Intensive and semi-intensive systems require adequate feed quality and quantity. Poor conditions may lead to abortions.
- **Extensive:** 30-35 weaned young per doe annually.
- **Semi-intensive:** 45-55 weaned young annually.
- **Intensive:** 50-60 weaned young annually (in European systems).

Mating Management

- Mating should occur in the buck's cage to avoid fights.
- Mating is more successful in cooler parts of the day, such as early morning or late evening.
- A red vulva is a strong sign of receptivity (80-90% success rate), but mating can still occur with a white vulva (10-20% chance).
- Bucks should not be used for more than 3-4 days per week or 2-3 times a day.

Pregnancy Diagnosis

- **Test mating**, **weight gain**, and the **palpation technique** are used to detect pregnancy.
- **Palpation** is the most reliable method and involves feeling the developing embryos between the 10th to 14th day after mating. Care must be taken to avoid causing harm.

Care During Pregnancy and Kindling

- Transfer the doe to the kindling box by the 27th to 28th day after mating.

- Adequate nesting material is essential, and a good mother will pluck her fur to prepare the nest.
- Kindling takes 15-30 minutes, and dead bunnies should be removed after birth.

Fostering

- Fostering is possible if the litter size exceeds the doe's ability to nurse (8-12 teats) or if the doe dies.
- Age difference between the foster litter and the fostered litter should not exceed 48 hours.
- Limit fostering to three young rabbits per foster doe.

Weaning

- Weaning should be done between 4 to 6 weeks.
- Avoid abrupt changes in feed to reduce mortality among weaners.

Handling and Sexing

- **Handling:**
  - Adults should be handled by gripping the scruff of the neck with one hand and supporting the hindquarters with the other hand.
  - Young rabbits can be lifted by holding them over the loins.
- **Sexing:**
  - Sexing is typically done at weaning by gently pressing the vent area. A slit-like aperture indicates a female, while a cylindrical round tip indicates a male.

Feeding of Rabbits

- **Herbivorous Diet:**
  Rabbits are monogastric herbivores. They can consume grains (sorghum, wheat, Bengal gram), legumes (alfalfa, berseem), kitchen waste, and vegetables (cabbage, carrots, etc.), as well as leaves. They can also be fed forage and kitchen waste.
- **Feeding Pattern:**
  The feeding pattern is imposed by the dam, which feeds her young only once every 24 hours. By the 3rd week, young rabbits begin consuming small amounts of forage and grains alongside the mother's milk. Feeding tends to be nocturnal.
- **Pellet Feeding:**
  Pellet feeding is preferred in organized farms. The ideal pellet size is **3-4 mm in diameter and 10-15 mm in length**, ensuring ease of feeding and better digestion. Pellet feeding is more desirable than mash or ground feed.

Nutrient Requirement

- **Feeding Schedule:**
  Different categories of rabbits require specific quantities of concentrates and green forage.

Category	Body Weight	Concentrates (gm/day)	Green Grass (gm/day)
Bucks	4-5 kg	150	600
Does	4-5 kg	150	600
Lactating Does	-	200	700
Weaners (6 weeks)	600-700 gm	50	200

Dry Matter Intake:

Rabbits consume 6-8% of their body weight in dry matter, with roughage contributing up to 60%.

Protein Requirement:

Maintenance (non-lactating does): 12-15% protein.

Growers and lactating does: 16-20% protein.

Fibre Requirement

- Fibre is critical for healthy digestion, accounting for 18-20% of the diet. Indigestible fibre (lignocellulose) helps prevent gastric stasis and maintains healthy peristalsis. High-fibre diets also aid in the natural wear of molar teeth and prevent issues like obesity and enterotoxaemia.

Protein and Fat Requirements

- **Protein:**
  - 12-14% protein is sufficient for maintenance, while 16-20% is needed for growth and lactation.
  - Excess protein may cause respiratory issues and "sticky bottom syndrome."
- **Fat:**
  - 1% fat for maintenance, 3% fat for pregnancy and growth.
  - High-fat diets should be avoided as they can lead to arteriosclerosis.

Carbohydrates and Vitamins

- **Carbohydrates:**
  Excess carbohydrates can lead to obesity and promote the growth of harmful bacteria like *E. coli* and *Clostridia*.
- **Vitamins and Minerals:**
  - **Vitamin A** (10,000 IU/kg) deficiency may lead to reproductive issues and neonatal mortality.
  - **Vitamin D** (900 IU/kg) should be controlled to avoid calcium metabolism issues.
  - **Vitamin E** (50 mg/kg) deficiency may cause muscle dystrophy and paralysis.

- Calcium intake is directly related to the diet, and excess calcium can cause kidney stones and malocclusion.

Water and Grass Feeding

- **Water:**
  Fresh water must be available at all times, preferably through sipper bottles to prevent contamination.
- **Grass:**
  Fresh grass should be gradually introduced to the diet and pulled rather than cut to prevent digestive disturbances. Grass provides excellent fibre and stimulates natural chewing patterns essential for proper dental health.

Feeding Management

- **Routine:**
  Concentrates should be fed in the morning, and green forage in the evening. Clean water is essential, especially for pregnant and lactating does. In warm climates, water intake increases.

Coprophagy/Caecotrophy

- Rabbits practice coprophagy, consuming soft pellets (caecotrophes) directly from the anus, which are rich in protein and B vitamins. This aids in nutrient absorption and digestion.

Housing Considerations

- **Ideal Conditions:**
  The optimal temperature for rabbit housing is 10-20°C, with 75% relative humidity. Rabbits can be housed in deep litter or cage systems, and care must be taken to ensure adequate ventilation and space.

Types of Housing Systems

- **Deep Litter System:**A concrete floor is recommended to prevent digging, covered with bedding materials like paddy husk or sawdust.
- **Cage System:**Cages are better for management and can be arranged in flat-deck or multi-tier systems. The floor of the cage should be welded mesh to allow droppings to fall through, ensuring cleanliness.
- **Nest Boxes:**Nest boxes are essential for kindling, providing a safe, clean environment for nursing bunnies. These should be placed in kindling cages by the 27th day of pregnancy.

Rabbit Diseases

1. Bacterial Diseases:

- **Pasteurellosis (Pasteurella multocida):**
  - Symptoms: Hemorrhagic septicemia, chronic conjunctivitis (weeping eye), reproductive tract infections (swollen testicles in bucks, metritis in does), snuffles (thick nasal discharge), torticollis (wry neck), and pneumonia.
  - **Treatment:** Sulphaquinoxalines, Sulphadimidine (1 mg per liter of water).

- **Abscesses (Staphylococcus aureus):**
    - Symptoms: Abscesses, commonly subcutaneous but can also occur internally.
- **Mastitis (Staphylococci, Streptococci):**
    - Symptoms: Swollen teats, high fever, thirst, and lack of appetite in lactating does.

2. Viral Diseases:

- **Myxomatosis (Poxvirus of the Myxoma group):**
    - Spread by mosquitoes and fleas. Symptoms include swollen eyelids and body parts, especially at the base of the ears. Death occurs within 12 days in most cases.
    - **No effective treatment**, but vaccination is practiced in advanced countries.
- **Viral Hemorrhagic Disease (VHD, Calcivirus):**
    - Symptoms: Sudden death, fever, paralysis, spasms, and arching of the body. Death may occur quickly.
    - **Prevention:** Disinfection using 10% formalin or 2% sodium hydroxide.

3. Parasitic Diseases:

- **Coccidiosis (Eimeria spp.):**
    - Symptoms: Diarrhea, weight loss, pot-belly in hepatic form, harsh coat in intestinal form.
    - **Treatment:** Sulphaquinoxaline, Sulphadimidine, Nitrofurazone.
- **Ear Canker (Psoroptes cuniculi, Chorioptes cuniculi):**
    - Symptoms: Yellow or brown scabs in the ears, constant scratching, and head shaking. In advanced cases, wry neck may develop.
    - **Treatment:** Ivermectin injection (400 mcg/kg body weight), or external treatment with organophosphates or butox.

4. Nutritional Diseases:

- **Mucoid Enteritis:**
    - Symptoms: Diarrhea with mucous, dehydration, and sometimes death. Cause unknown.
- **Sore Hock (Ulcerative Pododermatitis):**
    - Symptoms: Dry, crusty scabs on the metatarsal region due to wire floors, leading to anorexia and weight loss.
    - **Treatment:** Zinc and iodine ointments, aluminum acetate solution, antibiotics for secondary infections.

5. Other Conditions:

- **Ringworm (Trichophyton spp.):**
    - Symptoms: Patches of hair loss, areas of baldness.

- **Treatment:** Griseofulvin.

- **Body Mange (Notoedres cati):**
  - Symptoms: Hair loss on ears and nose, scratching.
  - **Treatment:** Benzyl Benzoate or Ivermectin (0.1 ml/5 kg body weight).

Common Diseases and Their Treatments

Disease	Cause	Symptoms	Treatment
Myxomatosis	Virus (spread by fleas, mosquitoes)	Swollen eyelids, skin hemorrhages, mucopurulent conjunctivitis	No effective treatment, vaccination in advanced areas.
Pasteurellosis	Bacteria (Pasteurella multocida)	Snuffles, pneumonia, otitis media, torticollis, abscesses	Sulphaquinoxaline, Sulphadimidine
Coccidiosis	Protozoa (Eimeria spp.)	Diarrhea, anorexia, hepatomegaly, pot-belly	Sulphaquinoxaline, Sulphadimidine, Nitrofurazone
Mucoid Enteritis	Unknown cause	Mucous diarrhea, dehydration	No effective treatment
Blue Breast (Mastitis)	Staphylococcus, Streptococcus	Swollen teats, fever	-
Ear Canker	Psoroptes cuniculi (mites)	Scratching ears, head shaking, crusty exudate	Benzyl benzoate, Ivermectin
Sore Hock	Pressure on wire floors	Crusty scabs on feet, weight loss, anorexia	Zinc and iodine ointments, aluminum acetate
Ringworm	Fungus (Trichophyton spp.)	Patches of hair loss, baldness	Griseofulvin
Body Mange	Notoedres cati	Hair loss, scratching face and ears	Benzyl Benzoate, Ivermectin

Miscellaneous Disorders and Conditions

- **Bites and wounds** from fighting.
- **Congestion of mammary glands** due to death of bunnies.
- **Cannibalism** caused by first-time kindling, lack of maternal instinct, or nutritional deficiencies.
- **Heat stroke**, **overgrown nails**, and **pododermatitis (sore hocks)** due to poor management.

Breeds of chicken

Classification of Chickens Based on Place of Origin:

Class	Examples
Asiatic	Brahma, Langshan, Cochin
American	Plymouth Rock, Rhode Island Red, Wyandotte
Mediterranean	Leghorn, Minorca, Ancona
English	Orpington, Sussex, Cornish
Continental	Houdans, Hamburg, Polish
Oriental	Malaya, Yokohama, Sumatra
French/Latin American	Araucana
African	Negro, Jago

Classification Based on Utility or Commercial Value:

Category	Examples
Egg-type	Leghorn
Meat-type	Cornish, Plymouth Rock
Dual-purpose	Rhode Island Red, New Hampshire
Game type	Aseel
Fancy/Exhibition	Silky, Frizzled, Bantams
Desi type	Kadaknath, Naked Neck, Chittagong

Characteristics of Chicken Classes:

Class	Body Size	Egg Shell Color	Shanks	Skin	Comb	Examples
American	Medium-Heavy	Brown	Clean, Yellow	Yellow	Rose or Single	Plymouth Rock, Wyandotte, Rhode Island Red
Asiatic	Heavy	Brown	Feathered	Yellow	-	Brahma, Cochin, Langshan
English	Medium-Large	Brown	Clean, White	White	Single (Cornish: Pea)	Australorp, Cornish, Orpington
Mediterranean	Small	White	Clean, Yellow	Yellow/White	-	Leghorn, Minorca, Ancona

Indigenous Chicken Breeds in India

Aseel

- **Origin**: Andhra Pradesh
- **Characteristics**:
    - Literal meaning: "Real" or "Pure"
    - Known for its fighting qualities, endurance, stamina, and majestic gait
    - Larger build, with a cock measuring up to 28 inches in height
    - Standard weight:
        - Cock: 3-4 kg
        - Hen: 2-3 kg
    - Rudimentary wattles, short curved beak, and tough feathers with scanty plumage
    - Upright, alert posture with strong legs
- **Performance Profile**:

Trait	Value
Body weight at 20 weeks (g)	1220
Age at sexual maturity (days)	196
Annual egg production (number)	92
Egg weight at 40 weeks (g)	50
Fertility (%)	66
Hatchability FES (%)	63

Kadaknath ("Kalamasi")

- **Origin**: Madhya Pradesh
- **Characteristics**:
    - Known for black flesh, skin, and internal organs due to melanin deposition (Fibromelanosis)
    - Day-old chicks: Bluish-black with irregular stripes
    - Adult plumage: Varies from silver, gold spangled, to blue-black
    - Dark gray skin, beak, shank, toes, and soles, with purplish hue on comb and wattles
- **Performance Profile**:

Trait	Value
Body weight at 20 weeks (g)	920
Age at sexual maturity (days)	180
Annual egg production (number)	105
Egg weight at 40 weeks (g)	49
Fertility (%)	55
Hatchability FES (%)	52

Chittagong (Malay)

- **Origin**: Eastern India

Naked Neck

- **Origin**: Trivandrum, Kerala
- **Characteristics**:
    - Naked neck or a tuft of feathers on the neck
    - Large size, cylindrical neck, reduced feathering allowing better tolerance to tropical heat
    - Found in coastal and humid areas like Kerala, Andaman and Nicobar Islands, and the North-Eastern states
    - Adaptability to hot climates, with better meat taste and flavor
- **Performance Profile**:
    - Lays the largest eggs among Indian native chicken breeds

Frizzle

- **Characteristics**:
    - Oval body, well-developed comb and wattles
    - Thin, pinkish skin
    - Plumage color varies, with white, brown, black, and mixed colors being common
    - Found across coastal and humid areas, including the Andaman and Nicobar Islands and the hilly tracts of North-Eastern states
    - Adaptable to hot and humid climates

Duck Breeds Classification

Ducks are classified into four main categories based on their utility:

1. **Egg-type Breeds**
2. **Meat-type Breeds**
3. **Ornamental Breeds**
4. **Indigenous Breeds**

1. Egg-type Breeds

Breed	Origin/Characteristics
Campbell	Developed by Mrs. Campbell in the 19th century by crossing Rouen (male) with Indian Runner (female). Khaki Campbell is a color variety.
Indian Runner	Origin: East India. Known for their upright posture, resembling penguins. Available in Fawn, White, and White-penciled varieties. Excellent layers.
Nageswari	Indigenous breed from North-Eastern India. Highly disease-resistant, capable of laying 180-200 eggs under range conditions. Females: 1.5 kg, Males: 1.7 kg.

2. Meat-type Breeds

Breed	Origin/Characteristics
Pekin	Origin: China. Popular meat breed with creamy white plumage, yellow flesh, and deep orange legs and bill. Drake: 4 kg, Duck: 3 kg. Early maturity, good laying capacity.
Aylesbury	Origin: England. Spotless white plumage, orange legs and feet. Larger than Pekin. Drake: 4.5 kg, Duck: 4 kg.
Rouen	Origin: France. Used as a male line to develop Campbell ducks.
Muscovy	Origin: South America. Males have no drake feathers but have a knob on the head. Muscovy crosses with other ducks produce sterile “Mule ducks,” which have high growth rates and lean meat. Incubation: 35 days.

3. Ornamental Breeds

Breed	Characteristics
Buff Orpington	Ornamental duck breed.
Mandarin	Known for vibrant, striking plumage.
Crested White	Known for the unique crest on their heads.

4. Indigenous Breeds

Breed	Region/Characteristics
Sythetmet, Nageswari	Commonly found in North-Eastern states of India.
Kuttanad Ducks	Found in Kerala, with varieties like Chara and Chemballi.
Arani Ducks	Found in Tamil Nadu.

- **Indigenous ducks** are hardy, with moderate egg production, and highly suitable for extensive rearing systems. About 90-95% of ducks in India are indigenous or nondescript types.

Hybrid Ducks

Hybrid	Characteristics
Cherry Valley	Both egg and meat-type duck breed.
Hytop (Mule Duck)	Sterile hybrid with high growth rate and lean meat, produced by crossing Muscovy with other ducks.
Legarth	Meat-type hybrid.

Turkey Breeds aand Goose Breeds

Origin and Domestication

- Turkeys originated from **Northern and Central America** and were domesticated around 300 years ago by European colonists in North America.

Common Turkey Varieties

1. **Broad Breasted Bronze**
2. **Broad Breasted White**
3. **Beltsville White**
4. **White Holland**
5. **Narragansett**

Broad Breasted Bronze

- **Characteristics**:
    - Most popular and heaviest variety
    - Broad, prominent chest region with bronze-colored feathers
    - Male weight at maturity: **15-18 kg**
    - Female weight at maturity: **12-13 kg**
    - Many present-day hybrid turkeys are crosses of Broad Breasted Bronze and Beltsville White

- A popular hybrid in North America: **Nicholas Turkey** (cross of Broad Breasted Bronze and Beltsville White)

Beltsville Small White Turkey

- **Characteristics**:
  - Medium-sized with white feathers
  - Higher egg production compared to Broad Breasted Bronze
  - Male weight at maturity: **10-12 kg**
  - Female weight at maturity: **7-8 kg**

White Holland

- **Characteristics**:
  - Popular in European countries
  - Developed in Holland using varieties imported from North America
  - Often crossed with local turkeys to improve growth rate and reproductive ability
  - Male weight at maturity: **10-12 kg**
  - Female weight at maturity: **6-8 kg**

Narragansett

- **Characteristics**:
  - Popular variety, second only to White Holland
  - Commonly reared in **Germany** and **Italy**
  - Many hybrid turkeys in Europe are crosses of White Holland or Narragansett

Goose Breeds and Characteristics

Toulouse

- **Origin**: France
- **Characteristics**:
  - Non-broody in some strains, fair layers among heavy breeds
  - Slow-growing goslings; need more time to reach market weight
  - Flesh is coarser compared to Emden; higher proportion of bone and offal
  - **Cross with Emden**: Produces progeny with rapid growth and good fleshing qualities
  - Male weight: **14 kg**, Female weight: **9 kg**

Emden

- **Origin**: Hanover, Germany
- **Characteristics**:
    - Heavy breed, prolific breeder, quiet disposition, popular in New South Wales
    - Good egg production: **Up to 40 eggs per season**
    - Good sitters, early maturing, excellent foragers
    - High-value white feathers
    - Goslings can be sexed at day-old by down color (females have darker down)
    - Bill, legs, and feet are bright orange; plumage is pure glossy white

Basics of Poultry Management

1. **Historical Background**:
    - Chickens were domesticated around **5400 B.C.**, as per historical and archaeological evidence.
2. **Definition of Poultry**:
    - The term "poultry" includes all domesticated bird species such as **chickens, ducks, turkeys, Japanese quail, guinea fowls, geese, pigeons, ostrich, and emu**.
3. **Dominance of Chickens**:
    - Chickens are the most numerous and popular among domesticated poultry species, making up **92% of the total poultry population**.
4. **Duck Population**:
    - Ducks account for **9%** of the total poultry population (FAO, 2008).
    - Duck farming is primarily concentrated in **coastal states** like **West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Assam, Jammu & Kashmir, and Tripura**, where the presence of lakes and rivers supports their rearing.
5. **Primitive Duck Farming**:
    - Duck farming remains largely **primitive** in India.
    - Indigenous ducks outnumber exotic breeds despite their **inferior productivity**.
6. **Key Indigenous Duck Breeds**:
    - **Chara and Chemballi (Kuttanad ducks)** of Kerala.
    - **Sythetmete and Nageswari** from the Eastern region.
    - **Aarani ducks** from Tamil Nadu.
    - **Pati, Deo, Cinahanh, and Raj Hanh** from Assam.

Domesticated Poultry Species:

- **Chicken**
- **Ducks**
- **Turkeys**
- **Geese**
- **Quails, Guinea fowl, Pigeons**

Definitions:

Term	Definition	Examples
Class	Group of birds developed in certain regions or geographical areas.	American, Asiatic, Mediterranean, English
Breed	Group of birds related by breeding, possessing distinctive traits like body shape, plumage color, and comb type, and breed true.	Aseel, Rhode Island Red, Leghorn, Cornish
Variety	Sub-classification within breeds, differentiated by color, pattern, or comb type.	White Leghorn, Black Leghorn, Barred Plymouth Rock
Strain	Sub-classification of a breed, named after the person or institution that developed them, emphasizing specific traits like egg production or feed efficiency.	Meyer strain of White Leghorn, Sterling strain of Rhode Island Red
Lines	Subdivisions of a strain, where genes responsible for specific traits are fixed for commercial hybrid production.	-

Hybrids of Chicken:

Type	Common Examples
Egg-type Hybrid	BV-300, ISA, Babcock, Bovans, Euribrid, Hyline, HH-260, Dekalb, Keystone, Lohmann, H & N Nick Chick
Meat-type Hybrid	Cobb, Ross, Arbor Acres, Hub Chicks, Hybro, Hubbard, Lohmann, Pilch, Starbro, Tegel, Anak-2000, Marshall, Peterson, Samrat-2000, Avian-34

Nomenclature of Poultry Species by Age and Sex:

Species	Adult Male	Adult Female	0-8 Weeks	9-18 Weeks
Chicken	Cock	Hen	Chick	Male: Cockerel, Female: Pullet
Duck	Drake	Duck	Drakeling	Male: Drakelet, Female: Ducklet
Goose	Gander	Goose	Goosling	-
Turkey	Tom	Turkey Hen	Poult	-

Species	Adult Male	Adult Female	0-8 Weeks	9-18 Weeks
Quail	Quail Cock	Quail Hen	Quail Chick	-
Guinea Fowl	Guinea Fowl	Guinea Fowl	Keet	-
Pigeon	Pigeon	Pigeon	Squab	-

Evolution of Poultry Breeds:

- Birds evolved from cold-blooded reptiles.
- Modern birds are classified in **Class Aves**, **Subclass Neornithes**, and include groups like **Ratitae** (e.g., Ostrich, Emu) and **Carinatae** (flying birds).
- **Red Jungle Fowl** is the ancestor of modern chickens, and domestication originated in **Asia** (e.g., China, India, Bangladesh).

Zoological Names and Chromosome Numbers:

Common Name	Zoological Name	Chromosome Number (2n)
Chicken	*Gallus gallus domesticus*	78
Duck	*Anas platyrhynchos*	80
Turkey	*Meleagris gallopavo*	80
Goose	*Anser anser*	80
Japanese Quail	*Coturnix coturnix japonica*	78
Bobwhite Quail	*Colinus virginianus*	78
Guinea Fowl	*Numida meleagris*	78
Partridge	*Perdix perdix*	80
Pheasant	*Phasianus colchicus*	82
Pea Fowl	*Pavo cristatus*	80
Ostrich	*Struthio camelus*	80
Pigeon	*Columba livia*	80
Dove	*Columba oenas*	80
Muscovy Duck	*Cairina moschata*	80
Emu	*Dromaius novaehollandiae*	80

Breeds of chicken

Classification of Chickens Based on Place of Origin:

Class	Examples
Asiatic	Brahma, Langshan, Cochin
American	Plymouth Rock, Rhode Island Red, Wyandotte
Mediterranean	Leghorn, Minorca, Ancona
English	Orpington, Sussex, Cornish
Continental	Houdans, Hamburg, Polish
Oriental	Malaya, Yokohama, Sumatra
French/Latin American	Araucana
African	Negro, Jago

Classification Based on Utility or Commercial Value:

Category	Examples
Egg-type	Leghorn
Meat-type	Cornish, Plymouth Rock
Dual-purpose	Rhode Island Red, New Hampshire
Game type	Aseel
Fancy/Exhibition	Silky, Frizzled, Bantams
Desi type	Kadaknath, Naked Neck, Chittagong

Characteristics of Chicken Classes:

Class	Body Size	Egg Shell Color	Shanks	Skin	Comb	Examples
American	Medium-Heavy	Brown	Clean, Yellow	Yellow	Rose or Single	Plymouth Rock, Wyandotte, Rhode Island Red
Asiatic	Heavy	Brown	Feathered	Yellow	-	Brahma, Cochin, Langshan

Class	Body Size	Egg Shell Color	Shanks	Skin	Comb	Examples
English	Medium-Large	Brown	Clean, White	White	Single (Cornish: Pea)	Australorp, Cornish, Orpington
Mediterranean	Small	White	Clean, Yellow	Yellow/White	-	Leghorn, Minorca, Ancona

Indigenous Chicken Breeds in India

Aseel

- **Origin**: Andhra Pradesh
- **Characteristics**:
    - Literal meaning: "Real" or "Pure"
    - Known for its fighting qualities, endurance, stamina, and majestic gait
    - Larger build, with a cock measuring up to 28 inches in height
    - Standard weight:
        - Cock: 3-4 kg
        - Hen: 2-3 kg
    - Rudimentary wattles, short curved beak, and tough feathers with scanty plumage
    - Upright, alert posture with strong legs
- **Performance Profile**:

Trait	Value
Body weight at 20 weeks (g)	1220
Age at sexual maturity (days)	196
Annual egg production (number)	92
Egg weight at 40 weeks (g)	50
Fertility (%)	66
Hatchability FES (%)	63

Kadaknath ("Kalamasi")

- **Origin**: Madhya Pradesh
- **Characteristics**:

    - Known for black flesh, skin, and internal organs due to melanin deposition (Fibromelanosis)
    - Day-old chicks: Bluish-black with irregular stripes
    - Adult plumage: Varies from silver, gold spangled, to blue-black
    - Dark gray skin, beak, shank, toes, and soles, with purplish hue on comb and wattles
- **Performance Profile**:

Trait	Value
Body weight at 20 weeks (g)	920
Age at sexual maturity (days)	180
Annual egg production (number)	105
Egg weight at 40 weeks (g)	49
Fertility (%)	55
Hatchability FES (%)	52

Chittagong (Malay)

- **Origin**: Eastern India

Naked Neck

- **Origin**: Trivandrum, Kerala
- **Characteristics**:
    - Naked neck or a tuft of feathers on the neck
    - Large size, cylindrical neck, reduced feathering allowing better tolerance to tropical heat
    - Found in coastal and humid areas like Kerala, Andaman and Nicobar Islands, and the North-Eastern states
    - Adaptability to hot climates, with better meat taste and flavor
- **Performance Profile**:
    - Lays the largest eggs among Indian native chicken breeds

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- **Characteristics**:
    - Oval body, well-developed comb and wattles
    - Thin, pinkish skin
    - Plumage color varies, with white, brown, black, and mixed colors being common

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Duck Breeds

Duck Breeds Classification

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Hybrid Ducks

Hybrid	Characteristics
Cherry Valley	Both egg and meat-type duck breed.
Hytop (Mule Duck)	Sterile hybrid with high growth rate and lean meat, produced by crossing Muscovy with other ducks.
Legarth	Meat-type hybrid.

Turkey Breeds and Goose Breeds

Origin and Domestication

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Common Turkey Varieties

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7. **Broad Breasted White**
8. **Beltsville White**
9. **White Holland**
10. **Narragansett**

Broad Breasted Bronze

- **Characteristics**:
    - Most popular and heaviest variety
    - Broad, prominent chest region with bronze-colored feathers
    - Male weight at maturity: **15-18 kg**
    - Female weight at maturity: **12-13 kg**
    - Many present-day hybrid turkeys are crosses of Broad Breasted Bronze and Beltsville White
    - A popular hybrid in North America: **Nicholas Turkey** (cross of Broad Breasted Bronze and Beltsville White)

Beltsville Small White Turkey

- **Characteristics**:
    - Medium-sized with white feathers
    - Higher egg production compared to Broad Breasted Bronze
    - Male weight at maturity: **10-12 kg**
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- **Characteristics**:
    - Popular in European countries
    - Developed in Holland using varieties imported from North America
    - Often crossed with local turkeys to improve growth rate and reproductive ability
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- **Characteristics**:
    - Popular variety, second only to White Holland
    - Commonly reared in **Germany** and **Italy**
    - Many hybrid turkeys in Europe are crosses of White Holland or Narragansett

Goose Breeds and Characteristics

Toulouse

- **Origin**: France

- **Characteristics**:
    - Non-broody in some strains, fair layers among heavy breeds
    - Slow-growing goslings; need more time to reach market weight
    - Flesh is coarser compared to Emden; higher proportion of bone and offal
    - **Cross with Emden**: Produces progeny with rapid growth and good fleshing qualities
    - Male weight: **14 kg**, Female weight: **9 kg**

Emden

- **Origin**: Hanover, Germany
- **Characteristics**:
    - Heavy breed, prolific breeder, quiet disposition, popular in New South Wales
    - Good egg production: **Up to 40 eggs per season**
    - Good sitters, early maturing, excellent foragers
    - High-value white feathers
    - Goslings can be sexed at day-old by down color (females have darker down)
    - Bill, legs, and feet are bright orange; plumage is pure glossy white

Japanese Quails (*Coturnix coturnix japonica*)

General Characteristics:

- Popular in India for research studies and economical production.
- **Sex differentiation**:
    - Males weigh less than females.
    - Males have plain rust-colored breast feathers, while females have speckled breast feathers.
- **Eggs**: Mosaic patterned.
- **Known Breeds**:
    - **Manchurian Golden**
    - **British Range**
    - **English White**
    - **Tuxedo**

Quail Meat:

- Ready for market at **5 weeks of age**.
- Processing involves removing skin and feathers together after slitting the neck.
- Cleaned meat represents **70-74%** of the live body weight.

- High in protein (**22-24%**) and low in fat (**2%**), making it a good option for growing children, convalescent patients, and health-conscious adults.
- Quail meat contains **41% breast meat** and is rich in calcium.

Guinea Fowl (*Numida meleagris*)

Origin:

- Descended from wild species native to **Africa**, particularly from the Guinea region.
- Historically raised by Greeks and Romans for meat.

General Characteristics:

- **Adult Body Weight**: ~1.5 kg.
- **Sex Differentiation**: By voice (males and females sound different).
- **Age at Sexual Maturity**: **6-7 months**.

Varieties:

1. **Pearl**
2. **White**
3. **Lavender**

Egg Production:

- Annual production: **170-180 eggs**.
- Egg weight: **40-45 grams**.
- Egg shell color: **Dark brown**.

Purpose:

- Primarily reared for **meat**, known for red, lean meat with a strong game flavor.
- **Marketing Age**: **12-13 weeks**.
- **Incubation Period**: **28 days**.

Chicken Comb Types and Feather

A **comb** is a fleshy protuberance on top of a fowl's head, larger in males than females. The comb's pattern is often used to identify breeds and varieties. The growth of the comb is controlled by hormones (oestrogen and androgen), making it an indicator of reproductive ability and overall health. A healthy comb is brick-red, erect (except in some breeds like White Leghorn females), and soft to the touch. Sick or poor-laying birds have pale, dry, and cold combs.

Comb Anatomy:

- **Base**: The lower solid portion.
- **Blade**: The upper part.
- **Serrations**: The spaces between spikes.

- **Spikes**: Protruding points on the top of the comb.

Common Comb Varieties

1. **Single Comb**:
    - Narrow when viewed from the front, with spikes arranged one behind the other.
    - Common in breeds like **White Leghorn** (five or six spikes) and **Rhode Island Red** (six spikes).
    - Serrations and spikes vary by breed.
    - Example: **White Rock**.
2. **Rose Comb**:
    - Flat on top, covered with small, irregular points finished with a spike.
    - The size, number of points, and spike direction depend on modifying genes.
    - Example: **Rose-combed Leghorn**, **Wyandotte**.
3. **Pea Comb**:
    - Appears like three small single combs joined together at the base.
    - Example: **White Cornish**, **Dark Cornish**.
4. **Walnut (Strawberry) Comb**:
    - Resembles half of a strawberry or walnut with a round top and irregular grooves.
    - Small in size.
    - Example: **Malay**.
5. **Cushion Comb**:
    - Small, round, cushion-like comb.
    - Example: **Silkie**.
6. **Cap (V-shaped) Comb**:
    - Looks like a stylish cap, commonly found in certain breeds.
    - Example: **Polish**.
7. **Cup Comb**:
    - Cupped between two single combs, stretched apart and fused at the base.
    - Example: **Buttercup**, **Poland**

Feather Structure and Types

Parts of a Feather:

- **Calamus**: The root of the feather.
- **Quill**: The base of the feather, from which the shaft arises.

- **Shaft (Rachis)**: The main central part of the feather.
- **Barbs**: Structures arising from the shaft.
- **Barbule**: Small extensions from the barbs.
- **Barbicels**: Tiny hooks that interlock to form the **vane**.
- **Function**: Feathers provide protection from weather and are essential for flight. Feather color and patterns help in breed identification and sex differentiation.

Sex Differentiation by Feathers:

- **Male fowls**: Sickle-shaped tail feathers.
- **Male ducks**: Curved tail feather (sex curl) known as the **Drake Feather**.
- **Tom turkey**: Longer tail feathers compared to females.
- **Japanese quail**: Male has golden or rust-brown feathers on the neck and breast, while the female has speckled feathers.

Types of Feathers:

1. **Contour Feathers**: Cover the body and wings, including large flight feathers.
2. **Covert Feathers**: Located at the base of the wings, lacking barbicels, and are also called fluff.
3. **Down Feathers**: Found in newly hatched chicks and beneath contour feathers in certain regions.
4. **Filoplume**: Hair-like structures found under contour feathers.
5. **Pin Feathers**: Very small feathers.

Feather Tracts (Pterylae):

- Feathers arise from specific regions known as feather tracts. There are 10 pairs of these tracts:
    1. **Cephalic** (Head)
    2. **Alar** (Wings)
    3. **Humoral**
    4. **Spinal**
    5. **Crural**
    6. **Ventral**
    7. **Femoral**
    8. **Cervical** (Neck)
    9. **Auxiliary**
    10. **Caudal** (Tail)

Egg

Egg Formation Process

1. **Graafian Follicle Development**:
    - The **yolk** grows within the Graafian follicle and is surrounded by alternate layers of white and yellow yolk.
    - Yolk deposition occurs over about 7 days, with white yolk deposited during the night and yellow during the day.
    - The nucleus migrates to the periphery of the yolk as it increases in size.
2. **Hormonal Control**:
    - **Follicle-Stimulating Hormone (FSH)**: Regulates growth and maturity of the follicle.
    - **Luteinising Hormone (LH)**: Triggers ovulation, the release of the ovum from the Graafian follicle.
    - Ovulation typically occurs **14 to 75 minutes** after **oviposition** (laying of the previous egg).
3. **Albumen Formation**:
    - Most of the **albumen** (egg white) is formed in the **magnum** (albumen-secreting region of the oviduct).
    - The **chalazae** (protein cords anchoring the yolk) form in the uterus.
4. **Shell Formation**:
    - Shell membranes form in the **isthmus**.
    - The **uterus (shell gland)** forms the shell by depositing calcium mobilized from feed and bones.
    - Shell pigments, such as **porphyrin** (responsible for brown shell color), are secreted during the last 5 hours before oviposition.
5. **Oviposition**:
    - The egg is laid through uterine contractions, stimulated by **oxytocin** and **vasotocin** released from the posterior pituitary.

Egg Structure

The egg consists of four major components arranged from the outside to the inside:

1. **Shell**
2. **Shell Membranes**
3. **Albumen**
4. **Yolk**

1. Egg Shell

The egg shell serves as the outer protective layer and consists of the following:

- **Cuticle**: The outermost layer.

- **Spongy or Calcareous Layer**: The primary structure of the shell.
- **Mammillary Layer or Matrix**: Contains pores for gas exchange.

Pores:

- Funnel-shaped and act as channels between the shell membrane and cuticle.
- An egg has **8,000 to 10,000** pores, distributed unevenly with more pores at the broad end than the narrow end.

2. Shell Membranes

There are two shell membranes:

- **Outer Shell Membrane**: Firmly attached to the shell, extended by small cones from the shell surface.
- **Inner Shell Membrane**: Surrounds the albumen.

Air Cell:

- Formed between the outer and inner shell membranes at the broad end.
- Occurs due to contraction of the egg contents after **oviposition** (laying) as a result of temperature differences before and after oviposition.

3. Albumen (Egg White)

The albumen is made up of **four layers**:

1. **Chalaziferous Layer** (3%): The inner thick white, closest to the yolk.
2. **Inner Thin Albumen** (17%).
3. **Outer Thick Albumen** (57%): Also called the firm or dense albumen.
4. **Outer Thin Albumen** (23%).

Chalazae:

- Twisted cords formed from the chalaziferous layer that hold the yolk in place.
- Composed of **lysozyme**, a protein with antimicrobial properties that helps protect the egg from spoilage.
- Anchors the yolk centrally, preventing movement.

4. Yolk

The yolk is structured in **concentric layers** of dark and light material, due to chemical composition differences.

Components:

- **Latebra**: The central core of light-colored fluid, which does not harden completely upon boiling.
- **Nucleus of Pander**: A cup-shaped structure connecting the **germinal disc** to the latebra.

Fertility Status:

- **Infertile Egg**: Contains a unicellular **blastodisc** (ovum) with a haploid chromosome number, circular in shape (~3.5 mm diameter), with vacuoles.
- **Fertile Egg**: Contains a multicellular **blastoderm** with a diploid chromosome number, oval in shape (~4.5 mm diameter), without vacuoles.

Vitelline Membrane:

- A semi-permeable, elastic membrane surrounding the yolk, separating it from the albumen.

Functions of the Egg Components:

- **Shell**: Protects the egg, allows for gas exchange through the pores.
- **Shell Membranes**: Provide additional protection and contain the **air cell**, which is important for respiration during incubation.
- **Albumen**: Provides nutrition and protects the yolk. The chalazae anchor the yolk and contain antimicrobial lysozyme.
- **Yolk**: Supplies nutrients to the embryo or serves as food storage in infertile eggs.

. Male Reproductive Structures in Poultry

1. **Testes**:
    - Paired, small, ovoid structures located on the dorsal body wall, anterior to the kidneys.
    - **Color**: Reddish-yellow.
    - **Size**: Left testis is slightly larger than the right.
2. **Vas Deferens**:
    - The vas deferens arises from the seminiferous tubules in the testes and continues down to the cloaca.
    - Sperms undergo maturation in the **epididymis** before entering the vas deferens.
3. **Cloaca**:
    - The vas deferens terminate in the cloaca, where semen is discharged during copulation.
4. **Rudimentary Copulatory Organ**:
    - A small button-like structure, the **copulatory papilla**, is present on the median ventral portion of the cloaca.
    - During copulation, this papilla is everted and pressed against the female's papilla to transfer sperm into the **urodeum**.

Functions:

- **Spermatogenesis** occurs in the seminiferous tubules.
- **Spermiation**: The release of fully formed sperms into the lumen of the seminiferous epithelium.
- **Maturation**: Sperms mature in the epididymis, gaining motility.

- **Semen pH**: 7.45 to 7.63.
- **Daily sperm output**:
    - Cocks: Approximately **2000×10^6**.
    - Toms (turkeys): Less than **1120×10^6**.
- **Copulation**: Sperms are ejected directly into the female urodeum and squeezed into the oviduct by contractions.

Topic 10. Female Reproductive System in Poultry

- Birds are unique in reproducing through eggs, which contain all the necessary components for embryonic development.
- The **female reproductive system** includes the **ovary** and **oviduct**.

Ovary:

- At hatching, only the **left ovary** and oviduct are functional; the right set atrophies.
- The left ovary is located in the dorsal abdominal cavity, above the kidneys.
- The ovary is responsible for **yolk formation**.

Oviduct:

The oviduct is a long, zigzag glandular and muscular tube extending from the ovary to the cloaca. It has **five distinct parts**:

1. **Infundibulum**:
    - Funnel-shaped, about **9 cm** long in laying hens.
    - Engulfs the mature ovum after release from the **Graafian follicle**.
    - Ovum remains here for about **18 minutes**.
2. **Magnum**:
    - Largest portion of the oviduct, about **33 cm** long in laying hens.
    - The **albumen-secreting region** of the oviduct.
    - Ovum remains here for about **2 hours and 54 minutes**.
3. **Isthmus**:
    - About **10 cm** long.
    - Responsible for secreting the **shell membranes** and shaping the egg.
    - Ovum stays here for about **1 hour and 14 minutes**.
4. **Uterus** (Shell Gland):
    - Pouch-like structure, about **10-12 cm** long.
    - Responsible for **shell formation**.

- Ovum stays in the uterus for about **20 hours and 40 minutes**.

5. **Vagina**:
    - The terminal portion, about **12 cm** long.
    - Contains a muscular sphincter at the **utero-vaginal junction**.
    - Helps in expelling the egg during **oviposition**.

Scavenging System of Management in Poultry

Introduction to Backyard / Rural Poultry Keeping:

- **Backyard poultry farming** is often referred to as "Walking Banks" because it provides a ready source of money for rural households.
- It serves small and marginal farmers, landless laborers, tribal communities, and the backward classes.
- This system generates income and provides a balanced diet with minimal input.
- **Advantages**:
    - Low financial investment.
    - Minimal management.
    - Can generate a sizable income using household wastes, farm products, and free-range scavenging.
    - Contributes to alleviating **protein deficiency** in rural areas.

Housing Systems in Scavenging Poultry Management(Backyard poultry)

1. Extensive (Free-Range) System of Housing:

- Poultry are reared by **allowing them to roam freely** over a large area.
- **Birds are not confined**; they scavenge for food in fields and open spaces.
- **Shelters**:
    - Temporary or rudimentary shelters may be provided for protection.
    - Birds may roost in trees and nest in bushes.
- **Flock Composition**:
    - Different species and varying ages of birds are kept together.
- **Feeding**:
    - Birds are fed a small quantity of grain in the morning and evening, supplementing their scavenged food.

2. Semi-Intensive System of Housing:

- A **combination** of extensive and intensive systems.

- Birds are given access to **shelters** but are allowed to roam in a confined space during the day (Pen and Run system).
- **Success factors**:
    - Maintaining cleanliness in the confined areas or runs is essential to prevent contamination.
    - **Foul-patch**: The ground surrounding the houses where birds congregate needs regular maintenance.
    - Feed and water are available in sheltered areas to **prevent wastage** from rain, wind, or predators.

Feeding through Scavenging

- Birds in a scavenging system fulfill their energy needs by picking up farm-produced grains like **maize**, **jowar**, and **millets**.
- To meet their **protein, mineral, and vitamin** needs, birds prey on insects, worms, larvae, snails, termites, maggots, and other natural resources.
- **Variability in feeding patterns** is influenced by:
    - Climate.
    - Terrain.
    - Ethnic groups.
    - Socioeconomic conditions.
- **Challenges**:
    - Natural feed resources fluctuate with seasons, particularly during peak production or dry periods, leading to vitamin and mineral deficiencies.
- **Supplemental Feeding**:
    - Essential when scavenged feed is insufficient.
    - Supplemental feed ensures optimal production, particularly during times of natural feed scarcity.

Feed Resources under Free-Range Rearing

- **Available feed resources** vary greatly depending on geographic, climatic, and agricultural factors.
- Common resources include:
    1. **Household wastes**.
    2. **Naturally occurring organic materials** such as worms, insects, maggots, termites, and snails.
    3. **Crop surpluses** and by-products.
    4. **Fodder materials**.
    5. **Non-commercial feeds** like grasses, herbs, and algae.

Newly Developed Coloured Plumage Birds for Rural Poultry

Coloured Chicken Varieties for Backyard Farming

Variety	Institution	Characteristics
Nandanam Chicken-1	TANUVAS, Chennai	Dark red plumage, medium-sized dual-purpose breed derived from Rhode Island Red.
Nandanam Broiler-II	TANUVAS, Chennai	Multi-colored broiler chicken, developed through selective breeding, suitable for backyard systems with good survivability.
Giriraja	UAS, Bangalore	Polycross, multi-colored, sturdy, disease-resistant breed released in 1989. Popular for backyard rearing.
Swarnadhara	KVAFSU, Bangalore	Compact bird, similar to Giriraja with high egg production (180-200 eggs). Better suited for scavenging due to thin and longer shanks.
Vanaraja	PDP, Hyderabad	Multi-colored dual-purpose chicken, fast-growing with higher egg production than native chickens. Adapted to free-range conditions.
Gramapriya	PDP, Hyderabad	Multi-colored, egg-purpose chicken. Lays more eggs than native birds with tinted brown eggs and better adaptability.
Krishna-J	Jabalpur Farm Varsity	Mixed plumage, egg-purpose chicken variety.
Grama Laxmi	Kerala Agricultural University	Multi-colored bird, suitable for dual purposes.
Kalinga Brown	CPDO, Bhubaneswar	Brown plumaged bird, well suited for backyard farming.
CARI Nirbhik	CARI, Izatnagar	Cross between Aseel and Cari Red. Large, active birds with high stamina and fighting nature, adapted to various climatic zones.
CARI Shyama	CARI, Izatnagar	Cross between Kadaknath and Cari Red. Dark plumage, internal organs show black pigmentation, adapted to hot and humid environments.
Upcari	CARI, Izatnagar	Developed from Frizzle and Cari Red cross. Multi-colored, heat-adapted due to frizzle plumage, suitable for tropical climates.
Hitcari	CARI, Izatnagar	Cross between Naked Neck and Cari Red, suited for tropical climates, especially in hot and humid coastal regions.

Key Coloured Chicken Varieties

1. **Giriraja**:
   - Released in 1989 by UAS, Bangalore.
   - Multi-colored, disease-resistant bird suitable for backyard rearing.
   - Tolerant to various agro-climatic conditions and thrives in scavenging conditions.
2. **Swarnadhara**:
   - Released in 2005 by KVAFSU, Bangalore.
   - Similar to Giriraja, but more compact and better suited for scavenging.
   - Produces 180-200 eggs annually.
3. **Nandanam Chicken-I & Nandanam Broiler-II**:
   - Developed by TANUVAS, Chennai.
   - Nandanam Chicken-I: Dual-purpose bird with dark red plumage.
   - Nandanam Broiler-II: Multi-coloured broiler, good for backyard farming, with high survivability.
4. **Vanaraja & Gramapriya**:
   - Developed by PDP, Hyderabad.
   - Vanaraja: Dual-purpose, fast-growing with high egg production.
   - Gramapriya: Egg-purpose bird, laying more eggs than native birds, with better adaptability.

Brooding Management for Egg-Type Chicks

Brooding is the management of young chicks from day-old to around 8 weeks of age, providing them with the necessary warmth, feed, water, and space to ensure healthy growth.

Purpose of Brooding:

- Chicks are unable to regulate their body temperature during the first few weeks of life. Brooding provides artificial heat and warmth to help chicks maintain their body temperature.
- The primary goal is to prevent **cold shock** and ensure the chicks' survival during their early stages.

Classification of Brooding:

1. **Natural Brooding**:
   - Done by broody hens, which care for the chicks for 3-4 weeks after hatching.
2. **Artificial Brooding**:
   - Large numbers of chicks are raised without a hen using artificial heat sources (electricity, gas, charcoal, kerosene, etc.).
   - Brooders consist of:
     - **Heating Source** (electric brooder, infrared bulbs, gas brooder, etc.)
     - **Reflectors/Hovers** (flat or canopy types)

- **Brooder Guard** (prevents chicks from wandering too far from the heat source).

Brooder Operation:

- **Before Chick Arrival**:
  - Clean and disinfect the brooder house.
  - Spread litter material (sawdust, wood shavings, paddy husk) to a height of 5 cm.
  - Set up **brooder guards** (circular, 150-180 cm diameter) and arrange heating systems.
  - Ensure **feeders and waterers** are placed alternately in a "cartwheel" arrangement.
- **After Chick Arrival**:
  - Immediately check the chicks' health and count.
  - Moisten the chicks' beaks in water containing **vitamins and electrolytes**.
  - Place them gently into the brooder area and monitor their behavior for signs of comfort.

Feeding and Watering Recommendations:

- **Feed**:
  - Use **brooder mash** containing 22% crude protein and 2700 Kcal/kg of metabolizable energy.
  - Spread feed on the floor or in feeders for easy access.
- **Water**:
  - Provide **medicated water** with vitamins, electrolytes, and glucose (8g per liter) during the first few days to reduce stress and improve immunity.
  - Water intake increases as chicks grow.

Brooding Temperature and Duration:

- **Initial Temperature**:
  - 90-95°F (32-35°C) during the first week.
  - Reduce by **5°F** each week until it reaches 75°F (24°C).
- **Duration**:
  - Typically, brooding lasts for 2-3 weeks, depending on the season (longer in winter/rainy seasons and shorter in summer).

Chick Comfort Zone

- Chicks should distribute evenly under the brooder if the temperature is correct.
  - **Huddling under the heat source**: Indicates cold temperatures.
  - **Moving to the edges, avoiding the heat**: Indicates high temperatures.

- **Even distribution**: Indicates a comfortable environment.

Space Requirements for Chicks:

- **Floor Space**:
  - **0.75 sq. ft.** (675 cm²) per chick during the brooder stage.
- **Feeder Space**:
  - **1.0 cm** per bird up to 4 weeks, and **2.5 cm** up to 8 weeks.
- **Water Space**:
  - **0.5 cm** per bird up to 4 weeks, and **1.0 cm** up to 8 weeks.

Feed and Water Intake for Layer Chicks:

Age (weeks)	Feed Intake/Week (kg)	Water Intake/Day (liters)	Body Weight at Week's End (g)
1	40	10	60
2	80	25	105
3	140	45	160
4	200	65	230
5	250	80	300
6	300	95	370
7	350	105	440
8	390	120	510

Additional Brooding Practices:

- **Debeaking**: Performed to prevent feather pecking and cannibalism.
- **Vaccination Schedule**: Follow recommended vaccination protocols for common diseases such as Marek's, Newcastle, and Infectious Bronchitis.
- **Cage Rearing**: In some systems, chicks are raised in cages for better management and space utilization. Cage brooding with multi-tier setups is also practiced.

Debeaking/Beak Trimming

Debeaking is an important management practice in poultry farming, especially for layer chicks, to reduce feed wastage and prevent aggressive pecking (cannibalism).

Procedure:

1. **Timing**:
    - Ideally, debeaking is done once around the **fourth week** of age.
    - It can also be performed earlier, at the **end of the second week**, with a possible repetition at **12-14 weeks**.
2. **Beak Trimming**:
    - **Upper beak**: Cut **2/3rd** of the beak.
    - **Lower beak**: Cut **1/3rd** of the beak.
    - The cut portion is cauterized using a hot plate, ensuring the **tongue is held back** to avoid injury.
3. **Conditions**:
    - Perform debeaking during the **cooler parts of the day** to minimize stress.
    - Provide **anti-stress vitamins** (B-complex and vitamin K) in drinking water before, during, and after debeaking to reduce stress and promote recovery.
4. **Adjustments**:
    - Adjust the height of feeders and waterers to be lower, considering the shortened beaks of the chicks.
5. **Expertise**:
    - Ensure the task is performed by **experienced personnel** to minimize stress and the need for repetition.

Benefits:

- Reduces **feed wastage**.
- Prevents **cannibalism** and **pecking injuries**.
- Helps maintain better flock health and uniform growth.

Vaccination Schedule for Layer Chicks

A proper vaccination schedule is essential to protect layer chicks from common poultry diseases. Below is the recommended vaccination protocol:

Age (Days)	**Vaccine**	**Method**	**Remarks**
0	**Marek's Vaccine**	Hatchery-administered	Ensure vaccination at hatchery.
5-7	**RDVF/LaSota**	Eye/nasal drops	Protection against Newcastle Disease (ND).

Age (Days)	Vaccine	Method	Remarks
14-16	**IBD Vaccine**	Eye drops or subcutaneous injection	Protection against Infectious Bursal Disease.
20	**IB Vaccine**	Eye drops	Optional, consult with local veterinarian.
26	**IBD Vaccine (Intermediate)**	Eye drops or drinking water	Booster for IBD.
30	**LaSota Vaccine**	Drinking water or eye drops	Protection against ND.
56	**RDVK/R2B**	Subcutaneous injection	Final vaccination for ND.

- Ensure **quality vaccines** are used and stored under proper conditions.
- Follow the **recommended dosage** for each vaccine to ensure effectiveness.
- Minimize stress to the birds during vaccination for better immune response.

Management of the layer chicken

Cage Rearing for Layer Chicks (0-8 Weeks)

Chicks can also be reared in cages from day-old to 8 weeks of age. This method is used to save space and improve management practices.

Cage Specifications:

- **Height**: Cages are elevated at **75 cm** above the floor.
- **Dimensions**: Each cage is **180 x 90 cm** with a height of **30 cm**.
- **Capacity**: Each cage can accommodate **100 chicks**, with **160 cm² of space** per chick.

Cage Setup:

- **Flooring**: Made of **1.25 x 1.25 cm welded mesh** of 16-gauge thickness.
- **Heat**: One **100-watt bulb** is sufficient for providing heat during the first three weeks.
- **Feeders and Waterers**:
    - For the first two weeks, place small feeders and waterers inside the cage.
    - After two weeks, feeders and waterers can be placed outside on the sides of the cage.
- **Safety**: Use **cardboards on the sides** of the cage to prevent young chicks from falling through the mesh during the first few days.

Housing and Feeding of Growers (Layer Birds)

The grower phase, which extends from about 9 to 20 weeks of age, is a crucial period for the proper development of reproductive organs in layer birds. Proper management during this stage ensures that the birds develop well and are prepared for optimal egg production later on.

Housing for Growers:

1. **Grower Houses**:
    - Growers can either be reared in separate grower houses or in a brooder-cum-grower house.
2. **Floor Space**:
    - **1.4 sq. ft. (1260 cm²)** per bird.
3. **Feeder Space**:
    - **6-8 cm** per bird.
    - One linear feeder of **120 cm length and 8 cm depth** can serve 40 birds.
    - Adjust the height of the feeders as the birds grow.
4. **Waterer Space**:
    - **2 cm** per bird.
    - A circular waterer of **36 cm height, 8 cm depth, 6-litre capacity** is suitable for 50 birds.
    - Ensure that water is fresh and potable, and provided twice a day.
    - **15-20 litres of water** per day is needed for 100 birds.
    - Avoid water spillage on the litter to maintain dryness.

Feeding of Growers:

1. **Grower Mash**:
    - Contains **16% crude protein** and **2600 Kcal/kg** of metabolizable energy.
    - Growers consume around **60-80 g of feed per bird per day**.
2. **Restricted Feeding Program**:
    - **Ad libitum feeding** is not recommended as it may lead to excess fat accumulation, which can reduce egg production persistency.
    - Use **restricted feeding** if the birds are overweight.
        - **Alternate day feeding** or feeding **75% of the normal quantity** helps control body weight.

Types of Restricted Feeding:

1. **Quantitative Feed Restriction**:
    - The amount of feed is reduced below the normal requirement.
    - Methods: Day-to-day reduction, skip-a-day program, or skip-two days in a week program.

    - Ensure that the average body weight matches the breeder's standard.
2. **Qualitative Feed Restriction**:
    - The quality of the feed is reduced by using lower nutrient ingredients.
    - The quantity of feed remains unrestricted.

Advantages of Restricted Feeding:

- **Feed Cost Savings**: Only **80% of the calculated feed requirement** is offered.
- **Improved Feed Efficiency**: Birds may consume less feed during the laying period.
- **Reduced Fat Accumulation**: Leads to better egg production.
- **Early Identification of Weak Birds**: Weaker birds can be culled early, improving flock health.
- **Heavier Eggs**: Feed-restricted birds tend to produce heavier eggs with longer clutch lengths.

Flock Uniformity:

- **Goal**: At least **70% of the flock** should have a body weight within 10% of the flock's average.

Factors for Achieving Flock Uniformity:

- Use chicks of uniform weight.
- Provide proper feeding, watering, and floor space.
- Adjust the height of feeders and waterers according to bird age.
- Regularly take **sample weights** of the flock to monitor growth and adjust feed accordingly.

Growth Pattern of Growers:

Age (Weeks)	Body Weight (g)
9	565
10	635
11	705
12	785
13	855
14	920

Age (Weeks)	Body Weight (g)
15	985
16	1045
17	1100
18	1160
19	1210
20	1260

Lighting and Vaccination for Growers:

1. **Lighting**:
    - If natural day length is **constant (10-12 hours)** or decreasing, artificial lighting is unnecessary.
    - If day length is increasing, provide additional lighting to maintain a constant day length during the growing phase.
2. **Vaccination Schedule**:
    - **10th week**: Fowl pox vaccine via web puncture.
    - **12-13th week**: Infectious bronchitis vaccine (optional).
    - **16-17th week**: RDVK/R2B vaccine (Ranikhet disease) via subcutaneous injection.

Deworming and Dipping:

1. **Deworming**:
    - Deworm between **16-18 weeks** of age, just before transferring birds to laying cages.
    - **Piperazine, levamisole, thiobendazole, zodex, panacur** can be used to remove roundworms and tapeworms.
    - Withhold water for two hours before administering **medicated water** to ensure proper dosage intake.
2. **Dipping**:
    - If **ectoparasites** (like lice or mites) are present, dip the birds in **0.25% sumithion, malathion, or sevin** solution.
    - Perform dipping on sunny days, allowing birds to dry under sunlight.

Culling:

- Regularly cull poorly developed, injured, or lame birds.

- Aim to keep **mortality below 4%** during brooding and **below 3%** during the growing phase.
- Keep detailed records of chick numbers, feed intake, mortality, and vaccinations.

Cage Rearing for Growers:

- Growers can be reared in **cages** with **welded mesh flooring** (1.25 x 5.0 cm).
- Cage size: **180 x 90 cm**, with a capacity for **50 birds** (325 cm^2 per bird).
- Feeders and waterers are placed on the sides, one below the other, for efficient feeding.

Housing and Feeding of Growers (Layer Birds)

The grower stage is crucial for the proper development of layer birds' reproductive organs, ensuring they are ready for egg production in the laying phase. Neglect during this stage can negatively affect the birds' long-term productivity.

Housing for Growers:

1. **Separate Grower Houses**:
   - Growers can be housed in separate grower-specific housing or in brooder-cum-grower houses.
2. **Floor Space**:
   - **1.4 sq. ft. (1260 cm^2)** per bird.
3. **Feeder Space**:
   - Provide **6-8 cm** feeder space per bird.
   - One linear feeder of **120 cm length and 8 cm depth** can serve 40 grower birds.
   - As the birds grow, adjust the height of feeders.
4. **Waterer Space**:
   - **2 cm** of waterer space per bird.
   - A circular waterer of **36 cm height, 8 cm depth, and 6-litre capacity** can serve 50 grower birds.
   - **100 birds** consume around **15-20 litres** of water per day.
   - Ensure that water does not spill on the litter and rake the litter regularly to manage moisture.

Feeding for Growers:

1. **Grower Mash**:
   - Feed them grower mash containing **16% crude protein** and **2600 Kcal/kg** of metabolizable energy (M.E.).
   - **60-80 g** of feed per bird per day is typically required.

2. **Restricted Feeding Program**:
    - **Ad libitum feeding** is not recommended as it can lead to excess fat accumulation, which affects future egg production.
    - **If overweight**, consider:
        - **Alternate day feeding**, or
        - Provide **75% of the normal feed quantity** to reduce body weight.

Types of Restricted Feeding:

1. **Quantitative Feed Restriction**:
    - **Feed quantity is reduced** below the bird's normal requirement.
    - Methods: Daily reduction, **skip-a-day program**, or **skip-two days per week**.
    - The restriction is based on flock body weight matching breeder standards.
2. **Qualitative Feed Restriction**:
    - The **quality of the feed** is reduced by including lower-nutrient ingredients.
    - The quantity remains unrestricted.

Advantages of Restricted Feeding:

- **Cost savings**: Only **80%** of the calculated feed requirement is provided, reducing feed costs.
- **Improved feed efficiency**: Birds tend to consume less feed per dozen eggs during the laying period.
- **Reduced fat accumulation**: Leads to more eggs and better laying persistency.
- **Early identification of weaker birds**: Weaker birds can be culled early, saving feed and improving flock health.
- **Heavier eggs**: Restricted birds produce heavier eggs in longer clutches.

Flock Uniformity:

- Ensure **70% of the flock** falls within 10% of the flock's average body weight by maintaining proper feeding, watering, and space.

Steps for Flock Uniformity:

- Use chicks of **uniform weight**.
- **Adjust feeder and waterer height** according to the bird's growth.
- **Monitor body weights** regularly to ensure consistency in growth.
- Provide adequate **feeding space** so all birds can consume feed simultaneously.

Growth Pattern of Growers:

Age (Weeks)	Body Weight (g)
9	565
10	635
11	705
12	785
13	855
14	920
15	985
16	1045
17	1100
18	1160
19	1210
20	1260

Lighting and Vaccination for Growers:

1. **Lighting**:
    - If natural day length is constant (10-12 hours), no additional lighting is required.
    - If day length is increasing, provide **supplemental lighting** to maintain a constant day length.
2. **Vaccination Schedule**:
    - **10th week**: Fowl pox vaccine via **web-puncture method**.
    - **12-13th week**: Infectious bronchitis vaccine (optional).
    - **16-17th week**: RDVK/R2B vaccine for Ranikhet disease via **subcutaneous injection**.

Deworming and Dipping:

1. **Deworming**:
    - Deworm birds between **16-18 weeks** to prevent roundworms and tapeworms, especially if raised on deep litter.
    - Use medications like **piperazine, robendol, levamisole, thiobendazole**, etc.

    - Withhold water for 2 hours before administering **medicated water** to ensure proper dosage.
2. **Dipping**:
    - For **ectoparasites**, dip birds in **0.25% sumithion, malathion, or sevin solution**.
    - Perform dipping on sunny days to allow the birds to dry.

Culling:

- Regularly **cull** poorly grown, injured, or lame birds.
- Maintain a **mortality rate below 4%** during brooding and **below 3%** during the growing phase.
- Keep accurate records of **chick numbers, feed intake, mortality, culling, and vaccinations**.

Cage Rearing for Growers:

- **Cage System**: Growers can also be reared in cages.
    - **Floor size**: Welded mesh flooring of **1.25 x 5.0 cm**.
    - **Cage size**: **180 x 90 cm** with a capacity for 50 birds (**325 cm² per bird**).
    - **Feeders and waterers**: Fitted lengthwise along the sides

Deep Litter System of Rearing - Layers

The deep litter system is a common method for rearing layers, providing birds with a natural, comfortable environment. In this system, layers are typically transferred to layer houses by the **18th week** after deworming, dipping, and vaccination against Ranikhet disease.

Housing and Space Requirements:

1. **Litter Material**:
    - Litter material such as sawdust or rice husks is spread to a **12-15 cm** height to create a soft and absorbent bedding for the birds.
2. **Space Allowance**:
    - Provide **2 sq. ft. (1800 cm²)** per bird to ensure sufficient movement space.
3. **Feeders**:
    - **Feeder space allowance**: 10-12 cm per bird.
    - Use either circular or linear feeders. A linear feeder of **180 cm length and 10 cm depth** can accommodate 35 birds.
4. **Waterers**:
    - **Waterer space allowance**: 2.5 cm per bird.
    - A **circular waterer** of **45 cm diameter and 7 cm depth** is sufficient for 50 birds.
    - Ensure fresh, cool water is provided twice a day.

- During the laying stage, 1000 birds will consume approximately **250 litres** of water per day.

5. **Arrangement**:
   - Feeders and waterers should be arranged alternately at equal distances to ensure birds can access feed and water easily.
   - Adjust their heights to minimize feed wastage by preventing birds from spilling feed.

Layer Mash:

- Feed **layer mash** with the following composition:
  - **18% crude protein**
  - **2700 KCal/kg** metabolizable energy (M.E.)
  - **2.75% calcium**
  - **0.80% available phosphorus**
- Provide **ad libitum feeding** to layers to ensure constant access to food.

Nest Boxes:

- Provide **nest boxes** made of galvanized iron (G.I.) or aluminum at a height of **45 cm**, one box for every **3 to 5 birds**.
- Train layers to use the nest boxes to prevent eggs from being laid on the floor, which can result in higher breakage.
- Nest box dimensions: **30 cm width x 20 cm depth**.
- You can also use pots as nest boxes as they create a cooler environment, reducing stress during egg laying.

Cage Rearing for Layers:

1. **Types of Cages**:
   - **Single or Individual Cage**: Houses one bird.
   - **Multiple Bird Cages**: Accommodates 2 to 10 birds, usually 3 to 4 per cage.
   - **Colony Cages**: Hold more than 11 birds per cage.
2. **Cage Arrangement**:
   - Cages can be arranged as:
     - **Single-deck**, **Double-deck**, **Triple-deck**, or **Four-deck**.
     - **Stair-step cages** (M-type, L-type) or **Battery cages** (vertical cages).
3. **Cage Size**:
   - Cages are sized based on the number of birds they house:
     - **45 x 30 cm** for 3 birds.

        - **45 x 40 cm** for 4 birds.
        - **55 x 45 cm** for 5 birds.
    - Cage height: **40 cm**.
    - Mesh size: The floor has **2.5 x 5 cm** weld mesh (14 gauge) and sides have **7.5 x 7.5 cm** mesh (16 gauge).
    - Cage floors are sloped (1/6) towards the front to allow eggs to roll down for easy collection.
4. **Waterers and Feeders**:
    - Waterers are fitted above the feeders at the front of the cage.
    - **Automatic waterer nipples or buttons** may be provided for efficient water distribution.

Elevated Cage Houses:

- Elevated cages (5-6 feet above the ground) are gaining popularity due to the ease of waste management, allowing droppings to dry faster and facilitating easier removal.

Advantages of Cage Rearing for Layers:

- **Easy Management**: Cages make it easier to handle birds and collect eggs.
- **Space Efficiency**: More birds can be housed in a smaller area.
- **Better Egg Weight**: Caged birds often produce eggs with more uniform weight.
- **Clean Eggs**: Eggs stay clean and free of contamination.
- **Reduced Mortality**: Cages make it easier to monitor and cull weak birds.

Lighting Management for Layers:

- Provide **artificial lighting** during the laying stage, typically using a **60-watt bulb** for every 200 sq.ft. of space.
- Gradually increase the total day length by **20 minutes per week** until a total of **16 hours** of light per day is achieved (natural daylight + artificial light).
- This lighting schedule should be maintained until the birds reach **72 weeks of age**.
- **Note**: Never decrease the day length during the laying period, as it can disrupt egg production.

Vaccination Schedule for Layers (0-72 Weeks of Age)

Age	Type of Vaccine	Route of Administration
0 day	Marek's Disease Vaccine	S/C 0.2 ml (Turkey Herpes Vaccine)
5-7 days	Ranikhet Disease Vaccine (RDVF)	Ocular/Nasal (O/N)

Age	Type of Vaccine	Route of Administration
10th day	Leechi Disease Vaccine	Water
12-14 days	Infectious Bursal Disease Vaccine (Intermediate)	O/N or Water
18-22 days	Infectious Bronchitis (IB) Vaccine	O/N or Water
24-27 days	IB Vaccine Booster	Water
28-30 days	RD Vaccine Booster (La Sota)	Water
6th Week	Fowl Pox Vaccine or Infectious Coryza (if prevalent)	S/C
8th Week	RD Vaccine (RDVK or R2B)	S/C or I/M
9th Week	Fowl Pox Vaccine	Wing Web
10th-11th Week	Infectious Coryza	S/C
12th-13th Week	IB Vaccine Booster	Water
18th Week	RD Booster (RDVK or R2B)	S/C or I/M
45th-50th Week	RD Vaccine (La Sota)	Water (Repeated every 2 months)

Practical Rations and Nutrient Requirements for Layers (21-72 Weeks of Age)

Ingredients	Layer Mash (%)
Maize	54
DORB (De-Oiled Rice Bran)	9
SB Meal (Soya Bean Meal)	14
SFOC EXT (Sunflower Oil Cake Ext.)	8
Dry Fish	8
MM (Mineral Mixture)	2
Shell Grit	4

Ingredients	Layer Mash (%)
DCP (Dicalcium Phosphate)	1
Total	**100**

Nutrient Composition of Layer Mash (Per kg of feed)

Nutrient	Layer Mash
Crude Protein (C.P)	18.04%
Metabolizable Energy (ME Kcal/Kg)	2706
Calcium (Ca)	3.02%
Phosphorus (P)	0.55%
Lysine	0.97%
Methionine	0.3%

Moulting in Poultry

Moulting is a crucial physiological process in poultry that involves the shedding and renewal of feathers. This process significantly impacts egg production, especially in layers. By understanding moulting, poultry farmers can optimize flock management for improved productivity and better bird health

Natural Moulting

- **Definition**: Moulting is the natural process in which birds shed their old, worn-out feathers and replace them with new ones. This occurs in both male and female birds.
- **Purpose**: In the wild, birds typically moult before the onset of cold weather or before migratory flights to ensure they have fresh plumage for insulation and flight. For laying hens, moulting is closely associated with the reproductive cycle and a decline in egg production.

Commencement of Natural Moulting

- **Timeframe**: In commercial layers, natural moulting usually begins after 8 to 12 months of egg production.
- **Feather Shedding Order**: The process of feather shedding is orderly:
    1. **Head feathers** are shed first.
    2. **Neck feathers** follow.
    3. **Body feathers** are then lost.
    4. **Wing feathers** are next.

5. **Tail feathers** are shed last.

- **Hormonal Regulation**: Moulting is regulated by hormones, particularly a decrease in estrogen levels. The thyroid gland and gonads also play a role in initiating and regulating this process.

Factors Affecting Natural Moulting

1. **Body Weight and Physical Condition**: Underweight or overweight birds may experience delayed or prolonged moulting.
2. **Day Length**: Moulting is often triggered by shorter days or reduced light exposure, which signals to the bird that it is time to renew its feathers.
3. **Nutrition**: Birds that receive a well-balanced diet rich in essential nutrients like protein, calcium, and vitamins tend to have smoother moulting periods.
4. **Environmental Conditions**: Cold temperatures and high humidity can slow down the moulting process, while dry, warm conditions can speed it up.

Force Moulting (Flock Recycling)

Force moulting is an induced process used by commercial poultry farmers to improve flock performance and egg quality after the birds have completed a production cycle. By controlling the moulting process, hens are rejuvenated for another period of egg production.

Purpose of Force Moulting

1. **Cost Reduction**: Force moulting reduces the cost of bringing the flock into production for a second cycle.
2. **Increased Egg Production Period**: Induced moulting allows for an extended egg production cycle, improving overall profitability.
3. **Egg Price Management**: If egg prices are low, the flock can be temporarily removed from production and then brought back when prices are expected to rise.
4. **Cash Flow Management**: Force moulting provides a solution when there are cash flow constraints for feeding the flock.
5. **Optimal Utilization of Housing**: It can help manage housing space availability more effectively by delaying the need for new birds.

Force Moulting Requirements

In a forced moulting program, the flock manager induces feather loss and ceases egg production through diet manipulation and lighting changes.

Steps in Force Moulting

1. **Initiating the Moult**:
    - **Feed Restriction**: A common method is fasting or limiting key nutrients like protein, calcium, or sodium to halt egg production. This reduction of essential nutrients forces the bird's body to shed feathers and stop laying eggs.

- **Light Reduction**: Artificial lighting is reduced to 8 hours or less per day, simulating shorter days and signaling to the birds that it's time to moult.

2. **Resting the Flock**:
   - Once the flock stops laying, it is held out of production for 1 to 5 weeks. This "resting" period allows the reproductive tract to regress and rejuvenate, preparing the hens for another production cycle.
   - **Nutritional Adjustment**: During this time, a low-protein or low-calcium diet is provided to keep the hens out of production and promote feather growth.
3. **Returning the Flock to Production**:
   - After the resting period, the hens are gradually returned to full feed, specifically a layer diet, and lighting is increased to 14 to 16 hours per day.
   - Egg production typically resumes within 2 to 3 weeks, and peak production is reached after an additional 2 to 4 weeks.

Types of Force Moulting Programs

1. **Two-Cycle Moulting Program**:
   - **Overview**: This program involves one forced moult, followed by two egg production cycles.
   - **Timeline**: Hens are typically moulted after 10 months of egg production and are brought back into production for a second cycle. They are sold after 24 months.
2. **Multiple-Cycle Moulting Program**:
   - **Overview**: This program includes two or more moults, leading to three or more cycles of egg production.
   - **Timeline**: Hens undergo their first moult after 9 months of production and continue for shorter production cycles. They are eventually sold after 30 or more months.

Methods of Force Moulting

1. **Conventional Force Moulting Program** (On/Off Program):
   - **Process**: A combination of feed and water deprivation along with light reduction to induce moult.
   - **Schedule Example**:

Day	Feed	Water	Light
1	None	None	8 Hours
2	None	None	8 Hours
3	45g/hen	Water	8 Hours
4-9	Alternating feed and no feed days	Water	8 Hours

Day	Feed	Water	Light
10-60	Restricted feed (75% of normal)	Water	8 Hours
61+	Full feed layer ration	Water	14-16 Hours

The practice of force moulting through starvation is **banned in India** due to concerns over animal welfare.

2. **Low Nutrient Diet Program**:
    - **Fasting Alternative**: In countries where fasting is banned, low-nutrient diets (low protein, calcium, or phosphorus) are used to achieve the same effect as feed deprivation without completely removing feed.
3. **Moulting by Feeding Zinc**:
    - **Zinc as a Moulting Agent**: About 20g of zinc per kg of feed is added to the diet for 5 days, which reduces egg production and promotes feather shedding.
    - **Results**: Birds lose 340-450g of body weight, and egg production stops within 5 days. After returning to a normal diet, birds resume production within a week, and peak egg production (75-80%) is reached depending on the age of the flock.
4. **Use of Drugs and Other Compounds**:
    - Experimental drugs like methalibure, progesterone, and other hormonal compounds can induce moulting, though they are less commonly used in commercial settings.

Broiler management

Brooding and Space Requirements for Broilers

Brooding is a critical phase in the early life of broiler chicks, where proper management of temperature, space, and nutrition ensures healthy growth and reduces mortality.

Brooding of Broilers

- Brooding for broiler chicks (unsexed day-old chicks) follows similar procedures as for layer chicks but with adjustments in space and equipment.
- **Brooder Guard**: The diameter of the brooder guard should be 150-240 cm to accommodate 175-300 chicks per unit.
- **Newspaper and Brooder Guards**: The newspaper, spread on the litter for the first few days to prevent litter ingestion, should be removed after three days. Brooder guards can be dismantled after eight days.

Space Requirements for Broilers

- **Floor Space**: Broilers require different space allowances as they grow:
    - Up to 18 days: 450 cm^2 (0.5 sq.ft.) per bird.
    - After 18 days until market age: 1000 cm^2 (1.1 sq.ft.) per bird.

- **Feeder Space**:
  - First 18 days: 3 cm per bird.
  - After 18 days: 6-7 cm per bird.
- **Waterer Space**:
  - First 18 days: 1.5 cm per bird.
  - After 18 days: 3 cm per bird.

The feeders and waterers should be upgraded as the birds grow to provide enough space for all birds to access feed and water.

Feeding and Watering Broilers

Feeding: Broiler feed is typically given in two phases:

1. **Broiler Starter Phase (0-4 weeks)**:
   - **Crude Protein**: 22-23%.
   - **Metabolizable Energy (M.E.)**: 2950 Kcal/kg.
2. **Broiler Finisher Phase (After 4 weeks to market age)**:
   - **Crude Protein**: 19.5%.
   - **Metabolizable Energy (M.E.)**: 3100 Kcal/kg.

In some systems, the feed may be divided into three phases: starter (0-2 weeks), grower (3-5 weeks), and finisher (6 weeks onward).

Watering:

- Provide clean, fresh, potable water, ensuring waterers are cleaned every day. Watering is typically done twice daily, and feeding should be done four times a day.
- Fill waterers and feeders only to 2/3rd of their capacity to avoid spillage and wastage.

Monitoring: Birds should not be disturbed excessively, and feeding/watering should follow a consistent schedule to minimize stress. Monitoring and minimizing feed wastage is critical to maintaining feed efficiency.

Monitoring Growth Rate in Broilers

- **Weekly Weighing**: Weigh at least 10 birds of average size weekly to monitor growth. If the growth rate is slower than expected, check for issues with feed quality (toxins, nutrient content) or possible infections.
- **Feed and Water Consumption**: Track daily feed and water intake, as sudden changes could indicate problems such as feed quality issues or disease.

Growth Performance and Feed Efficiency Chart for Broilers

Age (weeks)	Mean Body Weight (g)	Feed Intake per 1000 birds/day (kg)	Cumulative Feed Intake per Bird (g)	Feed Efficiency	Water Intake per 1000 birds/day (liters)
0	42	--	--	--	--
1	170	19	146	0.86	46
2	380	37	426	1.12	89
3	720	68	945	1.31	165
4	1170	102	1730	1.48	245
5	1680	134	2720	1.62	320
6	2220	168	3996	1.80	405

- This table provides a guide to expected body weight, feed intake, and water consumption at different stages of broiler growth. These values can fluctuate based on seasonal variations (e.g., feed intake decreases in summer while water intake increases).

Vaccination Schedule for Broilers

Age	Vaccine	Administration Method
0 days	Marek's Disease Vaccine (HVT)	0.2 ml, Subcutaneous (S/C)
5-7 days	Ranikhet Disease Vaccine (RDVF)	Oral/Nasal (O/N)
10 days	Infectious Bronchitis Vaccine	Oral/Nasal (O/N)
12-14 days	Infectious Bursal Disease Vaccine (Intermediate Georgia)	Oral/Nasal (O/N)
28 days	Ranikhet Disease Booster (La Sota)	Drinking wate

Duck Farming

Duck farming in India remains traditional, characterized by **nomadic, extensive, and seasonal methods**, often managed by small and marginal farmers. **West Bengal** and **Kerala** are the primary consumers of duck eggs and meat due to their culinary preferences, especially in fish-based dishes. The binomial name for ducks is ***Anas platyrhynchos***.

Advantages of Duck Farming

1. **Higher Egg Production**: Ducks are more prolific than backyard chickens, producing 15-20 more eggs annually.
2. **Larger Eggs**: Duck eggs are 10-15 grams larger than chicken eggs.
3. **Extended Productivity**: Ducks have a longer productive life, laying eggs well into their second and third years.
4. **Cost Efficiency**: Ducks forage for food, reducing the overall feed cost.
5. **Adaptability to Poor Land**: Ducks thrive in marshy, swampy, and wet lands unsuitable for chickens.
6. **Early Egg Laying**: Ducks lay eggs between 3 a.m. and 8 a.m., allowing easy collection.
7. **Integration with Paddy Farming**: Ducks and paddy farming have a symbiotic relationship.
8. **Ease of Management**: Ducks are intelligent and easy to train, reducing labor.
9. **Hardiness**: Ducklings are easy to brood, and ducks are resistant to common poultry diseases.

Housing for Ducks

- Ducks require **simple, well-ventilated, dry, and rat-proof** housing.
- In **semi-intensive systems**, houses should have easy access to an outdoor run, where ducks prefer to spend their day.
- **Drainage**: Ensure the run slopes away from the house to prevent waterlogging.
- A **water channel** of 50 cm width and 15-20 cm depth should be constructed in grower and layer houses.

Brooding of Ducklings (0-4 weeks)

- **Brooding Systems**: Ducklings can be brooded on **wire floors, litter, or in batteries**.
- The **brooding period** for **layer ducklings** is 3-4 weeks, while **meat-type ducklings** need only 2-3 weeks.
- A **hover space** of 90-100 cm^2 per duckling is recommended under a brooder, with a 250-watt bulb heating 30-40 ducklings.
- **Temperature**: Start at 32°C in the first week, reducing by 3°C weekly until it reaches 24°C by the fourth week.
- **Space**: Wire floors need 0.5 sq.ft per duckling, while litter systems require 1 sq.ft per bird up to three weeks of age.
- **Water Depth**: Ensure water in drinkers is 5.0-7.5 cm deep, enough for ducklings to drink but not dip themselves.
- **Litter Thickness**: Maintain at least 3 cm of litter to absorb moisture from duck droppings.

Grower Rearing Practices (5-16 weeks)

- **Housing Systems**: Ducks can be reared in **intensive or semi-intensive systems**.
    - **Intensive**: 3 sq.ft per bird.
    - **Semi-Intensive**: 2-2.5 sq.ft per bird in night shelters, with 10-12 sq.ft per bird for outdoor runs.
- **Water Depth**: Provide drinkers with water 10-12 cm deep for ducks to immerse their heads.

- **Rural Farming**: Male and female ducks are raised together until 20 weeks, with females kept for laying and males sold for meat, except for selected breeding stock.

Layer Duck Rearing (17+ weeks)

- **Housing**:
  - Intensive: 4 sq.ft per bird.
  - Semi-Intensive: 3 sq.ft per bird for night shelter, with 10-12 sq.ft for the outdoor run.
- **Feeding**: Provide 10 cm of feeding space for wet mash and 7.5 cm for dry mash or pellets.
- **Nest Boxes**: 30x30x45 cm nests should be provided at a rate of one for every three ducks to ensure clean egg collection.
- **Lighting**: 14-16 hours of light is essential for optimal egg production.
- **Egg Production**: Khaki Campbell ducks typically begin laying at 120 days, reaching 50% production by 140 days, with an annual yield of 300 eggs.
- **Feed and Egg Weight**: At 40 weeks, ducks consume 120-140 grams of feed daily, weigh around 1800 grams, and produce eggs weighing approximately 68 grams.

Feeding Ducks

- **Foraging**: Ducks are excellent foragers, feeding on insects, snails, earthworms, small fish, and fallen grains in paddy fields, which also benefit from duck droppings as fertilizer.
- **Extensive Rearing**: Ducks graze in **paddy fields, ponds, lakes**, and canals, with paddy fields offering a symbiotic environment.
- **Feed during Non-laying Periods**: Ducks are often fed low-cost feed like **paddy husk, broken rice**, and other grains.
- **Intensive Systems**: Ducks can be fed **dry mash, wet mash, or pellets**, with **wet mash** being preferred due to easier swallowing.
- **Feeding Frequency**: Ducks should always have access to feed for the first eight weeks, after which they may be fed twice daily.

Watering for Ducks

- Ducks do not require swimming water but need **deep water drinkers** that allow them to immerse their heads for cleaning their bills and preventing eye infections.
- Ensure proper water availability to keep ducks healthy.

Common Diseases of Ducks

1. **Duck Virus Enteritis (Duck Plague)**:
   - A highly contagious disease affecting adult ducks, characterized by severe hemorrhaging and vascular damage.
   - Symptoms: droopiness, ruffled feathers, nasal discharge, greenish diarrhea, and in males, penis prolapse.
   - Prevention: **Vaccination** of breeding and commercial stocks.

2. **Duck Virus Hepatitis**:
    - Affects ducklings aged 2-3 weeks, leading to severe liver inflammation.
    - Symptoms: convulsions, falling, closed eyes, and death.
    - Prevention: Vaccination of breeding stock.
3. **Salmonellosis**:
    - Caused by **Salmonella typhimurium**, commonly affecting young ducklings and layers.
    - Symptoms: swollen eyelids, pericarditis, and arthritis.
    - Treatment: **Sulfa drugs** and **Furazolidone**.
4. **Pasteurellosis (Duck Cholera)**:
    - Caused by **Pasteurella multocida**, leading to sudden death in ducks.
    - Symptoms: raised temperature, green diarrhea, and leg paralysis.
    - Treatment: Antibiotics and vaccination.
5. **Aflatoxicosis**:
    - Caused by **Aflatoxins** from moldy feed, resulting in liver damage.
    - Symptoms: poor growth, purple discoloration of legs, ataxia, and death in ducklings.
    - Prevention: Avoid wet, moldy feed, and use **fungistats and toxin binders**.
6. **Aspergillosis**:
    - A fungal infection caused by **Aspergillus fumigatus**, affecting the respiratory system.
    - Symptoms: accelerated breathing and ocular discharge.
    - Prevention: Proper litter management and avoiding overcrowding.

Japanese Quail Farming

Japanese quail farming involves raising **Coturnix coturnix japonica**, a domesticated bird species widely reared for both meat and eggs. They are known for their small size and unique behavior, which involves running or crouching rather than flying to escape danger. Quail farming has gained popularity due to several practical and economic advantages.

Advantages of Japanese Quail Farming

1. **Low Capital Investment**: Quail farming requires minimal capital, with no need for specially designed housing.
2. **Small Space Requirement**: The quail's small size means they need less space per bird, making farming more efficient in terms of area usage.
3. **Fast Growth and Maturity**: Quail are ready for market at just **five weeks**, and they start laying eggs from the **sixth week**, ensuring rapid returns on investment.
4. **Disease Resistance**: Japanese quail are generally more disease-resistant than chickens, eliminating the need for frequent vaccinations or deworming.
5. **Lower Feed Costs**: Due to their smaller body size, quail consume less feed compared to other poultry.

Japanese Quail Rearing Methods

1. **Floor Rearing**:
    - Roofing can be made of thatch or tiles, while the floor should be concrete or cement for easy cleaning.

    - **Density**: 5 quail per square foot of space (180 cm² per bird). A 10' x 10' room can house up to **500 quail** up to market age (five weeks).
    - Quail can be reared on the floor for two weeks, followed by cage rearing until market age.
2. **Cage Rearing**:
    - Specifically designed **multi-tier cages** are used. These cages allow for better space management, with four to five tiers arranged vertically, each separated by a gap and equipped with droppings trays.

Brooding Arrangements for Japanese Quail Chicks

- **Preparation**: The brooder house must be cleaned and disinfected in advance. Spread **2.5 cm of litter material**, such as paddy husk or groundnut hulls, with a newspaper layer on top.
- **Brooder Guard**: A circular brooder guard, 20 cm in height, is set up to protect the chicks.
- **Heating**: Adequate warmth is essential, provided by **infrared bulbs** or other heating methods. The temperature at chick level should be around **98°F**, reduced by 3°F every three days.

Brooding Space Requirements

- In a **3-foot diameter brooder circle**, about **150 chicks** can be housed. It is not advisable to exceed **300 chicks** per circle.
- **Heating**: A 15 cm high electric bulb is used for warmth, providing about **1 watt per chick**.
- **Temperature**: The heat source must be maintained for 24 hours a day for the first week, and at night during the second week. Heating may continue for three weeks in colder seasons, but is only needed for **10 days** during summer.

Drinkers and Feeders – Space Requirements

1. **Drinkers and Feeders Placement**: Should be kept away from the heat source.
2. **Space Requirement (0-2 weeks)**:
    - **Drinker space**: 0.3 cm per bird.
    - **Feeder space**: 0.6 cm per bird.
3. **Space Requirement (3-5 weeks)**:
    - **Drinker space**: 0.6 cm per bird.
    - **Feeder space**: 1.2 cm per bird.
4. **Drinkers**: Ensure the gap between the brim and the cup is no more than 1 cm to prevent chicks from drowning.

For 150 chicks:

- 2 chick drinkers (10 cm diameter, 500 ml capacity).
- 2 feeder plates (22 cm diameter, 2 cm height).

From the third week:

- Use **linear feeders** (45 cm long, 2.5 cm high, 10 cm wide) and larger drinkers (15 cm diameter, 1200 ml capacity).

Cage Rearing for Japanese Quail

1. **Brooder Quail Cage Rearing**:
    - Quail chicks are reared in **brooder cages** from day-old to **17-18 days**.
    - **Cage Design**: Multi-tier cages with four or five tiers, each divided into compartments of **90 x 60 cm**, with a 10 cm gap between tiers.
    - Each compartment can house **100 chicks**.
    - Side feeders and drinkers are provided inside the cage compartments.
2. **Grower Quail Cage Rearing**:
    - **Cages**: From **18-19 days** to market age, the grower cages are larger, typically **240 x 120 x 25 cm**, divided into compartments (120 x 60 cm). Each compartment houses **60 quail**.
    - **Feeding and Watering**: Feeders and drinkers are fixed outside the cage. Feeding is done **three times daily**, and watering **twice daily**, ensuring continuous access to food and water.

Brooding

- **Brooder Guard Space**: Brooder circles with a diameter of **3 feet** can house up to **150 chicks**.
- **Heating**: Adequate heating is vital in the early weeks, reducing over time depending on the climate.
- **Watering and Feeding**: Quail chicks need proper space in drinkers and feeders to ensure healthy growth and avoid overcrowding.

Growth and Space Management

- Japanese quail farming is highly efficient in terms of space and costs, and provides rapid returns due to the early market readiness of the quail. Cage rearing is a highly efficient method to manage large numbers of birds while keeping hygiene and growth optimized.

Turkey Farming

Turkey farming in India is gaining popularity due to the increasing demand for diversified food products. With its roots in European traditions, turkey farming is being promoted by various agricultural institutions in India, offering an alternative livelihood for small and marginal farmers.

Intensive System of Turkey Rearing

1. **Housing**: Similar to chicken, turkey houses should be located on elevated ground, preferably with cement floors for easy maintenance.
2. **Brooding Management**:
    - **Space Requirements**:
        - First 3-4 weeks: 900 cm^2 per poult.
        - 4-8 weeks: 0.135 m^2 per poult.
        - 9-12 weeks: 0.18 m^2 per poult.
        - 13-16 weeks: 0.23 m^2 per poult.
        - Post-16 weeks: 0.36 m^2 per bird.
    - **Temperature**: Start with a brooder temperature of **95°F** in the first week, reducing by 5°F weekly until it reaches **70°F**.
    - **Debeaking**: Debeak poults at around 10 days of age to reduce pecking injuries.

Feeding of Turkeys

- **Nutritional Needs**: Turkey diets have a lower energy-to-protein ratio due to their lower fat content in meat compared to chickens. Balanced feed may need to be prepared on-site as it is not as readily available commercially.
- **Feeding Challenges**: Turkey poults are slower to start feeding than chicks, requiring careful attention to ensure they find feed and water.

Nutritional Requirements by Age:

Age (weeks)	Feed Type	Crude Protein (%)	Metabolizable Energy (KCal/kg)
0 - 5	Starter diet	28	2800
6 - 8	Grower-first diet	26	2800
9 - 12	Grower-second diet	22	3000
13 - 16	Finisher diet	16	3300
13 - 24	Holding/pre-layer	12	2750

Semi-Intensive and Range Systems

- **Semi-Intensive System**: In this system, turkeys are kept in confinement during the first 4-6 weeks, then allowed to forage for part of the day. They return to a shelter at night.
- **Foraging**: Turkeys are excellent foragers and can digest fiber better than chickens, reducing feed costs by supplementing with foraged greens.

Space Allowances (Semi-Intensive System):

Age (weeks)	Shelter Space (m^2)	Open Yard Space (m^2)
7 - 12	0.09	0.18
13 - 16	0.16	0.32
17 - Market	0.22	0.45
Breeders	0.27	0.54

Disease Management in Turkeys

- **Common Diseases**:
  - **Resistant Diseases**: Turkeys are resistant to **Marek's disease** and **Infectious Bronchitis**.
  - **Mild Diseases**: **Newcastle Disease**, **Fowl Pox**, and **Coccidiosis** occur in milder forms.
  - **Significant Diseases**:

        - **Mycoplasmosis** (caused by *Mycoplasma meleagridis*): Can be transmitted through eggs and semen. Prevention includes using Mycoplasma-free breeding stock.
        - **Fowl Cholera** and **Erysipelas**: Controlled through vaccination.
- **Disease Control**:
    - Sick birds should be isolated immediately.
    - The brooder house should be thoroughly cleaned if an outbreak occurs during the brooding period. For range-raised birds, move them to clean ground.
    - **Mortality Rate**: A mortality rate of 6-10% up to maturity is considered normal under standard management.

Vaccination Schedule for Turkeys

Age (weeks)	Vaccine	Remarks
6-8	Fowl Pox Vaccine	Prevents fowl pox
7-8 months	Booster for Breeders	Prevents fowl pox
8-12	Vaccination for **Fowl Cholera** and **Erysipelas**	Immunization

Turkey Farming

- **Market Potential**: Turkey farming in India has the potential for growth as consumer demand for diversified food products increases.
- **Nutritional and Foraging Benefits**: Turkeys are excellent foragers, which reduces feed costs, especially in semi-intensive systems.
- **Disease Management**: Although generally hardy, turkey flocks must be carefully monitored for diseases like Mycoplasmosis and Fowl Cholera, with timely vaccinations.

Rearing Methods for Guinea Fowl

Guinea fowl can be reared in various systems depending on the purpose, such as meat or egg production. Here are the primary rearing methods:

1. Free Range System

- **Description**:
    - This system allows guinea fowl to roam freely during the day and use trees or night shelters for resting.
    - Free-range guinea fowl farming is popular in many countries and requires minimal infrastructure.
    - Birds forage for food during the day, supplementing their diet with insects, seeds, and plants.
- **Advantages**:

- Minimal cost for housing and feeding.
- Guinea fowl are natural foragers, which reduces feed costs.
- This system is more aligned with their wild habits, providing better welfare.

2. Semi-Free Range System

- This system involves housing guinea fowl in aviaries or enclosures with access to outdoor space but controlled by wire mesh and netting.
- For 1,000 guinea fowl chicks, a starter house of 24 m² is required for the first three weeks.
- After that, they are transferred to a rearing house (40 m²), which is equipped with perches and leads to an aviary of about 200 m².
- It is important to locate this setup on permeable soil with a slight slope to allow for water drainage.

- **For Egg-Type Guinea Fowl**:
  - The hens are often made flightless by amputating the extremity of their wings at the most distal joint, ensuring they stay within the designated area.
  - The hens lay eggs freely without the need for nests, choosing their own spots to lay eggs in their natural environment.

3. Confined Rearing System

- **Description**:
  - Guinea fowl are fully confined to indoor rearing spaces, with no outdoor access. This method is preferred for better performance in terms of meat production.
  - **For Meat Production**:
    - Batches of up to 500 birds can be housed in lighted houses with a density of 8-10 birds per m².
    - In dark houses, higher densities (up to 12 birds per m²) are allowed.
- **Layer Type Rearing**:
  - **On Soil**: The recommended density is 3-5 birds per m² in houses equipped with perches.
  - **In Battery Cages**: Breeding females are maintained in cages and artificial insemination is used to ensure fertility.

General Considerations:

- **Perches**: Perches should be provided in both semi-free and confined systems to support the birds' natural roosting behavior.
- **Water Drainage**: Good drainage in outdoor areas is crucial to avoid wet and unhealthy conditions, particularly in semi-free systems.
- **Feeding**: Guinea fowl in confined or semi-free systems need balanced feed supplements, especially when they cannot fully forage.

Optimum Conditions for Incubation of Eggs

- Incubation requires the management of several physical conditions to achieve optimum hatchability. These include:
  - **Temperature**

    - **Ventilation**
    - **Humidity**
    - **Turning of eggs**
- These conditions are vital for all bird species but may vary slightly depending on the species.

1. Temperature

- **Importance**: Temperature is the most critical factor in achieving optimum hatchability and producing strong, viable chicks. Temperature affects:
    - Hatch period
    - Size and quality of chicks
    - Embryonic mortality
    - Viability of chicks
- **Optimal Range**:
    - In a forced draft incubator, the ideal temperature for poultry eggs is around **37.5 to 37.8°C** during the incubation period up to the time eggs are transferred to the hatcher.
    - In a hatcher, the temperature is reduced slightly to **36.5°C**.
- **Effects of Incorrect Temperatures**:
    - **High Temperatures**: Can result in dull, deformed chicks (e.g., crooked necks, toes, spread legs) and delayed hatching with poor hatchability.
    - **Low Temperatures**: Lead to poor embryonic development and may cause delayed hatching.
- **Factors Influencing Temperature Variations**:
    - Egg size and shell quality
    - Breed or strain of the bird
    - Age of the egg before setting
    - Humidity levels during incubation

2. Humidity

- **Importance**: Humidity plays a crucial role in controlling the water loss from eggs during incubation, which is necessary for creating space for the growing embryo.
- **Optimal Humidity**:
    - A **relative humidity of around 55%** during incubation is ideal to prevent excessive moisture loss from eggs.
    - During hatching, humidity is increased to around **70%** to ensure proper hatching conditions.
- **Effects of Incorrect Humidity**:
    - **Low Humidity**: Causes excess water loss, leading to small, dry, and hard chicks. In severe cases, embryos may die in the shell.
    - **High Humidity**: Can produce large, soggy chicks and cause delayed hatching.
- **Weight Loss**: About **12% weight loss** from water evaporation is expected during the incubation phase.

3. Ventilation

- **Importance**: Adequate ventilation is essential for providing oxygen to the developing embryo and for the removal of carbon dioxide (CO_2).
    - The embryo's oxygen needs increase as it grows, while its CO_2 output also rises.
- **Oxygen and CO_2 Levels**:
    - Oxygen levels in the incubator should be around **21%**.
    - CO_2 levels should not exceed **0.3% to 0.5%**, as higher concentrations can cause embryonic mortality.
    - **5% CO_2** concentration is lethal to all embryos.
- **Altitude Considerations**: Hatchability is reduced in areas at high altitudes (above 3500 feet) due to lower oxygen concentration.

4. Turning of Eggs

- **Importance**: Eggs must be turned frequently during incubation to ensure proper embryo development and to prevent embryos from sticking to the shell.
- **Optimal Turning**:
    - Eggs should be turned **4-5 times a day** at an angle of **45°** from the perpendicular axis.
    - Turning stops one day before the hatching process begins, as turning is not required in the hatcher.
- **Consequences of Improper Turning**:
    - Failure to turn eggs can lead to increased embryonic mortality and deformities.

5. Setting of Eggs

- **Positioning**: Eggs should be set in an **upright position** with the broad end facing up.
    - This position helps keep the air cell in a regular spot, allowing the embryo to develop with its head toward the air cell, facilitating pulmonary respiration.
- **Effects of Reverse Setting**:
    - If eggs are set in reverse, hatchability can decrease by about **8%**, and chick quality may be compromised.

6. Transferring of Eggs to the Hatcher

- **Timing**: Chicken eggs are transferred to the hatcher after **18 days of incubation**.
    - In the hatcher, eggs are placed horizontally, and turning is no longer required.
- **Conditions in the Hatcher**:
    - Temperature: **36.7°C**
    - Humidity: **70%**
    - Adequate oxygen levels must be maintained as CO_2 levels rise due to the newly hatched chicks.
- **Hatching**: The embryo pips the shell when pulmonary respiration begins, using the **egg tooth**, a small projection on its beak, to break through the shell.

Nutrient Requirements for Poultry

Poultry raised in an intensive rearing system requires a complete feed that includes all essential nutrients. Nutrient requirements vary based on:

- **Species**
- **Breed/variety**
- **Age**
- **Purpose of rearing** (meat, eggs, breeding)
- **Environment** and rearing system

Feed Quality: A high-quality feed must contain all the essential nutrients in the right proportions. In India, the **Bureau of Indian Standards (BIS)** sets the nutrient requirements for chicken feed. For other poultry species, standards from organizations like the **National Research Council (NRC)** or the **Agricultural Research Council (ARC)** are followed.

4. Feed Supplements and Additives

Feed additives or supplements are substances added to poultry feed to improve feed quality, bird performance, and overall health. These can be classified as:

a. Nutrient Feed Supplements

- **Vitamin Supplements**: Include fat-soluble vitamins (A, D3, E, K) and water-soluble vitamins (B-complex and C).
- **Mineral Supplements**: Include both macro-minerals (e.g., calcium, phosphorus) and micro-minerals (e.g., zinc, manganese).
- **Essential Amino Acids**: Include lysine, methionine, and tryptophan.
- **Protein Hydrolysates**: Pre-digested proteins such as hydrolyzed feather meal.
- **Liver Extracts and Yeast**: Provide nutrients and digestive enzymes.

b. Non-Nutrient Feed Supplements

These additives help improve the overall efficiency of feed, maintain health, and prevent diseases. They include:

- **Antioxidants**: To prevent feed rancidity.
- **Preservatives**: To protect feed from microbial growth.
- **Color Enhancers**: To improve the appearance of egg yolk or meat.
- **Digestive Enzymes**: To enhance nutrient absorption.

5. Functions of Feed Additives

Feed additives serve multiple purposes:

- **Enhance feed quality and efficiency**.
- **Promote growth and egg production**.
- **Boost the immune system** and protect birds from diseases.
- **Improve feed palatability** and prevent spoilage.

- **Prevent nutritional imbalances** and deficiency diseases.

Non-Nutrient Feed Additives in Poultry

Non-nutrient feed additives are substances added to poultry feed that do not directly provide nutritional benefits but enhance feed quality, improve bird health and performance, and prevent feed spoilage. These additives are critical in managing diseases, reducing stress, and improving the efficiency of digestion and nutrient absorption.

Classification, Uses, and Examples of Non-Nutrient Feed Additives

Non-nutrient feed additives can be classified based on their function and purpose:

1. **Antibiotic Feed Supplements**:
    - **Purpose**: Control sub-clinical bacterial infections, enhancing performance.
    - **Examples**: Tetracyclines, lincomycin, tylosin, erythromycin, bacitracin, flavomycin, and virginiamycin.
    - **Note**: The use of probiotics has limited the usage of antibiotics due to concerns about antibiotic resistance.
2. **Non-Antibiotic Antimicrobial Feed Supplements**:
    - **Purpose**: Control bacterial infections without using antibiotics.
    - **Examples**: Furazolidone, chlorhydroxyquinoline.
3. **Antimycotic Agents**:
    - **Purpose**: Prevent the growth of mould and the production of toxins in feed.
    - **Examples**: Copper sulphate, gentian violet, propionic acid, calcium propionate, and sodium benzoate.
4. **Coccidiostats**:
    - **Purpose**: Prevent outbreaks of coccidiosis, a common parasitic infection.
    - **Examples**: Dinitro-ortho-toluamide, salinomycin, robenidine, nicarbazine, monensin, and maduramycin.
5. **Anti-Parasitic Additives**:
    - **Purpose**: Control parasitic infestations.
    - **Examples**: Dichlorophan, niclosamide, praziquantel.
6. **Antioxidants**:
    - **Purpose**: Prevent oxidative rancidity of fats and oils in the feed.
    - **Examples**: BHT (Butylated Hydroxytoluene), BHA (Butylated Hydroxyanisole), and Ethoxyquin.
7. **Enzymes**:
    - **Purpose**: Aid digestion by breaking down feed components like proteins, fats, and carbohydrates.
    - **Examples**: Protease, lipase, cellulase, amylase, phytase, and pectinase.
8. **Hormones**:
    - **Purpose**: Promote growth, improve feed efficiency, and increase egg production.
    - **Examples**: Caseated iodine, melengestrol acetate, ethylestranol, stanazol.
9. **Arsenicals**:
    - **Purpose**: Improve growth rate, feed efficiency, and carcass quality.

    - **Examples**: 3-Nitro-4-hydroxyphenyl arsanilic acid.
10. **Adsorbents**:
    - **Purpose**: Bind toxins in the feed, preventing their absorption in the intestines.
    - **Examples**: Zeolites, activated charcoal.
11. **Pellet Binders**:
    - **Purpose**: Facilitate feed pelleting, making it easier for birds to consume and reduce feed wastage.
    - **Examples**: Bentonite, sodium alginate, carboxymethyl cellulose, gelatin, lignosulfonate, carrageenan, guar gum.
12. **Deodorising Agents**:
    - **Purpose**: Reduce the production of ammonia in the litter.
    - **Example**: Yucca extract.
13. **Flavouring Agents**:
    - **Purpose**: Improve the palatability of feed, thereby increasing feed intake.
    - **Examples**: Essential oils, fish oils.
14. **Pigments**:
    - **Purpose**: Enhance the colour of feed, egg yolks, and bird skin.
    - **Examples**: Canthaxanthin, lutein, zeaxanthin.
15. **Herbal Preparations**:
    - **Purpose**: Improve liver function, boost appetite, and increase resistance to diseases.
    - **Examples**: Extracts from herbs.
16. **Performance Boosters**:
    - **Purpose**: Enhance overall bird performance.
    - **Examples**: Nitrovin, avoparcin.
17. **Immuno-Stimulants**:
    - **Purpose**: Boost immune responses and enhance resistance to diseases.
    - **Examples**: Tetrahydrophenylimidazole, immogen, levamisole.
18. **Miscellaneous Additives**:
    - **Purpose**: Perform specific functions to improve feed or bird health.
    - **Examples**: Electrolytes, egg-up, egg toner.

Probiotics (Direct-Fed Microbials - DFM)

Probiotics are live microbial feed supplements that beneficially affect the host by improving intestinal microbial balance. Probiotics typically consist of bacteria, fungi, or yeast and are added to poultry feed to enhance overall health and performance.

- **Common Probiotic Preparations**:
    - **Bacteria**: Strains of *Lactobacillus*, *Leuconostoc*, *Bifidobacterium*, *Pediococcus*, and *Streptococcus*.
    - **Fungi**: Strains of *Aspergillus*.
    - **Yeast**: Strains of *Saccharomyces*.
- **Mechanism of Action**:
    - Probiotics suppress the growth of harmful bacteria like *Escherichia coli* by producing antibacterial compounds and competing for nutrients and adhesion sites in the intestines.

- Probiotics enhance growth rates, egg production, and reproductive performance, particularly in stressed birds.

B.I.S. Specifications for Chicken (IS - 1374-1994)

The **Bureau of Indian Standards (B.I.S.)** and **National Research Council (NRC)** have set specifications for the nutrient requirements of various poultry species to ensure optimal growth, production, and health. These standards guide poultry farmers and feed manufacturers in formulating balanced diets for different types of birds, including chickens, turkeys, ducks, Japanese quails, and guinea fowls. Below is an overview of the **B.I.S. specifications for chicken** and the **NRC nutrient requirements** for turkeys, ducks, quails, and guinea fowls.

B.I.S. Specifications for Chicken (IS - 1374-1994)

- **Moisture**: Max 11% for all types of feed.
- **Crude Protein**: Ranges from 16% (Grower Feed) to 23% (Broiler Starter Feed).
- **Crude Fibre**: Max 6-8% depending on the feed type.
- **Calcium**: Min 1% for Chick Feed, Grower Feed; 3% for Layer and Breeder Feed.
- **Methionine**: Min 0.25% (Grower Feed) to 0.5% (Broiler Starter Feed).
- **Metabolizable Energy (ME)**: 2500-2900 Kcal/kg depending on the feed type.
- **Vitamins and Minerals**: Essential vitamins like A, D3, E, K, and minerals like Manganese and Zinc are included in specific concentrations to promote optimal growth and production.

NRC Nutrient Requirements for Poultry

1. **Turkeys (Males and Females)**
   - **Protein**: Ranges from 12% (Holding Diet) to 28% (Starter Diet).
   - **ME**: Increases from 2800 Kcal/kg (0-4 weeks) to 3300 Kcal/kg (20-24 weeks).
   - **Calcium**: 0.5% for holding diet; 2.25% for layers.
2. **Ducks**
   - **Protein**: 15-22% based on the age and production stage.
   - **ME**: Ranges from 2900-3000 Kcal/kg depending on the stage.
   - **Calcium**: 0.60% (Breeding) to 2.75% (Breeding).
   - **Vitamins**: Vitamin A (2500-4000 IU/kg), Vitamin D3 (400-900 IU/kg).
3. **Japanese Quail**
   - **Protein**: 20-24% based on growing or breeding phase.
   - **ME**: 2900 Kcal/kg for both stages.
   - **Vitamins**: Vitamin A (1650-3300 IU/kg), Vitamin E (12-25 mg/kg), Vitamin D3 (750-900 IU/kg).
4. **Guinea Fowl**
   - **Crude Protein**: Ranges from 17% (Grower) to 24.5% (Pre-Brooder).
   - **ME**: 2650-2850 Kcal/kg depending on the stage.
   - **Calcium**: 1.1% (Grower) to 3.41% (Layer).
   - **Lysine**: 0.84% to 1.45%.

1. Composition of milk and its affecting factor

Milk: whole, fresh, clean, lacteal secretion obtained by the complete milking of one or more healthy milch animals, excluding that obtained within 15 days before or 5 days after calving, colostrum-free, and containing the minimum prescribed percentage of milk fat and milk solid not fat (FSSR, 2011)

Market milk refers to whole fluid milk that is sold directly to consumers for drinking and is not used for further processing or manufacturing of dairy products.

Composition and Properties of Milk

- Water: 85-88%
- Total Solids: 12-15%
- Fat: 4-6%
- Proteins: 3.3% (Casein 82%, Whey Proteins 18%)
- Lactose: 4.9%
- Minerals and Vitamins: Includes calcium, potassium, and vitamins A, D, E, K.

	Water	Fat	Protein	Lactose	Ash
Cow	86.6	4.6	3.4	4.9	0.7
Buffalo	84.2	6.6	3.9	**5.2**	0.8
Sheep	79.4	**8.6**	**6.7**	4.3	1.0
Goat	86.5	4.5	3.5	4.7	0.8
Sow	89.6	4.8	1.3	3.4	0.9
Mare	89.1	**1.6**	2.7	**6.1**	0.5
Ass	90.0	**1.3**	1.7	**6.5**	0.5

Type of Milk	Fat % (min)	SNF % (min.)
Cow milk	3.5	8.5
Buffalo Milk	5	9
Standardized milk	4.5	8.5
Toned milk/ Recombined milk	3	8.5

Double Toned milk	1.5	9
Skim milk	0.5 max	8.7

Milk Fat:

- Milk fat is the most variable and economically important constituent of milk.
- It exists primarily in the form of glycerides, with **triglycerides** being the most common type.
- **Milk fat is an oil-in-water type emulsion**, present as fat globules ranging from 0.1 to 22 microns in size, with an average size of **2 to 5 microns** (1-5 microns in cows and 3-8 microns in buffaloes).

The fatty acids in milk fat can be categorized as:

- **Saturated fatty acids (65%)**
- Monounsaturated fatty acids (MUFA) (30%)
- Polyunsaturated fatty acids (PUFA) (5%)

Milk fat can be divided into two main categories:

- True fat (98-99%), which consists of the most common triglycerides
- Associated fat (1-2%), which includes:
  - Phospholipids (lecithin, cephalin, and sphingomyelin)
  - Steroids and cholesterol
  - Fat-soluble vitamins (A, D, E, K)
  - Pigments (carotene and xanthophyll)

PROTEINS

Milk proteins primarily consist of **casein** (82%) and **whey proteins** (18%). They exist in a colloidal form, which scatters light and gives milk its characteristic white color.

- ## Casein:
  - Comprises about 3% of cow's milk and 4.3% of buffalo milk.
  - Found as a calcium caseinate phosphate complex.
  - Contains phosphorus and coagulates at a pH of 4.6.
- ## Whey Proteins:

- Do not contain phosphorus and remain soluble in milk at a pH of 4.6.
- The principle of coagulation at reduced pH is fundamental to cheese and curd formation.
- Additionally, riboflavin contributes to the color of whey proteins, while casein is responsible for the white color of milk.

Casein:

Caseins in milk form complexes known as **micelles**, which are dispersed as a colloidal suspension in the water phase of milk, primarily as a **calcium caseinate phosphate complex**.

- **Composition of Casein Micelles**:
    - Consist of subunits from different types of caseins: **α, ß, and γ**.
    - **ß-casein** is divided into two parts: **A1** and **A2**, differentiated by the 67th amino acid (A1 has histidine, while A2 has proline). A1 protein upon digestion produces beta casoporphin-7 (BCM-7) which has adverse health properties.
- **Characteristics**:
    - Casein micelles are spherical in shape and range from **0.04 to 0.3 µm** in diameter.
    - **Kappa casein** is the specific site where rennin acts during cheese-making.
- **Uses**:
    - The adhesiveness of milk, attributed to casein, makes it useful in glue production.

WHEY/ Serum Proteins:

Whey proteins account for about **18%** of the total protein content in milk, primarily consisting of:

- **ß-lactoglobulin** (approximately **50%**)
- **α-lactalbumin** (about **20%**)
- Other components include **blood serum albumin**, **immunoglobulins**, **lactoferrin**, **transferrin**, and various minor proteins and enzymes.

Functions of Key Whey Proteins:

- **ß-lactoglobulin**: Acts as a carrier for **vitamin A**.
- **α-lactalbumin**: Plays a critical role in the synthesis of **l actose**.
- **Lactoferrin and Transferrin**: Involved in the absorption and transportation of **iron**.
- **Immunoglobulins**: The major type is **Ig G1**, which contributes to immune function.

Whey proteins are present in milk as a **colloidal solution**, contributing to the nutritional and functional properties of milk.

CARBOHYDRATES:

Lactose is the sugar found in milk, composed of **glucose** and **galactose**. **It exists as a true solution in the milk serum and is the least variable component of milk.**

- Lactose plays a crucial role in the **absorption of calcium** and **phosphorus** from the intestine.

Chemical Reactions Involving Lactose

- **Maillard Reaction**: This reaction occurs at ultra-high temperatures between lactose and the amino acid **lysine** in milk, leading to browning and flavor changes.
- **Isomerization**: Lactose can be converted to **lactulose,** which has laxative properties and potential antineoplastic effects.

Forms of Lactose

- Lactose exists in two anomeric forms: **α-lactose** and **ß-lactose**.
- The **α-monohydrate lactose** crystals contribute to the sandy texture found in products like **ice cream** and **condensed milk**.

VITAMINS AND MINERALS:

- **Mineral Content**:
    - **Good Sources**: Milk is a good source of calcium (Ca), phosphorus (P), sodium (Na), potassium (K), and magnesium (Mg).
    - **Poor Sources**: It is a poor source of iron (Fe) and copper (Cu).
    - The **calcium to phosphorus (Ca:P)** ratio in bovine milk is approximately **1:2**.
- **Vitamin Content**:
    - **Good Sources**: Milk is rich in the **Vitamin B complex**.
    - **Poor Sources**: It is a poor source of **Vitamin C** and **Vitamin K**.

MILK ENZYMES:

- **Lipoprotein Lipase**:
    - **Type**: Major lipase.
    - **Association**: Linked with casein micelles and fat globule membranes (FGM).
    - **Function**: Plays a role in the digestion of milk fats.
- **Plasmin**:
    - **Type**: Major protease.
    - **Association**: Associated with casein micelles.
    - **Function**: Contributes to desirable flavor and texture in cheese.
- **Alkaline Phosphatase**:
    - **Type**: Heat-sensitive enzyme.
    - **Function**: Used as an indicator of pasteurization. It can cause oxidation and rancidity of fats in milk.
- **Lactoperoxidase**:
    - **Location**: Present in milk serum.

    - **Function**: Exhibits antibacterial properties, helping to preserve milk.

- **Catalase**:
    - **Significance**: Generally insignificant in normal milk.
    - **Function**: Increased concentrations may indicate udder infection.
- **Lysozyme**:
    - **Amount**: Present in very limited quantities in bovine milk.
    - **Function**: Has antibacterial properties, contributing to milk's natural defense mechanisms.

PIGMENTS & GASES:

Carotene: Responsible for the **yellowish color** of cow's milk.

- In buffalo milk, carotene is converted to **Vitamin A** by the enzyme **carotenase**.
- **Carotene Content**:
    - Cow milk: **30 µg/g**
    - Buffalo milk: **0.25 - 0.48 µg/g**

- **Riboflavin** (also known as lactochrome or lactoflavin):
    - Contributes to a **greenish tinge** in whey.

Gases in Milk: Carbon Dioxide (CO_2), Nitrogen (N_2), Oxygen (O_2)

Nutritive value

- **Cow Milk**: **Energy**: 75 kcal per 100 g
- **Buffalo Milk**: **Energy**: 100 kcal per 100 g

Nutritional Composition

- **Energy Contribution**:
    - **Milk Fat**: 9.3 kcal/g
    - **Protein**: 4.1 kcal/g
    - **Sugar (Lactose)**: 4.1 kcal/g

Cholesterol Content

- **Cow Milk**: 3.14 mg/g
- **Buffalo Milk**: 0.65 mg/g

Vitamins and Minerals

- **Vitamins**: Good source of vitamins, except for **Vitamin C** and **Vitamin K**.
- **Minerals**: Good source of minerals, except for **Iron (Fe)** and **Copper (Cu)**.

Factors affecting milk yield & composition

1. **Species**: Different species of dairy animals (e.g., cows, buffalo, goats) produce milk with varying compositions, including fat, protein, and lactose content.
2. **Breed**: Within a species, different breeds (e.g., Holstein, Jersey, Guernsey for cows) have distinct milk characteristics, such as fat content and protein levels. **Holstein Friesian (HF)**: Known for the **highest milk yield per lactation** but has the **lowest milk fat content**.

Highest Milk Fat:

- **Exotic Breeds**: Jersey cows have a high milk fat content of approximately **5.5%**.
- **Indian Breeds**: The Red Sindhi breed is noted for its higher fat content.
- **Buffalo**: The **Bhadawari breed** is recognized for having exceptionally high milk fat content, reaching around **14%**

3. **Individuality**: Each animal has unique genetic traits that can affect milk yield and composition. Individual differences can result from genetics, health, and environmental factors.

4. **Interval of Milking**: The time between milking sessions can influence milk composition. Longer intervals may lead to increased fat and protein concentration due to the accumulation of milk in the udder.

5. **Frequency of Milking**: More frequent milking can lead to lower milk fat content, while less frequent milking may increase fat concentration due to higher milk accumulation.

6. **Disease and Abnormal Conditions**: Health issues such as mastitis or metabolic disorders can significantly alter milk composition, often resulting in increased somatic cell counts and changes in fat and protein levels.

7. **Portion of Milking**:

- **Fore Milk**: The initial milk released, which is usually lower in fat and higher in lactose.
- **Stripping**: The last portion of milk, which tends to be richer in fat and proteins.

8. **Stage of Lactation**: The stage of lactation affects milk composition. Early lactation milk (colostrum) is rich in antibodies, while milk later in lactation may have higher fat content.

9. **Feeding**: The diet of the dairy animal impacts milk quality. High-quality forage and balanced rations can enhance milk composition, while poor nutrition can lead to deficiencies.

10. **Season**: Seasonal changes can affect milk production and composition. For example, summer heat may stress animals and reduce milk yield, while winter feeding practices may alter nutrient intake.

11. **Age**: The age of the animal can influence milk production and composition. Mature cows typically produce more milk with a different fat and protein profile compared to younger cows.

12. **Condition of Cow at Calving**: The body condition of the cow at calving can affect milk yield and quality. Cows in good condition tend to have better milk production and composition.

13. **Administration of Drugs and Hormones**: The use of certain medications or hormones can impact milk composition, either positively or negatively. For instance, hormones can increase milk production, while some drugs may affect milk quality.

2.physio-chemical and nutritional characters of milk and milk products

1.Physico-Chemical Properties of milk

1. Acidity and pH

- Amphoteric Nature: Freshly drawn milk is amphoteric, meaning it can act as both an acid and a base. This is due to the presence of amino acids that exist in a zwitterionic form.
- **pH Levels:**
    - Overall Milk pH: Approximately 6.6.
    - Cow Milk: Ranges from 6.4 to 6.6.
    - Buffalo Milk: Ranges from 6.7 to 6.8.

Variations: The pH of milk will be higher in cases of mastitis (inflammation of the mammary gland). The pH will be lower in colostrum (the first milk produced after calving, rich in antibodies).

Buffering Action: Milk has a buffering capacity that helps maintain its pH, which is critical for its stability and quality. The buffering action is provided by:

- Proteins
- Phosphates
- Citrates and Carbon Dioxide (CO_2)

Titratable Acidity in Milk: Titratable acidity is the total acidity present in milk, which can be divided into two components:

1. **Natural or Apparent Acidity**:
    - Freshly drawn milk has some inherent acidity due to its constituents like casein, acid phosphates, citrates, and carbon dioxide (CO_2) present in the solids-not-fat (SNF) portion.
    - Typical values for natural acidity:
        - Cow milk: 0.13 to 0.14%
        - Buffalo milk: 0.14 to 0.15%
2. **Real or Developed Acidity**: This acidity develops due to the formation of lactic acid by bacterial fermentation of lactose.

The total titratable acidity is the sum of these two components:

Titratable Acidity = Natural Acidity + Developed Acidity

Color of Milk and Its Components

- **White Color:** Milk appears white due to the scattering of light by colloidal particles, primarily casein micelles.
- **Yellow Color:** The yellow color of milk is attributed to the presence of carotene pigments.
    - The intensity of the yellow color increases when cows are fed green fodder, as it is rich in carotene.
    - Buffalo milk appears white in color due to the absence of carotene, which is converted to vitamin A.
- **Greenish-Yellow Color:** Addition of dilute acid or rennet to milk results in a distinct greenish-yellow color due to the precipitation of casein, revealing the underlying pigment riboflavin.
- **Whey Color:** Whey appears greenish-yellow due to the presence of riboflavin.
- **Skim Milk Color:** Skim milk has a bluish tinge, attributed to the presence of lactochrome.

Sensory Properties of Milk

- **Taste and Smell Interaction**: The sensory property of milk is significantly influenced by both taste and smell, making it essential for overall evaluation.
- **Sweet Taste**: The sweetness in milk is primarily due to lactose, which contributes to its flavor profile.
- **Salty Taste**: The presence of chloride is responsible for the salty taste, particularly noticeable in mastitic milk and during the late stages of lactation.
- **Richness in Taste**: The richness is attributed to phospholipids, which enhance the flavor experience.
- **Cooked Flavor**: A cooked flavor can develop due to the presence of sulfhydryl compounds, often resulting from overheating during processing.
- **Cowy Flavor**: This flavor is associated with ketosis, where the presence of acetone contributes to the off-flavor.
- **Barny Flavor**: A barny flavor may arise from poor ventilation during storage or processing.
- **Malty Flavor**: The *Streptococcus lactis var. maltigenes* bacteria can produce a malty flavor, affecting the sensory quality of milk.

DENSITY & SPECIFIC GRAVITY

Density Measurement

- **Pycnometer:** A glass or metal container with a precisely determined volume, used for determining the density of liquids by weighing the defined volume.

- **Hydrostatic balance:** Also known as a Mohr balance, it is a reliable and precise method used by national metrology institutes as the primary method for density measurement.

Specific Gravity Measurement

- **Lactometer:** Used for measuring the density (creaminess) of milk. It is based on the Archimedes principle, where the lactometer sinks deeper in less dense samples.

Types of Lactometers:

  - Quevenne lactometer
  - Zeal's lactometer

- **Specific gravity: 1+ CLR/1000** Where CLR is the corrected lactometer reading

Typical Values

- **Cow milk:** 1.028 to 1.030
- **Buffalo milk**: 1.030 to 1.032
- **Skim milk**: 1.035 to 1.037
- **Colostrum:** Around 1.070 due to high total solids content

Other Points

- Milk fat is the lightest constituent of milk
- Milk is heavier than water due to the presence of milk solids

Factors Affecting Specific Gravity

- **Increased Specific Gravity**:
  - Addition of **skim milk**.
  - Removal of **fat**.
  - Lowering the **temperature** of the milk.
- **Lowered Specific Gravity**:
  - Addition of **water**.
  - Addition of **cream**.
  - Increasing the **temperature** of the milk.

Recknagel Phenomenon

- The Recknagel phenomenon refers to the observed increase in the specific gravity of fresh milk over time, typically by 0.001, due to the hydration of proteins. This phenomenon indicates that the density of milk measured immediately after milking is lower than that of milk stored for a longer period.

Measurement Recommendations

- For accurate determination of specific gravity, it is recommended to measure SG 1 hour after milking.
- The milk should be heated to 40 °C and then cooled before measurement to ensure consistency and accuracy.

Freezing Point Depression (FPD)

- refers to the decrease in the freezing point of a solvent (in this case, milk) caused by the addition of a solute (such as lactose, proteins, and minerals).
- FPD is measured using a **Hortvet Cryoscope**, which accurately determines the freezing point of milk.

Average Freezing Points

- **Cow Milk**: Average FPD is approximately **-0.547°C**.
- **Buffalo Milk**: Average FPD is approximately **-0.549°C**.

Effects of Water Addition

- **Addition of Water**: When water is added to milk, the freezing point moves closer to **0°C**. Specifically, the freezing point increases by **0.006°C for every 1% of water added**.
    - It is possible to detect the addition of up to **3% water** in milk based on changes in the freezing point.

Effects of Heat Treatment

- **Boiling and Sterilization**: Both processes increase the freezing point depression of milk.
- **Pasteurization**: This process has no significant effect on the freezing point depression of milk.

Surface Tension:

Surface tension is the stress at the surface of a liquid, which affects how the liquid behaves in various conditions.

Surface Tension Value:

- The surface tension of milk at 20 °C is approximately 54.5 dynes/cm.
- As the temperature increases, surface tension decreases. For example, at 60 °C, it ranges from 40 to 45 dynes/cm.

Measurement Methods:

- Falling drop method
- Platinum ring method

- **Comparison with Water**: The surface tension of milk is lower than that of water, primarily due to the presence of proteins in milk.
- **Factors Affecting Surface Tension**: The presence of fat, acidity, and the process of churning all contribute to lowering the surface tension of milk.

Oxidation-Reduction Potential (ORP)

The oxidation-reduction potential of milk ranges from + 0.2 to + 0.3 volts.

- Tests such as the MBRT (Methylene Blue Reduction Test) and the Resazurin test are based on ORP to assess milk quality.

Viscosity

- The viscosity of milk is measured between **1.5 to 2 centipoises:**
  - **Cow Milk:** Approximately 2 centipoises.
  - **Buffalo Milk:** Approximately 1.8 centipoises.
  - **Skim Milk:** Approximately 1.5 centipoises.
- Viscosity in milk is primarily due to the presence of casein and fats.
- Homogenization increases viscosity by promoting a uniform distribution of fat molecules.

Boiling Point: The boiling point of milk is slightly elevated, ranging from 100.15 to 100.17 °C.

Refractive Index: The refractive index of milk is measured using a Zeiss refractometer, with values ranging from 1.344 to 1.348.

3.processing of raw milk and production of market milk

Pasteurization

- It is process of heating every particle of milk to at least 63°C for 30 min or 72°C for 15s or to any temperature-time combination which is equally efficient, in properly operated equipment.
- After pasteurization, the milk is immediately cooled to 5°C or below.
- started by **Louis Pasteur in Wine and Dr. Soxhlet in milk**

Importance of Pasteurization

1. Safety for Human Consumption

- **Destruction of Pathogens**:
  - Pasteurization effectively destroys pathogenic microorganisms that can cause foodborne illnesses.
  - This includes harmful bacteria such as like Coxiella burnetti.
  - By eliminating these pathogens, pasteurization makes milk safe for human consumption.

2. Improved Keeping Quality

- **Reduction of Spoilage Organisms**:
  - Pasteurization kills a significant percentage of spoilage organisms (approximately **85-99%**).
  - This helps extend the shelf life of milk and maintains its quality during storage and distribution.

- By reducing microbial load, pasteurized milk is less likely to spoil quickly, making it more suitable for consumers.

Drawbacks of Pasteurization

1. Diminished Cream Line or Cream Volume

Denaturation of Cryoglobulins (IgM):

- Pasteurization can lead to the denaturation of cryoglobulins, which affects the cream line or cream volume in milk.
- This can result in a less appealing appearance and texture, particularly for consumers who prefer milk with a rich cream layer.

2. Increased Renneting Time

- **Impact on Cheese Production**:
  - Pasteurized milk may increase the renneting time, which is the time it takes for milk to coagulate during cheese production.
  - This can affect the efficiency of cheese-making processes and may require adjustments in production techniques.

3. Incomplete Destruction of Bacterial Toxins

- **Survival of Toxins**:
  - While pasteurization effectively kills many microorganisms, it does not destroy all bacterial toxins that may be present in the milk.
  - This means that if milk is contaminated with certain bacteria that produce heat-stable toxins, those toxins can still pose a risk to consumers.

4. Accumulation of Milk-Stone:

- The heating section of pasteurization equipment can experience the accumulation of milk-stone, which is a deposit formed by minerals and proteins.
- This buildup can affect the efficiency of the equipment, require regular maintenance, and potentially lead to contamination if not properly managed.

1. Batch or holding pasteurization (LTLT)	**63 ° C for 30 minutes**
2. High Temperature Short Time (HTST) pasteurization/ Flash pasteurization	72 ° C for 15 sec
3. Electric pasteurization	Using electricity for 15-20 sec
4. Vacuum pasteurization (vacreation)	under reduced pressure by direct steam

5. Ultra high temperature pasteurization	135 ° C to 150 ° C for no hold
6. In- bottle pasteurization	63-66 ° c for 30 minutes
7. Stassanization	74 ° c for 7 sec
8. Uperization/ultra – pasteurization	150 ° c for a fraction of a second

Batch Pasteurization Process

- In batch pasteurization, milk is heated to a minimum temperature of **62.7°C** (approximately **144.9°F**) and held at this temperature for a minimum of **30 minutes**.
- After this holding period, the milk is rapidly cooled to **4°C** (39.2°F) or below to inhibit the growth of any surviving microorganisms.

Batch pasteurizers can be classified into three main types:

- **Water-Jacketed Vat**: This type utilizes hot water that circulates around the vat to maintain the desired temperature. The design ensures even heating and effective thermal transfer.
- **Water-Spray Type**: In this system, hot water is sprayed onto the milk container's exterior, providing rapid and uniform heating. This method is efficient for smaller batches.
- **Coil-Vat Type**: This design features coils through which hot water flows, heating the milk directly as it passes through the coils. It allows for effective heat exchange and is commonly used in small-scale operations.

High Temperature Short Time (HTST) pasteurization

is the most widely used modern method for pasteurizing milk. It involves heating milk to a minimum temperature of **72°C (161.6°F)** for at least **15 seconds**, followed by rapid cooling.

HTST Process

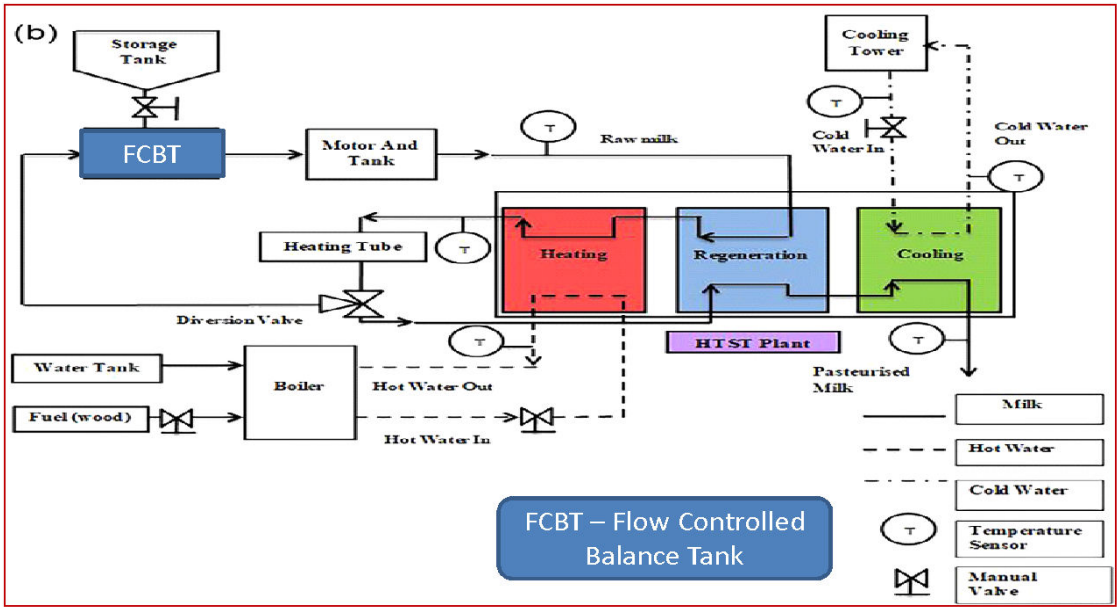
- **Cold raw milk** (4°C or 39.2°F) enters the pasteurization plant.
- The milk passes through the **regenerative heating section** of a plate heat exchanger. This section consists of stainless steel plates stacked together with spaces in between, forming chambers. Cold raw milk flows through the "A" chambers, while hot pasteurized milk flows through the "B" chambers. Heat from the hot milk is transferred to the cold milk through the steel plates, warming it to 57-68°C (134.6-154.4°F).
- The partially heated milk then enters the **heating section**, where hot water or steam in the "B" chambers raises the milk temperature to at least **72°C (161.6°F)**, the minimum for HTST pasteurization.

- The hot milk is held in a **holding tube** for about **15 seconds**, fulfilling the time requirement for HTST pasteurization.
- After the holding tube, the **pasteurized milk** passes back through the regenerative section, where it warms the incoming cold raw milk, cooling itself to around 32°C (89.6°F).
- Finally, the milk enters the **cooling section**, where chilled water or glycol further cools it to 4°C (39.2°F) or below before packaging.

Pressure Considerations

- **Pasteurized milk** is maintained at a pressure of around **15 psi** to prevent boiling.
- **Raw milk** pressure is slightly lower at **14 psi**.
- The **heating and cooling media** (water/steam/glycol) are maintained at 12-13 psi.

Regeneration Efficiency: The efficiency of the regenerative heating and cooling section is typically **85-90%**.



Pasteurization ensures **complete destruction of pathogens**, **negative alkaline phosphatase test** and least damage to the cream line.

Index organism for pasteurization: Coxiella burnetti

Keeping quality of milk after Pasteurization at 4°C: 4-7 days

Vacuum pasteurization, also known as **vacreation**, is a specialized method used primarily for pasteurizing cream under reduced pressure. This technique enhances the efficiency of heat treatment while preserving the quality of the cream. Here's an overview of the process and its parameters.

Vacuum Pasteurization (Vacreation)

Process Overview

- **Equipment**: The equipment used for vacuum pasteurization is called a **Vacreator**. This device operates under a vacuum to allow for effective pasteurization at lower temperatures, which helps retain the cream's flavor and quality.
- **Heating Method**: The cream is pasteurized by direct contact with steam while under reduced pressure. This method allows the cream to reach the required pasteurization temperature quickly without excessive thermal damage.

Benefits of Vacuum Pasteurization

- **Improved Quality**: The vacreation method helps maintain the flavor and nutritional quality of cream better than traditional pasteurization methods, leading to higher quality butter production.
- **Enhanced Shelf Life**: By effectively reducing microbial content, vacuum pasteurization extends the shelf life of cream and butter products.
- **Flavor Preservation**: The lower temperatures used in vacuum pasteurization help preserve the delicate flavors of cream, which can be affected by higher temperatures in conventional pasteurization methods.

- **Thermization** The milk is typically heated to a minimum of **62°C to 65°C** (approximately **144°F to 149°F**) for **15 to 20 seconds**. It helps reduce microbial load while preserving the sensory attributes.

Sterilization

Sterilization is a more intense heat treatment aimed at ensuring the long-term preservation of milk:

- **Temperature and Time**: Sterilization can involve heating to **115°C** (239°F) for **15 minutes** or **145°C** (293°F) for **3 seconds**. These conditions are designed to eliminate all viable microorganisms, allowing the milk to be stored at room temperature for at least **15 days**.
- **Quality Check**: Sterilized milk must pass a **negative turbidity test**, indicating that it is free from microbial contamination.
- **Loss of nutrients:** In Pasteurization, 10% Vitamin B1 and 20% of Vitamin C is lost while in Sterilization 30-50% Vitamin B1 and 50% of Vitamin C lost.

Bactofugation: process of removal of microorganisms from milk using centrifugal force. Most of the microorganisms are inactivated by pasteurization. However, the highly heat resistant spores survive pasteurization. It is special form of separation of microorganisms (99%), mainly spore formers (Bacilli/Clostridia).

Homogenization of Milk

Homogenization is a mechanical process used in the dairy industry to create a stable emulsion by breaking down fat globules in milk into smaller sizes (typically less than **2 µm**) and distributing them evenly throughout the milk serum. This process prevents cream separation and improves the overall quality of milk.

Key Features

- **Increased Surface Area**: The homogenization process increases the surface area of fat globules by **four- to six-fold**, enhancing the texture and mouthfeel of the milk.
- **No Cream Separation**: after homogenization, cream can not be separated from the milk, ensuring a consistent product.

Principle of Homogenization

- **High Pressure Application**: Milk is forced through a narrow valve at high pressure, typically between **150 to 200 bar** (15-20 MPa), with an additional **5-10 MPa** in a two-stage homogenization process.
- **High Velocity**: The milk travels at velocities of **100 to 200 m/s**, generating:
    - **High Shearing Stresses**: These stresses deform the fat globules.
    - **Cavitation**: The formation and collapse of vapor bubbles contribute to the breakup of fat globules.
    - **Micro-Turbulence**: Enhances mixing and distribution of fat globules.
- **Deformation and Breakup**: The fat globules become deformed and wavy before breaking apart into smaller sizes.

Temperature Control

- **Inactivation of Lipase**: The process is conducted at temperatures of **65-70°C** to inactivate lipase enzymes, preventing rancidity and ensuring the stability of the milk.

Efficiency of pasteurizarion:

Scharer Rapid Phosphatase Test

- method used to assess the effectiveness of pasteurization in milk and dairy products by detecting the presence of alkaline phosphatase, an enzyme naturally found in raw milk that is destroyed during proper pasteurization.
- The test involves adding a substrate that alkaline phosphatase can hydrolyze; leading to a color change to blue that can be measured.
- The intensity of the color produced correlates with the enzyme's activity, indicating the level of pasteurization.

4.Indian dairy products

Dahi/ Curd:

- Sweet Dahi with acidity < 0.7%
- Sour Dahi with acidity around 1%
- Sweetened Dahi: by adding 6.25% cane sugar

Starter culture for sweet dahi*:* *Streptococcus lactis, Str. cremoris*, *Str. diacetalactis*

Starter culture for sour dahi*:* same as above along with *Lactobacillus bulgaricus and Str. Thermophilus*

Flavor due diacetyl (obtained from mother compound acetyl methyl carbinol)

Sweetened Dahi: Misti Dahi or Lal Dahi:

- is a popular sweetened yogurt from the eastern region of India, particularly Bengal.
- This traditional dessert is characterized by its brown color and cooked, caramelized flavor, making it a favorite among many.
- **Color and Flavor**: Misti Dahi has a distinctive brown color due to the caramelization of sugar, which also imparts a cooked, rich flavor to the yogurt.

- **Sugar Content**: The recipe typically involves the addition of **6.25% cane sugar**, which contributes to its sweetness and enhances the overall taste.

Shrikhand:

- sweetened-dewatered dahi.
- This product is extremely popular Western and some parts of Southern India inoculated with culture containing **Str. lactis subsp. lactis and Lactococcus Lactis var. diacetilactis**
- Minimum fat % 8.5 and total solids 58% ; Titrable acidity not more than 1.4%

Indian Dairy product	Western counterpart
Kheer/ Basundi	Condensed milk
Khoa	Evaporated milk
Rabri	Clotted cream
Kulfi	Ice cream
Ghee	Butter oil
Lassi	Butter milk
Channa	Lactic coagulated green cheese

Paneer	Soft cheese

- Cultured/ fermented milk products: curd, lassi, Dahi, Chakka, Shrikhand
- Acid coagulated milk products- Channa, panner
- Acid and Rennet coagulated milk products- Cheese
- Heat dessicated/ dehydrated(concentration and coagulation) - Rabri, Basundi, Khoa, Khurchan (23.6%fat)

Chhana-based sweet

- Rasogolla
- Pantooa
- Sandesh
- Rasmalai
- Cham Cham
- Chhana-murki
- Chhana podo

Channa:

- milk solids obtained by the acid coagulation of boiled hot milk and subsequent drainage of whey.
- It should not contain more than 70 per cent moisture and milk fat should not be less than 50 per cent of the dry matter

Preparation:

- - Boiling of milk in karahi.
- - Reducing the temperature of milk to 80°C and required quantity of coagulants is added slowly till the coagulation.
- - The strength of the coagulating acid solution is 1-2%.
- - Coagulants are lactic (for rosogolla) and citric acid (for sandesh).
- - Contents of vessel emptied over a piece of muslin cloth.
- - No pressure is applied

Yield of channa:

- Cow milk is 16-18%.
- Buffalo milk is 22-24%
- Cow milk preferred for channa making, because it has open texture
- yields smooth textured and smooth body product.
- Used for making sweets like rosogulla, Sandesh

Paneer:

Heat acid coagulated milk solid heated at 82 °C and cooled to 70°C

- moisture 60-70%
- Total solids 30-40% (milk fat not less than 50% of DM basis)
- pressure is applied for removal of whey while in Channa hanged over a hook wrapped in cloth
- Buffalo milk preferred –whitish, sweetish

Khoa/ Mawa: Khoa is a partially dehydrated, heat-coagulated whole milk product that is prepared by continuously heating and stirring milk over a direct fire until it reaches a semi-solid consistency.

Production Process

- Milk, preferably buffalo milk, is heated in a karahi (a type of pan) over a direct fire.
- The milk is constantly stirred and scraped while heating to prevent scorching and promote even cooking.
- The heating and stirring continue until the milk reaches a semi-solid consistency, typically taking several hours.

Milk Fat Content: The milk fat content in Khoa should not be **less than 20 percent.**

Preference for Buffalo Milk

- Buffalo milk is preferred over cow milk because it yields a higher quantity of Khoa with a better quality.
- Buffalo milk Khoa has a soft, smooth body and a granular texture compared to cow milk Khoa.

Overrun and Yield

- The overrun in Khoa is primarily due to the presence of moisture.
- The yield from cow milk is typically 17-19 percent, while for buffalo milk, it ranges from 21-23 percent.

Type of milk	Composition of khoa					
	Moisture	Fat	Protein	Lactose	Ash	Iron(ppm)
Cow	25.6	25.7	19.2	25.5	3.8	103
Buffalo	19.2	37.1	17.8	22.1	3.6	101

- Three main varieties are "**pindi**" for burfi, "**dhap"** for gulabjamun, pantooa etc., and "**danedar**" used for kalakand
- Increase in Iron content :From 2 to 4 ppm in milk, the iron content in khoa exceeds 100 ppm due to scrapping of the pan surfaces during the manufacture

Constituents	Khoa type		
	Dhap	Pindi	Danedar
TS (%) min	55	65	60
Fat (% dmb) min	37	37	37
Protein (% dmb) min	37	37	37
Ash (%dmb) max	6	6	6
Titrable acidity (% LA) max	0.6	0.8	0.9
End uses	Gulabjamun, milk cake	Burfi, peda Pantua	Kalakand,

- keeping quality of *khoa* at room temperature-5 days and 10 weeks at 4°C
- **Generally 4 kg of buffalo milk or 5 kg of cow milk yield one kg of *khoa***
- ***Pantua, Kala jamun manufactured from both Khoa and channa***

Ghee:

Clarified butter fat prepared chiefly from cow or buffalo milk.

- Milk fat - 99 to 99.5%
- Moisture Not more than 0.5 %
- Buffalo milk preferred being richer in fat content and gives larger yield of ghee
- Flavor of Ghee is because of Lactones

Properties:

- Specific gravity: 0.93-0.94
- Refractive index 40-45
- RM number: min. 28 (cotton seed feeding areas 20)
- Polenske number: min. 2 (------do□1.5)

- Solidifying point 28 to 15° C
- Iodine value : 26 to 38
- Saponification number: 220
- Melting point: 28-44° C
- Granularity in Ghee: presence of high melting saturated FA e.g Stearic, Palmitic acid
- buffalo: white color with greenish tinge due to Biliverdin
- cow- golden yellow due to carotene
- Natural antioxidants: Tocopherol, carotene
- Synthetic: BHA, BHT, hydroquinone, gallic acid esters
- BHA level should not exceed 0.02% in Ghee (PFA, 1976)

Ghee may contain BHA not more than 0.02% as antioxidant

Table 4: Agmark standards of *Ghee*

Sr. No.	Tests	All India	Winter regional	Summer
1.	B audouin	Negative	Negative	Negative
2.	Phytosterol acetate	Negative	Negative	Negative
3.	B.R. reading (40°C)	40.0-43.0	41.5-44.0	42.5-45.0
4.	R.M.value (Minimum)	28	23.0	21.0
5.	Polenske value	1.0-2.0	0.5-1.2	0.5-1.0
6.	Moisture (%)	Maximum	0.3	
7.	Free fatty acids (as % Olic acid)			
	Special grade (Red label)	Not more than	1.4	----------
	General grade (Green label)	Not more than	2.5	
	Standard grade (Chocolate label)	Not more than	3.0	----------

Ghee is prepared by five methods, namely,

- Desi
- Creamery butter
- Direct cream
- Pre-stratification method
- Continuous method – industrial method

Pre-stratification method:

- a top layer of floating denatured particles of curd,
- a middle layer of fat,
- a bottom layer of buttermilk

Test for adulteration:

- Valenta test: animal fat adulteration
- Halphens test: for cotton seed oil
- Nitric acid test, Baudin test, Phytosterol test: vegetable oil adulteration

Panir: indian variety of rennet coagulated small sized soft cheese e.g. surati panir, bandal cheese

Kheer/ basundi: partial dehydation of whole milk in karahi

Khurchan: concentrated, sweetened whole milk product prepared by simmering without stirring in karahi and have fat % of 23.6

Rabri: concentrated and sweetened milk product containing several layers of clotted cream and have 20% fat

Defects in processing, packing, storing, distribution and marketing of milk and milk products and their remedial measures.

1.Milk by products

Main product	By product
Cream	**skim milk**
Butter	butter milk
Ghee	**ghee residue**
Channa/paneer/cheese	**whey**
Curd	lassi

Packaging material for milk and milk poducts

Product	Packaging Material

Liquid milk	Glass bottles (obsolete) LDPE film Paper laminates for tetra packs
Milk Powder	Tin plate containers, nitrogen packed, and lacquered from outside. Flexible laminates such as metallized PET / BOPP / Aluminium foil / Poly laminates. Refill packs; lined cartons laminated with BOPP / PET, varnished on the outside. Bag-in-box; Powder filled in laminate and packed in cartons.
Butter	Duplex board with vegetable parchment paper Tin plate containers Aluminium foil
Cheese / Cheese spread	Tin plate containers lacquered from inside First packed in aluminium foil and then in duplex board carton Injection moulded PP / HDPE container
Ghee	Tin plate containers lacquered from inside Glass bottles HDPE film pouches
Ice cream	Thermoformed / Injection moulded plastic containers Duplex board carton (poly laminated) Laminates of BOPP (Biaxially Oriented Polypropylene) / PET
Indian Dairy Products	Injection moulded / thermoformed containers (shrikhand, gulab jamun) Stand up laminated pouches

APPENDIX

Bacteriological standards as prescribed by Bureau of Indian Standards (BIS)

Bacteriological standards of raw milk (IS-1479 PART III-1997)

Grades	Direct microscopic count per ml (lakhs)	Standard plate count per ml (lakhs)	Methylene blue reduction time (hr)	One hour resuzurin disc. (No.)	Presumptive coliform test (in 0.01 ml) i.e. 1 in 100
Very good	NS	< 2	> 5	NS	absent
Good	< 5	2-10	3-4	4 or higher	absent
Fair	5-40	10-50	1-2	3.5 to 1.0	absent
Poor	40-200	> 50	< 1/2	0.5 to 0	present
Very poor	> 200	NS	NS	NS	NS

NS : Not specified

Bacteriological standards of pasteurised milk (IS-6397-1971)

Test	Requirement
Standard plate count	Maximum 30000 cfu/ml
Coliform count	absent in 1:10 dilution
MBRT	more than 4 hr
Alkaline phosphatase	test negative

Bacteriological standards of cream (IS-3509-1966)

Type of Cream	Type of count	Level in Cfu/ml or g (lakhs)	Grade
Raw Cream	Standard plate count	< 4	Very good
		4-20	Good
		20-100	Fair
	Coliform count	100	Poor
		< 100	Satisfactory
Pasteurised	Standard plate count	< 60000	Satisfactory
	Coliform count	< 10	Satisfactory

Bacteriological standards of butter (IS-3507-1966)

Yeast & Mold count/ml	Quality
< 20	Good
21-50	Fair
51-100	Poor
> 100	Very poor

Bacteriological standards of ice cream (IS-2802-1964)

Test	Limit
Standard plate count (per g)	not more than 2,50,000
Coliform count (per g)	not more than 90
Phosphatase test	negative

Bacteriological standards of condensed milk (IS-1166-1973)

Characteristics	Full cream	Skim milk
Bacterial count (cfu/g. maximum)	500	500
Test for Coliforms	Negative	Negative
Yeast and Mold count (cfu/g. maximum)	10	10

Bacteriological standards of milk powder (IS-1165-1975)

Types	WMP and extra grade SMP	Standard grade SMP
Total bacterial count, max, cfu/g	40,000	50,000
Coliform count	absent in 0.1 g	absent in 0.1 g
Salmonella	absent in 25 g	not specified
Staph aureus (coagulase positive)	absent in 0.1 g	not specified
Shigella	absent in 25 g	not specified

Bacteriological standards of indigenous dairy products.

Product	Standard plate count max (cfu/g)	Coliform count, max (cfu/g)	Yeast and mold count, max (cfu/g)	ISI Manual Reference No.
Khoa	NS	90	50	IS-4883-1980
Burfi	30,000	NS	10	IS-555-1970
Paneer	5,00,000	100	250	IS-10984-1983
Kulfi	2,50,000	100	NS	IS-10501-1983
Chakka	NS	10	20	IS-9532-1980
Shrikhand	NS	10	50	IS-9532-1980
Canned Rasogolla	500	Nil	NS	IS-4079-1967

Microbiological standards for assessing the sterility of utensils/equipments as prescribed by BIS (cited from *Fundamantals of Dairly microbiology* by Prajapati p:44.)

	Rinse method Colony count per liter capacity of can	Swab method Colony count per 900 sq.cm. area of equipment surface
Satisfactory	< 1000	< 5000
Fairly satisfactory	1000 to 5000	5000 to 25,000
Unsatisfactory	> 5000	> 25,000

Flavor Profiles in Milk

1. **Bitty Flavor**: Caused by proteolytic microorganisms, particularly *Bacillus spp.* and *Pseudomonas spp.* These bacteria produce enzymes that break down proteins, leading to off-flavors.

2. **Potato Flavor**: Resulting from *Pseudomonas mucidolens* and *Pseudomonas graveolens*, these bacteria contribute to a flavor reminiscent of potatoes.

3. **Cooked Flavor**: Associated with the presence of sulfhydryl compounds, this flavor typically arises from overheating during processing.

4. **Cowy Flavor**: This flavor is linked to ketosis in dairy animals, primarily due to the presence of acetone, which imparts a distinct taste.

5. **Barny Flavor**: Often a result of poor ventilation during storage or processing, leading to a flavor reminiscent of barnyard conditions.

6. **Malty Flavor**: Caused by *Streptococcus lactis var. maltigenes*, this flavor adds a sweet, malt-like characteristic to the milk.

7. **Phenolic Flavor**: Associated with *Bacillus circulans*, this flavor can impart a medicinal or phenolic taste to the milk.
8. **Unclean Flavor**: Resulting from contamination with *E. coli*, this flavor indicates poor hygiene practices during milk handling and processing

Defects in Cream:

- **Oxidized/oily/Metallic/Tallowy:** Fat oxidation due to direct contact of milk with copper or iron, exposure of milk or cream to sunlight, etc.
- Rancid: Fat hydrolysis due to lipase action in milk or cream
- **Bitterness and thinning:** Bacillus subtilis
- Highly acid/sour

  i. Using sour milk for separation

  ii. Acid development in cream
- **Bitty cream**: lecithinase enzyme of *Bacillus cereus* var *mycoides*

Defects in Butter:

- **Gritty** - Undissolved coarse salt, incorrect salting
- **Grainy -** Incorrect neutralization of high acid cream with lime
- *Yeasty flavour and odour*: fermentation of the cream by Torula Cremoris and Torula sphaerica
- **Fishy flavor** - Hydrolysis of phospholipid to form trimethylamine is one of the reasons attributed for the 'fishy' flavor defect in butter
- **Skunk like odor**- P. mephitica
- **Apple taint** – P. fluroscrns

Defects in Ghee:

- **Rancidity**: lipase action (incidence is low), oxidation of fat (more chances) through exposure to light and contact with metal ions e.g. Cu, Fe, etc.
- **Dark/Burnt color**: Excessive high temperature (> 120 C for some period) of clarification of ghee can lead to 'dark brown' colored ghee

Defects in KHOA:

- At room temperature (24-30°C) a rancid flavor is developed on *khoa*

- low temperature (5-10°C) a stale and sour flavor is observed and there is mould growth on the surface

Defects in Cheese:

- **Rind rot** – excessive acidity or moisture in cheese before curing
- **Gassiness/ Late blowing in cheese:** Clostridium tyrobutyricum
- **Fish eyes/yeast holes**: Contamination with yeasts (Torula sp.)

Cleaning and sanitization of dairy equipments and plants, special milks, Methods of preparation of butter, ghee, khoa, lassi, curd, ice cream and cheese.

1.Cleaning and sanitization of dairy equipments

Cleaning is the process in which complete removal of soil (unwanted matter on food-contact surfaces) is accomplished using appropriate detergent chemicals under recommended conditions from the internal and external surface of the equipment

Sanitation: It involves effective bactericidal treatment with chemical/thermal agents to reduce the bacterial count including pathogens to a safe level on the utensils and equipment.

- Most frequently used dairy sanitizers include steam, hot water and chemical sanitizers. Chemicals include – iodophores, chlorine, Iodine, acids, quaternary ammonium compounds
- Some of the precipitates remains intact to equipment after cleaning and forms a film over equipment surface called **water stone**
- Heat denaturation of protein present on the equipment surface or absorbed by other components forms **milk stone** quickly over heated surfaces
- Milk stone – dried milk solids and salts from hard water and washing solution

cleaning modes - Manual, COP, CIP

Cleaning agents/ detergents:

- strong alkali: Sodium hydroxide (caustic soda) potassium hydroxide (caustic potash) – corrosive
- mild alkali: Sodium carbonate and sodium silicates, Trisodium phosphate (TSP) - commonly used
- Mild Acids- phosphoric, tartaric, citric, gluconic acid
- Strong acids- Nitric acid- 1% for stainless steel, HCL, Sulphuric acid
- Polyphosphate and chelating chemicals: tetra phosphate, hexametaphosphate
- Surface active/ wetting agents: Teepol, Acinol – N, common soaps

Choice of detergents in organized dairies

S. No.	Ingredients	Quantity	Remarks
1.	Tri-sodium phosphate	850 g.	For general use
	Wetting agent	150 g.	
2.	Tri-sodium phosphate	650 g.	For aluminium
	Sodium meta-silicate	200 g.	utensils
	Wetting agent	150 g.	
3.	Tri-sodium phosphate	750 g.	For tinned uten-
	Sodium sulphite	100 g.	sils
	Wetting agent	150 g.	

CIP (Clean In Place) has been opted in milk industry for good cleaning and sanitation.

- The cleaning cycle in dairy comprises following steps-
- Recovery of product residue by scrapping, drainage with water or compressed air.
- Pre- rinsing with water to remove dirt.
- Cleaning with 0.15-0.6% alkaline detergent
- Rinsing with clean water.
- Cleaning with acidic detergent.
- Rinsing with clean water (Hardness not exceeding 112mg/L)
- Sodium Hypochlorite/ Chlorine: 200ppm

Iodophores:25mg/L QUATS: 200mg/L

2.special milks

- **Concentrated Milk**: A product obtained by evaporating part of the water from whole or skim milk, with or without the addition of sugar.
- **Condensed Milk**: Full cream sweetened milk that has had a portion of its water content removed and sugar added.

- **Evaporated Milk:** Full cream unsweetened milk that has been concentrated by evaporating about 60% of its water content.
- **Skimmed Milk Products**: Can be sweetened or unsweetened.
-
- **Unsweetened Condensed Milk** - Equivalent to evaporated milk, which is concentrated without added sugar.

Concentration Ratios

- **Full Cream Products**: Ratio of concentration of milk solids is **1:2.5**.

- **Sweetened Condensed Skim Milk**: Ratio of concentration of milk solids is **1:3**

Type of milk	**Fat %**	**Milk Solids % (minimum)**
Evaporated milk	8% (minimum)	26
Condensed milk	9% (minimum)	31
Evaporated Skim milk	0.5% (maximum)	20
Condensed skim milk	0.5% (maximum)	26

Cane Sugar in sweetened milks: 40% (minimum)

Seeding: Crystallization of lactose by the addition of fine powder of lactose or small quantity of condensed milk from previous batch.

- Purpose: **forms very small crystals** in the supersaturated solution

Pilot Sterilization test: to determine the amount of chemical stabilizer to be added in evaporated milk

Dried milks/ Milk Powders: obtained by removing water from milk through various drying methods, resulting in a solid product with low moisture content. (less than 5%)

	Whole Milk powder (WMP)	Skim Milk powder (SMP)
Moisture % (max)	5	5
Fat %	26 (minimum)	1.5 (max)
Solubility index	15 if roller dried and 2 if spray dried	

Milk drying: Milk is commonly dried using either spray drying or roller drying methods.

- In spray drying, concentrated milk is atomized into fine droplets and dried by hot air, producing a fine milk powder.
- Roller drying involves applying a thin film of pre-concentrated milk onto heated rotating drums, where the milk forms a dry layer that is scraped off as powder.
- Spray drying is the more widely used method due to its ability to produce high-quality milk powders with good solubility and nutritional properties.

Fermented milk:

- **Acidophilus Milk:** Fermented milk developed using Lactobacillus acidophilus culture.
- **Bulgarian Milk:** Made using the culture Lactobacillus bulgaricus.
- **Kumiss:** Traditionally from Russia, originally made from mare's milk, now often made from cow's milk.
  - **Co mposition:** Fermented with lactic acid and alcohol, containing about 2.5% alcohol.
- **Kefir:** A self-carbonated milk beverage.
  - **Composition:** Contains approximately 1% lactic acid and 1% alcohol.

- **Filmjolk:** A Scandinavian sour milk product.

Functional milk products: specialized dairy items designed to provide additional health benefits beyond basic nutrition

- lactose-free milk - made by filtering regular milk to remove half the lactose and adding enzyme Lactase
- **Filled milk:** homogenized product prepared from refined vegetable oil & water.
- **UHT processed milk:** packed & aseptically sealed in pre-sterilized containers. can be stored Unrefrigerated for at least 3 months
- **Designer milk**: as per consumer requirement using biotechnology
- **Irradiated milk:** increased Vitamin D content by UV rays exposure
- **Evaporated milk** must be fortified with Vit. D
- **Recombined Milk:** product obtained when butter oil (also called anhydrous milk fat), skim milk powder and water are combined in the correct proportions to yield fluid milk.
- **Reconstituted milk:** dispersing milk powder in water
- **Humanized milk:** chemical composition modified to match human milk
- **Imitation milk:** milk of non dairy origin
- **Vegetable toned milk**: milk protein of SMP substituted by groundnut protein (MILTONE BY CFTRI , Mysore)

3.Methods of preparation of butter, ghee, khoa, lassi, curd, ice cream and cheese

ghee, khoa, lassi, curd refer indian dairy product

Butter

- Balancing wheel of dairy industry
- Butter is defined under the Food Safety and Standards Regulations (FSSR) as a fatty product primarily composed of a **water-in-oil emulsion** derived exclusively from milk or milk products.

Types of Butter

- **Table Butter:** Made from pasteurized cream.
- **White Butter/Cooking Butter/ deshi butter**: Typically has a lower fat content than table butter.
- **Composition Standards**

Table Butter:

- Moisture: Maximum 16.0%
- Milk Fat: Minimum 80.0%
- Milk Solids-Not-Fat: Maximum 2.0%
- Common Salt: Maximum 3.0%
- No preservative except common salt
- No coloring material except annato or carotene
- Flavoring agent – Diacetyl (not more than 4ppm)

    - **White Butter/Cooking Butter**: Milk Fat: Minimum 76.0%

Theories for butter making:

- Fisher and Hooker's Phase reversal theory
- Rahn's Foam theory
- King's modern theory

Steps in butter making:

- Neutralization of cream: reduce the acidity of cream to 0.14-0.16%
- Standardization of cream: 33-40%
- Pasteurization of cream: 90- 95 ◦ C for 15 or 105-110◦C with no holding
- Cooling and ageing at 5-10 ◦ C

- **Ripening of cream**: by mixture of both acid producing (*Streptococcus lactis, S.cremories*) and flavour producing (*S.diacetylactis, Leuconostoc citrovorum* and/or *Leuc. Dextranicum,* Clostridium butyricum)

- Cream is incubated at about 21°C till desired an acidity is reached.

- **Churning of Cream**: Winters- 10-13°C Summers: 7-9°C (Avg. 9-11)

- **Salting & Working:** Working of butter is a kneading process in which butter granules are formed into a compact mass

- Storage -23 to -29°C

Overrun: increase in the amount of butter made from the given amount of fat caused by the presence of

moisture , curd, salt etc in butter. Maximum possible is 25%

Ice cream

Ice cream may be defined as a frozen dairy product made by suitable blending and processing of cream and other dairy products together with sugar and flavor, with or without stabilizers or color, and with the incorporation of air during the freezing process.

According to PFA, 1976

- Permitted stabilizers and emulsifiers not exceeding 0.5% by weight.

- The mixture must be suitably heated before freezing.

- The product should contain not less than 10% milk fat, 3.5% protein, and 36% total solids.

Sr. No	Characteristics	Requirements
1.	weight (g./litre) min.	525
2	Total solids(%wt .min)	36.0

3.	Milk fat (% wt. Min.)	10.0 (Tentative)
4.	Acidity (% lactic acid max.)	0.25
5.	Sucrose (%wt. Max.)	15.0
6.	Stabilizers/emulsifiers(%wt. Max)	0.5
7.	Standard plate counts (per g.)	Not more than 2,50,000
8.	Coliform count (per g.)	Not more than 90
9.	Phosphatase test.	Negative.

Stabilizers:

prevent the formation of objectionable large ice crystals in ice cream, especially during storage. Sodium alginate, methyl cellulose, gelatin

Emulsifiers:

improve upon and provide a uniform whipping quality of the mixture. Egg yolk, sorbitol, propylene glycol esters

- Ice cream without Hardening process: Soft serve or Softy
- overrun due to air - Maximum 100%
- **Sandy Texture:** caused by Lactose crystals which do not dissolve readily and produce a rough or gritty sensation in the mouth
- **Whipping quality:** reduced air cell sizes and a homogeneous distribution of air in the ice cream
- The ageing temperature should not exceed 5 ºC.

Cheese

Cheese has been defined as a product made from the curd obtained from milk by coagulating the casein with the help of rennet or similar enzymes in the presence of lactic acid produced by added or adventitious microorganisms, from which part of the moisture has been removed by cutting and /or pressing which has been shaped in a
mould, and then ripened by holding it at some time at suitable temperature and humidity.

Types of Cheese Based on Moisture Content

Cheese can be classified into different categories based on its moisture content:

- **Very Hard Cheese (Less than 25% moisture):** These cheeses have an extremely low moisture content, resulting in a hard, dry texture. The low moisture and high salt content inhibit microbial growth, allowing these cheeses to be aged for extended periods. Examples: Parmesan, Romano
- **Hard Cheese (25-36% moisture):** Hard cheeses have a firm, sliceable texture. The moisture content is higher than very hard cheeses, but still relatively low. Examples: Cheddar, Swiss
    - Cheddar is ripened by bacteria and does not have eyes (holes).
    - Swiss cheese is also hard, but is ripened by propionibacterium shermanii, which produce the characteristic holes or "eyes".

- **Semi-hard- 36 to 40 % moisture**

- Ripened principally by bacteria: Brick
- Ripened by bacteria and surface microorganisms: Limburger
- **Ripened principally by blue mould:**
    - External – Camembert (*Penicillium camemberti*)
    - Internal – Gorgonzola, Blue, Roquefort (*Penicillium roqueforti* and *Penicillium Glaucum*)
- **Soft Cheese (>40% moisture):**

- These fresh cheeses are not aged and have a high moisture content, resulting in a soft, spreadable texture. Unripened soft cheeses: Cottage cheese
- Ripened soft cheeses **(40-80% moisture)**: Example: Neufchatel

Name	Moisture	Fat	Protein	Ash and salt

Brick	42.5	30.7	21.1	3.0
Camembert	47.9	26.3	22.2	4.1
CHEDDAR	36.8	33.8	23.7	5.6
Cottage	69.8	1.0	23.3	1.9
Cream	42.7	39.9	14.5	1.9
Edam	38.1	22.7	30.9	6.2
Limburger	54.8	19.6	21.3	5.2
Parmesan	17.0	22.7	49.4	7.6
Roquefort	38.7	32.2.	21.4	6.1.

Withania coagulans, also known as Indian rennet or Paneer doddi, is a plant that serves as a natural rennet substitute in cheese production. It contains a rennet-like protease that can coagulate milk, making it a viable alternative to traditional animal-derived rennet.

Steps in cheese making:

- First stage is Souring /ripening
- Second stage is Clotting /coagulation by rennet
- Third stage is Cutting and drainage of whey.
- Fourth stage is Matting of the curd.
- Fifth stage is Maturing /curing

CHEDDAR CHEESE:

Hard cheeses are characterized by their low moisture content and firm texture. The production process typically involves specific starter cultures, rennet, and careful monitoring of various parameters.

Starter Culture:

- The starter culture usually contains **Streptococcus lactis** and/or **Streptococcus cremoris**.
- These lactic acid bacteria are essential for acidification and flavor development during the cheese-making process.

Coagulation Process:

- **Rennet**: The coagulation of milk is achieved using rennet, which consists of **rennin (clotting enzyme)** and **pepsin (proteolytic enzyme)**.
- The typical addition rate is **15-25 ml per 100 liters of milk**.
- The **hot iron test** is conducted to determine the end of the cheddaring process, which is crucial for achieving the desired texture.

Temperature and Culture Addition:

- The starter culture is added at a rate of **0.5-1% of the milk volume** at a temperature of **30-31°C**.
- This temperature supports optimal bacterial activity for fermentation.

Color and Salting:

- For coloring, **30-200 ml of colorant per 1000 kg of milk** may be used, depending on the desired hue of the final product.
- Salting is typically done at a rate of **1-2%**, which helps in flavor enhancement, preservation, and texture development.

Standardization:

In cheese making standardization refers to adjustment of the casein/fat ratio in cheese to 0.68 to 0.70.

Objectives:

- To regulate the fat in the dry matter of cheese.
- To produce the maximum amount of cheese per kg of fat in cheese milk.

Addition of calcium chloride:

- Excessive heat treatment of milk causes the precipitation of a part of calcium salts in milk.
- It results in slower renneting action and a weaker curd which can be corrected by the addition of **0.001 to 0.003 %** calcium chloride to milk.

Detection of adulterants in milk and milk product, utilization of byproduct of livestock produce.

1.Adulteration of Milk

Adulteration refers to the practice of adding cheaper or inferior substances to milk or removing valuable constituents, such as fat, to increase profit margins. This not only compromises the quality and nutritional value of milk but can also pose health risks to consumers. Understanding common adulterants in milk is crucial for ensuring safety and quality.

Common Adulterants in Milk

- **Water**: The most prevalent adulterant, water is often added to increase the volume of milk. It dilutes the nutritional content, reducing the levels of proteins, fats, and vitamins.
- **Starch**: Starch is sometimes added to thicken milk and give it a creamier texture.
- **Cane Sugar**: Sugar is added to enhance sweetness and mask the taste of spoiled milk.
- **Condensed Milk or Milk Powder**: These are sometimes mixed with fresh milk to increase volume and reduce costs.
- **Urea**: Urea is sometimes added to increase the apparent protein content of milk.
- **Detergents**: Detergents may be added to improve the foaming properties of milk. This is highly toxic and poses serious health risks to consumers.
- **Sodium Bicarbonate**: This is used to neutralize acidity and improve the shelf life of milk. Excessive use can lead to digestive issues and alter the taste of milk.
- **Mixing of Cow and Buffalo Milk**: Mixing different types of milk can be done to increase fat content or reduce production costs. This can mislead consumers regarding the type of milk they are purchasing and can affect the quality and flavor

Test	Adulterant
Iodine solution Test	Starch adulteration in milk
Nitric acid	Skim milk powder
Bromocresol purple solution	Detergent in milk
p - dimethyl amino benzaldehyde	Urea adulteration in milk
Resorcinol	Cane sugar detection
Rosallic acid test	Sodium Carbonate
Storch's peroxidase test	Heated milk in fresh milk
Hansa Serum (Hansa Test)	Mixing of cow & buffalo milk
Picric acid solution/ Mercuric Nitrate	Gelatin in milk
Formalin	Milk powders
Conc. HCl	Calcium Chloride
Delvo kit test	Detect antibiotic and sulpha residues

Lactometer reading, freezing point, nitrate detection	Water in milk
Baudin test	Vegetable oil adulteration in ghee

Fat estimation: Gerber test (Fucoma Test), Babcock test, Rose Gottileb and Adam's test

Total Solids & SNF estimation: Gravimetric Method, Lactometer Method, Infrared Spectroscopy

Milk by products

Main product	By product
Cream	**skim milk**
Butter	butter milk
Ghee	**ghee residue**
Channa/paneer/cheese	**whey**
Curd	lassi

Ante mortem and Post mortem inspection, meat inspection, Abattoir practices, Meat Inspection Laws, quality control of meat and eggs and their products.

1.Ante-mortem inspection and Post-mortem inspection of meat animal

- main objective of meat inspection is to provide safe and wholesome meat for human consumption.
- professional examination of live animal before slaughter by a qualified veterinarian.

  Objectives:

  - **Public Health**: Separation of animals that may be suffering from zoonotic diseases and therefore may be a potential of infection for other animals and human.
  - **Animal Health:** Certain diseases may be detected at the slaughter house and these have to be intimated to state veterinary services for protection of other animals.

- **Animal Welfare**: Ensures that only health animals are slaughtered and therefore prevent distress to injured animals.
- AM examination conducted in Lairage
- All animals that are to be slaughtered should be rested for at least 24 hrs before slaughter.
- They should not be fed for 12 hrs before slaughter but should be provided abundant water.
- The antemortem examination should be conducted on the day of arrival of the animal and should be repeated if slaughter is not carried out within 24 hrs of the examination.
- The inspection includes observing the animal at rest and in motion both individually and collectively

Categories/ Judgment

1. **Fit/ Passed:** If the animal is health and suffering from any disease condition.

2. **Unfit/ Discard/ Condemned:** unsafe for consumption.

3. **Slaughter under special conditions/ suspect**: symptoms or local lesions that require further investigation during PM examination before being passed as fit.

4. **Delayed:** The slaughter is delayed for a few days in case of animals that are fatigued, excited, suffering from transit sickness/ fever.

5. **Casualty slaughter:** animals that are not in acute pain or are not in any immediate danger of death but are suffering from a chronic condition. Some such conditions are obturator paralysis, post-partum paraplegia etc

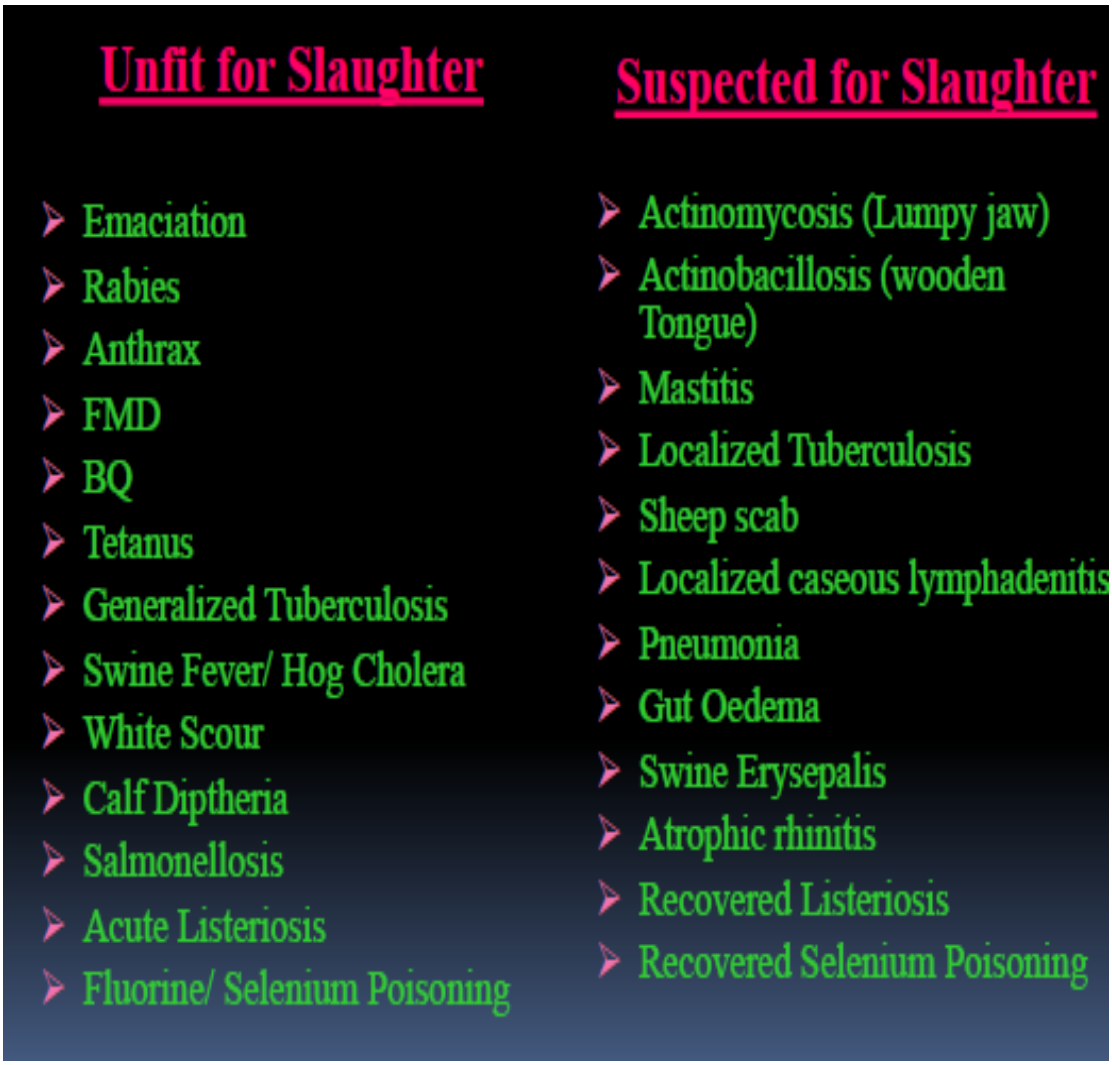
6. **Emergency slaughter:** This is required when the animal is in acute pain or suffering from a condition in which delay may cause distress to the animal. Such meat does not have any harmful effect on human health.

Unfit for Slaughter

- Emaciation
- Rabies
- Anthrax
- FMD
- BQ
- Tetanus
- Generalized Tuberculosis
- Swine Fever/ Hog Cholera
- White Scour
- Calf Diptheria
- Salmonellosis
- Acute Listeriosis
- Fluorine/ Selenium Poisoning

Suspected for Slaughter

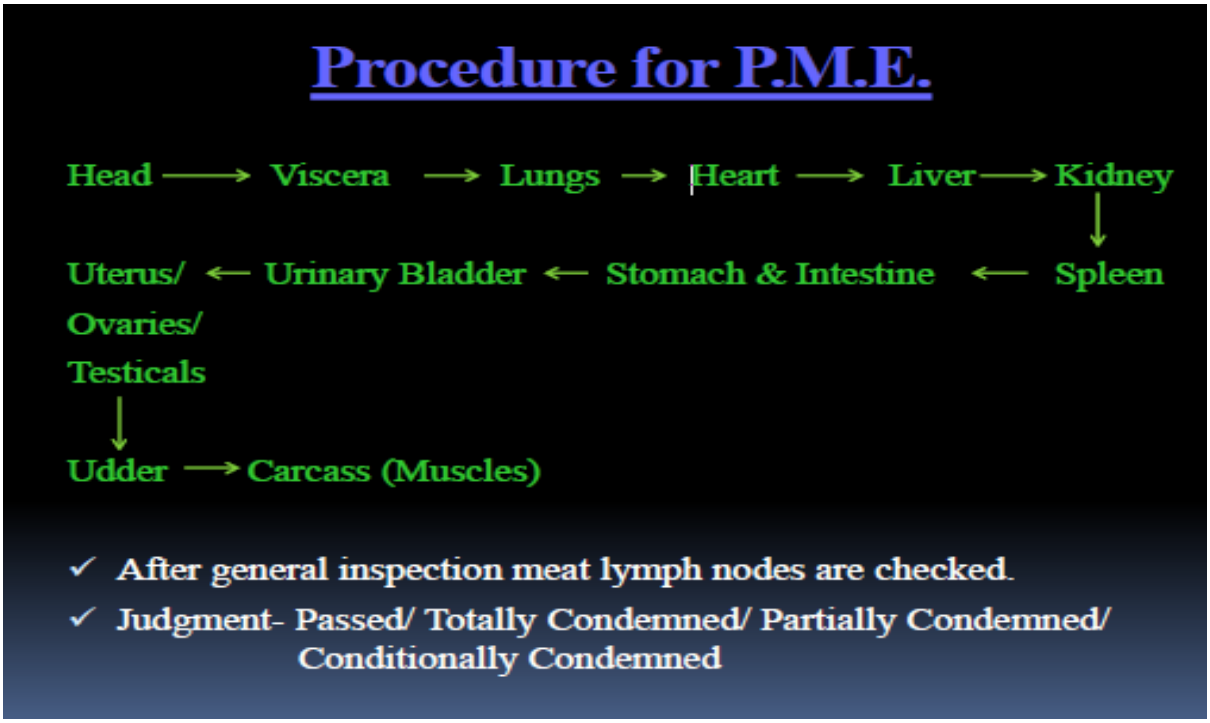
- Actinomycosis (Lumpy jaw)
- Actinobacillosis (wooden Tongue)
- Mastitis
- Localized Tuberculosis
- Sheep scab
- Localized caseous lymphadenitis
- Pneumonia
- Gut Oedema
- Swine Erysepalis
- Atrophic rhinitis
- Recovered Listeriosis
- Recovered Selenium Poisoning



Post-mortem inspection:

- systematic examination of dressed carcass and their organs including blood by a meat inspector with the object of providing wholesome meat to consumers.
- The main objectives of this examination are:

1. To detect and eliminate any abnormalities to ensure wholesome meat production.
2. Checking the efficacy of slaughter and carcass dressing technique.
3. Aids in animal health by identification of disease condition and thereby disease control.



Entire carcass, organs, viscera should be rejected as unfit for human consumption if evidence of following disease conditions are seen:

Anaplasmosis Algal disease African swine fever Black leg, Bruising (extensive and severe) B.S.E., BVD Braxy, black leg Cysticercus bovis (Generalized) , Cysticercus cellulosae, cysticercus ovis, Emaciation (pathological), Actinobacillosis, Actinomycosis (generalised), Anthrax, FMD, Glanders

PM examination in animals		
Sl. No	**Condition**	**Judgment**
1.	Actinomycosis/ Actinobacillus	Condemn the affected part/ organ
2.	African horse sickness	Total condemnation
3.	Anthrax	Total condemnation
4.	Blue tongue	Depends on the type of lesion
5.	BVD	Total condemnation in acute cases Accepted after removing alimentary tract in chronic cases
6.	Brucellosis	Total condemnation or passed after heat treatment
7.	Campylobacter	Total condemnation
8.	Clostridial infections Black quarter Braxy Botulism Tetanus	 Total condemnation Total condemnation Total condemnation Total condemnation as poor keeping quality
9.	CBPP/ CCPP	Passed after removing affected organ
10.	FMD	Total condemnation or passed after heat treatment

11.	Glanders	Total condemnation
12.	JD	Total condemnation when emaciated, otherwise passed after removal of viscera & lymph nodes
13.	Leptospira	Total condemnation
14.	Listeria	Total condemnation
15.	HS	Total condemnation
16.	Pox	Total condemnation in acute cases, passed in recovered cases
17.	Rabies	Total condemnation
18.	RP	Total condemnation in febrile cases
19.	Salmonella	Total condemnation
20.	Swine fever	Total condemnation
21.	Tuberculosis	Total condemnation Passed when lesions not so severe
22.	Ringworm	Passed
23.	Cysticercosis	Total condemnation in generalized cases

		Passed is restricted to a part
24.	Hydatid	Passed after removal of affected organ
25.	Trichinosis	Total condemnation
26.	Toxoplasma	Total condemnation
27.	Emaciation	In the absence of disease condition approval after heat treatment.
28.	Fever	Total condemnation
29.	Improper bleeding	Total condemnation
30.	Tumor	Passed after removal Total condemnation when exetnsive

PM examination in poultry		
31.	Ranikhet Disease	Total condemnation
32.	Infectious Laryngotracheitis	Total condemnation
33.	Infectious-Coryza	Total condemnation
34.	Chronic Respiratory Disease	Total condemnation
35.	Ornithosis and psittacosis	Total condemnation
36.	Salmonellosis	Total condemnation
37.	Fowl Typhoid	Total condemnation
38.	Pullorum Disease	Total condemnation
39.	TB	Total condemnation
40.	Fowl Pox	Total condemnation
41.	Coccidiosis	Total condemnation
42.	Aspergillosis	Total condemnation
43.	Marek's disease	Total condemnation

- **Conditionally admissible meat**: meat affected with certain conditions which do not allow its unconditional sale and thus need to be treated before sending to market.
- Conditional basis of system: Friebank system to provide nutritious feed to economically weaker section of society.

Dressing percentage / Carcass yield: ratio of dressed carcass weight to the weight of the live animal, expressed as a percentage

Species	Dressing %
Cattle/ buffalo	43-54
Sheep	40-50
Goat	43-52
Pig	70-75
Poultry	65-70

2.Abattoir practices

Abattoir and Slaughter

- A place where animals are killed for their meat
- **Abattoir planning:** max. daily killing and disposal and treatment of edible and inedible byproducts.

1. **Selection of site:**

- Proper water and electricity supply should be there
- Sewerage
- Availability of rail and road transport.
- Availability of labor.
- No pollution from other industries
- Good availability of stock near by
- Isolated from local housing.
- In general urban sites are avoided and nominated industrial area should be chosen

2. Water

- Potable water must be distributed to all parts of plant under adequate pressure.
- Pressure should be at least 20 Psi in main pipe lines.
- Hot water of at least 82°C should be available in plant for cleaning and disinfection of machinery and for scalding.
- Recommended water requirement:
    - 454 liters /day/pig
    - 272 liters /day/bovine
    - 45 liters /day/sheep

3. Electricity:

- industrial 3 phase electricity
- Generator for emergency

4. Area size

- Small abattoir up to 30,000 units/year - 1-2 acres
- Medium abattoir up to 50,000 unit/year - 2-4 acres
- Large abattoir up to 10,00,00 units/year – 4-6 acres
- For calculating of area size: 1 adult bovine (ALU) = 2 pigs = 3 calves = 5 sheep.

5. Lighting

- Adequate natural or artificial lighting must be provided throughout the meat plant.

- Intensity of lights is usually taken at levels of 0.9 m from floor except in inspection area where height is 1.5 m

Overall intensity should not he less than:

- **540 lux (50 foot candle) - at all inspection points.**
- 220 lux (20 foot candle) - in work rooms/ slaughter hall
- 110 lux (10 foot candles) - in other areas

6. Ventilation:

Must be adequate to prevent excessive heat steam and condensation, accumulation of odour.

7. Floor and wall finishes:

- Easily cleaned.
- Non-absorbent.
- Floor: Non-slip material.
- General Gradient: Floor slope towards drains should be 1:50 (least 2 cm per 100 cm)
- Drainage valleys under the dressing rail where the blood tends to collect, the gradient should be 1:25.
- One drainage inlet for every 36 m^2 of floor space.
- Ceiling height should be at least 5 m.
- Walls: covered with smooth impervious material like (tiles) up to 3 m.
- Doors should be wide enough to allow passage of workers, trolleys and carcasses (4.5 ft). Self closing and double action doors are preferable.

BUILDINGS IN A MODERN ABATTOIR

1. **Lairage: rest area -**

- Rest is to be given for 24 hrs
- Unrested animals after journey may suffer depletion of glycogen in muscles which results in black meat.
- It should have enough space to hold **2 days killing stock for large animals and one day stock for small animals**
- Distance of at least 10 m between lairage and slaughter hall
- holding pen is connected to the stunning pen through passages known as Race.
- Animals have to be kept off feed up to 12 hours before slaughter in lairage

Minimum space requirement in lairage:

- **Cattle loose** 2.3-2.8 m^2/ animal
- **Cattle tied** 3.3 m^2 animal
- **Pig (small)** 0.6 m^2/ animal
- **Heavy pig. calf, sheep and goat** 0.7 m^2

Cattle lairage:

- Horned animals should be separated from hornless animals.
- Large enough to hold 20-25 cattle
- Drinking water must be available
- Feeding of animal: twice a day except on day of slaughter.

Sheep lairage:

- Height of sheep pens should be 3 feet (0.9m) with passage 3 feet wide between pens
- Rails of the pens should not he more than 15 cm (6 inch) apart.

Pig lairage:

- Pig pens are preferably constructed with solid walls.
- If rails used: horizontal rails should not be more than 6 inches (15 cm) apart.
- In hot weather water spraying of pigs is useful to prevent fighting among them and it also improves quality of pork

2. Isolation block: It is actually a small abattoir and provided with a lairage, slaughter hall and hanging room.

- Situated near a suspected meat detention room and should have direct communication with byproducts department.

Emergency slaughter house

- For animal which are diseased or suspected are housed separately and slaughtered in isolation block.
- Conditions like - fracture of limbs, severe laceration and bruising, damage to pelvis, lightening strike, animal overlain and suffocated, lactation tetany, pregnancy toxaemia, enterotoxaemia etc.

SLAUGHTER HALL: Main hall where animals are slaughtered.

- Stunning, bleeding, dressing, evisceration
- A raised platform (killing floor) from lairage with an easy gradient is provided to facilitate the movement of animals on killing floor.
- Horizontal water sprays: along with path for cleaning of animals.

Size and type:

- It should be an open hall which is well ventilated and lighted.
- Sufficient natural or artificial light: intensity of 20 foot candle be provided (50 foot candle at meat inspection site)
- Gradient of slaughter hall/ work room floor: 2 inches in every 10 feet.
- Blood must be collected in shallow trays of 20 inches diameter and 4 inches deep. It is used for manufacture of black pudding(blend of onions, pork fat, oatmeal/barley, flavorings and blood)

DRESSING SYSTEM

- **Booth or Bed System**: slaughter is carried on floor by 1-2 persons; no person has specific work, Prevalent in India; Hygiene is poor
- **Modified booth system:** facility for stunning and bleeding; booths with cradles and hoists;
- **Cradle and Semi-line system**: stunning and bleeding; rail for breast opening, pluck removal and evisceration; Better hygiene
- **Line or On-the rail dressing**: conveying the carcass by gravity or power through overhead rail to various places after stunning and sticking. Also known as one man one job system. Men will be at different places carcass will reach them and they will attend to their allotted work. labor saving devices such as brisket cutter, hock cutter, hide puller etc. are used.

Types of Line or On-the rail dressing

a. Gravity rail system:

- In this method the carcass will be suspended from a spreader and single wheel trolley or runner, gravitated to each station and stopped by manually operated stop on the overhead rail
- The system is used for lower slaughter **rates 10-40 animals/ hr**
- Most compact and economical
- Less chance of breakdowns with consequent loss of production
- Adequate ceiling height is necessary because of the pitch of the rail to gravitate the carcass

b. Intermittent Powered System:

- carcass is suspended over a spreader(gambrel) and trolley
- moved mechanically on a level rails at an intervals by means of variable timing device
- Slaughter rate - 10-75 animals/hr

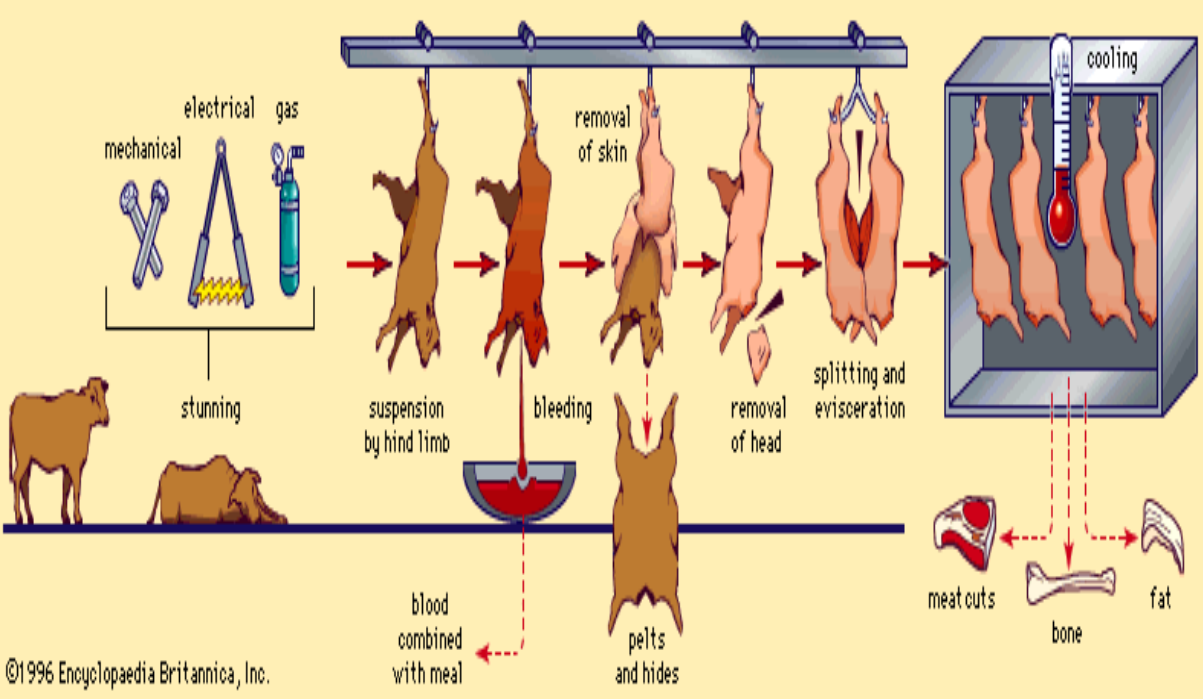
c. Continuous Power System:

- Here dressing line will be in continuous motion
- More sophisticated instruments are used in the slaughter line (mechanical hide puller, etc.). Thus, the platform may be fixed or movable, elevated or lowered
- Carcass can be revolved to a full 360°

- Rate of slaughter 40-120 animals/hr

d. Canpak System:

- Continuous conveyor is used in which heavy trolleys or runners suspend the carcass from overhead rail
- Here everything is done systematically (mechanically)
- Rate of slaughter 50-150 animals/hr
- Most Common in modern meat plants
- •From arrival of animals till completely dressed the work is divided into 32 divisions (each work is carried out by one man).
- Developed and patented by the Canada Packers Ltd., Canada hence called Canpak system



Advantages

- Time is saved
- Safer for operators
- More Hygienic
- A comfortable operative position is provided to the operator
- Increased output and enhanced value of carcass
- Less space per carcass is required

Possible Disadvantages

- High standard of engineering maintenance is needed

- When break down occurs production ceases completely
- Trained personnel needed
- Meat inspection is sometimes more difficult and possibly less efficient

4. Chilling room:

- Rapid cooling of carcass immediately alter slaughter is must.
- Chilling space should be enough for storing at least 2 days slaughter.
- **Temp:** between -1.5°C to 4.5°C.
- Chilling temperature should be less than 7°C for meat and less than 3°C for offal.
- Minimum space between carcass on rails should be 0.3 to 0.4 m.
- Minimum space between rails should be 0.9 m for beef, 0.7 m for pig and 0.5 m for lamb.

5. Hide and skin store:

- A separate room for keeping the skins, salting and piling up should be provided.

6. Guttery and tripery: Gut scraping unit, tripe (stomach of cattle and sheep) room, stores and byproduct plants. They should be away from main building for sanitation point of view.

7. Others: Offices, laboratory, dispatch room, effluent treatment plant, First aid room, toilets, staff canteen are essential in a modern slaughterhouse.

Transportation of meat animals

- Driving on hoof: short distance of 8-10 km and 4-5 Hrs.
- Transport by road truck: up to 500 km and 12-15 Hrs; animals should face in the direction of vehicle movement
- Transport by rail: > 500 km; break in journey after 1000 km
- Transport by sea: very expensive and time consuming, high mortality.
- Transport by air: mainly companion and zoo animals.

Loading/unloading: ramp should not be steeper than 30°.

Transit of animals (Road and rail) order, 1975

- **Schedule 1:** general provisions for road and rail vehicles and receptacles
- **Schedule 2**: Separation of animals during transportation
- **Schedule 3:** Cleaning and disinfection of vehicles

Transport rule: Welfare of animal during transport order, 1994

- For >50 km.
- Feed and rest at every 8 Hrs. interval

Considerations for planning a journey

- **Species of animals**
- **Health check up**: e.g. dipping in sheep 10 days before transport
- **Interstate and abroad transport**: vaccination history, breed, age, heath status
- **Space req.:**

  Railway wagon: (21.1 m^2) → 10 adult cattle/ 15 calves/ 3-6 horse/ 70 S/G per wagon

  By road truck: 4-6 Cattle/ horses

Weight loss during transportation: Shrinkage → water, urine, feces, carcass protein & fat loss during first few hours of transport

- E.g. Pigs: 2.2-5.4 kg during 24 hr journey and Sheep: 3.6 kg.
- **Disease induced by transportation:**
- Transit/ Shipping fever: in cattle with poor condition travelled long distance without food especially in cold climate.
- Transit tetany: in advanced pregnant cows and ewes. Similar to milk fever → Ca therapy.

Pre-slaughter practices

- Avoid unnecessary stress to animal
- Adequate rest at lairage
- Fasting and plenty of drinking water- better bleeding and dressing; less chances of bacterial contamination from intestine
- Feeding of easily digestible CHO like sugar especially to pigs after long journey – replenish glycogen

Stress: journey, feed, hunting, weather, fear etc.→ non-specific response in animal to adapt to maintain homeostasis

Types of Stunning:

- 1. Percussive stunning devices: Captive bolt– power operated or pneumatic
- 2. Free bullet method
- 3. Use of CO_2 anesthesia
- 4. Electrical stunning

Mechanical stunning/ Captive bold method:

Bolt is captive and cartridge is blank- bolt recoils back into barrel

- Bolt- 2 types
  - Blunt/ mushroom head - work by concussion – sudden jerk

- used when brain is kept edible- Claves

- Sharp head- Penetrate frontal bone

  - alter intracranial pressure

  - Brain trauma

  - used in cattle/ sheep but not in Pig and bulls (Thick frontal bone)

- Pneumatic captive bolt stunning device: pressure 80-120 psi

Site of shooting with captive bolt:

- Cattle: gun placed at right angle to the intersection of line joining the horns with median canthus of opposite eyes
- Calves: Slightly lower to the point of intersection
- Bull and old animals: 15 mm to the side of ridge which runs down the centre of forehead
- Sheep/goat (Hornless): pistol at the top of head aimed towards gullet
- Sheep/goat (Horned): Behind the ridge between the horns and aimed towards gullet
- Pigs: 2.5 cm above level of eyes and fired upward in cranial cavity
- Horse: 1 cm above the intersection of lines joining opposite ears to median canthus. Bolts are heavier and longer.

Water jet stunning:

This method emp loys a fine jet of water to penetrate the skull and mechanically destroy the brain by the induction of laceration, crushing or shockwaves to such an extent that immediate unconsciousness is induced.

Free bullet method: use of rifle at the site same for captive bolt method

Disadvantage: Brain destroyed non-edible and chance of injury to operator

Use of CO_2 anesthesia

- Mostly used for pigs
- Blocks nerve impulse
- Minimum CO_2 conc. 70%
- Low conc.: improper stunning
- High conc.: stiffening and poor bleeding
- Proper exposure pd.: 45 sec
- Longer exposure: superficial congestion/ bluish, convulsion and cardiac arrest

Note : Bleeding s/b done with 30 sec. otherwise recovery occurs in 1.5 min.

: For Sheep – uneconomical method because of wool- much CO_2 is wasted.

TYPES:

- **Oval tunnel**: For pigs only, 600 pigs/Hr, conveyer of 10 compartments, one for each pig
- **Dip lift**: pig/calf and sheep animal in cage descends vertically in to CO_2 pit.
- **Compact CO_2 immobilizer**: Horizontally revolving apparatus of 4-8 compartments

: 300 pigs/Hr.

Adv. of CO_2 anesthesia: no harmful residues in meat

: carcass: relaxed better dressing

: less noise and labor req.

: 0.75% more bleeding compared to other methods stimulate resp.

: No muscular hemorrhages (as in electric method)

: Lower meat pH and PSE condition is reduced

Electrical stunning: Most widely used method

Electrode: kept in brine, positioned such that current pass through thalamus and cortex chief sensory centers of forebrain

: Animal s/b dry (otherwise current passes over surface and not through brain)

: massive depolarization of nerves

: Mostly for pigs and poultry, but also for sheep and calves

: not satisfactory for adult cattle/buffalo: insulating hairs on head

: Low caloric intake and good state of hydration: better passage of current

Signs of genuine electric shock:

Cattle: eyes wide open with no corneal reflex, hind legs stretched, head bent backward and ceased respiration temporarily.

Poultry: feather spread, extended wings, tail feathers turned over back

Sheep/goat: flexion of forelimbs, closing of eye and extension of hind limbs.

- Effective bleeding in electrical stunning: increased blood pressure due to vasoconstriction and muscular contraction.
- Bleeding should be done immediately after electrical stunning. Otherwise: increased arterial blood pressure causes blood splashing in muscles (Blood splashing/ Muscle splashing) due to rupture of smaller arterioles and blood vessels muscular hemorrhages
- If voltage is high, it causes cardiac arrest and animal dies and whole blood remains in the body.

- **Missed shock:** If voltage is low or electrodes are poorly positioned, animal is paralyzed but fully conscious.

Devices for electrical stunning

1. **Hand stunning device:** for small animal and slow rate of killing.

   : 70 volt for 1-3 sec fowl and 90 volt for 9-10 sec for turkey

2. **Elther apparatus:** Rapid and complete bleeding with no blood splashing

: 285 watt for 1 sec. for cattle and 198 watts for 1 sec calf, sheep and fowl.

3. Automatic stunning device: line processing system.

Method of electrical stunning depending upon voltage applied:

a. **Low voltage**: less than 150 volts and minimum 7 seconds less effective

b. **High voltage:** 300 volts or more and minimum 3 seconds more effective

Method of electrical stunning depending upon method of application:

a. Head only: applied on head only. Min. 400 mA for pigs and 250 mA for sheep & lambs

b. Head to back stunning: High voltage current applied simultaneously to head a& legs/back.

BLEEDING

Spp	**Incision**	**Bleeding time**	**Blood yield**
Cattle	1. Bilateral carotid arteries & jugular vein by incision across throat caudal to larynx 2. Incision in jugular furrow at neck base with knife directed towards chest to incise brachiocephalic trunk and Ant. Vena cava.	6 min	Cattle: 13.6 kg Calf: 2.7 kg (Cow > bull of same age)
Sheep/goat	Jugular furrow close to head: cut both, carotid arteries and veins	5 min	1-2.5 kg
Pig	Middle of the neck at the depression in front of sternum, cut the anterior vena cava	6 min	Pigs: 2.2-3.0 kg Boar: 3.6 kg

Poultry	ventral neck cuts	2.25 – 3 min	30-50gm

- Malachite Green test – to check efficiency of bleeding
- Sticking – process of severing neck for bleeding
- Back bleeding/ oversticking – contamination of lungs due to improper sticking
- Splash – appearance of petechial haemorrhages in s/c tissue in pigs

PITHING: done in animals stunned by captive bolt

- A long rod is inserted in brain to destroy medulla oblongata to minimize reflex muscular activity
- Length of rod: not more than 0.6 m splanchnic nerve damage: main for vasoconstriction of abdominal cavity congestion in liver, kidney, intestine etc.
- Slaughter spleen: improper pithing spleen congested and enlarged

3.Quality control of meat and eggs and their products.

Meat packaging,Casings,Meat byproduct

- **Function:** protection from physical damage, chemical changes & microbial contamination

Fresh meat: oxygen permeable film recommended

1. **Overwraps:** Low density polyethylene (most widely used), PVC, nylon-6,11.
2. **Tray with overwraps**: polystyrene trays
3. **Shrink packaging:** polypropylene, PVDC, irradiated polyethylene irreg. cuts
4. **Vacuum packaging:** long term storage PVDC, nylon, polythene (meat-purple)
5. **Modified atmosphere packaging(MAP):** O_2(color),CO_2(bacteriostatic),N_2 (Filler).

ensure retention of meat quality for a period of at least 8 weeks in fresh meat and 10 weeks in case of cured meat at a refrigerated storage of 0°C

Frozen meat: Low density polyethylene, cellophane, polyester moisture proof

Cured meat: polyethylene, PVC, nylon-6,11, PVDC

Dehydrated meat: metal foil/plates/laminates moisture and O_2 proof

Thermo-processed meat: tin cans/ laminates

Meat byproducts (products other than dressed meat)

Poultry byproducts: 1kg bird 25-30% waste = 35 g blood; 80 g feather, 30g head, 40 feet and 90 viscera

Feather meal: 85% CP with 80% digestibility

Manure: high Nitrogen

Casings

- Prepared from sub-mucosa of the small intestine
- Measured in Hanks
- Used for stuffing sausage
- Rounds: casings from sheep and goat/ Pigs
- Runner: small intestine of cattle
- Middle: large intestine of cattle
- Bung: caecum of cattle
- Weasand: Esophagus of cattle
- Maws: pig stomach
- Chitterling/ black gut: colon (LI)
- Cap: caecum
- Paunch: stomach

Term	**Corresponding Organ/Part**
Diaphragm	Skirt
Tripe	Rumen & Reticulum
Spleen	Melt
Book/Bible/Farthing/Manyplies	Omasum
Pancreas	Gut (Sweetbread)

Weasands/Roll/Gullet	Oesophagus
Thymus	Sweetbread
Rapes/Runnes/Ropes	Small intestine of cattle
Reed	Abomasum
Buff/Lites	Lungs
Rind	Skin of pig
Caul/Crup Fat	Omental fat
Web	Ox mesentery
Cod Fat	Scrotal fat
Crow/Crown Fat	Mesenteric fat of pig

Use of meat byproducts:

- **Offal:** part other than the carcass
- **Variety meat:** Tongue, brain, sweetbread, heart, kidney, liver, Chitterlings
- **Lamb fries/ mountain oyster**: cooked testicles of lambs and calves
- Tripe, blood and pig stomach: sausage (tube-like case containing meat)
- Ox-tail: soups
- Bone: bone meal (21% Ca and 10% P), Bone china, Bone char
- Blood: 80-90% CP, lysine & Fe rich
- Neats foot oil: hoof/ feet of cattle lubricant

Pharmaceutical byproducts

- Adrenal gland: epinephrine
- Pancreas: insulin
- Pineal: melatonin
- Thyroid: thyroxin
- Beef fat: ointment base

- Stomach: **pepsin (Rennet from unweaned calf stomach (4th):** milk dig/ cheese)
- Gelatin: capsule, ice-cream
- Glue: adhesive
- Catgut: mucosa and submucosa of small intestine of sheep

Hide and Skin: one of the most important by-products

Hide

- Skin of **Large Animal**
- Large, Thick and Heavy
- Av. yield 7.0% of live wt.
- **75-80%: Fallen Animals** and 20-25 %: Slaughtered animals

Skin

- Skin of **Small Animal**/ young calf
- Small, Thinner and Tighter
- Av. Yield 11.0% of live wt.
- **80 %: Slaughtered animals** and 20%: Fallen Animals

Flaying: Process of skin removal from dead animal

Processing: Drying/Curing Conditioning Tanning Leather (Product)

Fallen animals: Coagulated blood capillaries stain the hide: inferior leather

Classification (wt, lb): Slunk Skin (Unborn Calf);

Classification (Weight, lb)	**Description**
Slunk Skin	Unborn Calf
Calf Skin	Immature Calf (9-15 lb)
Kip Skin	Calf (15-25 lb)
Heifer Skin	Heifer (25-30 lb)
Cow Hide	Cow (> 30 lb)
Light Cow Hide	Light Cow (< 53 lb)

Heavy Cow Hide	Heavy Cow (> 53 lb)
Extreme Light Hide	Steer (32-48 lb)
Light Steer Hide	Steer (48-58 lb)
Heavy Steer Hide	Steer (> 58 lb)
Bull Hide	Bull (60-100 lb)

Bristles of pig: stiff wiry hairs of pigs: making of brushes

Tanning: Process of conversion of hides/ skins to insoluble and non-putrescible leather without destruction of original structure.

- Types:
  - Vegetable Tanning
  - Chrome Tanning

Glue and Gelatin

- Bone constitute almost 15% of the weight of dressed carcass
- Bone collagen (ossein) is main organic constituent
- bone collagen or ossein, which is the mother substance for gelatine and glue.
- **Gelatin:** Gelatin can be obtained by boiling ossein or by boiling degraded bones in water acidified with Hydrochloric acid, which separates the gelatinous substances.

Glue: Glue is the inferior gelatin

Quality Evaluation of Meat Products

Physico-chemical qualities

1. pH: 6.1-6.7 (fresh meat: 5.5 to 6.2)

2. Emulsion stability: ability to maintain moisture, fat

3. Water Holding Capacity (WHC)

4. Cooking Yield (CY)

5. Shear Force Value: to measure meat tenderness Warner–Blatzler device

Microbiological Qualities

1. SPC

2. Coliform count

3. Yeast and Molds count

Color:

- **Meat color:** main pigment responsible for meat color is myoglobin (role of hemoglobin negligible)
- **Bloom:** bright red color of meat due to oxymyoglobin
- meat with a higher proportion of red fibers has a higher concentration of myoglobin
- **Beef and Carabeef:** bright cherry red
- **Mutton and chevon:** light to dark red
- **Pork:** grayish pink
- **Poultry:** grayish white to dull red
- **Veal**: brownish pink

Water holding capacity

- ability of meat to hold its own or added water during the application of external forces such as cutting, heating, grinding and pressing
- Related to juiciness of meat along with texture and color
- DFD has high WHC while low in PSE
- A decrease in WHC can be seen through fluid exudation called weep in unfrozen raw meat; or drip in frozen meat which is thawed, folds in cooked meat

Marbling

- The intramuscular fat visible within the meat, which is a key determinant of flavor and tenderness, especially in beef.
- Solidification of fat during chilling contributes to firmness

Tenderness/ Shear force

- Most important sensory attribute
- Warner–Blatzler device/ Penetrometer to measure meat tenderness
- Higher the whc – more will be tenderness
- Meat tendering Enzymes from plant: papain (papaya), bromelain (nanas), and ficin (ficus)

Firmness

- Collagen in muscle tissue determine the toughness
- Firmness more in old animals than young

- Although collagen content high in young animals but that is more heat labile and convert to gelatin on heating causing tenderness
- Firmness increases during carcass chilling due to loss of extensibility

Evaluation and grading of dressed carcasses

- Carcass evaluation is a broader term which gives idea about carcass yield, meat processing character, palatability and overall quality of meat.
- **Carcass Yield:** calculated by dividing the chilled carcass weight by the live weight and multiplying by 100.
- **Carcass Length:** Forward edge of the first rib to the forward edge of the pubic bone.
- **Back fat Thickness:** back fat deposited opposite 1st rib, last rib, and last lumbar vertebra for pork and 12-13th rib for beef/lamb.
- **Loin Eye Area (LEA):** cross section of longissimus dorsi muscle between 12-13th rib (ruminants) and 10th -11th rib (pork) for muscle development.
- **Fat Depth:** Using a back fat probe measure the fat depth including the skin at the rib eye/streak (6th rib onward).
- **Ribbing of Carcass:** opening the carcass by a cut made perpendicular to the length of carcass just below the 11th rib.
- Meat cutting room: temp. 15-20°C & RH 80%

Grading

- It is process of segregating meat and meat products on the basis of palatability, yield or other economically important traits into standardized group with minimum common characteristics.

Generally: two types of grades:

1.Quality Grade: based on the factors related to the palatability and acceptability of meat and meat products to the consumers.

2. Quantity grade /Yield Grade: As assigned to the carcass based on the yield of trimmed retail cuts and are established only for beef, pork and lamb carcasses.

Factors used to establish grades:

1. Conformation - Morphology of animal

2. Quality – firmness/ texture, tenderness. palatability, color, juiciness, odor, water holding capacity, etc.

3. Finish - quantity, amount, colour and distribution of fat. This includes:

- External: Subcutaneous fat (Blubber in marine animals)
- Intramuscular fat (between bundles- perimyseal CT): **Marbling** → juiciness

- Intermuscular fat: Seam fat
- Feathering: fine streaks of fats in inter-costal muscles
- Flank streaks: streaks of fat in epimysium of flank muscles

Evaluation of Sheep & Goat Carcass

Grading done on basis of (BIS)

- Length of the carcass
- Thickness of back
- Fullness of legs and flank
- Amount of fat in intercostal muscles.

Types

- Prime Grade
- Choice Grade
- Utility Grade
- Cull Grade

Evaluation of Buffalo Carcass

Grading done on basis of

Conformation, finish and quality of the carcass

Types

- Prime Grade
- Choice Grade
- Good Grade
- Commercial Grade
- Utility Grade
- Cutter and Canner Grade

Evaluation of Swine Carcass

Based on

- **Carcass length-** Edge of first rib to front of aitch bone.
- **Dressing %-** (Ratio of carcass wt. to live wt.) X 100.
- **Yield-** Average of four lean cuts (Ham, Loin, Boston Butt & Picnic Shoulder)
- **Loin Eye Area**- Proportional to muscle (*Longissimus dorsi)* development in carcass.
- **Back Fat Thickness-** Average of back fat on first rib, last rib and last lumbar vertebra.
- **Meat color-** Pinkish red > Greyish Red > Pale

- **Firmness-** Very Firm > Reasonably Firm > Soft and Watery
- **Marbling**- Small/Moderate > Slight > No Visible Marbling

Egg Preservation

- Recommendation for production of quality egg on farm
- 3 time egg collection daily
- Carefully handling while keeping in filler flats
- Quickly cooling of egg to 50 °F or less @75-85% relative humidity
- Marketing of egg twice a week
- Additionally lose of water content also responsible for spoilage of egg
- Methods are used to counteract it and increase shelf life of egg

Methods Of Preservation

- Refrigeration/ Cold storage
- Immersion liquids
- Thermo stabilization
- Egg shell treatment
- Overwrapping
- Radiation

Immersion liquids

- Lime water: For Long term storage (2-3 months).
- 0.5 Kg of lime dissolve in 1 litre of boiling water, the solution is kept over night and the supernatant is poured in a jar. In this solution 2.5 litres of cold water is added and the entire solution is then filtered with a muslin cloth.
- NaCl may be added @ 112 gms/litre of the supernatant solution.
- Eggs are kept dipped in this solution for 24 hrs, they are then dried and packed.

WATERGLASS

- 10% sodium silicate solution prepared in hot water.
- Eggs are then immersed in this cooled solution and stored in areas where temperature does not rise above 70 ^{0}F.
- Eggs preserved by this method are usually punctured before boiling so that the shell does not break while boiling and the shell peels of easily.

Shell Sealing Method

- It involves use of oil which seals the egg shell pores, thus preventing the escape of moisture and CO2 from the egg content.

- Thin albumen layer below shell membrane get coagulated
- Types: Oil Coating & Oil Water Emulsion
- Technique: Dipping or Spraying.
- Using color less odorless oil
- Cotton seed, linseed and ground nut oil are prefered

Thermostablisation

- Good for fertile egg as it killed embryo
- Known as defertilisation method
- Eggs are immersed in hot water at different time temperature combination
- 130 °F X 15 minutes
- 142 °F X 2 minutes
- 212 °F X 5 seconds
- Remain edible for a month

Over Wrapping

- Eggs stored in cartons which are then over wrapped in cellophane
- This technique is effective in maintaining egg albumen quality.
- Reduction in evaporation rate and maintaenace of low albumen pH.
- Over-wrapping cannot replace refrigeration but should be used in conjugation with it.
- Compared to oil coated eggs, eggs stored under plastic overwrap peel easily.

Cold Storage

- Best method of storage
- Temp : 30-32°F or 0 °C and 85-90% RH for 5-10 month
- Temp : 50-55 °F and 60-70% RH for 2-3 month

Radiation

- Shell egg irradiation dose starts at 1.0 kGy upto 5.0 kGy
- Radiation destroys the ovomucin protein of the albumin
- The gel-like structure of the albumen is lost on irradiation.

Packaging

- Wooden Boxes, Cardboard Boxes, Plastic Boxes, Plastic Trays

- Aluminum Trays, Paper Boards
- Moulded Pulp Cartons
- Boxes made from Straw/Organic fibres.

Filler trays

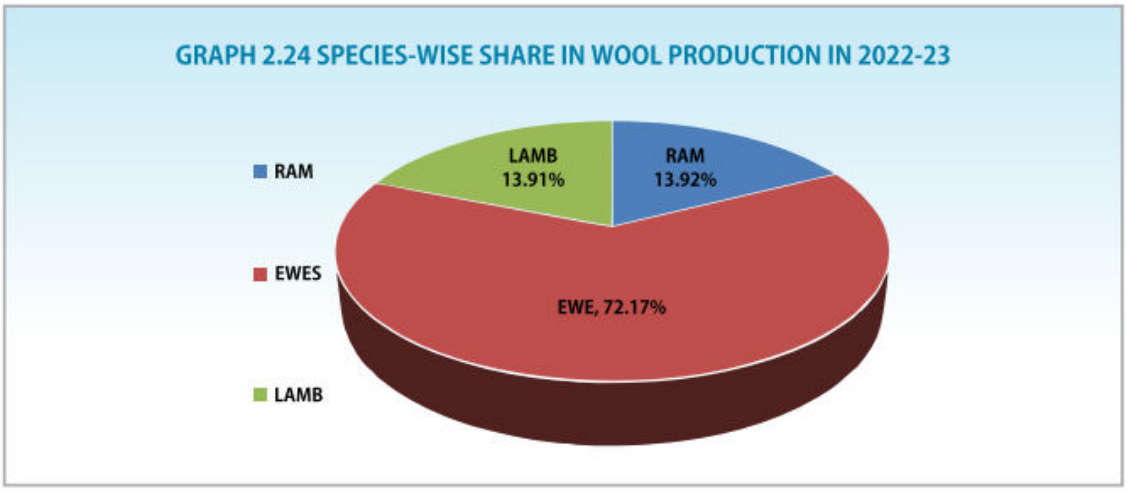
- Filler trays are made up of wood pulp or cardboard or plastic.
- They are moulded/constructed in such a way that they can be stacked one on top of the other and they can also be placed in boxes for transport.

Wool science

MAJOR HIGHLIGHTS OF WOOL PRODUCTION

- The total wool production in the country is 33.61 million Kgs.
- The Wool production has increased by 2.12% as compared to previous year.
- The top 5 wool producing States are Rajasthan (47.98%), Jammu & Kashmir (22.55%), Gujarat (6.01%), Maharashtra (4.73%) and Himachal Pradesh (4.27%). They contribute 85.54% of total wool production in the country.

2.4.1 SPECIES-WISE SHARE OF WOOL PRODUCTION



- **Wool:** is a natural fibre of animal origin consists of a cortex and cuticle, it is devoid of a medulla & Obtained from sheep, goat, yak, camel, etc.
- **Hair**: tend to be sleeker, straighter, more diameter and less crimpy than the wool fibers. consists of cuticle, cortex and medulla.
- **Mohair:** Natural fibre obtained from Angora goats and has high lustre and sheen, devoid of medulla and less developed scales unlike wool.
- **Fur**/pelage: A synonym for non-human hair (similar to hair); consists of cuticle, cortex and medulla.

Structure of Wool

- Fibrous Protein: keratin (Cysteine links, Ionic links, Hydrogen bonds)
- Sulphur containing AA: cysteine.
- **Cuticle:** Outer most protective layer of scales.
- **Cortex:** Internal cells of fibre, contributes 90% of the fibre.
- **Medulla:** hollow central core found in coarse and medium wool fibre consist of cells separated by gaps of air.

Wool development

Follicles appear in the second month of gestation

Primary follicles: developed earlier coarse fibres

Secondary follicles : developed later fine fibre Merino – majority

- S:P ratio of follicles determine types of fleece produced

Properties of Wool

- Flexible
- Resilience: restore their original shape after removing the external loading
- Elastic: stretch up to 30% of its normal length
- Crimpiness: 2-12/cm curliness
- Hygroscopic: 18-50% of own weight
- Specifc gravity: 1.304 and refractive index: 1.553- 5.00
- Water proof and non-inflammable

Wool processing

1. **Sorting**: Raw wool bought to the mill and is sorted
2. **Opening & Dusting**: Clumps are opened

3. **Scouring**: removal of impurities hot water (45°C-120°C) and soap/sodium carbonate
4. **Burr picking**: **carbonization**: Vegetable content is removed (NaOH solution)
5. **Oiling**: lubrication with oil to reduce breakage and maximise cohesion.
6. **Carding**: wool fibers are untangled and aligned in one direction. The wool fibre are bundled into strips known as "Roving/Sliver".
7. **Spinning**: twisting to give yarn strength and size.
8. **Weaving**: intertwining the yarns into desired product
9. **Dyeing** : permanent colour into the wool fibres.
10. **Finishing**: improves the appearance. Steps involved:

- **Milling**: Shrinkage of the fabric to the required degree in order to thicken it and give it a desired appearance.
- **Carbonization**: Chemically burr is removed by treating the finished product with dilute acid at high temperature.
- **Raising**: lifting out of wool from the body of the fabric.
- **Shearing**: levelling of raised out wool fibres.

11. **Testing**: assesses the quality, value, defect and other characteristics of the end product.

Wool Quality Parameters

- **Fibre-fineness**
- **Length (cm):** Determines spin-ability of the fibre
- **Crimp frequency**- crimps per unit length of the fibre (Merino: up to 100 crimps per inch)
- **Moisture Content:** % proportion of water absorbed in undried specimen
- **Medullation Percentage:** Volume occupied by medulla in a fibre: 5%-99%. Medullated fibres are hollow & cause serious problems in dying process hocks and briskets of sheep.
- **Scouring Yield:** The process of cleaning of wool is called scouring.
- **Burr Content:** Types: Low Burr 3%; Medium Burr: 3-5%; Heavy Burr >5%
- **Colour:** near white to shades of cream and yellow. Intense yellow discoloration **canary stain**: fleece under the influence of moisture, temperature and bacterial activity.
- **Lustre:** coarse wools have higher lustre than fine types.

Wool Glossary/ Terminology

1. Fleece: Fibre coat that covers a sheep
2. Lock: A group of fibres clinging together in fleece

3. Suint: natural greasy substance in sheep's wool Secretions of sudoriferous glands.
4. Lanolin/ Wool wax: Secretions of the sebaceous glands of the skin.
5. Greasy wool: Shorn wool with grease and wax before removal of impurities.
6. Wool Yolk: Wool wax with suint in raw wool is known as yolk.
7. Kemp: A coarse, weak and brittle wool fibre with irregular medulla
8. Crimp: Natural waviness/curliness of a wool fibre.
9. Staple Length: Length of a wool fibre without disturbing its natural waviness.
10. Fibre Length: Length of the fibre in stretched condition.
11. Burr: Vegetable matter present in wool
12. Scouring: removal of impurities detergent (sodium carbonate)
13. Carbonization: removal of burr with chemical treatment of wool
14. Shearing/ Clipping: Removal of fleece from body of sheep
15. Skirting: Removal of objectionable parts and stains from body of fleece after shearing
16. Pelt: undressed skin along with it's hair/wool/fur.
17. Sweating: process of removal of wool by bacterial digestion (proteolytic enz.) of pre-keratinous region of fibre root or by application of depilatory agent to the under surface of pelt.
18. Rooing: Plucking of fleece of indigenous sheep having double coat under going loosening of the fibre. Natural break in the growth of the wool in spring. This causes the fleece to begin to peel away from the body, and it may then be plucked by hand without cutting.
19. Fellmongering: removal of wool from sheep skin through use of chemical applications (sodium sulphide or thallium).
20. Felting: ability of textile material to undergo irreversible increase in bulk density when subjected to friction and pressure under suitable physical conditions.
21. Yarn: thread made from wool in the form of a loosely twisted collection of fibers
22. Count: It is an index of thickness or diameter of yarn.
23. Hank: a coiled or wrapped unit of yarn
24. Warp: longitudinal section of fabrics arranged in form of sheet
25. Weft/ woof: transverse section of fabrics
26. Weaving: technology in which two distinct sets of yarns/threads are interlaced at right angles to form a fabric or cloth
27. Scale: A cuticle of flattened cells protecting the cortex of fibres.

28. Keratinization: Hardening of previously soft plastic fibrous protein.

29. Gare: Partially medullated mohair fibre which at sometimes also arise from some secondary follicles.

30. Crimp width: The distance between the mid point of the successive valleys of the projected crimp wave image.

31. Crimp amplitude: It refers to crimp wave and is half the total depth from crest to trough.

32. Rise in wool: Seasonal increase in flow of wax.

33. Hunger Finess: Wool of under nourished sheep as of nutritional scarcity producing lighter but finer fleece.

Wool grading

1. Blood system of grading: based on the percentage of Merino blood e.g. fine, 1/2-blood, 3/8-blood, 1/4-blood, low 1/4-blood followed in USA

2. Numerical system: based on no. of yarns made from one pound of scoured wool

3. Based on the length and diameter of the wool grading is done.

- Fine
- Medium
- Long
- Cross bread
- Mixed

Coarse wool fibre: (25–70 μm diameter): carpets

Fine merino fibre: (10–25 μm): apparels