Applied Zoology

Dairy

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Introduction:

Animal husbandry in India has close relationship with agriculture. This sector provides nutritional security through milk, meat and eggs and export opportunities through milk, wool, hides, skin, hooves, bones and hairs. In India, agriculture accounts for 27 per cent of GDP and livestock accounts for 26 per cent of agricultural GDP and 9.1 per cent of total GDP. India constitutes less than 3% of the world's, total land area but it supports 55% of the world's buffaloes, 16% of the world's cattle, 20% of the world's goat, 5.4% of the world's sheep and 1 % of the world's swine population (FAO, 1998). According to the livestock census (1992) our country has about 205 million cattle, 80 million buffaloes, 46 million sheep, 111 million goats and 11 million pigs. Only 18% of total stock of cattle and buffaloes are of well defined breeds and rest 82% are classified as non-descript animals.

Livestock production performance has been more impressive than that of food grain production. While food grains, cereals and pulses registered an average growth rate of 1 to 3 per cent per annum, milk, egg, meat and fish showed growth rate of 5 to 10 per cent. In addition to this, Livestock industry provides draught power and manure for the crop production and this in turn provides feed and fodders.

Cattle and Buffalo Production:

Related Terminology:

Cattle or Ox:	It is a general term that signifies all the members of the cow species ie., cow, bull, bullock, heifer and calves etc.
Cow:	A female of bovine species that has calved at least once.
Buffalo:	A female of butaline species that has calved at least once.
Bull:	An uncastrated sexually matured male of the species under question.
Stud bull or breeding bull:	The bull that is used for breeding purpose.
Scrub bull:.	A non-descript type of strong village bull
Brahmini bull:	The bull that are left in the name of dead person which is a practice prevailing in certain parts of country.
Pedigree bull :	Whose ancestral record is known.
Pure breed:	Breed for a number of generation among closely related individuals to attain purity.
Crossbred:	The animal produced by mating two different breeds of the same species.
Sire:.	The bull that serves (Male parent)
Dam:	The cow that serves (Female parent)
Bullock or steer:	A castrated male OX of over 2 years age.
Calf:	A young animal of bovine species under 1 year of age.
Heifer:	A female of bovine species that has not yet calved.
Buffer cow:.	A cow apparently always in heat, oestrus
Free-martin:	When twin calves of different sexes are born, the female one is usually sterile, such a female calf is called a “free - martin".
Hybridization:	Cross of animals of two different species such as (i) Male horse X Female ass > Hinny (ii) Male ass X Mare --> Mule
Calving:	Act of Parturition in cattle or buffaloes.

Cattle Breeds :

There are 861 breeds of cattle in the world out of which 26 are Indian breeds. Besides Indian breeds, India possesses some exotic cattle breeds also. On the basis of performance Indian cattle breeds may be classified into 3 groups as under :

(a) Milch breed: Cows grouped under milch breed are characterized by wedge shaped outline, loose dewlap and sheath, wide and capacious abdomen, feminine appearance with loosly, soft and pliable skin; well developed udder between thighs and well developed veins on the udder. Cows are high yielders and their production varies from 1500 to 2500 liters/lactation but their bullocks are poor.

(b) *Dual Purpose Breed*: They are characterised with sound constitution, small horns, long skull and face and back of the body is developed. These cows provid bullocks for agriculture purpose and are producing average quantity of milk. Milk yield varies from 1200 to 1500 litres/lactation.

(c) *Draught breed* :The cows of this type of breed are poor milk producers but their calves are excellent for plaughing and transport purposes.

Indian Cattle Breeds:

S.No.	Breed	Place of Origin/ distribution	Chief Characteristics
		1. Milch Breeds	
1	**Sahiwal**	Distt. Mantgomari (Pakistan),NDRI Karnal, Chakgajaria(Lucknow), Haryana and West U.P.	Generally red in colour, body symmetrical, broad forehead, small and thick horns, soft skin and high milk yielder.
2	**Red Sindhi**	Sindh state (Pakistan)/Military Farm Merrut, State Farm M.P, Nagpur	Medium sized, symmetrical and compact body, wedge shaped, docile, well developed udder, deep dark red color of body high milk yielder.
3	**Gir**	Kathiawar, Rajputana/Jamnagar, Junagarh, Ahamedabad, Bombay, Nasik, Pune	Forehead broad and convex, long ears, irregular horns, red with white patches or white body colour, developed udder
4	**Tharparkar**	Sindh State (Pakistan)/ Kutch, Jodhpur, Amarkort	Cows are strong, compact having grey white colour, medium sized, ear long and convex forehead, good milker.
		2. Dual Purpose Breeds	
1	**Deoni**	Western Hyderabad/Udaigiri cattle breeding farm.	Black and white or Red and white similar to gir breed, dewlap developed, small ears down wards.
2	**Haryana**	Rohtak, Hissar, Karnal, Gurgaon, Delhi, West U.P., and Alwar, Bharatpur (Rajasthan)	Narrow mouth, convex fore head, small horn and ears. Medium sized, white or light grey colour.
3	**Ongole**	Gantur (A.P.), Ongole tract of A.P., Nellore	Large, heavy' and muscular body white colour, Broad forehead, stumpy horns with thick base, docile.
4	**Mewati**	Alwar and Bharatpur	Similar to Haryana, face is long

		(Raj.) Mathura Distt. of U.P.	but narrow, large hump, long tail and white colour
5	**Kankrej**	North GujratlSouth-east of Rann of Kutch to Tharparker Distt.	Heavy breed, broad chest, Powerful body. straight back, silver gray or iron grey or black in colour.
6	**Nimari**	Narmada valley of M. P.	Long and narrow face, flat forehead, long body, straight back, medium horns, red with white patches on body.
7	**Rathi**	Alwar and Rajputana region of Rajsthan	White or light grey in colour, medium sized similar to Haryana breed, short tail.
8	**Dangi**	Ahmednagar and Nasik distt of Maharastra	Broken red and white or black and white, medium sized body, small ears, horns and head, oily skin.
		3. Draught Breeds	
1	**Amritmahal**	Nillore distt./Karnatak state	Grey colored body with dark head, neck, hump and quarters, Narrow face with prominent forehead compact body with straight back.
2	**Hallikar**	Hassan and Tumkur distt. of Karnataka state.	Grey to dark grey colour, medium sized, long head and horns close to each other.
3	**Kangayam**	Coimbatore distt. of Tamil Nadu	White with black markings grey to black markings. Fine skin, strong horns, body long, straight back.
4	**Malvi**	Malwa, Gwalior (M.P.) and Rajsthan	Grey to iron grey and black on the neck and quarters, short but compact body, short ear but alert, Tail long.
5	**Nagori**	North east Jodhpur and Nagore distt. of Rajsthan.	White or grey colour, long and deep body, broad forehead, Narrow and long face.
6	**Kerigarh**	Lakhimpur-khiri distt. of U.P.	White body colour, bright eyes, small active ears, long tail and short neck.
7	**Ponwar**	Pilibhit and Lakhimpur-khiri distt. of UP.	Black and white in colour,
8	**Siri**	Hill tract of Dargeeling, Sikkim and Bhutan	Black and white or red and white in colour, Massive body, small head, sharp horns, small ears and strong legs.
9	**Kankatha**	Uttar Pradesh	Grey to dark grey colour, short deep and compact body, straight back, short head and broad forehead.
10	**Khillari**	Sholapur and Satara distt. of Maharastra.	Grey with brick dust colour over the fore quarters. Compact body

			resembles Amritmahal breed.
11	**Gaolao**	Maharastra.	Pure white but males are grey over head, neck and humps, medium sized, long and narrow face, medium ears and short horns.
12	**Krishna Valley**	Bombay-Hyderabad border, bank of river Krishna, Ghataprabha and Malaprabha areas in Karnatak.	Grey white colour, A mixt ure of ongole and Gir breed, Long and massive body, small horns, broad chest.
13	**Bargur**	Coimbatore distt. of Tamil Nadu	Red and white some times light grey, medium sized body, tail short, horns grow backward.
14	**Bachaur**	Sitamarhi distt. of North Bihar	Grey, compact body, straight back, broad and flat forehead, large eyes, medium ears, short tail.
		4. Exotic Breeds of Cattle:	
S.No.	**Breed**	**Place of Origin**	**Chief characteristics.**
1	**Holstein -Friesian**	Netherland	Black and white, large feeding capacity, head is long, narrow and straight, Average. milk yield 5500 litres/lactation.
2	**Jersey**	Island of Jursey in English channel.	Fawn, with or without white markings, cows have straight top lines, level rump and sharp withers. Average. milk yield 4400 litres/lactation.
3	**Brown-Swiss**	Switzerland	Brown, large head, thick loose skin, breed is docile and has more capacity to heat tolerance than Jersey. Average. milk yield 5000/lactation.
4	**Ayrshire**	Scotland	Red, Brown or combination of these with white, shorter and thicker neck, straight top lines, level rump and good udder. Average. milk yield 4600/lactation.
5	**Guernsey**	Guernsey Island of English channel.	Golden colour, medium sized, beautiful in looking. Average. Milk yield 4000 litres/lactation.

Cross bred: Some crossbreds have been evolved with the cross of Indian cattle (dam) and exotic bull (male) as under:

Karan-swiss : This breed has been evolved at National Dairy Research Institute, Karnal (Haryana) by crossing the Sahiwal cows with the semen of Brown Swiss imported from U.S.A.

Karan-Fries: This breed was also originated at National Dairy Research Institute, Karnal (Haryana) and now it is gaining popularity in the country. This was produced by crossing Tharparkar cow and Holstein-Friesian bull.

Sunandini : This breed has been evolved in Kerala by crossing the non-descript local cows with Jersey, Brown-swiss and Holstein - Friesian bull followed by selection. More than 20 lac Sunandini cows are reared in Kerala and contributing significant in milk production. Now-a-days, semen of Sunandini bulls is exported to Tamil Nadu, West Bengal, Karnataka and Orissa.

Jer-Sindh: This breed was evolved by crossing Jersy bull and Red Sindhi cow.

Brown-Sindh: This breed was produced after crossing Brown-Swiss bull and Red sindhi cow.

Buffalo Breeds:

There are 74 breeds of buffaloes in the world out of which 7 important breeds are in India.

S.No.	Breed	Place of Origin and distribution	Chief Characteristics
1	**Murrah**	Punjab, Haryana, Delhi, U.P. and Rajasthan.	Jet black colour, short curled horns, bright eyes, skin soft and smooth, good milker; Average. Milk yield 1800 litres/lactation.
2	**Mehsana**	Baroda, Mehsana, Sabarkanda and Banaskanta (Gujrat)	Jet black colour or brown grey, medium sized, breed is docile, white marking on the face, legs or tips of the tail. Average. Milk yield 1800 litres/lactation.
3	**Jaffarabadi**	Gir forest of Kathiawar, Junagardh, Jamnagaar, Kutch (Gujrat)	Prominent forehead, heavy horns, body long and compact, Average. Milk yield 1365 litres/lactation
4	**Surati**	Kaira, Baroda and Surat distt. of Gujrat.	Broad and long head, horns grow downwards, well developed under, black or brown colour of body, Average. Milk yield 1370 litres/lactation.
5	**Bhadawari**	Gwalior (MP) and Agra, Etah, Etawah (U.P.)	Medium size and wedge-shaped body, small head and horns, short legs, copper colour of body, Average. Milk yield 1100 litres/lactation.
6	**Nili Ravi**	Mostly in Pakistan, East Punjab and bank of Ravi and Satluj rivers.	Medium sized, coarse and heavy head, small horns, black colour of body. Average. Milk yield 1590 litres/lactation.
7	**Nagpuri**	Central and Southern India, Akola, Nagpur, Amarawati (Maharastra)	Black colour of body and white marking on face and leg, lighter breed, Average. Milk yield 900 litres/lactation.

Methods of Breeding:

Natural method: It is very old and conventional method of breeding in which a cow or buffalo is directly get mating to their respective bull during heat period. In this way, a bull can bred 50 to 60 cows per year.

Artificial insemination method: In this method the semen of a bull is collected with the help of artificial vagina (AV), diluted and the required quantity of semen is inseminated in cow or buffalo through an inseminating tube.

Therefore, artificial insemination is primarily an economical measure because in this case few bulls are required and maximum use can be made of the best sires. For semen collection the parts of AV should be clean, sterile and dry. Before semen collection, warm water of 45 to 50^0 C is filled between outer cylinder and inner latex to provide inside temperature between 42° C to 46° C. The pressure inside the AV should match with the natural vagina (45 to 55 mm Hg). During collection, the collector should hold the AV at 45° angle to the ground, so that it should be in the line of penis. Semen collection can take place twice a week. Semen is diluted using egg yolk citrate or sodium citrate diluters.

A cow usually remain in heat for 18-24 hours (buffalo upto 36 hours) and should be inseminated between 6-10 hours before the end of oestrus. For this purpose, inseminating pipette (containing 0.8 to 1.2 ml of diluted semen) is introduced through the vaginal passage and inserted halfway into the cervix where semen is left.

Feeding and Management:

Since cattle and buffaloes are ruminants, crude fiber is very important in their ration because they need acetic acid for maintaining normal milk fat % as well as total milk production. Acetic acid and other volatile fatty acids originate from fermentation of cellulose of feed in the rumen. Conventionally a cattle or buffalo is fed about 30 to 40 kg green and 4 to 5 kg dry fodder per day as a basic ration. 1 kg concentrate/day is fed to dry animals to meet maintenance requirements. Additional 1 kg concentrate is fed during advanced pregnancy. If good quality green fodder is given there is no need of concentrate to feed the animal yielding upto 5 kg milk per day.

For feeding different categories of animals there are four types of ration:

(i) Balanced Ration: A feed mixture which contains all the essential nutrients (i.e. Carbohydrate, Protein, fat, minerals and Vitamins) in right quantity and quality as needed by the animal called "Balanced Ration".

(ii) Maintenance Ration: The amount of balanced ration required to fulfill the maintenance need of a particular animal is called " Maintenance Ration".

(iii) Productive Ration: The amount of feed offered for growth, work or production over and above the maintenance need is known as " Productive Ration" It is given in the form of concentrate mixture.

(iv) Ideal Ration: Feed mixture containing all the essential components of a balanced ration which has ability to fulfil all the need of a particular animal when given according to his body weight is called "Ideal Ration".

Salient Points for cattle and buffalo Feeding:

(1) Feed should be balanced and offered twice a day with 8-10 hours interval.

(2) Cattle and buffalo require dry matter daily @2.5 kg and 3.0 kg/100kg body weight, respectively.

(3) About 2/3 parts from dry +green roughages and *1/3* part of total dry matter need should be fulfilled with concentrate mixture.

(4) If green fodder is in practice of feeding the animal, concentrate mixture should have 11-12 % protein. If there is no green fodder then atleast 18% protein must be in the concentrate mixture.

(5) Type of feed should be changed gradually otherwise it will provide adverse effect on the digestion system of the animal.

(6) Dry and green fodder should be offered just after feeding the concentrate mixture.

(7) Animal should be allowed to drink fresh and clean water twice a day.

(8) Animal should be offered clean, tasty, digestible, nutritious and cheap feed.

(9) 40 -50 gm Sodium chloride and 2%mineral mixture should be given/day/animal.

(10) Breeding bull should be provided 20-30% additional ration above to maintenance need.

(11) For growth, milk production and pregnancy, extra ration in the form of concentrate mixture should be offered.

(12) 1 kg concentrate mixture for production of each 3 kg milk in case of cattle and each 2 ^{1}/2 kg milk in buffalo should be given per day.

(13) Above 6 months of pregnancy, 1 kg and 1 ½ kg concentrate mixture per day should be given to cow and buffalo, respectively.

(14) At least 5 kg green fodder per day must be included in the feeding of milch animal otherwise milk production will be decreased.

(15) While feeding the animal, one should behave lovely.

Housing Requirement:

Cattle and Buffaloes need comfortable place to stand, lie down and rest. Actually an animal needs more place than what it can occupy physically. The space requirement of the animal depend on size and age of animal to get enough free air and freedom of movement and comfort.

Space required for Cattle and Buffaloes

Type	**Covered area (Sq cm)**	**Open area (Sq m)**	**Feeding space (cm)**	**Water space (cm)**
Bull	12.0	12.0	60-75	60-75
Cow/Buffalo	4.0	8.0	60-75	60-75
Sucking calf	1.0	2.0	40-50	10.15
Old calf	2.0	4.0	40-50	10.15

Common Diseases of Cattle and Buffaloes:

Few diseases are most prevalent in calves and some are very common in adult animals. For proper treatment of a disease, one should consult the nearest veterinary doctor.

Diseases of Calves

S.No.	**Name of Disease**	**Causal Organism**	***Symptoms***	**Treatment**
1	**Navel ill**	Streptococcus, Staphylococcus	In newly born calves navel is rotten and	Antiseptic medicines like Acriflavin,

			produces dirty smell.	Cibazol powder, Procaine Penicillin injection.
2	**White Scour**	B.Coli, Salmonella bacteria	Fever, Constipation, white dysentry and sometimes blood also.	B.coli antiserum or omanomycin I/V injection or sulphaguadin tab.
3	**Pneumonia**	Pneumonococci	In cold season coughing, sneezing sound in respiration, flow of white watery from nose.	Sulphadiazine or sulphadi-midine tab. Strepto - pencillin 20-30 lac unit in 3-4 days, massage of linament oil on chest.
4	**Cough Dyphtheria**	Virus	Watery boils in mouth, oesophagus, tongue and gum.	Terramycin or Ampicillin injection.
5	**Ascariosis**	Organisms of Nematode group	In suckling calves dullness, less food dysentery.	Piperazine or piperex or vermex or Neelworm.
6	**Paratyphoid**	Contamination	High fever, swelling on mouth, dullness, greasy material in eyes.	Consult V.S. and clean the place of calf.

Diseases of Adult (Cow and buffalo) Animals:

S.No.	**Name of Disease**	**Causal Organism**	***Symptoms***	**Treatment**
			(A) Viral Disease	
1	**Rinderpest (R.P.)**	Virus	High temperature (104-107°F), bloody dysentry, secretion from eyes, nose and mouth	Vaccination 50-100 ml, Inj.of sulphamezathene.
2	**Foot and Mouth disease (F.M.D.)**	Virus AOC and Asia-1, Set-1, Set-2, Set-3	Secretion from mouth, scraps on udder, teats, hooves and mouth, fever.	Wash mouth with 2% alum solution and wash hooves with 4% phenyl solution, Magsulf 60 g + 80 g molasses should be given if fever exists.
3	**Cow Pox**	Virus	Stop feeding and rumination, boils on udder and teats.	Save the animal from Pneomonia etc.
			(B) Bacterial Disease	
1	**Anthrax**	Bacillus anthracis	High fever (105°F), Bleeding from mouth,	No proper treatment, spore vaccine 1 ml in

			nose and anus, Suffocation, Pain in stomach, neck and chest, black faeces	the skin of neck.
2	**Haemorrhagic Septicaemia (H.S.)**	Pasteurella boviseptica in cows and pasteurella bubaliseptica in buffaloes.	High fever (107°F) dullness, stop feeding suphocation, trouble and sound in breathing, swelling in neck and intestine, secretion of fluid from mouth and nose.	Sulphamidin sodium inj. I/V, Sulphadizine or sulphathiozole tab.
3	**Black Quarter (BQ)**	Clostridium chauvoei	Seldom high fever (107°F), stop rumination painful swelling on thigh, rough and dry skin.	Vaccinate 5 ml form-alinised B.Q. vaccine in skin of neck, Penicillin Inj. 20-40 lac unit/animal.
4	**Johne's disease**	Mycobacterium paratuberculosis	Anaemia, loss of appetite, weakness, lack of water in body, long period disease.	Streptomycin inj. 1-2 gm/ day for long period.
5	**Tuberculosis (T.B.)**	Mycobacterium tuperculosis	Deposition of cough in lymph glands, difficult breathing, loss of appetite, weakness, increase or decrease in fever.	**I/M inj. of streptomycin 2-5 gm/day or streptopencillin dicrysticin 20-40 ml/day.**
6	**Mastitis**	Streptococci Staphylococci	Swelling on teats and high fever reduced milk production.	Syringe1% Acreflavin solution in teats with teat syphon.

Some Other Common Diseases:

(1) <u>Impaction of Rumen:</u> Mainly due to feeding of dry and hard fodders, insufficient water intake and/or sudden change in feed ingredients/feeding pattern. For treatment, 500 gm Magsulf is dissolved in water and offered to the animal for quick releaf.

(2) <u>Tympanitis:</u> Mainly due to sudden change in feed and/or feeding of fungal infected or rotted feed ingredients, feeding of high carbohydrates content feeds and/or feeding on large amount of leguminous green fodders. For treatment-Mix Turpentine oil 50 ml with 400 ml Linseed oil and give to the animal. In acute stage, difuse the gas from rumen with the help of Trocar and Canula.

(3) <u>Milk Fever:</u> Due to deficiency of calcium in blood, continuous lack of calcium in ration and/or less dry period before calving, milk fever occurs in high yielding cows and buffaloes. There is no fever but it is due to deficiency of Ca in body. Calcium borogluconate should be provided orally or it should be syringed through teats.

Salient Points of Cattle and Buffalo Production:

(1) About 11.29% of the total cultivated area in India is used for Animal Husbandry purpose.

(2) A heifer on an average matures in 25-30 months and life span is about 18 years.

(3) A male calf reared with good technique will be breedable in 2.5 years of age.

(4) Highest population of cattle and buffalo is in Uttar Pradesh.

(5) Kankrej is a heaviest breed of Indian Cattle.

(6) Colostrum is provided to calf @ 1/10 part of its body weight. It provides immunity to the calves.

(7) Lactation period of a cow or buffalo is about 300 days.

(8) There are 4 incisors in mouth of a cow.

(9) A cow or buffalo becomes full mouth in $5\text{-}5^{1}/_{2}$ years.

(10) First ring in horns of a calf is formed at the age of 3 years and then one ring is formed at every year.

(11) A heifer comes in heat first time at the age of $2^{1}/_{2}$-3 years.

(12) A cow or buffalo remains in heat for 24-36 hours.

(13) The period of heat cycle in cow or buffalo is 21 days.

(14) About 75 to 90 days after parturition a cow comes in heat.

(15) Artificial Insemination was introduced first time in India in 1939.

(16) Interval between two calvings of a cow is 12-14 months.

(17) Average body temperature of a cow or buffalo remains at 101.4°F.

(18) Pulse rate of a cow or buffalo ranges between 40 to 60 per minute.

(19) Respiration rate of a cow or buffalo varies between 12 to 18 per minute.

(20) To destroy breeding efficiency of an animal is called as 'Castration' and it is performed with the help of 'Bardizzo Castrator'.

(21) Sahiwa1 is considered best milch breed amongst Indian cattle.

(22) Crossbred cows produce 2 to 4 times more milk than the indigenous cows.

(23) India is native place of buffaloes.

(24) 'Silage' is a preserved green fodder which is used for feeding the animals during scarcity of green fodder.

(25) Crossbred 62.5% pure are most suitable for Indian conditions.

(26) A crossbred heifer gives birth a calf at the age of 24-25 months.

(27) The milk of Bhadawari buffalo contains highest fat (upto 13%).

(28) Wheat bran is a richest source of phosphorus to the animals.

(29) ‘Dehorning’ means removal of horns from the head of a calf, which is done with the help of ‘Caustic stick’.

(30) For determining pulse rate in a cow, a finger is kept on coccygeal artery and palpations are counted per minute.

(31) For determining temperature of an animal, thermometer is slightly inserted in the anus and rise in temperature is noted after 1 minute.

(32) Oxytocin hormone is used for milk let down.

(33) Adralin is responsible for holding up the milk.

(34) Gestation period of a cow is 282 days and for buffalo, it is 310 days.

(35) Giving birth to an offspring in cow or buffaloes is known as 'calving' or 'parturition'.

Cost Benefit Analysis of Dairy Production:

Setting up of dairy production unit is mainly for generation of additional employment and to supplement income of the farmers/animal keepers. For this purpose, loan is provided by the banks or other financial organizations, with some times a part of the fixed or working costs being subsidized from government funds. How such units would perform, is depend on how efficiently the unit is run. However, some broad idea can be obtained from the examples given below:

Example:

Cost benefit analysis of dairy farming of 50 crossbred cows.

Expenditure parameters

I. Fixed Expanses:-

1. Livestock

Total no. of Cows = 50	
Total no. of Milch Cows	= 40
Total no. of Dry Cows	= 10
Note: Bull is not maintained as breeding of cows will be taken care by A.I.	

2. Herd Expanses: -

Cost of 50 cows (@ Rs. 10,000/cow) = 10,000 x 50 = Rs. 5,00,000

Annual depreciation: - Assumed Value after 7 years of productive life is Rs. 4000/- for each cow.

Therefore, annual depreciation = 5,00,000 (4000 x 50)/7 = Rs. 42, 857=00

3. Building Expanses: -

(a)	Covered area	= 70 Sq feet /animal
(b)	Uncovered area	= 100 Sq feet /animal

Therefore, total covered area = 70 x 50 = 3500 Sq feet

and uncovered area = 100 x 50 = 5000sq feet

Roads and offices = $\frac{(3500+5000) \text{ X } 10}{100}$ = 850 Sq feet

(@ 10% of total area)

Therefore total land required = 9350 Sq feet or 868.61 m^2

or about 0.22 Acres

(i) Cost of land Rs. 75,000/acre (unproductive land)

Therefore the cost for 0.22 acres = Rs. 16, 500.00

(ii) Cost of Construction, For covered area (@ Rs.200/Sq feet)

= 200 x (3500 + 830) = Rs. 8, 70,000/-

For uncovered area (Rs. 50 Sq feet) = 50 x 500 = Rs. 2,50,000/-

Assuming that life of covered area is 50 years

therefore annual cost of production

= $\frac{8,70,000}{50}$ = Rs. 17, 400.00 (depreciation/year)

and life of uncovered area is 30 years, therefore annual cost of construction = 2,50,000/30 = Rs. 8,333.00 (depreciation/year)

4. Cost of Equipments: -

Equipment	**Quantity**	**Unit rate**	**Total Expenditure**
Chaff cutters (Simple electrically operated)	2	(@Rs.10, 000/each)	Rs.20,000/-
Milk Cans	4	(@Rs.500/each)	Rs.2000/
Wheel barrow trolley	2	(@Rs.2000/each)	Rs.4,000/-
Tie chains for cows	50	(@Rs. 100/-each)	Rs. 5000/-
Shovel/Spades	5	(Rs. 50/-each)	Rs.250/
Miscellaneous			Rs 3000/
Total			**Rs. 34,250/-**
Assuming that life of equipment is 10 years, therefore annual depreciation = 34,250/10 = Rs. 3,425/-			

5. Interest on fixed capital: - @12% on herd, land, building and equipment costs.

Cost of Herd	= 5,00,000.00
Cost of land	= 16,500.00
Cost of building	= 8,70,000.00 (covered area)
Cost of building	= 2,50,000.00 (uncovered area)
Cost of equipments	= 34,250.00
Total Cost	= Rs. 1,6,70,750.00

Therefore, Interest on fixed capital = 16,70,750 X 12/100 = Rs. 2,00,490

Total annual fixed cost = 42,857+17,400+8333+3425+2,00,490

= Rs. 2,72,505.00

II Variable Expanses: *-*

1. **Fodder Expenses:-**

Green fodder @ 40 kg/day/animal

For one year = 40X50X365 = 730000 Kg ot 7,300 qt.

Therefore cost of fodder (@Rs. 50.00 qt) = 7300 X 50 = Rs. 3,65,000.00

2. **Concentrate Mixture**

Assuming that maintenance requirement is met by green fodder.
The concentrate requirement for production would be as follows: -

Average yield of cow = 9 litre/day (assumed)

For 3 kg milk 1 kg concentrate is required, therefore for 9 kg milk 3 kg concentrate is needed

For 40 milking cows, for 365 days = 40 X 3 X 365 = 43, 800 kg or 438 qt. concentrate is required.

For 10 dry cows, for 365 days (@1kg/cow/day) = 10 X 365 = 3650 kg or 36.50 qt.

Total requirement of concentrate mixture = 438 + 36.50 = 474.50 qt.

Cost of concentrate mixture (Rs 700/qt) = 474.50 X 700 = Rs. 3,32,150.00

3. Labour Expenses: -

(i) Cow needs ½ hr/day man hour labour Therefore 50 cows needs 25 hours/day	= 3 Laboures
Labour cost (@Rs. 60/day)	= 60 X 3 X 365 = Rs. 65, 700.00 per year
(ii) Supervisor (1) @ Rs. 4000/-per month X 12 months	=Rs. 48,000.00 per year.
Total labour charges	= 65, 700 + 48,000 = Rs. 1, 13, 700.00 per year.
(iii) Light and water charges (Rs. 10/animal/month), 50 animals	= 50 X 10 X 12 = Rs. 6000/- per year
(iv) Medicine and AI expenses (@Rs. 200/animal/year)	= 200 X 50 = Rs. 10, 000.00
(v) Miscellaneous expanses	= Rs. 5000/- per year
Total Variable cost= 365000 + 332150 + 113700+ 6000 + 10000 + 5000	= Rs. 8, 31, 850.00
Total Expenditure = Total Fixed Cost + Total Variable Cost=	272505 + 831850 = Rs. 1104355.00

Income parameters: -

1. **Sale of milk** (@ Rs 12/litre)

Amount of milk produced	=9 X 40 X 365 =1,31,400 litres per year
Price of milk	= 1, 31, 400 X 12 = Rs 15, 76, 800.00

2. **Sale of manure: -**

Total manure = 20 X 50 X 365 = 3,65,000 kg per year (@ 20 kg/cow/day) or 3,650 qt. per year.Price of manure (Rs 25/qt.) = Rs. 91, 250.00

3. **Sale of empty gunny bags of concentrate mixture:**

Total no. of bags = 730 Price of gunny bags (@ Rs. 10/Bag) = Rs. 7,300.00

4. **Sale of Calves**: -

40 calves (assuming 20 males and 20 females)	
Price of male calves (Rs. 100 each)	= 100 X 20 = Rs. 2000/-
Price of female calves (@Rs. 500 each)	= 500 x 20 = Rs. 10,000/-
Total	**= Rs. 12,000/-**
Total income	**= 15, 76, 800 + 91, 250 + 7, 300 + 12, 000 = Rs. 16, 87, 350.00**
Net income	= 16, 87, 350 – 11, 04, 355 = Rs. 5, 82, 995.00 per year or Rs. 48, 584.00 per month
Cost of milk production	= Total expenditure/ Total milk yield = 11,04,355/1,31,400 = Rs. 8.40
Cost/kg milk	= Rs. 8.40
Net profit/kg	= 12 – 8.40 = Rs. 3.60

Contribution of Biotechnology in Livestock Production:

Modern techniques of biotechnology have a vast potential to offer more benefit in animal production. With the emergence of new reproductive technologies and use of applied molecular biology, it is possible to get desired results.

(1) Synchronization of oestrus :

Generally high yielding animals and some others also show silent heat, hence it is difficult for the owners to detect heat. As a result animals remain unbred for a long time and the owners start worrying when already 5-6 months are past after calving and milk yield gets reduced. Synchronization of oestrus involves manipulation of reproductive processes so that females can be bred during a short time.

For this purpose, synthetic Progesterone hormone called as Progestogens which are potent to mimic the action of natural Progesterone are used. The commonly available Progesterone preparations with their doses are as under:

(i) MAP (Methyl acetoxy progesterone): 10 *mg/day*

(ii) CAP (6 chlor-6dehydro 17-acetoxy progesterone) or (Chlormedinone): 10 *mg/day*

(iii) MGA (Melengesterol acetate : 1 *mg/day* (A highly potent)

These preparations are given to the animal orally for 14-18 days. Progesterone can be administered daily through intramuscular injection

of 25 mg for 10 days for getting desired effects.

(2) Super ovulation or Multiple ovulation:

A bull is capable of producing millions of sperms daily but a cow or buffalo on the other hand normally produces one ovum (Occasionally two) after every 21 days. With the administration of hormones or other drugs now it is possible to obtain several ova from a cow at one oestrus.

Super ovulation consists of injecting fertility drugs in female causing the larger follicles to mature and ovulate or to release the eggs. Injections are administered in the middle period of the cycle (9.5 days after oestrus in cows or buffaloes). FSH (Follicle stimulating hormone) is injected twice daily (4-5 mg per dose for 4-5 days). Further on 3rd or 4th day of FSH injection, ,Prostaglandin F_2 alpha is also injected which will destroy previously formed CL (Corpus luteum) on the ovary. With this treatment, females will produce and ovulate more eggs than normal. The eggs can be fertilized inside the female or removed and fertilized in the uterus of other animal or fertilized in-vitro (outside the animal body). In this manner a number of offsprings may be produced at a time by multiple ovulation of a female.

(3) Embryo Transfer Technology (ETT):

The application of the technique of artificial insemination has provided considerable opportunity to improve the genetic potential of the animals by using semen from proven males. Embryo transfer, a term most commonly used in animals is more or less similar to the' test-tube baby technique' in case of human beings. The first bovine calf from embryo technology was produced in Nov. 1988. A Murrah buffalo calf was born through transfer of in-vitro fertilized embryo first time in the world at NDRI, Karnal (Haryana). It refers to a technique by which embryos are collected from a female called the 'donor' and then transferred for development to another female known as the 'recipient'. This technique permits exploitation of superior female genotypes, giving more offsprings from the same genetic donor than would arise under normal conditions of breeding.

Multiple ovulation and embryo transfer (MOET or ET) technique increases the reproductive potential of the dam and is also important for the followings:

(i) To obtain more calves from a valuable high quality cow/buffalo. In a year minimum of 12 calves can be produced.

(ii) To increase the speed of genetic improvement or change in herd.

(iii) To get offspring from female with high genetic merit.

(iv) To increase the number of twins.

(v) Those high Yielding animals who have lost the ability to conceive, can be successfully utilized for ET programme and good embryos for transfer can be produced and frozen for further use.

(4) Genetic Cloning:

Gene is chemically a fragment of DNA (deoxyribo nucleic acid) -a molecule of DNA. In nutshell, genetic cloning is isolation of a gene, which is transported via another molecule, which is the carrier. With the use of applied molecular biology it is possible to transfer the desired traits in animals by altering the genetic make up of the animals at individual genetic level. This involves the gene manipulation technique through direct insertion of a foreign gene into the existing genome of the animal. The animal in whose genome a foreign DNA is introduced is called 'transgenic'. Thus genetic cloning has 3 steps:-

(i) Isolation of targeted gene,

(ii) Introduction of isolated gene into a different living organism,

(iii) Assurance that the recipient accepts the donor gene and inherits the properties. This process is called 'cloning'.

Similarly, cloning of embryo can be effectively carried on by transferring the nucleus of individual blastomeres of 8 cells to 16 cells stage embryo into nucleated individual cytoplasm of recipient oocytes.

Achievements from Biotechnology in Livestock production:

(1) Production of sterile male or female were eradicated through genetic engineering.

(2) A number of calves from a female can be obtained in a year through embryo transfer technique.

(3) Desired traits can be transferred to the poor yielding animals through gene engineering.

(4) Cows or buffaloes treated with Recombinant Bovine Growth Hormone (rbGH) have increased milk production by 10 to 25%.

(5) Human genes have been placed in pigs to produce leaner animals.

(6) Bovine genes have been inserted into chicken to enhance their growth thus to make business more profitable.

(7) Transgenic chickens are ready for slaughtering at early age and it is now very common in the markets of western countries.

(8) Use of more effective and safer vaccines for prevention of various animal diseases has been possible through genetic engineering.

(9) Genotypes resistant to biotic and abiotic stresses affecting livestock have been developed.

(10) Improvement in animal nutrition was done through microbial and enzymatic treatment of roughages and genetic engineering of rumen bacteria. Production of microbial protein (Single cell protein - SCP) for feeding the animals is a good example.

Milk and Milk Processing:

In 1998, India occupied first rank in the world regarding milk production with its output about 78 million tonnes. The per capita availability is about 220 g per day or 80.3 Kg per year. But various surveys indicate that the actual average milk intake is as 20 g/ day/capita in eastern region, as against a high of 400 g/day/capita in the northern region of India. About 45.7% of the total milk produced in India is consumed as fluid annually and rest 54.3% is converted into the preparation of milk products like butter and ghee (34%), dahi (6.9%), khoa and condensed milk (6.5%), milk powder (3.7%), Paneer, Chhana and cheese (1.9%); Ice-cream, Kulfi, cream and others (1.3%).

Definition:

"Milk, in general, is the secretion of mammary glands of mammalian animals intended for the immediate nutrition of the newly born offsprings of the species in question." (Davies).

"Milk is the entire product of the complete and interrupted milking of milch cows which are properly cared for and in good health" (Elsdon and Walker).

"Milk is the fresh and clean lacteal secretion obtained by complete milking of one or more healthy cows. properly fed and kept, excluding that obtained within 15 days before and 10 days after calving and containing not less than 3.25% of milk fat and not less than 8.5% of solids-not-fat" (USA.).

Composition of Milk:

Milk contains all the essential nutrients required for a living like carbohydrate (Lactose), fats, proteins, minerals and vitamins.

Average Chemical Composition of Milk

Milk Constituents	**Percent**
Water	86.6
Fat	4.5
Carbohydrate	4.7
Protein	3.5
Minerals	0.7
Solids not fats	8.9
Total Solids	**13.4**

Average Chemical Composition (%) of milk from different species:

Species	**Water**	**Fat**	**Protein**	**Lactose**	**Ash**	**SNF**	**TS**
Cow	87.10	3.90	3.40	4.50	0.75	9.00	12.90
Buffalo	83.49	6.66	3.88	5.23	0.80	9.81	16.51
Goat	86.50	4.50	3.50	4.75	0.89	9.00	13.50
Ewe	79.83	8.62	6.24	4.25	1.06	11.55	21.27
Camel	87.68	3.02	3.45	5.15	0.71	9.31	12.33
Ass	89.88	1.53	2.01	6.07	0.51	8.59	10.12
Mare	89.86	1.59	2.69	6.14	0.51	9.37	10.96
Sow	89.60	4.80	1.30	3.40	0.90	5.60	10.40
Human	87.70	3.60	1.80	6.80	0.10	8.70	12.30

Physico-Chemical Properties of Milk:

All the constituents of milk are found in three forms in the continuous phase of water as under:

(i) **In true solution form:** Whole lactose, Albumin and globulin and major portion of inorganic substances.

(ii) **In colloidal form:** Calcium caseinate and calcium phosphate.

(iii) **In emulsion form:** Whole milk fat.

(1) Colour:

Milk ranges in colour from yellowish creamy white (cow milk) to white (buffalo milk). White colour of milk is a blend of effects produced by colloidal casein particles and the dispersed fat globules both of which scatter light rays therefore milk looks white. Carotene and xanthophyll are responsible to produce yellowish tinge in cow milk.

(2) Taste and Flavour:

Normal milk contains more amount of lactose than the chloride, therefore, it has sweetish taste. But colostrum and milk of very late lactation have salty taste due to content of more amount of chloride than the lactose. Normal milk has desirable flavour and colostrum has bitter flavour.

(3) Specific Gravity-:

Normal fresh milk has 1.028-1.032 specific gravity and buffalo milk shows greater specific gravity than the cow milk because former contains slightly higher amount of protein, lactose and ash.

(4) Viscosity: -

At 20°C temperature, normal milk has 1.5 to 2.0 centipoise viscosity while water has 1.005 centipoise only which indicates milk is more viscous than the water.

(5) Surface Tension:

At 20° C temperature, normal milk has 40-60 dyne/cm surface tension while water has 62.75 dyne/cm. The presence of fat and protein in milk affects the surface tension.

(6) Electric Conductivity:

At 25°C temperature normal milk has 4.2 to 6.9 milli mhos. For maintaining electric conductivity in milk Na+, K+ and CI+ play an important role.

(7) Acidity:

Freshly drawn milk contains 0.12-0.16% acidity or pH 6.5 to 6.7.

This acidity is known as Natural acidity, which is supposed to be due to the presence of casein, $C0_2$ Citrates, Albumin and Phosphates in the milk.

(8) Specific Heat:

The specific heat of milk at 15.5° C temperature is 0.945 and for water is 1.00.

(9) Boiling Point:

Boiling point of milk depends on the amount of constituents dissolved in it. Although milk has 100.15° C and water has 100° C boiling point but milk starts boiling early than water because milk requires comparatively less specific heat.

(10) Freezing Point:

It is a constant property of milk. Water has 0° C freezing point but milk has less ($0.55\ ^0C$) because of the presence of lactose and salts in it. For determining the freezing point of milk 'Hortvet Cryscope' apparatus is used. This method is used to detect the adulteration of milk with water.

Colostrum:

The secretion which is obtained just after parturition is known as 'Colostrum'. It is an abnormal milk get converted gradually (4-5 days) into normal milk.

Importance of Colostrum:

(1) Colostrum has higher acidity, chloride and specific gravity than the normal milk.

(2) It has about 5 times more protein, 3 times more calcium and 2 times more phosphorus than the milk.

(3) Colostrum is a best food for newly born calves because it has high nutritive value.

(4) Colostrum has sufficient amount of iron and globulin which are responsible for the formation of blood in calves.

(5) Colostrum provides antibodies to the newly born calves which are drawn from the mother.

(6) Colostrum is laxative in nature which helps in passing the faecal material from the digestive tract.

(7) Colostrum contains sufficient amount of vitamin A, vitamin B-Complex and other vitamins which not only provide protection from diseases but also help in growth and development of calves.

(8) Tryptophane amino acid which is essential for the growth of calves, is found abundantly in colostrum..

(9) Colostrum contains 20 times more iron, 8 times more vitamin A, 2 times more vitamin D and 9 times more carotene than the normal milk.

(10) The freezing point of colostrum is slightly higher than the normal milk due to its high soluble salt contents.

Salient Features of Cow and Buffalo Milk:

(1) The energy value of buffalo milk is about 100 Kcal/100g and cow milk 75 Kcal/100 gm milk.

(2) Buffalo milk contains more amount of total solids, protein, fat, SNF, Ca and P as compared to cow milk.

(3) According to legal standards in U.P., cow milk should contain minimum 3.5% fat and 8.5% S.N.F. and buffalo milk should have minimum 6.0% fat and 9.0% SNF.

(4) The fat content in indigenous cow milk is supposed to be greater than the milk of exotic cattle, however, later produces large amount of milk.

(5) Milk may be considered ‘nearly a perfect food’ but not a balanced food because it is rather low in iron, copper and iodine contents.

(6) Lactose (disaccharide) is only found in milk.

(7) Generally price of milk is determined on the basis of its fat contents.

(8) 'Platform tests' mean all those tests which are performed to check the quality of the incoming milk on the receiving platform.

(9) In India, 'National Dairy Development Board' (NDDB) was established in 1965.

(10) 'Indian Dairy Corporation' was established in 1970 at Anand (Gujarat).

(11) For safe preservation, the milk is stored at 4°C temperature. This process of cooling is called as 'Chilling of milk' and the product is known as 'Chilled milk'. This milk may be kept safe for 48 hours.

(12) 'Operation Flood' term is related to the development of dairy industry.

(13) 'Hansa test' is applied for detecting the adulteration of buffalo milk into cow milk.

(14) Solids-not-fat (SNF) % in milk is calculated by substracting Fat % from total solids (TS.)%.

(15) Desirable flavour in dahi or butter or ghee is due to diacetyl content.

(16) Buffalo milk has higher fat but lower cholesterol as compared to cow milk.

(17) Separated milk contains 0.5 to 1% fat and more than 1.036 specific gravity.

(18) A fresh dahi contains 0.70 to 1.0% acidity and it is due to

production of lactic acid during fermentation of lactose.

(19) Human milk contains highest (6.8%) lactose content and energy value to the tune of 67 K *Cal/100*g.

(20) Due to greater amount of Albumin and globulin contents, the colostrum clots on heating.

(21) Buffalo milk has a better keeping quality as it contains natural antioxidant 'Tocopherol'.

(22) Buffalo is an efficient converter (5-8% more than cow) of low grade fibrous feed in high quality milk.

Milk Processing:

The importance of milk in human diet can not be overstressed. It is highly nutritious but quickly perishable product because it is supposed to be a best medium for the growth of organisms. Therefore, for enhancing the keeping quality and to ensure safe milk for human consumption various processes are practiced.

(1) Pasteurization:

The process by which milk is heated on certain temperature for definite period for destroying all the pathogenic and most of the non-pathogenic organisms is called as 'Pasteurization'. During heating nutritive value and cream layer of milk must not be effected too much. Although about 10% loss of thiamine and 20% ascorbic acid may be expected as a result of Pasteurization of milk. Mycobacterium tuberculosis (T.B. organism), being considered the most heat-resistant among pathogens, was chosen as an index organism for pasteurization. Any heat treatment (i.e. temperature time combination), which killed T.B. germs and also destroyed all other pathogen in milk. Methods for pasteurizing of milk are: -

(a) In Bottle Pasteurization:

Bottles are filled with raw milk, sealed and held at 63 to 66^0C (145-150^0F) temperature for 30 minutes. Then the bottles pass through cold water for decreasing the temperature which cools both milk and bottles.

(b) Batch or Holding Pasteurization:

This is also called as ‘Low temperature-long time (LTLT) method. Milk is heated to 63^0C or 145^0F for 30 minutes and quickly cooled to 5^0C or below.

(c) High Temperature-Short time (HTST) Pasteurization:

The milk is continuously pasteurized with the help of HTST pasteurizer at 72^0 C or 161^0F for 15 seconds and promptly cooled to 5^0C or below.

(d) Ultra-high temperature (UHT) Pasteurization:

This process was developed in 1950 s in which milk is heated at 135 to 150^0 C or 275 to 302^0 F for a fraction of a second.

(e) Uperization :

This process was developed in Switzerland and is a continuous process.

The milk is heated with direct steam up to 150^0 C or 302^0 F for a fraction of a second.

2. Sterilization:

The heating of milk at high temperature for certain period for destroying all the organisms and their spores without affecting nutritive value and cream layer of milk, is called 'Sterilization'. Sterilization process provides adverse affect almost on all the vitamins content in milk, however, highest loss of thiamine and ascorbic acid to the tune of 30-50 per cent and 50%, respectively was reported.

For sterilization, the milk is first preheated at $35\text{-}40^0$ C, then milk filled bottles are sterilized at 108 to 111^0 C ($225\text{-}230^0$ F) for 25-30 minutes, then the sterilized milk bottles are gradually cooled to room temperature.

3. Homogenization:

The process by which fat-globules of milk are broken and converted into smaller size is called 'Homogenization' of milk. By this process there are 3 advantages:

(i) By increasing the number of fat globules surface area is increased for enzymes which accelerates the digestion of fat.

(ii) There is no formation of cream layer on the top homogenized milk and

(iii) Fat is homogenously dissolved in whole milk.

For homogenization, first the fresh milk is heated up to 60^0C temperature then it is passed through thin film (1/1000 inch pores at 2500 to 3000 psi pressure). This process causes sub-division of the original fat-globules to less than 2 micron size (diameter), which is considered satisfactory. Homogenized milk is supposed to be easily digestible and most fruitful for children and old people.

4. Bactofugation :

It is a process of removing 99 per cent of the bacteria present in milk by centrifugal force. By this method the shelf-life of milk may be enhanced by 3 folds. Generally two centrifugal machines are adopted in a series, the first operates at high velocity (20,000 rpm) and the second at low velocity. The aim of bactofugation and pasteurization of milk is the same, alive bacteria are removed in case of former and bacteria are destroyed or killed in the later process.

Suggested Readings:

1. A textbook of Livestock Production Management in Tropic; Kalyani Publishers, Ludhiana (Punjab).
2. Essentials of Animal Production and Management; Kalyani Publishers, Ludhiana (Punjab).
3. Management and feeding of buffaloes; Vikash Publishing House Pvt. Ltd, New Delhi.
4. Domestic water buffalo; Oxford and IBH Publishing House, New Delhi.

5. Food preservation and processing; Kalyani Publishers, Ludhiana (Punjab).
6. Principles and Practices of Dairy farm management; Kalyani Publishers, Ludhiana (Punjab).