MANAGEMENT OF DAIRY ANIMALS

(DAIRY HUSBANDRY)

Theory

FOR

Class XII

2013

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भारत का संविधान

उद्देशिका

हम, भारत के लोग, भारत को एक '[सम्पूर्ण प्रभुत्व-संपन्न समाजवादी पंथनिरपेक्ष लोकतंत्रात्मक गणराज्य] बनाने के लिए, तथा उसके समस्त नागरिकों को:

सामाजिक, आर्थिक और राजनैतिक न्याय,
विचार, अभिव्यक्ति, विश्वास, धर्म
और उपासना की स्वतंत्रता,
प्रतिष्ठा और अवसर की समता

प्राप्त कराने के लिए, तथा उन सब में, व्यक्ति की गरिमा और [राष्ट्र की एकता और अखण्डता] सुनिश्चित करने वाली बंधुता बढ़ाने के लिए दृढ़संकल्प होकर अपनी इस संविधान सभा में आज तारीख 26 नवम्बर, 1949 ई॰ को एतद्द्वारा इस संविधान को अंगीकृत, अधिनियमित और आत्मार्पित करते हैं।

1. संविधान (बयालीसवां संशोधन) अधिनियम, 1976 की धारा 2 द्वारा (3.1.1977) से "प्रभुत्व-संपन्न लोकतंत्रात्मक गणराज्य" के स्थान पर प्रतिस्थापित।
2. संविधान (बयालीसवां संशोधन) अधिनियम, 1976 की धारा 2 द्वारा (3.1.1977 से), "राष्ट्र की एकता" के स्थान पर प्रतिस्थापित।

भाग 4 क

मूल कर्त्तव्य

51 क. मूल कर्त्तव्य – भारत के प्रत्येक नागरिक का यह कर्त्तव्य होगा कि वह –

(क) संविधान का पालन करे और उसके आदर्शों, संस्थाओं, राष्ट्रध्वज और राष्ट्रगान का आदर करे;

(ख) स्वतंत्रता के लिए हमारे राष्ट्रीय आंदोलन को प्रेरित करने वाले उच्च आदर्शों को हृदय में संजोए रखे और उनका पालन करे;

(ग) भारत की प्रभुता, एकता और अखंडता की रक्षा करे और उसे अक्षुण्ण रखे;

(घ) देश की रक्षा करे और आह्वान किए जाने पर राष्ट्र की सेवा करे;

(ङ) भारत के सभी लोगों में समरसता और समान भ्रातृत्व की भावना का निर्माण करे जो धर्म, भाषा और प्रदेश या वर्ग पर आधारित सभी भेदभाव से परे हों, ऐसी प्रथाओं का त्याग करे जो स्त्रियों के सम्मान के विरुद्ध हैं;

(च) हमारी सामासिक संस्कृति की गौरवशाली परंपरा का महत्त्व समझे और उसका परीक्षण करे;

(छ) प्राकृतिक पर्यावरण की जिसके अंतर्गत वन, झील, नदी, और वन्य जीव हैं, रक्षा करे और उसका संवर्धन करे तथा प्राणिमात्र के प्रति दयाभाव रखे;

(ज) वैज्ञानिक दृष्टिकोण, मानववाद और ज्ञानार्जन तथा सुधार की भावना का विकास करे;

(झ) सार्वजनिक संपत्ति को सुरक्षित रखे और हिंसा से दूर रहे;

(ञ) व्यक्तिगत और सामूहिक गतिविधियों के सभी क्षेत्रों में उत्कर्ष की ओर बढ़ने का सतत प्रयास करे जिससे राष्ट्र निरंतर बढ़ते हुए प्रयत्न और उपलब्धि की नई उंचाइयों को छू ले।

THE CONSTITUTION OF INDIA

PREAMBLE

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a [1] **SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC** and to secure to all its citizens :

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the [2] [unity and integrity of the Nation];

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949, do **HEREBY TO OURSELVES THIS CONSTITUTION.**

1. Subs, by the Constitution (Forty-Second Amendment) Act. 1976, sec. 2, for "Sovereign Democratic Republic (w.e.f. 3.1.1977)
2. Subs, by the Constitution (Forty-Second Amendment) Act. 1976, sec. 2, for "unity of the Nation (w.e.f. 3.1.1977)

THE CONSTITUTION OF INDIA

Chapter IV A

Fundamental Duties

ARTICLE 51A

Fundamental Duties - It shall be the duty of every citizen of India-

(a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;

(b) to cherish and follow the noble ideals which inspired our national struggle for freedom;

(c) to uphold and protect the sovereignty, unity and integrity of India;

(d) to defend the country and render national service when called upon to do so;

(e) To promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;

(f) to value and preserve the rich heritage of our composite culture;

(g) to protect and improve the natural environment including forests, lakes, rivers, wild life and to have compassion for living creatures;

(h) to develop the scientific temper, humanism and the spirit of inquiry and reform;

(i) to safeguard public property and to abjure violence;

(j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement.

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Chapter – 1

CARE AND MANAGEMENT OF DIFFERENT DAIRY ANIMALS- NEWBORN, YOUNG/HEIFERS, GROWING, DRY, MILCH, PREGNANT ANIMALS, BULL/BULLOCK AND SICK ANIMALS

Animal husbandry or livestock rearing is as old as human civilization. India has a traditions of intimating with animals or treating them as one of their family. With gradual change in societal structure, the conventional livestock system has transformed into a more commercial venture. Under domestication the animals are dependent on humans for their sustenance and performance. They need to be provided with appropriate levels of feeding, suitable housing, breeding, timely healthcare and management so as to obtain desired productivity. their feeding, housing, healthcare and routine management based on scientific recommended practices is essential for obtaining higher profits from dairy farming. The care and management of a dairy farm starts with the birth of a healthy calf. The healthy female calves born have to be fed and cared well to grow at a faster rate and become a producing cow or buffalo at an early age. Once in production, the dairy animals are managed for breeding regularly and to produce milk at higher level so that their rearing becomes profitable to the dairy farmer.

For running the dairy project in profit, it will be important to keep the feeding cost minimum by proper planning of feeding programmes. Proper planning of fodder production and feeding schedule for different categories of dairy animals are very important to run the project in profit. Feed costs are about 50 to 60 percent of the total cost of producing milk. Cows need to be fed balanced rations to give the most profitable level of production. Milk production of the individual cows is limited by heredity. Differences in milk production among cows of same breed are due to about 25 percent heredity and 75 percent environment. Feeding has the most influence on the milk or any other cow produce. Proper feeding and care allows the cow to produce closer to her potential ability.

Feeding programme should be revised periodically keeping in view the local casts & availability of feed ingredients for different categories of dairy animal preferably under expert supervision.

Calf Feeding & Management:

Calves are the future stocks of the farm. Successful rearing of young calves particularly the female calves is the key to a successful dairy enterprise. It is therefore important that they are reared economically to ensure early maturity. Success of dairy project also depends upon fast rearing to a breedable age and with a minimum mortality.

Mortality of calves particularly in the first month should be kept below 5% by proper management practices. Healthy calves with higher growth rate and low mortality rate are essential for higher profitability of a dairy project. In the management of larger growing stock or milking cows, management lapses can reduce growth rates or milk production, but even small mistakes with the very young calf can cause calf mortality and reduced profitability. Losing a calf earlier in its life means same as losing an adult cow. Thus, just keeping the calf alive during the first few weeks of life is a goal that requires preparation and execution of specific management practices. Additionally, the health of the calf, the development of its digestive tract function, and growth and development of its body during this period will influence subsequent performance.

CARE OF NEW BORN CALF

Package of health management practices for calves:

Age/days	Colostrum	Treatment	Preventive against
1	2-2.5	Use of antibiotics and nutritional formula as suggested by local veterinarian	Calf scours
1	-	Sealing navel vessel by ligating the navel cord	Navel ill
2	2.5	Vitamin A concentrate 1 ml vitablend or other similar supplement	Night blindness
3	2.5	Piperazine adipate 1 g/4 g live weight	Ascariasis
5	2.5	Piperazine adipate 1 g/4 g live weight	Ascariasis
6-11	-	Suitable antibiotic for coccidiosis prevention	Coccidiosis

Besides above practices, use mineral supplement vitamin supplements like TM-5 or Aurofac daily, Rovimix in oil once a week (10,000 I.U. of Vitamin A).

Milk feeding of calves

Calves are to be fed with milk @

- $1/10^{th}$ of body weight up to 4^{th} wks of age including the colostrums feeding from 0 – 5 day,
- $1/15^{th}$ of body weight during 5^{th} and 6^{th} wk. and
- $1/20^{th}$ of body weight during 7 – 8^{th} week.

The milk is to be warmed up to the body temp. Before feeding and should be discontinued after 8th week. The calf starter provided at the rate of 300 gm per day starting from 2nd week of age and increased @ 200 gm / wk. till it becomes 1.5 kg per calf per day. The green fodder fed *ad lib* starting from 2nd wk. of age.

Importance of Colostrum Feeding:

In cattle the antibodies (gamma globulins) are transferred from mother to the calf through colostrum. These gamma globulins will be absorbed as such by the calf and will enter its system forming a readymade antibody resistance system for the calf against all the disease producing agents and other antigens the mother has had, encountered during its lifetime. This will protect the calf against diseases in the early stages, until their own 'antibody manufacturing system takes over. Thus, if colostrum is not fed, the calves are denied antibody cover and, therefore, will remain susceptible to many diseases. Most likely, they will perish due to some disease or the other.

Besides, colostrum is highly nutritious. It is slightly laxative and prevents constipation. This is helpful because the diet of the young calf being totally devoid of crude fibre is constipatory.

Artificial colostrum: In absence of colostrum and fostering by other mother cows, artificial colostrum can be prepared.

Artificial colostrum ingredients

Warm water	275 ml
Raw egg (55g)	One
Castor oil	3 ml
Vitamin A	10000 IU
Warm whole milk	525 ml
Antibiotics	~80 mg

Milk Feeding Schedule

Age	Whole Milk	Skim milk/butter milk	Concentrate* mix (g)
0-5 days	$1/10^{th}$ of the body weight (colostrum)	Nil	Nil
5-30 days	$1/10^{th}$ of the body weight	Nil	Nil
1-2 months	$1/15^{th}$ of the body weight	1/25th of the body weight	125
2-3 months	$1/25^{th}$ of the body weight	1/15th of the body weight	250
3-4 months	Nil	6.5 kg	650
4-5 months	Nil	6.5 kg	1000
5-6 months	Nil	5.0 kg	1500

*Concentrate mixture

Maize/Barley/Oats	45%
Groundnut cake/Linseed/Til cake	35%
Fish meal	7%
Wheat bran/rice bran/chuni	10%
Mineral mixture	3%

Feeding of Milk replacer: Milk replacer is a constituted feed through cheaper ingredients which resembles the biological and chemical composition of milk. It is usually fed in gruel form. Feeding of milk replacer helps in reducing the calf mortality, better growth and development of

calves and in economical raising of calves. Milk can also be substituted with milk replacer to make calf raising economical. Milk replacer resembles milk in biochemical composition and saves cost of calf rearing. It contains minimum 22% crude protein and very less fibre. The milk replacer is diluted with water,

OBJECTIVES OF MILK REPLACER

1. To raise orphan calves
2. To supplement dam's milk
3. To wean calves at an early age.
4. To make raising of calves cheaper
5. To maintain normal growth of calves

Ingredients of Milk Replacer

Name of the ingredients	Quantity (kg)
Wheat	10
Fish meal	12
Linseed meal	40
Milk	13
Coconut oil	07
Linseed oil/cotton seed oil	03
Citric acid	1.5
Molasses	10
Mineral mixture	03
Butyric acid	0.3
Antibiotic mixture	0.3
Rovimix-A,B_2, D_3	0.015

Calf Starter**:** Calf starter has been evolved for use with limited whole milk. It is offered from 2nd week to 3 months of age with the main aim for an early development of rumen. It is a solid feed mixture of grains, protein feeds, minerals, vitamins and antibiotics. A good calf starter should be palatable enough, rich in energy content (75% TDN) and should contain approximately about 24% protein and fibre less than 7 percent. Antibiotics help in preventing calf scour.

Package of practices for calf management

Successful rearing of young calves is the key to the success of dairy farming enterprise. Calves are the future replacement stocks for the cows and bulls. It is therefore important that they are reared economically and in a sound manner to ensure early maturity. Following principles of calf management must be followed to ensure high growth and low mortality/morbidity in young calves.

- Immediately after birth wipe all the mucus or foetal membranes from around the nostrils and ensure that the calf is breathing normally. If not then provide necessary assistance to revive

breathing process quickly.

- Remove the calf to a well protected, clean bedded and dry area.
- If un-weaned the dam will lick the calf clean just after birth. Else wipe and dry the calf with clean dry cloth or wheat/paddy straw.
- Cut the navel leaving one to two inches from the stalk, squeeze out the contents, dip the navel in tincture of iodine legate it using clean thread to prevent local infection. Dip the navel cord in 7% Tincture of Iodine solution after squeezing the fluid content. Insert a cotton swab soaked in Tincture Iodine and ligate the cord. Watch for any injuries to the navel area and do proper dressing if they exist.This procedure is important for prevention of navel-ill and helps the umbilicus heal quickly.
- Ensure that the calf gets adequate quantity of (about 1 litre) first colostrum from its dam within 1/2-1 h after birth. The calves must get colostrum to help them to acquire passive immunity at birth. Thereafter ensure that the calves get colostrum every 6-8 hrs for first 4-5 days. Total quantity fed during 24 hrs should be about $1/10^{th}$ of its body weight.
- If hand fed ensure that the pails, bottle on hand are properly cleaned. Bottles are better as they, ensure slow rate of intake and prevent digestive problems during early life. Clean the equipment after each feeding using suitable sanitizer.
- House the young calves in clean and comfortable pens well protected from hot and cold drafts. Ensure adequate bedded area per calf. Also ensure that the place remains clean and dry. Housing individually in raised platforms is more effective in prevention of diarrhoea than in groups.
- Deworm the young calves routinely and follow the deworming schedule religiously. Take adequate preventive measures against diarrhoea/calf score, which is a major killer of young calves. Isolate the sick calves and treat them separately.
- Restrict unnecessary movement of persons/outsiders in the calf pens.
- To boost disease resistance provide Iron and vitamins A, D & E orally or by injection soon after birth. This is especially useful in weak/anaemic calves.
- Ensure proper ventilation, avoid over-crowding and ensure easy access to clean drinking water to young calves.
- Provide suitable barriers/Iron bars to prevent the calves from Jumping into the mangers and soiling them.

- Ensure proper hygienic standards and quality of ingredients, if milk replacer based feeding practices is followed.
- If scouring (diarrhoea) occurs, cut down the intake of milk till the calf recovers and provide fluid rehydration therapy.
- Take the body weight of the calf at birth and regular intervals thereafter if possible. Growth under field conditions can also be monitored by taking heart girth. The relationship between these two gives a good indication of growth.
- Vaccinate the young calves timely.
- Dehorn young calves, unless they adversely effect the value of the animal, reduces the risk of injury to the workers and herd mates. It should be done within 15 days after birth. It is better done using electric dehorner.
- Identify the calves by tattooing in the ear.
- Male calves can be separated after six months of age.

Management of Dairy Heifers, Periparturient Cows

Heifer is the female animal from one year of age up to first calving. Thus heifers are future cows of the herd. On most dairy farms 20-25 per cent of the cows are replaced every year with freshly calved heifers. Therefore, proper nutrition and management of heifers are necessary to provide adequate number of healthy and genetically superior herd replacements. Under Indian conditions the goal of dairy farmer should be raise well grown heifers that calve at an average age of about 30 months in case of crossbred cows, 36 months in indigenous cows and about 40 months in case of buffaloes.

The nutrition during this period shall mainly comprise *ad lib*. feeding of good quality green fodders supplemented with some amount of concentrate mixture so as to obtain a daily growth rate of 500-550 g in crossbred heifers and 450-500 g in heifers of indigenous cattle breeds and buffaloes. The heifers may be fed mostly on roughages and allowed to remain lean until pregnancy. During the last half of pregnancy it can be fed at a higher plane to achieve rapid growth which could cause maximum development of ducts and alveoli in the heifer's udder.

The loose system of housing heifers is generally followed through most of the country except in heavy rainfall and coastal areas. For better growth the heifers need to be protected from

summer stress especially under Northern Indian conditions. Water sprinkling or splashing during hotter parts of the day twice or thrice daily, provision of ceiling fans in the sheds, provision of misters cooling devices and wallowing especially in buffalo heifers are some of the practices to be followed for the protection of heifers from heat stress. For the protection from cold stress in winters the heifers are offered a well balanced nutritious diet. In severe cold weather conditions the allowance of concentrate mixture may be increased by 0.5 to 1.0 kg per heifer daily so that their growth is not adversely affected.

Heifers having stunted growth, late maturing, anatomical defects or bad disposition should be regularly culled from the herd. They need to be protected against ectoparasites such as ticks, lice etc. by spraying with insecticides like 1% malathion at monthly intervals. The floors, walls and roofs of the heifer sheds should also be sprayed to make them free from these parasites. The heifers at the age of puberty should be observed for signs of heat every day and should be bred with the semen of superior bulls. Attainment of 60 per cent of mature body weight (about 300 kg) is the stage at which the heifers should be bred. The advance pregnant heifers should be trained for milking by taking them to the milking parlour along with the milking cows and allowed to go through the milking routine. This will give them an opportunity to get adapted to the milking routine. Such heifers will not get excited and thus will not give any difficulty in milking after calving.

Following guiding principles must be adopted for the management of heifers from 6 months of age until first calving. Good care in feeding and management of heifer results into an earlier age at maturity.

Heifers should be fed good quality green fodders or straws supplemented with concentrates and mineral supplements.

- Growth and body condition of the heifers must be monitored closely. A growth rate of 500-600 g per day must be ensured.
- Heifers must be vaccinated regularly.
- Deworm all the heifers against internal parasites every 3 months.
- They should be kept in manageable groups and the grouping should be done based on the age and body weight of the heifers.

- Heifers must be well protected from inclement weather conditions and free access to clean drinking water must be ensured. The floor must be clean, dry and non-slippery.
- A close eye must be kept on the age of maturity. Optimum breeding weight for smaller (Indian) breeds of cattle can be 225-250 kg and that for larger breeds should be 275-325 kg. The optimum breedable weight in heavy breeds should be reached by 15-18 months and in smaller breeds it should not take more than 22-25 months. An optimum combination of age and body weight should be considered for breeding the heifers. Breeding very young heifers is also not recommended.
- From 15-20% of the average milking herd should be replaced every year. Replacements need is to be selected from those animals with the highest potential for milk production.
- Heifers should be fed good quality green fodders or straws supplemented with concentrates and mineral supplements.

Pregnant heifers – prepartum

- Feed good quality roughage and give concentrate supplementation as per requirement. Mineral supplement may be fed to pregnant heifers to prevent metabolic diseases such as milk fever.
- Vaccinate against FMD, hemorrhagic septicemia and other diseases as a vaccination program in the dairy region.
- De-worming for external and internal parasites should be carried out routinely. Signs that the cow is approaching parturition are that it becomes uneasy and separates from the herd. Signs of calving include enlargement of the udder and belly, and discharge from the vulva.
- In this period, one must be alert for heifers mastitis (mastitis before calving) and abortion.

At parturition

- The calving area may be prepared so as to ensure clean, dry, quiet and isolated environment for the cow. Also ensure to keep a constant watch on the cow close to calving to notice and provide help if the cow shows signs of difficulty during the birth.
- Signs of calving include enlargement of the vulva, distention of the teats and udder, loss of ligaments at the side of the tail-head, and restlessness. Other indicators are a marked

increase in the amount of mucous discharge from vagina and increasing frequency of abdominal and uterine contractions.

- After initiation of the labour pains if the water bag has not protruded for over 20 hours, the cow may require assistance from a veterinarian.
- If there has been no expulsion of the fetus or any contractions for more than two hours after the rupture of the water bag (allantoic sac), veterinary assistance will be required.
- During this period, there is the possibility of milk fever, uterine prolapse, or downer cow syndrome.

Soon after calving

- Natural expulsion of the fetal membrane should occur three to eight hours after calving or within 12 hours. If the fetal membrane is retained over 12 hours, the cow will require assistance from a veterinarian.
- Milk colostrum and feed to calf as soon as possible (within 2-3 hours).
- Remove the fetal membrane from the pen floor, clean the pen and the rearing area of the dam to reduce risk of infection etc.
- Feed the cow with good quality and quantity of food which is palatable because in this period the cow has less appetite and may remain under stress.
- Proper care and management to guard milk fever must be taken. The primary cause is often hypocalcemia. Hence, calcium and vitamin D feeding to the periparturient cows gives good result.
- Fat cows are very much prone to postpartum ketosis. Hence,

During this period, there is the possibility of retained placenta, metritis, milk fever, uterine prolapse and mastitis.

Feeding Milch Animals

Feeding management of dairy cows during the entire period of lactation is vital for harvesting the optimum milk production from the dairy animal. Proper management of the dairy animal during first few days after calving and during early lactation is of particular importance. The following management principles must be observed.

1. Soon after calving the animal must be fed laxative feed and warm gruel for first few days.

The animal at this time must be managed separately. Special care may be taken regarding emptying the udder as frequent emptying may result in occurrence of milk fever especially in high yielding animals and those poorly managed during previous dry period.

2. Feeding management during early postpartum must focus on attaining higher peak milk production and better persistency. This could be achieved by:
    i. Feeding the animal with higher energy diets and
    ii. Maximising dry matter intake
3. Monitor the body weight and condition regularly during early stages of lactation. It must be ensured that the animal does not lose excessive condition during this phase as this may result in fat infiltration of liver also called 'fatty liver syndrome'
4. Attempt must be made to return the animal in the positive energy balance soon as the long phase of negative energy balance results in poor persistency of milk production and lower reproductive efficiency. This can also be achieved by improving the quality as well as quantity of the feed.
5. After the peak milk production has been achieved the feeding must be based on the level of milk production.
6. The milk is most economically produced from fodders. All attempts must therefore be made to ensure supply of green fodders/silage/hay round the year. Concentrates should also be supplemented whenever necessary and depending on the level of production.
7. A combination of leguminous and non-leguminous fodders is best to meet the maintenance and production requirement of a cow weighing 400 g and yielding up to 8 litres of milk. With only 1 g concentrate supplementation. Non leguminous fodder feeding would necessitate additional half-g concentrate supplementation. Same cow if fed on hay would need proportionality higher quantities of concentrates 2.5 and 4.5 g respectively.
8. In case of dairy cows producing higher quantities of milk (>20 litres/days), no suitable combination of concentrates and fodders (even at high intake levels) can sustain this level of production without the mobilisation of body reserves. Such cows can also be supplemented with oils/fats in their diets at 300 g per day level.
9. Moderate levels of milk can be sustained on a suitable combination of green and dry fodders supplemented with desired amounts of concentrates. While feeding a mixture of

straw and green fodders, it will be desirable if 1 kg of straw is mixed with every 4-5 kg of chaffed green fodder for each 100 kg body weight.

10. If plenty of quality green fodder is not available and the ration is based on low quality straws/stovers then additional concentrate feeding is required.
11. The feed intake of moderate yielding lactating dairy cows in dry matter equivalent is about 2.5 kg dry matter per 100 kg body weight. The dry matter intake in high yielding animals could go up to 3.5 percent or higher.
12. In case of non-producing adult cows, dry matter requirement is about 2.0 percent of their body weight.
13. For optimum results the protein requirement of total ration should be adjusted at 13-14 percent level. Leguminous fodder (like berseem, Lucerne) contain about 12-14 percent crude protein, non-leguminous fodder (like maize, sorghum, oats and grasses etc) contain about 7-8 percent protein. Straws like wheat and paddy straws contain only 3-4 percent crude protein. The crude protein content of the concentrate mixture should be so adjusted to provide about 13-14 percent crude protein in total ration.
14. Roughage must be chaffed. However, very fine chaffing may be avoided, as it is likely to effect the regurgitation process adversely.
15. Grain portion of concentrates should be crushed else part of it may pass off undigested in the faeces. It is desirable to moisten the concentrate mixture and mix it with straws before feeding.
16. Ample availability of clean drinking water must be ensured to the milch cows.
17. Due care should also be taken to feed the advanced pregnant cows and buffaloes as the feeding management at these critical stages will determine the age at maturity and ensure adequate built up of body reserves for use during early stages of lactation when the energy intake of the animal often fails to keep pace with the level of milk production.
18. A suitable combination of Berseem along with oats, maize, wheat/paddy straw and concentrates (based on the level of production) is most practical strategy of feeding dairy cows and buffaloes during winters. The total dry matter content of such ration should be about 22 percent and the crude protein content should be about 14 percent. The respective dry matter and crude protein contents of the above feeds are (Berseem (12 and 14%), Oats (15 and 10 %), Maize (16 and 10%), Straws (90 and 4%) and Concentrates (90 and

20%) respectively. Cultivation of improved varieties of fodder crops have potential not only to improve the yield of the fodder but prolong the availability period also. The important varieties in the category are fodder Maize, Berseem and Oats.

19. If enough green fodders are not available and we have to depend on straws, we can improve the quality of these straws by treating them with urea under expert guidance.

Management of Dry Cows

Dry cows are those, which are not producing milk. Most cows need a dry period between lactations. Very after management neglects these animals, which may cause decrease in the profit in due course of time. Therefore, good management ensures proper management of these categories of dairy project animals.

A Cow in dry period should be fed a well balanced ration during this period for

1. Maintenance of the cow
2. Growth of the animal if she is pregnant
3. Growth of the foetus
4. For the production of colostrum when she calves next
5. Forming sufficient reserves of nutrients in the body of the cow for ensuring lactation.

The recently calved high producing cow is unable to eat enough feed to support her milk production. This means that she should have enough reserves of stored nutrition to be drawn to tide over the period of heavy demand in the early lactation during which period the cow loses weight. Many of the problems resulting in ketosis, displaced abomasum, fatty liver, retained placenta, prolapse etc. can be minimized by resorting to an all roughage feeding during the dry period. The roughage should be tough enough to stimulate and restore rumen muscle tone. During dry period cows can be fed only good quality green fodder with 1-2 kg concentrate.

Just a week or two before freshening one should start feeding the cows with high milk production, increasing the quantity of concentrates to challenge them to produce at the maximum level. This challenge feeding will condition her digestive system for the increased amount of concentrates of early lactation and provide enough nutrients to initiate lactation on a higher place.

During the dry period cows should receive enough of high quality green, fodder to provide enough of the precursor for Vitamin A. They also need salt, calcium, phosphorus and whenever deficiencies occur, other minerals. When leguminous roughages are fed in large

quantity, all that is needed is a. source like wheat bran. But when non-leguminous roughages predominate, sources of calcium and phosphorus like bone meal or dicalcium phosphate may be added to the ration. Other trace minerals may be needed if the soil and consequently the crops are deficit in them. Under normal circumstances, however addition of such minerals is not necessary in some cases.

Methods of Drying off

There are three methods of drying off of cows\

(a) Complete cessation: This method is followed for cows with low milk yield (<5 kg per day) and free for mastitis. If the animal is left unmilked, milk will be filled in the udder, and then get reabsorbed.

(b) Intermittent milking: This method is useful for cows with heavy milk yield (~10 kg daily milk yield). One time milking is first skipped, then two times and gradually the animal is milked once in few days is milked. Simultaneously, the animal's feed intake is gradually reduced to decrease the milk synthesis in the udder.

(c) Incomplete milking: This method is useful for cows with moderate milk yield. The principle is same as the intermittent method. Some amount of milk is left in the udder to get reabsorbed and reduce the milk synthesis.

Following points must be considered for their management:

- The cow should be dry for 45-60 days. The date to begin dry period is calculated back from projected date of calving.
- Conditioning for the dry period is done during last few weeks of lactation. Research shows that body fat is replaced most efficiently during late lactation than during the dry period. Cows should not be too fat or too thin at the end of the lactation. Adjusting the grain-to-roughage ratio can control weight. Give thin cows a higher percent of grain (concentrate) and fat cows less grain.

Follow proper procedure to dry off the cow to avoid udder problems. Following method is suggested:

Steaming up: Dry cows are fed in a nutrionally proper manner to get prepared for calving is called as Steaming up.

- Separate dry cows from the milking herd. They may be grouped with the bred heifers. Allow dry cows to get plenty of exercise.

- Do not over-fed or underfed, feed mainly good quality roughages and recommended concentrate. Limit body gain to no more than 45 kg from late lactation to the next calving. When dry cows get too fat, there are more problem with ketosis, depressed appetite milk fever, displaced abomasum. Cows that are too fat have problem at calving time.
- During last few days of the dry period, watch the cow closely for sign of calving. Ensure safe delivery in a calving-pen. Calving-pen floor should not be slippery and should have proper bed of dry straw. Ensure that after birth is expelled within 48 hours after calving. If it is not farm veterinarian must help.
- After calving watch the cow for signs of milk fever, ketosis, or other health problem. Provide fresh water and hay/soft roughages/wheat bran after calving. It takes several days to get a cow and bull feed after calving. Gradually increase the concentrate feeding.
- Care and precautions must be taken for prevention of udder edema. Heaving feeding or steaming up sometimes predispose the animals to edema. First calvers are more prone to edema. **Prenating** (milking before calving) in heavy yielder is sometimes practised, but it is not recommended.

Feeding based on body condition:

Body condition gives as indication of how the animal has been fed over the preceding weeks/ months. The level of milk production of the dairy cow also affects it. To assess the body condition of dairy cows objectively a procedure culled body condition scoring may be followed.

A simple body condition scoring scale is given below (Adapted from Shiv Prasad & Tomer, 1995)

Score	Evaluation	Description of Animal
1.	Very poor	Animal emaciated, deep cavities under tail head, no muscle cover between pelvis and skin all the bones very prominent.
2.	Poor	Animal appears weak, cavity under tail head marked, deep depression is loin area, some muscle mass evident all over the body.
3.	Moderate	Shallow cavity in tail head region seen, slight fatty tissue also evident, Pelvis can be felt easily, depression in loin region still evident. Ends of transverse processes of lumber region can be palpated with some pressure.
4.	Good	Fatty tissue can be felt all over the animal body (chine, loin and rump region). Skin appears smooth but pelvis can be felt. Ends of transverse processes can be felt but thick layer of tissue in the region evident. Only a slight depression evident in loin area..
5.	Fat	Folds of fatty tissue present all over, pelvis felt only with firm

		pressure. Transverse processes difficult to palpate. No depression in the loin area visible.
6.	Very fat	Tail head buried in fat tissue, skin distended, Pelvis can not be felt even with firm pressure, fat accumulation over transverse processes evidence. Bony structure not palpable.

Recommendation:

- Monitoring condition score over the lactation cycle is very useful in focusing on management and nutritional areas for further improvement. Optimum body condition the maximum milk production may be higher than that for optimum milk production (4-4.5 v/s 3-3.5).
- Feed conversion efficiency of a fat animal is lower.
- Excessive loss of body condition (> 1.0 point) after calving is more harmful than higher condition itself. The owner must ensure that the cow does not lose body weight excessively after parturition. This has adverse effect on milk production, reproductive and health of the animal.
- The body condition of the cow should not go below 2.5 - 3.0 even during peak lactation. This should be ensured in high yielders by:
    1. Providing adequate high quality feed.
    2. Maximise DM intake.

The optimum body condition at calving would be around 4-4.5. Animals fattier than this at calving are likely to develop fatty liver syndrome during early postpartum.

Reproductive indices for dairy cattle and buffalo under optimum conditions and suggested `acceptable' performance under tropical conditions

	Cattle			Buffalo	
	Optimum	Acceptable		Optimum	Acceptable
Age at puberty (m)	< 18	< 24		< 30	< 34
Age at first calving (m)	< 30	<36		< 42	< 46
Calving to first service (d)	< 60	< 90		< 60	< 90
Calving to conception (d)	< 85	< 115		< 85	< 115
Calving interval (m)	12-13	13-14		13-14	14-15
First service conception rate (%)	> 60	> 55		> 55	> 50
Overall conception rate (%)	> 80	> 75		> 75	> 70
Calving rate (%)	> 75	> 70		> 70	> 65
Services per conception	< 1.6	< 1.8		< 1.8	< 2.0

To fully tap the potentials of high yielding cows and buffaloes, the following points of feeding management are of practical importance:

1. Feeding dairy animals on home grown fodder, especially leguminous or a mixture of leguminous and non-leguminous and supplementation with concentrate is more economical as compared to feeding them on crop residues and concentrates.
2. The digestive system of a high producing dairy animal has a limited capacity and so to obtain the required nutrients, the digestibility of the ration on dry matter basis should be over 70 percent. Roughages must be supplemented with concentrates to ensure nutrients for maximum milk production.
3. The cow must be 'conditioned' adequately before calving as to have the needed body reserve for good milk production after calving. For this it must calve in relatively fat condition and so must be on a fattening ration for the last two months of the dry period. (A 10 kg milk producer, must gain 500 g / day in last two months of dry period and must be fed at least 1 kg concentrate per day).
4. For maximizing income, the dairy animals must be fed individually, according to their individual milk production and nutritional requirements. Liberal feeding is necessary for continued high production and its persistency throughout the lactation.
5. An abundant supply of clean drinking water must be provided all times. It is most essential feed ingredient.

Guidelines to feed high yielders:

1. Include optimum proportion of forage and concentrates in the ration. Good results are obtained by feeding a ration that derives 30 – 40% of the feed units from grains and 60-70% from forages.
2. The forage should be of excellent quality, at optimum stage. A short delay to cut the fodder can adversely affect its quality.
3. The feeding schedule should be such that it will maintain a continuous fermentation in the rumen. The cows should be fed minimum of four times a day at 6 hours intervals. Each feeding should comprise both grain and forage.
4. When high levels of grains are fed, feed it mixed with the roughages or feed it after the animal has consumed some roughage.
5. Processing of feed & fodder may be done.
6. During the late lactation, intake ability of a cow exceeds nutrient needs. This is the time when the cow starts needing extra allowances for the growing foetus. From 7^{th} month to

of gestation cows may be fed 1 to 2 kg concentrate feed in addition to their nutrient requirement. The cows may be made to gain 20-25 kg body weight during this period.

7. For **challenge feeding**, 2 weeks before expected date of calving, start feeding ½ kg of concentrate mixture increases this amount by 300-400 g daily until the cow is consuming ½ to 1 kg concentrate for every 100 kg body weight.
8. **Complete feeds** i.e. intimate mixture of concentrates and roughages in a desired proportion. This is done to avoid selective eating. This can be done by pelleting process. This will cause more uniform fermentation in the stomach.
9. Feed processing: grinding of grains, chaffing of dry roughages and fodders and soaking of straw & oilcakes in water.

Management of the Bulls

The bull is said to be "half the herd" as it is responsible for 50 per cent of the destiny of the herd. With the advent of AI, the bulls used for breeding should be of superior genetic quality as most of the genetic improvement in a population comes through proper bull selection. If a bull of low fertility is selected it produces disturbances in the periodicity of calving of a large number of cows leading to huge financial loss to the dairy farmers. The bulls used for breeding should be of good fertility, in good physical condition, be free from diseases and maintained in a good state of health by proper feeding and sound management practices.

Selection of breeding bulls:

1. Descriptive breeds of breeding bulls should be registered by authentic organization.
2. Bulls should be evaluated by any approved sire evaluation method.
3. Semen of the young stock, descended from proved parents can be used.
4. Bulls should pose 50 percent fertility rate (within 60 to 90 days) at first insemination.
5. Breeding value of bulls should be estimated.
6. Bulls should be free from IBD/IPV, FMD, Tuberculosis, Bovine brucellosis, Jhone's disease and trichomoniasis. The area within a radius of 100 km of the centre for AI should be free from infectious diseases.
7. Young bulls should be selected, if it is proved earlier can be used for longer period.
8. Bull should be selected based on pedigree performance. The dam should possess characteristics of higher milk production, with good dairy conformation.

9. Bulls should be free from any defects and contagious diseases.
10. Bulls should possess masculine look, wide chest, light barrel, big scrotum, active look and carriage.
11. Based on better performance of progeny bulls should be selected.

Housing

Bulls should be kept in concrete floor individual pens with corrugated asbestos roofed shed with the orientation of east-west direction through its long axis. Bulls are kept in individual pens (30′×10′) with adequate loafing area separated by solid partitions that restricted both direct physical and visual contact of bulls in adjacent pens, with a sufficient long rope to ensure its almost free movements within the shed. Hygienic measures should be taken to maintain cleanliness within and surrounding the bull farm. Bull calves are maintained at least for 6 months after birth with the female stock to bring early sexual maturity in bulls. The young bulls of six month age are kept in separate stalls in a group of two or three for their better care and management up to one and half year age. Then they are shifted to individual pens. The young bulls usually keep together in an enclosure daily for at least one to two hour for exercise.

Bull calves:

- Bull calves should be housed in individual pens
- Pens should be provided with feeding troughs and water bowls which has to be cleaned daily
- Calf pens should be provided with adequate bedding which should be changed regularly
- The pens should be cleaned and disinfected regularly
- Male and female calves should be separated before nine months of age

Adult bulls:

- The adult bulls can be housed in individual loose houses or a number of bulls can be housed together in confinement (single/double row stanchion barns)
- The individual loose houses should have a covered area (12 sqm) and an open area (120 sqm). In group housing each animal should be provided a standing space of 2.5 x 1.5 meters. The covered area should be half walled for free movement of air into the shed
- The loafing area should be enclosed by railing and should have shady trees
- The sheds should be provided with feeding mangers, water troughs and dung and urine channels

- Corners of mangers, troughs, drains and walls should be rounded to avoid injuries and to facilitate easy cleaning
- In summer, exotic bulls and buffalo bulls need cooling mechanism in the pen to maintain homoeothermy. During summer, sprinkling along with fan gives them some amount of relief from heat stress.
- In summer make available cool drinking water
- Regular disinfection of the pens should be carried out with insecticides to keep away the flies, fleas, ticks etc
- Foot bath should be provided at the entry point
- Slurry tanks should be constructed adjoining the sheds for the collection of dung, urine and wash water which then can be applied to the pastures and leys

Daily cleaning of manger and waterer is done. Left over feeds is removed from manger daily to prevent mould growth and refusal of fresh feed. Cleaning of the shed is done once daily early in the morning using hose pipe having pressure nozzle. Disinfectants like formalin or phenyl based compounds should not be used in the bull sheds. Alternatively compounds containing gluteraldehyde can be used. Weekly spraying with Sodium Bicarbonate (4%) should be practiced. The floor should be sterilized at least once a year by a blowlamp or by burning straws.

FEEDING OF MATURE BULLS

Concentrate is provided to the bulls to the tune of 2.0 to 2.5 kg per bull during morning hours. Seasonal green fodder such as maize, cowpea, berseem, jowar etc. depending on their availability, along with mixture of maize and oat silage during lean period was fed *ad lib.* to the animals. The bulls have free access to clean drinking water throughout the day. When energy intake is restricted, growth rate is decreased, testis growth is retarded, age at puberty is increased and sperm output is decreased. The bulls should be fed such that they are neither lean nor obese.

- Over feeding or under feeding results in reduced libido
- Adult bulls should consume 2.0 to 3.0 percent dry matter
    - Concentrate: 2-3 kg
    - Quality green grass: 25-30 kg
    - Dry roughage: 3-4 kg
    - Quality drinking water: Adlib

- Vitamin A supplementation during lean season
- Supplementation of mineral mixture and salt
- Mineral mixture should be supplemented as follows:
    - 50 g mineral mixture for bulls up to 200 kg body weight
    - 70 g mineral mixture for bulls between 200 to 350 kg body weights.
    - 100 g mineral mixture for bulls above 350 kg body weight

Table-1: Requirement of bulls

Bull groups	DCP (%)	TDN (%)	Dry fodder	Conc.	ME	Ca	P	Vit A
Growing bull	12 to 15	70	1 kg/ 100 kg body weight	1.5-2.0 kg	3.5 M.cal/ 100 kg b. weight	4.5 g/ 100 kg body weight	3.3 g/ 100 kg b. weight	4000 IU/ 100 kg b. weight
Service bull	10 to 15	70	1 kg/ 100 kg body weight	2.5-3.0 kg	3.3 M. cal/ 100 kg b. weight	4.0 g/ 100 kg b. weight	3.0 g/ 100 kg body weight	4200 IU/ 100 kg b. weight

Training for semen donation:

The bulls should be trained from an early age (1 year). Nose ring, halter and bull staff is generally used for training and leading the bull. Bull should be disbudded at an early age for easy handling of the bulls. The actual training of the bulls starts from 18 months of age for semen donation. Initially they are accustomed with the preparation of bull like exercise in bull exerciser, cleaning, tying before collection. They also need to be accustomed with sexual preparation activities like mounting on dummy, false mounting, application of artificial vagina, attendants and semen collector. Gradually they will start donating semen in this process of training.

Health and miscellaneous care

Vaccination, deworming and other herd-health programme is followed as per the farm schedule, to ensure good health. Bulls are exercised once a week, the day before semen collection in the rotatory exerciser so as to maintain the sexual behaviour of bulls and ensure quality semen production.

- Dehorning of bull calves
- Regular deworming
- Grooming of animals: Regular grooming and brushing should be done to keep the coat clean along with preputial washing with sterile saline water.
- Periodic clipping of preputial hair: Preputial hair should be 2 cm long; it should not be cut too short or too long.

- Regular exercise
- Regular vaccination of herd
- Regular screening for diseases
- The place around the penis should be cleaned with soap or detergent in case of soiling. Sick or diseased animals should be kept in isolation yard till his recovery.
- Regular hoof examination and trimming: Routine trimming of hooves should be done for proper hoof care.
- Regular treatment for ectoparasites

Care of Young Bull

After young bulls are selected on the basis of the performance of pedigree and collateral relatives, they should be reared intensively by providing growing ration. When the bull calf is about 9-12 months of age, a light weight ring should be put in his nose which may be replaced with a strong, large ring when it is nature. Young bull should be trained for handling. The bulls should be kept near the collection shed during semen collection for imparting training for donating semen.

Care of Mature Bull

Mature bulls should be controlled by a nose ring with caution. Young and mature bulls should be allowed exercise regularly for at least 2-3 times a week so that they do not put on fat. This will also check overgrown hooves and swollen/inflamed joints. Hair should be regularly clipped with a pair of scissors, leaving upto one centimeter length of hairs.

Health management

There should be regular screening and treatment of sick animals, control of flies and ticks. Periodically prophylactic measures should be taken against Foot and Mouth Disease, Haemorrhagic septicaemia, Black Quarters and Anthrax using a regular schedule of vaccination. Spraying, deworming and control of ecto and endoparasites should be carried out. Bulls should be tested regularly against TB, JD Brucellosis and IBR-IPV (Infectious Rhinotracheitis-Infectious Pustulo Vulvovaginitis) and Trichomoniasis.

Ringing the bull

When the male calf is about 9-10 months of age, a light weight ring of about 1.5 to 2” in

diameter should be put in his nose. It should be made of some non-rusting material such as copper or aluminum. When the bull is older, this ring should be replaced with a stronger and larger ring (3”).

Service

A bull should not be used regularly until 15 to 16 months of age. There should not be more than two services per week till the bull is 16 months old. Young bulls should be brought regularly for imparting training for donating semen. For an adult bull, there is a common practice to limit to 1-2 collection per week. Though semen volume and sperm concentration are reduced by frequent ejaculation, collections upto 14 times per month does not seem to affect fertility in most cases.

Maintenance of Sexual Libido

The degree of excitement increases both quantitative and qualitative seminal characteristics. Several factors which affect the libido are age, feeding, exercise, overuse, semen collection at unusual place, using unsuitable fittings, faculty feeding, obesity, inherent defect, chronic defects of legs, back, penis etc. Sexual behaviour is reduced in intensity during the period of physiological stress caused by debilitating disease, climatic stress or physical injuries. Similarly vitamin A deficiency and low phosphorous diet may reduce the expression of sexual behaviour. Certain conditional stimuli like sound of gate opening, whistling also contribute to enhance the libido. False mounts, changing the teaser etc., may lead to higher stimulus for ejaculation. In extreme climatic conditions like peak summer or winter, the libido as well as quality of semen declines. During summer bulls should be housed in cool and ventilated dry sheds. Showering with cold water during hot part of the day and protection against direct and reflected radiation should be provided. The bulls should be provided with soft bedding in winter to avoid the frost bite in Northern India. The buffalo bulls require protection from cold stress and warm bedding in winters and showers/wallowing in summers to achieve better semen quality and quantity.

The volume of semen produced per ejaculate varies from two to five milliliters in young bulls to five to 15ml in older ones. A normal sample should contain one to three billion (10^9) sperm per milliliter, with over 60 per cent of the sperm being alive and showing vigorous

motility. Many specialized tests are available for evaluating a sample of semen, including microscopic, biochemical and computer-based methods.

Sperm output from a bull depends on

Frequency of ejaculation

- Production target of the sperm station
- Number of breeding bulls available in the herd
- Facilities and manpower available in the lab
- Storage capacity of the laboratory
- Market demand for semen

Amount of sexual preparation provided to bull

- Permitting false mounts
- Active restraint of the bull
- Combination of false mounts and active restraint

Sperm output from breeding sires can be maximised by

- Pre-fixed collection schedule
- Selection of ideal teaser bulls
- Proper sexual stimulation of bulls
- Proper sexual preparation of bulls
- Sound semen collection technique

Regimes for semen collection

There are two accepted regimes for semen collection

- Single ejaculation regime: Where the bull is brought for collection three times a week and each day only a single ejaculate is collected.
- Double ejaculation regime: Where the bull is brought for collection twice a week and each day two ejaculates are collected.

Care and management of bullock

Bullock has excellent draft and transportation power. They are capable of 6 hours of carting or 4 hours of ploughing in case of normal work and 8 hours of carting or 6 hours of ploughing in case of heavy work. Keeping in view of welfare aspects they should be provided

sufficient space, protection from adverse climatic condition, free access to water, regular grooming and apply metal shoes to protect the hooves from wear and tear.

Review questions:

1. Define management. What is importance of good management of dairy animals?
2. Define colostrum. Write in brief about the importance of colostrum for calf.
3. Write ten important management practices for heifer management.
4. Write ten important management practices for pregnant animal management.
5. Write ten important management practices for dry cow management.
6. What is drying off? Write in details about drying off methods.
7. What is steaming up. Write the importance of steaming up.
8. Write important management practices for bull management.

Chapter – 2

ROUTINE MANAGEMENTAL PROCEDURE

In a dairy farm the primary objective is to produce quality milk and sell the same with profit. Therefore, routinely some activities or operations are carried out to meet this primary object. Correct implementation of such activities directly or indirectly augment the overall milk productivity of the dairy farm and detail description of all the activities are given below.

Weaning

Weaning is defined as the separation of young calves from their mother after birth. In bovine, weaning may be followed either just after birth called as weaning at birth or zero day weaning, or after colostrum period i.e. 3-4 days after birth. Weaner calves are fed milk @8-10% of their body weight. Weaning in dairy cattle has different advantages.

Advantages of weaning

- Actual milk production of a cow is properly recorded for future selection.
- Required amount of milk by calf is fed economically.
- Weaning improves the hygienic quality of milk.
- Weaning prevents teat injury in cow and occurrence of calf disease like calf diarrhoea which is result of uncontrolled milk intake.
- In automatic milk feeder based on daily milk intake and suckling behaviour (duration of suckling and visit to the feeder) weaner calves with ill health can be identified in advanced before diagnosis.
- Weaning does not affect milking after death of the calf as calf is not required for milk let down.

Disadvantages

Although, weaning has several advantages but has also certain disadvantages.

- In zebu or desi cattle and buffaloes weaning is very difficult owing to strong maternal instinct.
- Weaning produces stress to the young calves.

- If proper hygiene of milk feeding utensils like feeding bucket, pail etc. not maintained then chances of neonatal calf diarrhoea increases.
- In weaned calves, lack of satisfaction of suckling sometimes leads to abnormal behaviour like inter-suckling.

Milking practices

Milking is the most important daily routine activity in dairy farm. Milking is done commonly twice in most dairy farm morning and evening; however, if milk productivity of animal and labour availability is more then go for three times milking per day i.e. early morning, at noon and evening keeping the duration of milking interval equal. The primary objective of milking is to obtain maximum quantity of clean milk in shortest period from cow without causing any injury to teat or udder. Milking should be conducted gently, quietly, quickly, cleanly, completely and at regular intervals. Milk let down/milk ejection from secretory alveolar cell and small duct into cistern and major duct starts within ½-1 min of udder massaging under the influence of hormone oxytocin, so milking should be completed within 5-7 minutes, beyond that the effect of oxytocin is reduced. Milking may be hand milking or machine milking.

In hand milking, full hand milking or fisting is considered as best method of milking and commonly followed in high yielder dairy cows and buffaloes. In full hand milking the whole teat is hold in the fist, grasping the teat with all five fingers and pressing it against the palm. Then the teat base is closed by thumb and fore finger so that milk is trapped in the teat sinus and teat is compressed and thus forcing the milk out. The teat is alternatively compressed and relaxed in quick succession and removes milk quicker than stripping. Stripping is another method of hand milking that is followed in low yielder animals and animals with smaller teat size. Stripping consists firm holding of the teat between thumb and for finger and then drawing it down the entire length of teat and at the same time pressing it simultaneously, so that milk flow down in a stream. However, sometimes milker follow a defective method of milking called as knuckling, where thumb is bent against the teat during milking.

Machine milking is practiced in dairy farm with high yielder exotic or crossbred cows and high yielder buffaloes. For machine milking minimum number of high yielder cows or buffaloes should be at least 10. The working principle of machine milking is under negative pressure created by the vacuum pump and the vacuum pressure for cows 280-320 mm Hg and for buffaloes 320-360 mm Hg. Although, machine milking is time and labour saving but improper

cleaning leads to mastitis and reduces milk quality. Thus, regular cleaning of milking machine will maintain the cow health as well as ilk quality.

Weighing

Weighing is an important activity followed in dairy farm to assess the growth and health of animals. Young growing calves are commonly weighed at weekly interval as their growth is much faster than the adults. However, in adult animal weighing is followed at fortnight intervals or monthly interval depending on the labour availability. Regular weighing of dairy animals is essential for the following management.

- Computation of daily ration of different groups of animals.
- To monitor the health of animal as in sick animals appetite is reduced and thereby reduces body weight.
- To assess the growth of young stock which are the future cow in the farm.
- For the calculation and administration of correct dose of medicine.
- For the breeding management of young stocks as minimum weight of young breeding stock should be 60% of the mature body weight.

Marking/Identification

Marking of animals soon after birth for easy identification is important managemental practice in dairy farm. Although, several methods of identification are followed in dairy animals but tattoing, tagging and branding are most common methods. Tattoing is a common method used in animal with lighter body coat and preferably done at the ventral aspect of ear. Tattoing if done correctly then act as a permanent mark. In cattle and buffaloes ear tagging is done using either self piercing or non-piercing plastic or non-rousting tags. Under branding hot iron branding using hot branding iron or cold branding using branding iron dipped in liquid nitrogen is vogue. Marking in dairy animals has several advantages and disadvantages. Now-a-days for easy and automatic identification, electronic identification of animal is done using either electronic ear tag or neck collar.

Advantage

- To identify the dairy animals for maintaining proper records of growth, production, reproduction and health.
- Marking/identification helps for implementation of better management practices whenever needed.
- Marking also helps for herd registration of animals, insuring animals, issuing certificate etc.
- It helps in proper maintaining of register in animals and high yielder elite animals can be selected easily.

Disadvantages

- Branding reduced the skin/leather quality of cattle and buffaloes and thereby reduced the cost.
- Improper marking is painful to the animals.
- Poor care of animal after marking sometimes leads to infection.
- If marking done in extreme climatic condition then produces stress to animals.

Disbudding and Dehorning

Disbudding is the process of removing horn bud in young calves before its attachment to skull within 3-5 days after birth. On the other hand dehorning is the removal of horn after it has attached to the skull in older calves. However, in most dairy farm disbudding is practiced instead of dehorning as former is less painful. Moreover, in case of horn injury or horn cancer to check the spread of infection dehorning is practiced. Dehorning may be practiced by chemical cauterization using caustic soda, caustic potash or Silver nitrate sticks. In chemical method first hair around the horn bud clipped followed by application of Vaseline to protect the adjoining tissues. Then stick is vigorously rubbed on the base of horn bud till it started bleeding. Disbudding may be done mechanically using red hot iron or electrical dehorner pressing on the horn bud. Electrical dehorning is best as it requires only 10 minutes and less hazardous compared to chemical or hot iron method.

Advantages

- Prevents chance of bruising to other animals as well as human beings.
- Space requirement in dehorned animal during group housing is less.
- Animals without horn are handled easily.

Disadvantages

- Horn reflects the breed characteristics, so in exhibition it is less advantageous.

- If proper care is not taken after disbudding or dehorning then increases susceptibility to tetanus infections.
- It produces pain to the animals.
- Disbudding or dehorning during extreme climatic condition produces stress to animals.

Exercise in dairy animals

Exercise in dairy animals is an important daily activity that enhances the health and productivity of the animals. In loose housing management of dairy animals exercise is not much important because the animals move freely. However, in conventional housing management where animals are tied throughout the day and night, exercise is compulsory. Exercise should be recommended daily atleast once during morning just after milking for ½ to 1 hour. Exercise reduces the chance of deposition of fat, leg problems, bloat, calving difficulties etc.

Washing

Washing in dairy animals is generally followed to remove the dirt and loose hairs before milking for clean milk production. Washing of flank, udder and tail are washed with clean water followed by drying with a clean towel/cloth. During washing grooming is also followed that make easier to remove the dirt. During hot summer washing helps to mitigate heat load in animals and thereby increases milk production. Washing of animal may be sometimes occurs with soap to clean the body coat. Dairy animals are also washed for the show purpose with clean water and shop.

Grooming

Grooming or brushing of body hair coat is an important daily farm operation to make and keep the animals' body clean and fit. For grooming blunted type brush is used, if not available then use coarse rope made from paddy straw, coconut coir or dried grass. In India, grooming generally practiced before milking along with washing to improve the clean milk production. Different types of brush like dandy brush, curry comb and body brush are mainly used for grooming. The brush may be stationary type brush or rotating cow brush. However, rotating cow brush is accessible for higher percent of cows and easier to use, and rotation is activated when cow moves the brush.

Advantages

- Reduces the dirt and loose hairs from the body.

- Grooming reduces the number of external parasites and organism from body coat of cows.
- Grooming is practiced to prepare a cow for show or exhibition purposes.
- Grooming enhance blood circulation to the skin and make it pliable and shine.

Removal of extra teat

In normal cattle and buffaloes the number of teat on udder must be four, if beyond this then called extra teat or supernumerary teats. The incidence of supernumerary teat in cattle ranges from 20-69%. The extra teat may be without any gland or have orifices of small glands or may open into the one of the normal gland. Supernumerary teats are generally regarded nuisance as they blemish the udder, cause mastitis in association with glandular tissue and interfere while milking if attached to principal teats. The extra teat should be removed within 1-2 month after birth by surgical incision. In this method first the area around teat is cleaned and applied with antiseptic solution and clip it off using scissor. There is less bleeding or if bleeding is there then press with cotton plug and bleeding can be stopped.

Record keeping

Record keeping is an important daily farm activity, helpful for the evaluation of individual performance of cow and economic assessment of dairy farm as a whole. Daily farm record data entry is a challenge with rewards. The different types of record maintained in a dairy farm are birth register, body weight register, herd register, production register (milk yield register) death and disposal register, feed and fodder register, breeding register, treatment register, health care register, expenditure and income register, labour records etc. Record keeping in dairy farm has several advantages.

- Without accurate record a best cow in a herd may be given equal rank with the poorest.
- From recorded data individual animal's production and reproduction performance is evaluated.
- Record keeping helps for economic feeding based on growth and production.
- Record provides information regarding farm status which is helpful for the future planning of requirement of concentrate, roughage and labour as early as possible.
- Productive, reproductive and health data from record is useful for culling of inferior animals and selection of superior animals for genetic improvements.

- Based on production high yielder elite cows can be identified and helpful for better management to maintain the productivity.

Castration

Castration is the unsexing of both male and female, and during castration there is removal of testis and ovaries, respectively. However, surgical removal of testes produces pain to the animals. Moreover, castration with burdizzo castrator is most commonly used bloodless castration, where the testicles are not removed rather the spermatic cord is crushed and separated from each testicles. Separation of spermatic cord prevents the flow of semen from testis to outside through urethra and gradually the testicles size reduces and become rudimentary as the blood supply testicles reduced. In addition, strong tight rubber ring around testicle gradually reduces blood flow and testicle size reduced and finally become rudimentary. Castration is generally preferred at young age preferably within 1 year. Castration should be performed during cold season and strictly avoided in rainy season. Castration in dairy bull has the following advantages.

Advantages

- Castration prevents indiscriminate breeding.
- Male and female can be kept in one place.
- Castration reduces aggressiveness of male and prevent fighting and easy to handle.
- Castration enhance faster growth rate.

Disadvantages

- It produces pain to animals.
- If proper care is not taken increases susceptibility to infection.
- In surgical castration chance of tetanus is more.

Feeding

In dairy production system, feeding expenditure accounts approximately 65-70% of total cost of production and maintenance of animals. Hence feeding activity is most important daily routine operation and proper understanding of nutrient requirement and feeding management will reduce the expense. Generally dairy animals are given two types of feeds like concentrate which contains less than 18% fibers and beyond this called as roughages. Different group of dairy animals are fed separately according to their nutrient requirement. The amount of feed given to an animal during 24 hours is called as ration that contains all nutrients essential for the animal for a particular day. Dairy animals are generally allowed for free access to roughages but

measured amount of concentrate is given based on body weight for maintenance, milk yield, milk fat percent, pregnancy and growth. The roughage and concentrate are generally given separately; during milking only concentrate is given. However in complete feeding both concentrate and roughage mixed uniformly and then served to the animals. A complete feed mixture avoids the selective feeding in animals and thereby reduces feed wastage.

The daily requirement of dairy cattle and buffaloes are calculated based on daily dry matter intake. Cattle generally eat @2-2.5 kg dry matter per 100 kg body weight, whereas buffaloes are slightly heavy eaters and take @2.5-3.0 kg dry matter per 100 kg body weight. As a thumb rule upto 4-5 liter milk yield no concentrate is needed if sufficient green fodder is available. If a cow giving 10 lit milk with approximately 400 kg body weight then give 20-25 kg greens, 3-4 kg dry fodder and 5 kg concentrate; if buffalo than only extra 1 kg more concentrate i.e. 6 kg concentrate given compared to cow as buffalo produces more milk fat.

Hoof trimming

Hoof trimming is a routine procedure in dairy farm which corrects the hoof problems or lameness and extent the productive life of cows. The hoof growth and its wear occur simultaneous and influenced by the environment. It has been observed that the animals' foot will replace itself once a year. Therefore, simultaneously with the growth there should be wear of hoof to maintain the normal foot conformation. When hoof abnormally grown more its length increases and in severe condition it curl up and create lameness condition. The foot trimming in animals practiced at 6 month interval and cut only the extra grown hoof otherwise if excess than causes pain and bleeding.

Review questions:

[1] What are the advantages and disadvantages of waning in dairy cattle and buffaloes?

[2] What are the common types of hand milking in dairy cows?

[3] Write importance of record keeping in dairy farm.

[4] Why weighing of calf is important in a dairy farm?

[5] How a farmer can prevent indiscriminate breeding in dairy animals?

[6] Hoof trimming increases productive life of cow, Justify?

[7] How much dry matter requirement of cattle and buffaloes?

Chapter – 3

Record keeping- different records in dairy farm and its maintenance

Facts and Figures in the form of proper records help in efficient management of a farm. Record keeping is essential for evaluated the performance and for taking remedial actions to maximise profits. Application of computer has very crucial role in dairy record management. "Orderly maintenance of details on various activities" *or* "systematic arrangement of information of various events" at the farm is known as recording. It is done by using prescribed forms. All the similar forms may be kept bound in the form of the register. Recording is done with following objectives:

1. Records provides basis for evaluation of animals i.e. fixing proper prices of animal meant for purchase and sale.
2. Helps in systematic breeding programme for improvement of herd, in progeny testing of bulls
3. Helps in economic feeding of animals and to obtain guidelines for timely planning of sowing, production and harvesting of fodder crops etc.
4. A necessity for registration in central herd book.
5. Helps in preparing pedigree and history record of animals.
6. Helps in detection of abnormal condition with the health of animals leading to loss in body weight.
7. Helps in determining cost of milk production.
8. Helpful in comparing the efficiency of labour and herd with other farms.
9. To furnish information regarding the quantities of roughages and concentrated fed to animals, amount of milk production and method used in production to improve efficiency.
10. To obtain desired feedback for better managerial operations.

11. To select individual animal, provide action list for breeding, calving, etc. and for improving overall farm efficiency and also to cull the animals not economical to the farm/herd
12. To prepare financial estimates and records etc. and judge the farms profitability and productivity and which can be adjusted to gain the maximum profit by modifying the production (increasing production when price of the product is high and *vice versa*)
13. Livestock Insurance

The nature of the record should be devised after a thorough discussion and acceptance. These should be simple, concise and informative to be easily used by all concerned. These should be compatible with similar activities at other locations and correlate with other records maintained at the farm. Finally, these should be able to be easily analysed with the help of computer.

Caring the Records: It is an important activity. The records should be kept protected from any type of possible damage (worms, insects, damp, theft, tear, tampering, etc.).

Kind of records: Various kinds of records are maintained at the farms. These have been classified according to following manner.

Classification	Type of Records	Records
Based on - Aims/ Purpose/ Activities	Production Records	Production (Milk and byproducts) (Herd average, Wet average, Lactation length, Dry period, Wet: Dry ratio) (daily, monthly, annual, lifetime)
	Reproduction Records	Estrus detection of efficiency and accuracy Conception Rate, Incidence of reproductive problems: repeat breeding, anestrus, abortion, retention of fetal membrane etc. Heifers, Cows (Age at First Service, Age at First Calving, Service Period, Calving Interval,)
	History Records	Cattle and Buffalo History
	Nutrition Records	Feed Purchase/ manufacture Feed Stock (Daily / Monthly / Annual) Nutritional Analysis
	Health Records	Body weights, Disease outbreaks, Vaccination, Deworming etc.

	Financial & Stock Records	Animal Stock, Identification (Categories) Machinery and implements, Financial
	Labour register	Casual, Permanent, Skilled labours
Kind of Livestock/ units	Dairy farm records Register, cards, sheets, files	As above

Different types of record:

It is expected following records will be maintained at a dairy unit.

i) Date of birth and pedigree information (at least parents and preferably grandparents).

ii) Records on growth.

iii) Reproduction records (oestrus, breeding, pregnancy diagnosis and calving).

iv) Milk production records (daily).

v) Health and veterinary record (vaccination).

vi) Therapy of diseases and disorders.

vii) Feeding items records (daily consumption of green fodder, straw and concentrate) estimated values.

viii) Periodic test of milk fat, SNF, quality.

ix) History sheet.

x) Besides above records, following records are also to be maintained:

Complete farm business records (purchase of feed, seed, fodder, fertilizers, veterinary medicines, irrigation implements, electricity and fuel expenses, sale of milk, animals, skin, manure, labour wages etc.).

Some important applications of farm records analysis

i. In making decision about culling of animals.

ii. In reducing feed cost.

iii. In proper utilization of land and labour.

iv. Comparing performance with standard values.

v. Proper breeding of herd.

vi. Proper claiming from insurance companies.

vii. Adjusting profitability and productivity and which can be ed to gain the maximum profit by modifying the production (increasing production when price of the product is high and *vice versa*)

A. Cattle section records

1. Daily report register
2. History and pedigree sheet
3. Livestock register
4. Milk record register
5. Milk summary record
6. Calf feeding register
7. Register for receipt of cattle feeds
8. Register for feed consumption
9. Breeding and calving register
10. Progeny register
11. health register
12. Bull assignment register
13. pregnancy record
14. Weight register
15. Feed order book
16. Concentrate feeding schedule

B. Farm section records

1. Labour sheet
2. Muster roll
3. Machinery and implement book
4. Tractor register
5. Field register
6. Fodder cultivation record

c. General records

1. Ledger
2. Cash book
3. Purchase book
4. Bill payable book
5. Store stock book
6. Inventory register
7. Attendance and pay record

Review questions:

1. Write the importance of record keeping in livestock farm.
2. If you will not keep records in farm what kind of problem you will face?
3. Mention the name of the records maintained at a dairy farm.

Chapter – 4

PRINCIPLE AND DESIGNING OF ANIMAL HOUSING, LOCATION AND LAYOUT OF ANIMAL SHEDS

All domestic livestock are homeotherms; that is, they maintain relatively constant internal body temperatures, usually within a 1 to 2° C range. The body temperature of most domestic animals is considerably higher than the environmental temperature to which they are exposed most of the time. They maintain their body temperatures by balancing internal heat production and heat loss to the environment. The hypothalamus acts as a body thermostat by stimulating mechanisms to counteract either high or low ambient temperatures. There are few aspects of livestock production which aroused more interest, development and controversy in the last few years than the housing and environmental needs of farm animals. Inadequate housing, poor ventilation, overcrowding and uncomfortable conditions have detrimental effect on the productivity, health and overall wellbeing of the housed animals as well as production. This reduction in production efficiency in fact may be a greater cause of economic loss than losses caused by infectious diseases. Inclement weather conditions mainly the environmental temperature affects an animal's comfort, which, in turn, affects an animal's behavior, metabolism, and performance. The temperature that the animal experiences and the effect on the animal is the net result of air temperature, insulating effects of the surroundings, and the animal's age, sex, weight, adaptation status, activity level, posture, stage of lactation, body condition, and diet. The range of environmental temperatures over which animals use the minimum amount of metabolic energy to control body temperature is called the **thermo neutral zone** and is referred to as their comfort zone. Research results have shown that adult cattle can adjust the upper and lower limits of their comfort zone by as much as 2.22 ^{0}C in response to cold and heat stress. Environmental temperatures may be temporarily cooler or warmer than the comfort zone without compromising either the animals' overall well-being or their productive efficiency over the long term, but will lower productive efficiency in the immediate term.

In tropical and subtropical countries an animal may often be under heat stress; when the environmental temperature exceeds the upper critical level (18 to 24°C, depending on the species) there is usually a drop in production or a reduced rate of gain. Furthermore, when the temperature falls outside the comfort zone, other climatic factors assume greater significance; humidity becomes increasingly important as do solar radiation and wind velocity. Dairy Cattle show a reduced feed-intake under heat stress resulting in lowered milk production, reproduction and reduced growth. There are, however, important differences between breeds to environmental stress. European cattle (*Bos Taurus*) produce well at temperatures ranging from 4 to 24° C even at high humidity. Much lower temperatures (-10°C) have little effect as long as fluctuations are not too rapid or frequent. On the other hand, a drop in milk production results with temperatures exceeding 25°C. The drop may be as much as 50% at temperatures of 32°C or higher. In contrast, Zebu cattle (*Bos Indicus*), which are native to warm climates, have a comfort zone of 15 to 27° C and milk production begins to drop only when temperatures rise above 35°C and below 5° C.

Even though cattle are adaptable and can thrive in almost any region of the world, they must be protected from heat and cold stress caused by extreme weather events. They must have access to shelter even in moderate climatic regions. Heat stress adversely affects animal comfort more than does cold stress. Windbreaks, sunshades, or solid-roofed shelters are needed if trees or other landscape features do not provide adequate protection from winter storms and extremely cold or hot temperatures. Sunshades, sprinklers, misting, fans, and other methods of cooling, as well as dietary alterations, will reduce heat stress and prevent a decrease in milk production during hot weather.

When feed is converted by the animal's metabolism for the production of milk, heat is produced as a by-product. An increased production level and thus feed requirement will therefore result in increased internal heat production. High yielding animals are consequently more likely to suffer from heat stress in a hot climate than are low yielding ones. Feeding fiber-rich, low digestible feed stuffs like hay will result in high heat-production because of increased muscular activity in the alimentary tract and, in ruminants, increased microorganism activity in the rumen. An increased share of concentrates in the feed may therefore reduce heat stress in an animal under hot climatic conditions.

Air temperature, humidity, quality, and movement should be monitored carefully, especially during seasonal changes, to ensure animal comfort and prevent diseases. Humidity (the water vapor pressure in the air) influences the animal's ability to maintain its thermal balance. Relative humidity is ordinarily used to manage the air's moisture content and is easily determined. The relative air flow between animal and service areas in animal housing is an important consideration for reducing airborne transmission of disease agents or air pollutants. Air quality affects the health and well-being of animals and their caretakers. Quality is typically defined in terms of the air's content of certain gases, particulate matter, and liquid aerosols. Five primary pollutants are found in animal facilities--ammonia, hydrogen sulfide, carbon monoxide, methane, and airborne dust. Government standards for these pollutants have not been established for many agricultural animals, but have been established for human worker exposure.

Ammonia: no more than 25 ppm and ideally less than 10 ppm

Hydrogen sulfide: no more than 50 ppm and ideally less than 10 ppm

Carbon monoxide: no more than 150 ppm

Methane: no more than 50,000 ppm

Airborne dust: 5 mg/m3 for respirable dust (particle size of 5 um or less) and 15 mg/m3 for total dust

Compared with humans, animals can tolerate higher levels of inert, airborne dust without appreciable adverse effects on their health or well-being. However, airborne dust is important to control because microbes and pollutant gases attach to the dust.

Ways to lower airborne dust concentrations are to:

- Increase the relative humidity; not recommended for hot humid tropics.
- Moisten or add fat or oil to concentrate feeds; and,

Control animal activity and air velocity which, at high levels, stir up more dust particles and keep them suspended longer.

Further control of microbes in the air can be achieved by segregating or isolating animals with highly contagious diseases. Care should be taken to ensure that the ventilation system does not move air from infected animals to an area occupied by healthy animals.

Other ways to improve air quality are with waste management, husbandry practices, and good air movement, i.e., ventilation. Special ventilation should be used when emptying under-floor waste pits, as concentrations of hydrogen sulfide and methane may become potentially lethal. Special precautions, such as removal of animals and workers from the building, need to be taken prior to agitation of liquid manure storage. Methane gases can be deadly as well as explosive at certain concentrations in the air.

Adequate ventilation, be it natural or mechanical, helps to prevent respiratory and other diseases by removing heat, water vapor, air pollutants, and odors from an enclosed animal facility at the same time as it introduces fresh air. Ventilation also modifies the indoor air temperature, but supplemental heating and cooling may be needed when temperature control is critical. The rate of air movement, i.e., the ventilation rate can control the rise in temperature in a building. The rate should be ten times higher in summer than in winter.

Other factors that influence the desired ventilation rate are water vapor, heat, and (indirectly) odorous matter released from animals, equipment, and certain husbandry practices. A ventilation rate calculated on the basis of animal weight is more accurate than a rate based on air-exchange rate guidelines.

During winters, provision of dry, clean bedding keeps the animal dry and insulates the udder against cold temperatures and pathogens. Appropriate bedding materials and manure removal help prevent mastitis. Bedding should be of sufficient quantity and changed often enough to prevent animal waste from creating unsanitary conditions. Bedding material that is absorbent or well-drained, free of toxic chemicals or residues, and of a type not readily eaten by the animals minimizes injuries to the animal and to the caretaker. Any permanent stall surfaces, including rubber mats, should be cushioned with dry bedding.

A clean, dry, well-lit, well-ventilated calving area has many health benefits in delivery of calves. Wet, dirty calving areas foster the growth of bacteria that can invade the newborn calf's navel or mouth and create a disease load that overwhelms the calf's immune system. A separate calving area (maternity pen or paddock) that is designed to be comfortable, functional, and hygienic allows for close observation of the cow and easier, more effective assistance at calving. Patience and gentle firmness in handling calves and cows generates a better response than does force. If the cow and calf are confined to a pen, it is more likely that the cow will clean the calf and allow it to suck. Pens, corrals, or paddocks, should be cleaned between calving.

Calves should be protected from extreme temperatures, wind, drafts, and precipitation during periods of inclement weather. During cold weather, ventilation in houses for newborn calves should maintain acceptable air quality in terms of water vapor and other pollutants without chilling the animals. Avoid drafts or direct breezes on young animals. A dry calf protected from wind can endure lower temperatures during peak winter season.

Cow comfort plays a major role in obtaining optimum herd health and milk production for dairy producers. As dairy herds gets larger and production per cows

continues to increase it becomes extremely important to reduce the stress factors surrounding the cow in her environment. The condition in which the cow is expected to work will determine her performance. Cow comfort refers to everything from air quality, bunk management to walking surfaces and resting areas.

Importance of housing:

1. To protect the animals from adverse climatic conditions
2. To provide clean and comfort shelter
3. To protect animals from predators and theft
4. To improve production and reproduction efficiency
5. For proper feeding management
6. Better efficiency of herd and labour
7. Better care and supervision of animals
8. Better economic return from the farm
9. To improve clean milk production

Selection of site:

The houses for cattle and buffalo should be located on dry and elevated place, not exposed to strong wind, heat or cold. The following factors should be considered while deciding the location of the farm:

Facilities	Characteristics	Required for
Size & shape	Enough	Ease of operations
Topography	Elevated (high, leveled without abrupt slopes)	Low cost of construction
Soil type	Fertile and leveled	Low cost of fodder production
Water supply	Natural, Clean, Regular	For all operations
Drainage	Good drainage system	Hygienic need
Accessibility to fields	Easily visible, away from highways & rail tracks and approachable.	Ease of monitoring.
Roads	Away, but not far away.	Ease for transport.
Views	Good natural views	Aesthetic factor.
Sun exposure	Maximum	Disease control
Wind protection	From strong winds	Disease control and Stress reduction.
Electricity	Regular	For every operation

School, Bank, Hospital	Nearby, approachable	Essential for children, labour & workers.
Post Office, Telephone	Nearby, approachable	For fast & easy communication.
Mail route	Direct	For fast & easy communication.
Service facilities	Workshop, Medicines, General stores, Fertilizers, etc.	Ease of use.
Erosion control	Area be covered with vegetation	Protection to crops & soil.
Vegetation	Good cover	Ensures fertility of land, checks soil erosion
Marketing facilities	Nearby, assured, regular.	Ensure selling of products.

Review Questions:

1. What is the importance of housing for dairy cattle?
2. What are the points should be considered for selection of site for dairy animals.
3. Fill in the blanks

   Government standards for pollutants have been established for human worker exposure.

   Ammonia: no more than _____ ppm and ideally less than 10 ppm.

   Hydrogen sulfide: no more than _____ ppm and ideally less than 10 ppm.

   Carbon monoxide: no more than _____ ppm.

   Methane: no more than _____ppm.

   Airborne dust: _____ mg/m3 for respirable dust (particle size of 5 um or less) and _____mg/m3 for total dust.

Chapter – 5

Housing of dairy animals- conventional and loose housing, space requirement of different category of animals

Broadly speaking there are two systems of housing for cattle; loose housing system and the conventional housing systems. Each system has its own advantages and limitations. The final decision can be based upon the climatic variables air temperature, rain etc. in that area. In the loose housing system animals are kept in an open lot or on pastures and are not tethered except at the time of milking. The open area will have a shelter on one side under which the animal can retire during the time of excessive heat, cold or rains. One common manger and a common water tank can be provided for these animals. Congestion should always be avoided in loose housing system. Such system is ideal for areas of low rainfall such as Punjab, Haryana Rajasthan, Western U.P. and parts of Gujrat, Madhya Pradesh and Maharashtra. Even at other places this system can be used after making small modifications so as to protect animals from excessive continuous rains. Such houses are cheap to construct, easier to expand at short notice more congenial to efficient management less fire hazards to animals and helps cleaner milk production as a special milking barn is attached. On the other hand in the conventional system there is greater protection during winter season but proportionally the cost is very high.

Open housing system has been recommended for crossbred cows. This system of housing poses four problems. First, in summer season when ambient temperature rises beyond 38 to 40^0 C and second problem is faced when increase in temperature is associated with increase in humidity. Because of these two problems, animal becomes uncomfortable due to rise in body temperature which ranges from 1-20 C. Third problem is faced in winter when ambient temperature falls below 70 C in the months of December and January. There is a belief that in low temperatures, production efficiency of crossbred cows does not decline. In fact, animal maintained on sole green fodder, i.e., berseem with high moisture content, certainly face uncomfortable weather condition during winter nights. Milk productivity reduced from 2 to 2.5 kg per animal, depending on production potential of the crossbred cows. High yielding cows register more declines. Fourth problem encountered when crossbred cows with large body size are maintained on brick floor throughout day and night. Due to high body weight and soft hooves, injuries take place in hooves of cows. As a result of this, several animals develop foot injuries or lameness. About 20 per cent animals are culled from such system of housing as a result of hoof disease and locomotive disorders. Due to these four serious problems, the housing system required modifications with a view to improve animal comfort. Under Indian conditions, the basic principle is that, it should guide the dairy farmer or manager embarking on building a farm to reduce heat gain and promote heat loss from the structures of the animal house by radiation and conduction during summers. Economy should receive special attention in their initial cost and maintenance, health and comfort of animals.

A. Loose Housing System

In India scientific housing of animals was practically ignored in the past except in a few organized Govt. farms where the Western type of dairy cattle housing was followed.

This system of housing is mainly designed to suit the requirement of temperate climate and has proved unsuitable for all tropical climates.

In recent past loose housing system for dairy cattle is being advocated. This system has proved quite suitable and economical for tropical climate. But here too, sufficient modification is required for different regions of the country.

In loose housing, animals are usually kept loose in a open paddock in group of 40-50 throughout the day and night except during milking and some other specific purposes like treatment, breeding etc., when the animals are required to be tied. This housing system generally provides continuous manger along with covered standing space, open paddock which is enclosed by brick wall or railing and common water trough. A separate structure of calf pens, milking byres, calving pens, dry pens and heifer pens etc., are required for this system.

Under loose housing system, the entire shed is surrounded by boundary wall of 5 feet height on three sides and on one side of house; there is provision of 2-2.5 feet of manager space per cow. All along the manger, there should be wide water trough to provide clean drinking water. A common water tank can also be provided on one side of animal house. Concentrates are fed at the time of milking in hopper bin, where cows stand in stanchions under milking area. Paved area or open area is the place where animal gets fresh air and sunshine. There should be provision of balance for weighing animals and manure pit located away from the barn. In loose houses, it will be very useful to have shady tree both within the paddock area and around the building.

The loose housing of cattle has following advantages.

- The construction cost is less and thus economical.
- This system of housing is more flexible and so it can easily be extended to accommodate more number of animals without much difficulty.
- Animals move freely/comfortably and can eat or drink as and when they desire.
- Heat detection is easy and efficient.
- Feeding, watering and cleaning operation can be done conveniently with the minimum labour requirement.
- In planning and designing of suitable housing accommodation for dairy cattle, consideration should be given to the comfort and health of the animals along with economic use of labour for various dairy farm operations like feeding, cleaning milking and maintenance of farm sanitation etc. For the better welfare of the animals following points are to be considered in planning and construction of dairy cattle housing.
- Sufficient area should be available to all categories of animals. The floor should be sloped sufficiently for effective drainage.
- The partition of individual calf pen should be such that each calf has an opportunity to see other calf but cannot mix each other through partition.
- Adequate ventilation, effective temperature and humidity to be ensured in the animal shed.

- The space allowances for cattle housed in group should be calculated in relation to the total environment, the age of stock and the size of group. The group size should not exceed more than 50-60 and preferably be 35 to 40 per group.
- When the cattle are fed in group there should be sufficient feeding space to avoid undue competition for feed and fodders.

Disadvantages:

- Individual feeding attention is not possible.
- Health management is not adequate.
- Disturbances during heat period (oestrus) are encountered by fellow animals

Suitable modifications in loose housing system

The climate of India varies from region to region. So any single housing design for dairy cattle may not be suitable for entire country. Housing of the cattle to be planned and designed as per the agro-climatic conditions prevailing in a particular area. India can be classified in the following zones as per the agro-climatic conditions.

- Heavy rainfall area
- Plan area with medium rainfall
- Hot dry area
- Temperate high altitude area

The loose housing system which generally followed in our country provides covered standing space with continuous feeding Manger, open paddock area and common water trough is not wholly suitable for all agro-climatic zones in India. In heavy rainfall area, this system does not provide sufficient dry space for lying down the animals during continuous and heavy rains. The covered standing space which mostly remained wet is unsuitable for lying down. As a result animals get stress and thus production and reproduction performance decline. Similarly in hot dry areas also this housing system does not provide sufficient shade area to the animals for their protection against sunlight. These are the few lacunae in the loose housing system which can be modified to suit requirement for different areas of the country. The modification in the light of the above lacunae is suggested below for different agro-climatic zones of the country.

- **Heavy rainfall area**: The design of typical loose housing structure for the adult animals would be similar to general loose housing system except additional provision of covered resting area in one side of the paddock which will provide sufficient dry area for the animals during rainfall and strong wind. The floor of the resting area should be slightly elevated from open paddock and one side should be closed with brick wall which will work as wind breaker. During heavy and continuous rain for days together the animal can take rest under the covered rest area.
- **Hot dry area:** The suitable design of loose housing structure for hot dry area could consider that, covered resting area is located in the middle of the open paddock. This would provide indirect shaded area for animals during hot sunny day which saves the animals from direct solar radiation. All the sides of the resting area should be open for better ventilation.

- **Temperate high altitude area:** In temperate area, partially loose housing along with the closed conventional system of housing is desirable. In this system due attention is given to protect animal from heavy snow fall, rain and strong wind. Tail to tail system of conventional barn, completely roofed and enclosed with side wall is suggested with all provision of tying, feeding, watering and milking inside of the barn. Open paddock area with continuous manger in one side along with covered standing space is provided attached to the born. During good weather animals may be allowed to move the open area and feeding may be done outside.

B. Conventional housing system

Animals are confined together on a platform, secured at neck by stanchion. These are also called as stanchion barn. The cows are fed as well as milked in this barn. The barn is completely roofed and the wall also complete windows or ventilators located at suitable places. It is classified on the basis of barn system:

a. Single row cow byre system:

If the number of animals is less than 10, single row system is preferred. Manger is along the side wall parallel to the length of shed.

b. Double row cow byre system:

When numbers of animals are more than ten; they are tied in two rows in two ways.

Advantages:

1. Animals are less exposed to harsh climatic condition.
2. Animals can be kept clean
3. Maintain good health and hygiene

Disadvantages:

1. It is comparatively costly.
2. In warmer part of country it is not recommended because the air in the barn tends to humid and barn floor become damp during autumn and rainy season.

(1) Tail to tail system

The animals do not face each other. The manger & feeding passage is separated and the cleaning passage is common.

(2) Head to head system:

They face each other. Manger may be common or separate (with feeding passage)

C. Additional considerations for dairy cattle housing structure

Following guidelines are useful for designing effective housing structures

Orientation of shelter:

Shelter provided protection to the animals from various climatic extremes i.e., rainfall, hot and cold weather, wind, snow, frost etc. The orientation of shelter to be such, so that it can give maximum protection to the animals from direct sun light and allow proper ventilation as per wind direction of the location. In coastal area, the sheds shall be oriented

across the prevailing wind direction in order to protect the roof from being blown off by high wind at the same time to provide sufficient air movement in the shed. In humid region, building should be so sited as to avail the natural aeration and sunlight of the structure shall be east to west in coastal area and North to South in the dry hot area.

Slope/Gradient:

Proper and sufficient slope in the paddock is very important for maintaining clean and dry sheds. The slope in the open paddock should be at least 1 in 60 for effective drainage of rain water for preventing water logging. The slope of the standing space should be 1 to 40 for proper drainage of urine.

Drain:

The slope in the drain should be 1 in 40. There should be shallow drain in open paddock for complete channel out of rain water. The common drain of the dairy farm should be sufficient sloped and with optimum width for effective drainage of dairy washing etc. Open drain in dairy farm is preferable than closed underground drain which sometimes creates problems for proper drainage of dairy washing.

Ceiling height:

Sufficient ceiling height is pre-requisite to reduce radiation heat load. In warm and humid region the height of the shed should be about 4 to 5 meters. In hot dry climate the more ceiling height is recommended i.e., about 5 to 7 meters for elimination of radiation heat load.

Roof:

Roof should be light, strong, durable, weather-proof and bad conductor of heat. Materials used for constructing roof generally include galvanized sheet or fiber glass sheet or tiles or thatched etc., according to the availability in the local area. The pitch of the roof should be about 22 to 30 degrees. The pitch should be about 35^0, $25\text{-}30^0$, and $12\text{-}18^0$ in case of thatch, tiled and sheet roof respectively. Slope is generally kept steeper in heavy rainfall area. There should be provision of air circulation in the upper part of the roof. In any case the pitch of the roof should not exceed more than 35^0. Generally the eaves of the roof shall be projected out at least 50 cm away from the pillars and in the regions where extreme climatic conditions prevails the eaves may be projected out to 75 cm from the pillars in order to afford protection to the animals from rain, hot and cold wind. The height of the eves should be about 1.8 to 2.00 meters but in heavy rainfall area height shall be as lower as possible but not lower than 1.6 meters. A provision for fan with mist/fogger cooling system could be installed to protect the animals from severe heat stress during summer months. For protecting the animals from cold stress during winter providing wind breaks on the windward side which could be considered with provision for comfortable bedding material such as tree leaves/ rubber mats or surplus/ paddy straw etc. Tunnel cooling system is advised for closed housing system.

Floors:

Floor should be hard impervious easy to clean and non-slippery. It may be of (i) Cement concrete, (ii) Brick on edge, (iii) Stone slab flooring, (iv) Kanker flooring (v) Inter locking pavers. Cement concrete flooring is suitable for milking byre, calf pens, calving pens, etc where regular washing is essential. The floors under the roofed area of milking

cows and buffaloes shed, calf shed, heifers shed, dry cows & dry buffalo sheds should be made of RCC or paved with cement concrete flooring inter locking tiles. The surfaces of RCC floors should be made rough and non-slippery by making grooves with the impression of a piece of expanded metal or suitable wire mesh on the surface while the concrete is still moist. The grooves shall be formed in square of 15 X 15 cm for adult cows & buffaloes shed and in squares of 10 X 10 cm for the calf shed. The floors should have a gradient of 1 in 40 towards the drains. The U shaped drains of 30 cm width and 6 to 8 cm depth should be provided at the ends of covered area. The slope of the drains shall be 1 in 100 and it shall lead through two settling chambers to the septic tank constructed with a length, width and depth of 5, 5 and 10 feet respectively as shown in the building layout. About one half to one third of the open area towards the other end of the milking cows & buffaloes paddocks, calf's paddock, heifer's paddock and dry cows and dry buffaloes paddocks should preferably be katcha or sand bedded and the remaining one half to two thirds should be brick paved. The floors of the straw store, chaff cutter shed and implements room may be brick paved whereas the floors of the milk storage and feed grinding, mixing-cum-storage room should be made of RCC.

Pillars:

Pillars may be either of hard wooden post, cast iron pipes; Columns of bricks or reinforcement cement concrete (RCC). Each of them shall be placed at intervals of 2.50 to 2.75 meters.

Walls:

The covered areas and the open areas of the milking cows & buffaloes shed, calves shed, heifers shed and the dry cows & buffaloes shed should be enclosed by 5 feet high brick walls which are 22.5 cm thick. The height of walls along with which mangers have been constructed inside the sheds shall be 3 feet so as to allow for comfortable feeding from outside the sheds. The walls of milking cows and milking buffalo paddocks should have 10 feet wide centrally placed gates opening towards the road and the walls of calf shed, heifer sheds and dry cows & dry buffaloes sheds should have 6 feet wide centrally placed gates opening towards the road. The gates should be made of iron or strong wood. The height of straw store walls should be 20 feet. The covered part of the calf pen / shed should have walls on three sides up to the roof with door in the wall facing the open area. The fourth side (behind the manger) may be left open in summers and a tarpaulin curtain may be hanged from the roof in winters. During winter nights calves can be folded into this room and the doors closed. During daytime the calves can move through the opened doors into the open area to have the benefit of sunshine.

Fencing:

The fencing material should be cheap and locally available. The effective height of the fence for calf and adult may be 1 meter and 1.2 to 1.5 meters respectively. The fence may be made by brick wall or iron railing or iron wife. In railings/wire fencing 33.7 mm iron pipe or 5 mm iron wire may be provided horizontally and placed at 30, 60 and 100 cm for calves and 40, 80 and 120 cm height for adult cows from ground level with the support of posts made 6x4 cm angles iron pillar/5 cm (dia), ground iron pillar 10x10 cm timber pillar or brick pillar (40x30 cm) placed 2 meters apart. The provision of suitable size gates is also to be made in the fencing wall.

Gate

The gate is dairy farm varies in sizes. The width of the gate leading from sheds to sheds to be about 3.0 to 4.0 meters for easy movement of tractors for cleaning and delivery of fodder. The gate which leads from paddock to road is to be 3.0 to 4.0 meter. The main gate of the farm premises should be bigger in width i.e. 5.5 to 6 meters for easy entrance and exit of tractors, trolleys and other heavy vehicles.

To sum up, the capacity of an animal to produce differs between species, breeds and strains as a result of genetic factors. However, a complex of inter-related factors in the animal husbandry will influence the animal's ability to utilize that capacity for growth, development and production. Animal housing design is mainly concerned with the physical environment, in particular climatic and mechanical factors, but all other factors should also be considered in order to create a good layout, where healthy, high yielding animals can be provided with correct feeding, can be easily handled and can produce without stress or suffering physical harm.

Comparative study of loose and conventional housing system:

Parameter	Loose housing	Conventional housing
Enlargement or expansion	Easy and less expensive	**Difficult and more expensive**
Heat detection	Easier	**Less easy**
Labour saving	More	**Less**
Stabling costs	Less	**More**
Comfort to animal	More	**Less**
Health	More	**Good**
Benefit of sunlight	More	**Less**
Cleanliness	Less	**More**
Benefits of exercise due to movements	Yes	**No**
Efficiency and profitability	More	**Less**
Quality of milk	**Good**	**Better**

Comparative study of Tail to tail system and Face to face system:

Parameter	Double row system	
	Tail to tail system	**Face to face system**
Feed distribution	Difficult	**Easy**
Clearing gutter or middle alley	Easy	**Difficult**
Supervision at milking	Easy	**Difficult**

Possibility of stealing milk at milking time	Difficult	**Easy**
Detection of injury on hind quarter	Easy	**Difficult**
Look of animals at a glance	Easy	**Difficult**
Fresh air and direct sunlight		
Milkers at milking	Less	**More**
Animals	More	**Less**
Floor space for barn	More	**Less**
Cost of construction	More	**Less**
Gutter exposed in sun rays and kept quit	Less	**More**
Easier for cows to get in to stalls	No	**Yes**
Danger of spread of disease	Less	**More**
Back tracking of feed trolley	Needed	**Not required**
Safe for health of cow	**Yes**	**No**

Other Structures in a Dairy farm

Separate accommodation is provided for each class of animals in a organized dairy as per the requirement of the animals for safety and welfare of animals. Initially, the construction of the buildings should not be on a large scale and additional buildings can be added later on. However, a complete master plan may be drawn at the outset so that the location of the buildings is decided once and there is no haphazard growth of the farm buildings. The following buildings are essential in the beginning.

General barn for cows: All the cows are housed in this barn. A partition can be raised in this house for housing dry cows and teaser. The Manger in this pen should be 75 cm wide, 40 cm deep and height of the inside wall of the Manger should be 60 cm. Manger should have rounded corners. The outer wall of the Manger shall be not more than one meter high so that feed and fodder can be dumped into the Manger conveniently from outside and over this wall.

Suckling-calf Pens: This is to house young calves that are still suckling. A separate gate may be provided to this pen that opens into the general barn so that calves can be taken into milking barn quickly at milking time. The Manger in pen should be 40 cm wide, 15 cm deep and height of the inside wall of the Manger should be 20 cm.

Heifer pens: Calves from weaning age to breeding age can be housed in this pen. The Manger in this pen should be 50 cm wide, 20 cm deep and height of the inside wall of the Manger should be 25 cm.

Maternity pens: Pregnant cows are to be transferred into maternity pens two to three weeks before the expected date of calving. The size manger in these pens shall be the same as that in the general barn. The outermost maternity pen can be used as a bull pen. However in such a case an extra 100 square meter, enclosure is to be provided outside the bull pen, as the

open area of the pen is not sufficient for the bull to roam about the exercise. Alternatively in the case of limitation of space, bulls will have to be exercised by some other way.

Milking Barn: This is the place where the cows are milked in batches. There shall be 10 individual stanchions five in each row, tail to tail. The width of each stanchion is 1.2 meters and length 1.6 metres with a 1.3 metres wide central passage. The stanchion partitions can be made of steel tubing. Milking barn shall be cleaned thoroughly after each milking and kept closed until the time of next milking. Now a day's automatic milking barn are constructed for large size farm for more efficient milking og high producing animals.

Milk house: This is the place where the milk is collected, recorded and stored for short periods. The room shall have a door and glass window opening into the milking barn for better supervision of milking. The floors and the walls up to a height of 1.5 metres shall be of smooth surface, preferably lined with glazed tiles, so that occasional washing can be done. For hygienic storage of milk bulk milk coolers are installed according to milk holding capacity at 4 ^{0}C for 24 hr or more before sending to the market.

Ancillary Structures:

There shall be a grain store, straw and hay shed, chaff-cutter shed and a silo. These buildings will be situated towards the manger side of the buildings and at a distance of 5 metres from them with a feed passage in between. Feed trolleys and fodder carts can conveniently be taken over this passage along the manger and mangers filed-directly from these by using one or two labourers only. The grain store must be a complete room, the straw and hey shed shall have walls on the narrow ends only. The silo may be any type bit preferably a trench silo. It is advisable to plant trees all around the buildings in three rows to check sun and wind. The open spaces above the manger may be covered with tarpaulin or simple gunny sack curtain during extreme hot and cold seasons to protect animals against hot or cold winds.

Hay Store: If an adequate supply of green forage can be grown throughout the year, then only temporary forage storage and space for chopping is required. On the other hand if a prolonged dry season makes it necessary to conserve dry forage, a storage method that will prevent spoilage is essential. A raised slatted floor with a thatched or corrugated steel roof will provide good protection for hay. If the store is filled gradually, it may help to have some poles in the top of the shed on which to spread hay for final drying before it is packed into the store. Loose hay weighs about 60 to 70 kg/m^3. Although requirements will vary greatly a rough guide is 3 to 5 kg of hay or other forage per animal per day of storage.

Silo: Good quality silage is an excellent feed for cattle. However, it is not practical for the small holder with only a few cows because it is difficult to make small quantities of silage without excessive spoilage. Successful silage making starts with the right crop. The entire maize plant including the grain is ideal as it has enough starch and sugar to ferment well. In contrast many grasses and legumes do not ferment well unless a preservative such as molasses is added as the forage is put into the silo. It takes a good silo to make good silage. The walls must be smooth, air-tight and for a horizontal silo the walls should slope about 1:4 so that the silage packs tighter as it settles. The forage to be made into silage should be at about 30 to 50% moisture content and must be chopped finely and then packed tightly into the silo. The freshly placed material must be covered and sealed with a plastic sheet. Failure at any step along the way spells disaster.

Drinking water: Drinking water is to be made available in water trough provided for at a suitable place in each pen. The water trough is generally connected with the water supply and is normally the extension of the feeding manger from which it is separated by a mid partition.A very shallow 'U' shaped gutter about 15 cm in depth may be constructed throughout the length of the shed at about the junction of the covered and open area. The covered as well as the open area shall have a gradient of 1 in 80 to 100 towards the gutter for proper drainage. Outside the house the gutter for proper drainage should also be provided. Outside the house the gutter should be continued as a 'Pucca' channel up to the fields or up to the source of irrigation water. For continuous supply water storage tank should be constructed

Manure Handling:

Careful waste management is needed:

- to utilize the fertilizing qualities of the manure, urine and other wastes;
- to maintain good animal health through sanitary facilities;
- to avoid pollution of air and water and to provide good hygiene around the farmstead

The method of disposal depends on the type of wastes being handled. Solids can be stacked and spread on fields at the optimum time of year, while liquids must be taken to fields via channels or collected in tanks and spread from tank-wagons.

Manure from a livestock production unit may contain not only faeces and urine, but also straw or other litter materials, spillage from feeding, and water. If silage is produced on the farm, the runoff from the silos should be led to the urine collection tank. Depending on the wilt the amount of effluent can vary from zero to 0.1 m^3 or more per tonne of silage but normal storage allowance is 0.05 m^3 per tonne.

Manure is handled as solid when the dry matter content exceeds 25%. In this condition the manure can be stacked up to a height of 1.5 to 2 metres. This condition of the manure is only obtained when urine is drained away immediately and a prescribed amount of litter, like straw or sawdust, is used. The use of 1 to 2.5 kg of litter per cow per day will ensure that the manure can be handled as a solid. Manure with less than 20% solids has the consistency of thick slurry. It must be collected in a tank or pit but is too thick to handle effectively with pumps. It must be diluted with water to less than 15% solids before it can be pumped with a conventional centrifugal pump. If diluted in order to use irrigation equipment for spreading liquid manure, the solids must be below 4%. The amount of manure as well as the composition varies depending upon factors such as feeding, milk yield, animal weight, position in the lactation period, and health of the animal. Cattle fed on 'wet' silages or grass produces more urine.

Animal Dips: Ticks continue to be one of the most harmful livestock pests in hot environments As vectors of animal diseases ticks have been a great hindrance to livestock development especially in areas where breeds of cattle exotic to the environment have been introduced. At present the only effective method of control for most of these diseases is control of the vector ticks. Dipping or spraying with an ascaricide is the most efficient way of reducing the number of ticks.

Footbaths: Footbaths are provided to wash mud off the feet of the cattle to help keep the dip clean. At least two are recommended, each 4.5 metres long and 25 to 30cm deep, but in muddy areas it is desirable to have more. Up to 30 metres total length may sometimes be required. The floor of the baths should be studded with hard stones set into the concrete to provide grip, and to splay the hoofs apart to loosen any mud between them. The footbaths should be arranged in a cascade, so that clean water added continuously at the end near the dip, overflows from each bath into the one before it, with an overflow outlet to the side near the collecting pen. Floor level outlet pipes from each bath can be opened for cleaning. If water supply is extremely limited, footbath water can be collected in settling tanks and reused later.

Farm workshop facilities: A workshop provides a focal point at the farmstead for the repair and maintenance of machines, implements and structures. It also provides a place where tools can be stored in an orderly manner, a store for supplies and spare parts, and a shelter where work can be carried out during inclement weather. A facility of this type should be available on every farm. The size and design of a workshop, however, should be commensurate with the size of the farm and the work to be done in the shop. The workshop facilities should be cost effective. That is, enough savings should be realized from timely maintenance, repairs and construction projects to pay for the cost of the building and the necessary tools and equipment. Although it is difficult to put a monetary value on timeliness, there is no question that being able to make emergency repairs is important. Some farm operations (planting, spraying, milking) are more sensitive than others to prolonged interruptions, and having facilities to complete repairs on the farm can reduce delays to a minimum.

Standard Floor Space Requirement of Animals

Table 1: Floor space for cattle

Sl.No.	Type of animal	Floor space(m^2)		Max. No. of animals per pen	Height of shed for eves
		Covered area	Open area		
1	Bull	12	120	1	175cm(medium & heavy rainfall areas)
2	Buffalo	4	8	50	
3	Cow	3.5	7	50	
4	Down calves	12	12	1	220 cm (semi-arid & arid regions)
5	Young calves	1	2	30	
6	**Older calves**	**2**	**4**	**30**	

Table 2: Feeding and watering space for cattle

Sl. No.	Type of animal	Total manger length for 100 animals	Water trough length for 100 animals	Width of manger/water trough	Depth of manger/water trough	Height of inner wall of manger/ water trough
1	Cattle/Buffalo	6000-7000	600-750	60	40	**50**
2	**Calves**	**4000-5000**	**400-500**	**50**	**30**	**20**

Review questions:

1. What is loose housing system? Write the advantage and disadvantages of loose housing system.
2. What is conventional housing system? Write the advantage and disadvantages of conventional housing system.
3. Write in details about the conventional housing system.
4. Differential between tail to tail and face to face system of housing.
5. Draw schematic diagram of milking shed with tail to tail system of housing.
6. Draw schematic diagram of milking shed with face to face system of housing.

Chapter – 6

LAYOUT AND DESIGNING OF ANIMAL HOUSE /FARM

The primary objective of a dairy farm is to increase the overall productivity of the farm economically which is markedly influenced by layout along with design of animal house. Good housing provides comfortable environment to the animals, desirable working condition to the labour, integration of housing with feeding, watering, milking and cleaning and proper removal of manure. The animal house should be designing in such a way that it should provide good micro-climate close to the animal that directly affects the productivity and health of the animal. Animal housing design is primarily concerned with the physical environment, in particular climatic and mechanical factors; however, all other factors should also be considered in order to create a good layout, where high yielding animals can be provided with accurate feeding, easy handling and can produce without any stress or suffering.

Types and Systems of Housing

In India, depending on the climatic condition housing system for cattle is broadly classified into two type i.e. loose housing system and the conventional barn systems. Both system has some limitations, so depending on the regional climatic condition these two housing system can be modification little to provide comfortable environment.

Loose housing

In loose housing system the animals are kept loose in an open paddock or pasture land (grazing land) throughout day and night (except milking). The loose house has both covered area and open area and the floor space varies according to age of animal. The covered area is provided with common feed manger where fodder is given and standing platform that provide shelter during adverse climate; whereas, open area for exercise of animals. Inside the loose house water is provided in common waterer for all animals. The cows are milked at the milking parlour where they are tied and fed with concentrate. In loose housing system according to physiological stage and production grouped separately to make uniform group for better feeding management. The group size or stocking density and feeder space should be optimum otherwise it develops

competitive environment that affect the health and production negatively. In such housing system at most 30 calves/group, 50 adult female/group should be kept but both pregnant female in advanced stage of pregnancy (2-3 weeks before calving) and bull kept in individual pen. The feeder space should be 0.6-0.75 meters/adult animal and 0.4-0.5 meter/ calves, but water space is always provided for 10% of total animals as all animals don't drink together and recommended space is 6.0-7.5 meters per 100 adult cows and 4.0-5.0 meters for 100 calves.

Loose house is cheaper to construct compared to conventional house, whenever needed loose house can be expanded and modified. Direct sunlight easily reaches to the floor and acts as disinfectant and keeps the floor dry. Such houses are more congenial for efficient management, less fire hazards to animals and better for cleaner milk production as a special milking barn is attached. As open area provides more space so animals move freely and express their natural behaviour and suitable for the exercise that makes them healthy. In such housing system 10-15% more animal can be accommodated for short period without affecting their performance.

Loose housing system is followed all over the country such as Punjab, Haryana Rajasthan, Western U.P. and parts of Gujrat, Madhya Pradesh and Maharashtra except temperate Himalayan and heavy rainfall areas. Moreover, at other places this system can be used after little modifications so as to protect animals from excessive heat, cold and rains water.

Heavy rainfall area: The design of typical loose housing structure in heavy rainfall area is similar to the general loose housing system excluding additional provision of covered resting area in one side of the paddock. The additional covered area provides adequate dry area for the animals during rainfall and strong wind. To allow easy drainage of rain water the floor of the resting area should be slightly elevated from open paddock. Solid brick wall should be put to one side of resting area which acts as wind breaker.

Hot dry area: In hot dry area to provide shaded place during the whole hot sunny day the covered resting area is located at the middle of the open paddock. Thus the shaded area protects the animal from direct solar radiation. To provide better ventilation all the four sides of the resting area is kept open.

Temperate high altitude area: In temperate high altitude area primary objective of housing is to provide worm micro environment to animal and save them from the strong cold wind, snow fall and heavy rain fall. In this area loose housing system along with closed conventional housing system desirable. The conventional house is always tail to tail system with completely roofed

and solid side wall with provision of tying, feeding, watering and milking facilities inside the barn. There is provision of continuous manger towards one side along with covered standing along with standing platform in open paddock area to provide comfortable environment during hot weather. In open paddock the animals are allowed to move and also feed is provided in the manger during good weather.

Conventional barn

Conventional barn is also called as tie barn or stanchion barn where animals are secured by stanchion, neck chain or rope throughout the day and night. Such housing system provides little or no exercise to animals, hence the animal should be allowed ½-1 hour daily for exercise. In this system animals are fed as well as milked at the same place. The barns are completely covered with roof on the top and complete wall with windows located at proper places for ventilation along the four sides. Such system gives better protect to the animal from adverse climatic conditions like rain fall, sunlight, cold wind etc. In this system the animals are kept clean so better to control disease. Although this system of housing is advantageous in some aspect but humidity inside the house remain high and make the floor dump during rainy season. Hence, conventional housing system should be designed with open or semi-open side wall for maximum ventilation and air movement. Conventional housing system is recommended in the temperate Himalayan region and other cooler part of the country and the places where heavy rain fall occurs. Conventional housing system may be single row upto 10-12 adult cattle or buffaloes and beyond this better to follow double row system of housing with the cows facing outside, called tail to tail system. In loose housing system the milking parlour also tail to tail system is followed. In a tail to tail system dairy barn there is provision of feeding passage in front i.e. towards outside, followed by manger or feeder, standing platform or standing space, gutter or dung channel and milking passage at the rear end or central gateway between two rows.

Floor space requirement

The Indian Standard Institute (ISI) has recommended certain standard floor, feed manger and water space required for different cattle and buffaloes at different age and physiological conditions are presented in **Table 1**.

Table: Floor, Feeder and Waterer Space Requirements of Dairy Animals

Sr. No	Type of Animal	Floor Space) per animal (m^2)		Feeding (Manger) space per animal (cm)	Water trough space/ animal (cm)
		Covered area	Open Area		
1	Young calves (< 8 weeks)	1.0	2.0	40- 50	**10-15**
2	Older calves (> 8 weeks)	2.0	4.0	40-50	**10-15**
3	Heifers	2.0	4.0-5.0	45-60	**30-45**
4	Adult cows	3.5	7.0	60-75	**45-60**
5	Adult Buffaloes	4.0	8.0	60-75	**60-75**
6	Down calvers	12.0	20-25	60-75	**60-75**
7	Bulls	12.0	120.0	60-75	**60-75**
8	**Bullocks**	**3.5**	**7.0**	**60-75**	**60-75**

Site selection

The selection of site for construction of new farm building is the first most important consideration as location of farm and the climatic condition prevailing in that area which directly affect the animal comfort and consequently several structural detail of the building. The following points should be considered while selecting a site for construction of new building. The building should be constructed in such place that provides good drainage, plenty of fresh air, sunshine and shelter from strong wind. The place should be nearby market for lesser transportation cost and should be available with plenty of clean water and electricity supply. Although the building site is situated near by market but away from the human habitat. The topography of farm site should be high level but no abrupt slope, so require less site preparation easy to make drainage. The soil should be porous with gentle slope so that the wastes are removed easily and the farm place remains dry. There should be provision of maximum exposure to sunlight toward North side and minimum exposure toward South. There should also be

provision of telephone, veterinary and artificial insemination services, hospital for the staff and school facilities, the farmstead should be located near an all-weather road.

Arrangement and design of building

Orientation of shelter: After selection of site the farmstead/building should be arranged in such a way to save time and labour, protect from wind and fire. The office should be located in the central high place, so that other buildings will be easily accessible. The popular pattern of arrangement of different buildings in the site may be followed one of the given figures i.e. *E, U, L, C or F*. In coastal humid region, the long axis of building should be east to west to avail the natural aeration and sunlight, and in the dry hot area it should be north to south.

Slope/Gradient: Slope of the floor plays important role for drainage of water and liquid manure. Provision of proper and sufficient slope in the paddock is required to maintain clean and dry floor. The slope of the covered area in dairy farm should be 1:40 and in open area atleast 1:60 for better drainage. In conventional house the slope is similar to that of covered area in loose house i.e. 1:40 for better cleaning towards the drain.

Drain: The drain should be constructed in such a way that it must allow free flow of water and liquid waste while cleaning without any obstacle. The width of the drain inside the conventional area or loose housing system should be 1-2 feet depending on the farm size with slope 1:40 away from building. The drain should be shallow and U shaped for easy cleaning and complete channel out of rain water. The common drain of the dairy farm connected to different shed should be sufficient sloped with optimum width for effective drainage of dairy washing etc. In dairy farm open drain is generally preferred than closed underground drain which sometimes creates problems for proper drainage of dairy washing.

Ceiling height: Sufficient ceiling height is pre-requisite to reduce radiation heat load and to provide comfortable micro environment to the animal. The height of ceiling hot dry climate should be lower than at warm and humid region to reduce radiation heat load. In Indian condition ceiling height should be about 2 to 3 meters in warm and humid region whereas about 4 to 5 meters in hot dry climate.

Roof: The roof in animal house should be light, strong, durable, weather-proof and bad conductor of heat. The roof may be sloping or flat, the former one is preferred in dry and low rainfall areas whereas the later one preferred in medium to heavy rainfall areas. The roofing materials should be water proof and provide comfortable environment to the animal. The

common roofing materials used in India are galvanized iron sheet, aluminum sheet, corrugate asbestos sheet, tiles, wood, thatch etc. The iron sheet, aluminum sheet and asbestos are lighter in weight and require less support and are durable, fire proof etc. On the other hand tiles require strong support because of heaviness. Thatch and wood roofs are good insulator but are prone to fire hazard. Among all these materials thatch is economic but require regular repair or replacement due to less durability. The pitch angle of roof that reflect the slope and for thatch, tiled and sheet roof should be 35^0, 25-30^0, and 12-18^0, respectively. In high rainfall areas the slope is generally kept steeper and in no case it should exceed > 35^0. The eaves are commonly projected out at least 50cm away from the pillars and the place where extreme climatic conditions prevails it may be upto 75cm to protect the animals from rain, hot and cold wind. Generally the height at eves should be about 1.8-2.00 meters, and lower in heavy rainfall area but not below 1.6 meters.

Floors: Floor should be hard, impervious to water, easy to clean and non-slippery. The height of floor should be above the outside ground for better drainage and varies from 2.5-5 cm above the ground. It may be of (i) Cement concrete, (ii) Brick on edge, (iii) Stone slab flooring, (iv) Kanker or moorum flooring (v) Wooden floor. The cement concrete floor is suitable for the place where regular washing is essential like milking byre, calf pens, calving pens, stores etc. The concrete flooring should be roughened by imprinting the impressing of a suitable wire mesh to prevent slipping of animals. In loose housing system in general floor of open area is preferred brick-on-edge or stone slab and covered area concrete flooring. The Kanker or moorum floor is cheapest but requires regular maintenance. In temperate Himalayan region wooden floor is generally preferred as wood is a bad conductor and keep the floor warm during severe cold.

Foundation, wall and pillars: The foundation is the base of the wall and should be strong enough to provide support to the roof. The depth of the foundation depends on the condition of soil, made up of granite or cement concrete and 2-4 times wider than the actual wall. The wall of animal shed not only provide support to the roof but also acts as wind breaker and prevent entry of rain water from side. However, the wall may be full walls, half walls or no wall at all depending on the climatic condition and to support the roof only pillars are put. The materials for wall may be bricks, hollow blocks, stones or mud and their use depend on the availability and cost. The inner surface of wall should be smooth upto 15cm for easy cleaning and washing. Pillars are used to hold the roof when solid wall is not preferred for proper ventilation. Pillars

may be either hard wooden post or cast iron pipes, bricks or reinforcement cement concrete (RCC) and each of them put at an intervals of 2.5 to 2.75 meters.

Fences: Fences locate the dairy farm boundaries; protect the cultivated fodder crop and property from intruders and improves the attractiveness and value of the farm. It also prevents the animal to move outside and sometimes serves as shelter. The fencing material should be cheap, durable and locally available. The different types of fencing materials are barbed wire, iron or wooden rails, wooden poles etc. The line post of the fence should be 2-3 meters apart depending on the type of materials and soil. The post at the end corner of fences should be well fixed in concrete bed to increase durability of fence. The effective height of the fence for calf and adult should be 1 meter and 1.2 -1.5 meters, respectively.

Gate: In a dairy farm the size of the gate varies depending on their position. The width of the gate leading to individual sheds should be about 1.0-1.2 meters and the gate which leads from paddock to road is 2.5 meter. However, for easy entrance and exit of tractors, trolleys and other heavy vehicle the width of the main gate of farm premises should be larger and preferably 5.5-6 meters.

Types of animal houses and ancillary structures

For proper housing of different classes of dairy animals the following types of houses are followed.

Suckling-calf Pen: The suckling calf pen should close to the milking barn, so that calves can be taken quickly to the barn. If weaning is practiced on day zero or at birth then there is no need to keep calf pen very close to milking barn but should be nearby, so that milk from the parlour can be easily taken to feed the calves. The house should be provided with well drainage system and proper ventilation otherwise wet and dump floor causes respiratory problem in young calves. Calf shed should be provided with open paddock for proper exercise.

Older-calf pen: Calves from weaning age to breeding age or after milk feeding stage can be housed in this pen. Both male and female calf upto 1 year kept in same enclosure, but beyond this kept separately as male calves become dominated over female. The calf pens are provided with feed manger, water and sufficient space for exercise.

Maternity pens: Pregnant cows are to be transferred to the maternity pens or calving pens 2-3 weeks before the expected date of calving. In each pen only one pregnant animal kept to avoid injury due to fighting between them. Before shifting of cow the pen is cleaned and disinfected

properly and provided with bedding material like straw. The pen is provided with manger and waterer as well as well ventilated. The cows after calving during colostrum period i.e. upto 3-4 days remain in the maternity pen.

Milking Barn: The milking barn should be nearer to the office which is meant for collection, weighing and storage of milk. The milking barn is preferably tail to tail system of housing. The approximate width provided for each animal is 1.2 m and length 1.5 m. The central common milking passage will be 1.5 meter for comfortable working. The size of the milking barn should be such that it can accommodate ¼- ½ number of milking cows at a time. The doors and windows of the milking barn should be fly-proof and kept closed until next milking. The milking barn should be cleaned thoroughly after each milking otherwise it will act as source of microbes as milk provides all essential nutrient required by the microbes. The floors and the walls should have smooth surface upto a height of 1.5 m preferably lined with glazed tiles, so that occasional washing can be done.

Cows shed: Adult cows are housed in cow shed, where partition is put to keep dry and milch cows separately. The manger in this pen should be 75 cm wide, 40 cm deep and the height of the inside wall of the Manger should be 60 cm. However, outer wall of the manger should not be more than one meter high for easy dispense of feed and fodder into the manger from outside and over this wall.

Isolation box: Isolation box is a place where the sick animals suffering from infectious diseases are kept and should be away from the other herds and barns. The space provided in this shed should be around 15 square feet. The isolated box has separate drainage system for disposal of waste.

Bull shed: Bull shed is preferably kept one end of maternity pen, but the open paddock is provided with larger space i.e. 120 square meters and one bull kept per pen. The larger open paddock is sufficient for exercise and makes the animal fit and healthy and also provide adequate ventilation and comfortable environment to bull. Lack of exercise leads to over growth of hoof and causes lameness. The bull shed should be nearby other pens and he can see the other animals otherwise feel isolated. The bull shed is connected with a service crate via a swing gate which saves the labour to bring it into the crate. In a dairy farm for 50 breedable cows/buffaloes 1 bull is kept in individual pen.

Ancillary structure

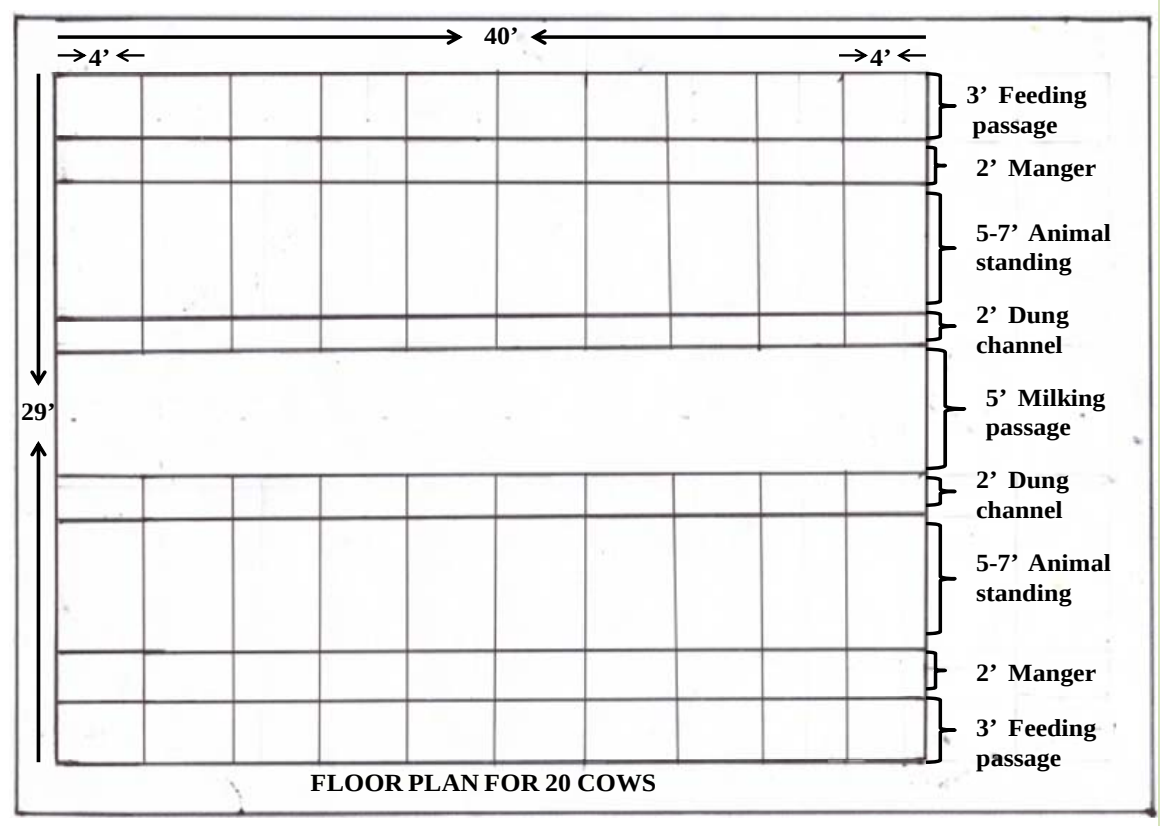
Stores: stores for concentrate, dry fodder, equipments, and utensils are essential for dairy farm. Provision of 0.2 m^3 storage space per animal is sufficient for cattle and buffaloes. There should be one main feed mixing room-cum store room and small stores adjacent to the large shed for keeping concentrate for one or two days. The storage room should be water and rodent proof.

Dry fodder shed: The common types of dry fodders used in animal feeding are hay or crop by-products. These fodders are only available at the harvesting season, so one has to store sufficient quantities of these items for use throughout the year. Space requirement for storage of dry fodder depends on the manner in which dry fodder are stored; when hay is stored in loose the floor space/quintal is 1.6 cubic meter, where as when baled and chopped the space is 0.7 and 0.6 meter, respectively. The adult animal consume approximately 6 kg dry fodder/day but young stock consume 1-3 kg/day depending on age and based on this annual requirement of fodder and the required space can be calculated. Generally for storing of straw or hay three sided solid wall shed is preferred or a simple framed shed with gabled roof is sometimes preferred. The dry fodder shed should be located far away from the animal shed due to fire hazards.

Silos: Silos are used for the preparation of silage, fermented preserved high moisture important feed for dairy animals. Silos may be tower, pit or trench type but in our country trench silo is commonly used. The size of the silo depends on the demand and the surplus availability of green fodder. Silo should be nearer to the cow shed to prevent transportation cost.

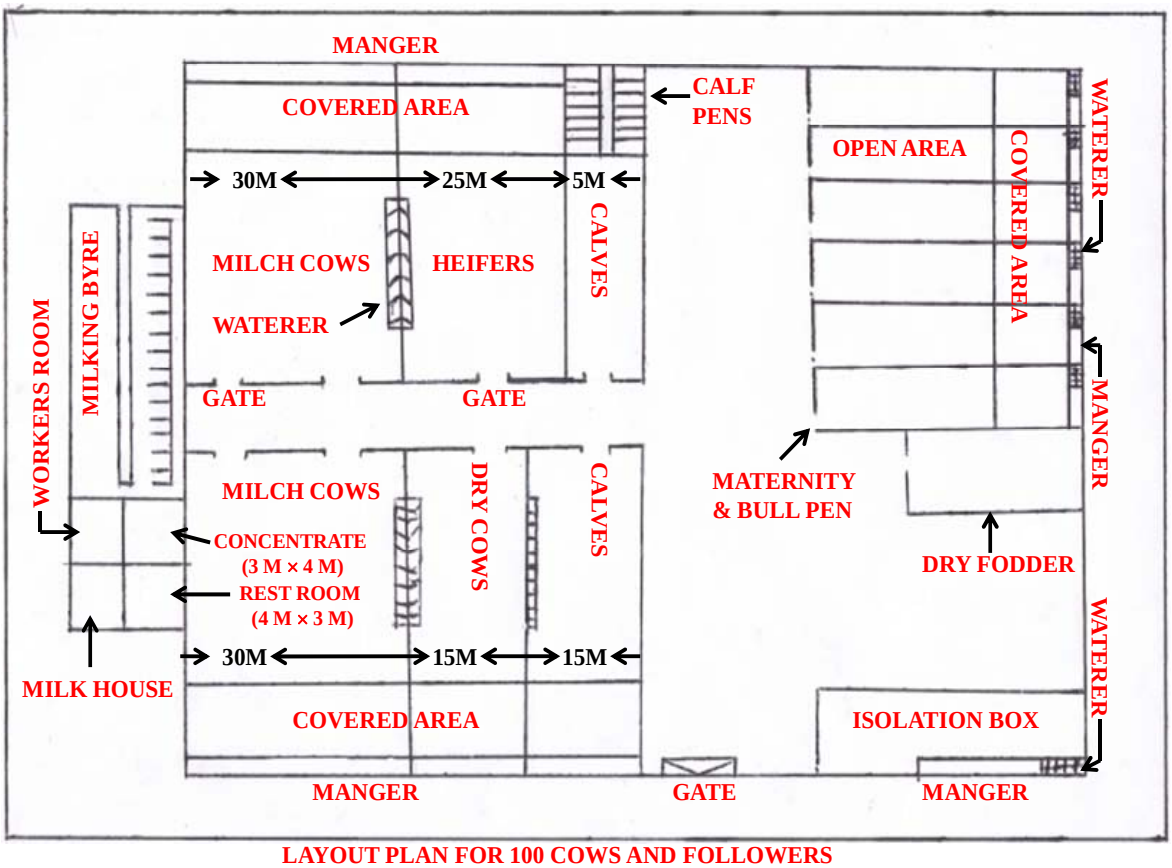
Handling yard: Handling yard is most important ancillary component in larger farms, used for collecting, filling and control of individual animal for operation such as weighing, marking, hoof trimming, vaccination, drenching of medicine etc. Depending on the number and type of the animals to be handled the size and design of the yard differ. Handling yard comprises of the facilities like collecting yard, chute, trevis, weighing platform and holding yard. To provide comfortable to both workers and animal the collecting yard and holding place should have shady trees. The chute should be curve instead of straight and interposed with the trevis and weigh-bridge. The animals are provided with feeding and watering facilities at the holding yard and animals in the holding yard should easily visualize their partners in collecting yard to encourage them to move through the chute, trevis, weigh-bridge and holding yard.

Lay out for 20 cows in tail to tail system:



FLOOR PLAN FOR 20 COWS

Lay out for 100 cows



LAYOUT PLAN FOR 100 COWS AND FOLLOWERS

Review questions:

[1] What are the beneficial effects of loose housing system of management?

[2] What are the common ancillary structures found in dairy farm?

[3] What is isolation box?

[4] What is milking barn? What is its importance in a dairy farm?

[5] What are the different types of floor in a dairy farm?

[6] What is pitch angle?

Chapter – 7

Protection of dairy animals from extreme climatic condition

Introduction:

Animal environment is affected by climatic factors that include temperature, humidity, precipitation, radiation and wind movement. Extreme climatic conditions (hot or cold) can alter heat energy transfer between the animal and its environment and have deleterious effect on production and reproduction in dairy animals. One of the major contributors of milk in India is buffalo and crossbred cattle, but they are highly susceptible to hot, humid and cold climate. To unwind the effect of climatic stress, the mechanism of thermoregulation takes place within the animal body which might result in reduced milk production, milk fat content, impaired reproductive performance and making the animal more susceptible to various health problems.

Thermoneutral zone is the range of environmental temperatures from lower critical temperature (LCT) to upper critical temperature (UCT) where normal body temperature is maintained and heat production is at the basal level. In the thermoneutral zone, the animal spends the least amount of energy for thermoregulation. This zone is, by definition, the region where the animal has available the largest amount of energy for growth and production. The lower critical temperature is the easier to define, as it is the ambient temperature below which the animal must increase its metabolic heat production to maintain a relatively constant core body temperature.

Thermoneutral zone depends on the age, breed, feed intake, diet composition, previous state of temperature acclimatization, production, housing and stall conditions, tissue insulation (fat, skin) and external (coat) insulation and the behaviour of the animal. Dairy cattle experience heat stress or cold stress when environmental temperature is not within the thermoneutral zone and thereby there is a decrease in milk production under such stress conditions. Moreover, high temperature and humidity alter the balance of endocrine profiles in dairy cattle, leading to lower intensity of estrous behavior, anestrus, embryonic death, and subsequent infertility. The bovine thermal comfort zone is -13ºC to 25ºC. Within this temperature range, the animal comfort is optimal, with a body temperature between 38.4ºC and 39.1ºC.

Further, in next section addresses the heat and cold stress that affect productive and reproductive performance and to suggest best strategy for the dairy farmers to employ

management tools to ameliorate the animals from the stress. Most of these stress factors can be managed with modern technologies to achieve maximum production.

Heat stress

Heat stress occurs in animals when there is imbalance between heat production (thermogenesis) within the body (gain) and heat dissipation (thermolysis) from the body i.e. impaired thermoregulation. Increased ambient temperature may lead to enhanced heat gain as compared to heat loss from the body and cause heat stress in animals.

Heat stress is an inevitable part of life during the summer for dairy farmers in India. When feed is converted by the animal's metabolism for the production of milk, eggs, meat, off-spring etc., heat is produced as a by-product. An increased production level and thus feed requirement will therefore result in increased internal heat production. High yielding animals are consequently more likely to suffer from heat stress in a hot climate than are low yielders. Hence utmost considerations must be taken to protect the high yielders from heat stress.

Zebu breeds are more resistant to the effects of heat stress. A hump, large ears and loose, thin skin including a prominent dewlap characterize the Zebu. These characteristics promote heat loss by convection and evaporation and thus efficient body temperature regulation under hot climatic conditions. In addition, the Zebu has less subcutaneous fat, a lower body volume for the surface area, and short smooth hair, all of which contribute to the animal's comfort under hot conditions. The European breeds on the other hand have thick skin held tightly to the body, long hair and a large amount of fat which serve as insulators, traits desirable for cold or temperate climates. Although there is a considerable range in size within each breed, the Zebu is a relatively small animal, a fully-grown bull rarely exceeds 700 kg, and while European cattle are large, reaching 1,000 kg live weight. Calves seem most sensitive to cold draughts and poor ventilation, but are quite tolerant of a wide range of temperatures.

Factors affecting severity of heat stress:

The severity of heat stress experienced by an animal depends on a number of factors. The key ones include:

- Animal factor
    - Size of the animal
    - Level of milk production and dry matter intake prior to the heat stress (higher producing animals will experience greater effects of heat stress)

    - Breed
    - Coat color and texture (lighter color coats absorb less sunlight and glossy coat radiates more heat)
    - Hair coat depth
- Environmental factors
    - Ambient temperature and humidity
    - Length of the heat stress period
    - Degree of night cooling that occurs
- Managemental factors
    - Ventilation and air flow
    - Housing – type, ventilation, overcrowding, roof type, orientation etc.
    - Water availability

Signs of heat stress

During heat stress the animals usually show the following signs.

- Restlessness
- Lethargy
- Reduced appetite (decreased dry matter intake) to minimize metabolic heat production
- Increased thirst and more crowding around the water tanks
- Decreased activity
- Crowding under shade
- Usually more animals remain standing rather than lying down
- Increased respiration rate (gasping): More than 70-80 breaths/ min.
    - 80 to 120 breaths per minute in moderate heat stress
    - 120 to 160 breaths per minute in strong heat stress
    - Over 160 breaths per minute in severe heat stress
- Increased sweating and panting to lose more heat (help thermolysis)
- Increased salivation
- Rise of rectal temperature
- Reduction in heart rate
- Maintenance requirement may increase by 20-30% in animals under heat stress.

- Blood flow to the skin is increased while blood flow to the internal organs and digestive tract is decreased
- Reduction in weight gain

Effect of heat stress

Effects of heat stress in dairy animals are direct or indirect which include:

- Feed intake decrease- During high environmental body temperature, the animals try to maintain body temperature by minimizing metabolic heat (heat produced during feed digestion and nutrient metabolism) by reducing their feed intake. But, this will lead to low energy intake by animals. At the temperatures of 25-26 ºC feed intake in dairy animal begins to decline and drops more rapidly above 30 ºC. At 40 ºC, dietary intake may decline by as much as 40%. Heat stress in high producing lactating dairy cows results in considerable reduction in appetite, roughage intake and rumination. This may be due to elevated body temperature and gut fill as these animals have a lower rate of feed passage and reduced gut motility. Heat stress affects rumen fermentation adversely and the total volatile fatty acid (VFA) production is decreased even when the feed intake is same. During heat stress, DMI (dry matter intake) or nutrient intake declines whereas nutrient requirement for maintenance and active cooling processes like panting increases. Therefore, offering more forage to animals will cause more heat production in animal's body, adding on to the heat stress problem. On the other side blood flow to internal organs like the mammary gland is reduced delivering fewer nutrients to these organs for metabolism. Thus, fewer nutrients are available for milk production during heat stress. In case of dry cows, off-feed or decrease in DMI during the heat stress can lead to more health problems at parturition and potentially reduce milk production during the subsequent lactation.

  Besides these the following impacts of heat stress on feed intake or digestion have been observed

  - Increased feed refusals
  - Increased feed sorting
  - Reduced natural buffering capacity due to reduced saliva production and increased carbon dioxide expiration
  - Increased loss of minerals due to sweating, panting, and urination

- Increased metabolic disorders (acidosis)
- Metabolism is reduced due to reduction in thyroid hormone secretion, plasma growth hormone concentration and secretion rate, ruminal pH and gut motility in heat stressed cattle. Major changes in dietary electrolyte balance (Na^+, K^+, Cl^- and the buffer HCO_3^-) and acid/base balance associated with heat stress takes place.
- Disruption of intestinal tight junction barrier
- Increase of intestinal permeability to luminal endotoxins and lead to bacterial translocation
- Increased susceptibility to GI infection

- Water intake increase- The total body water is estimated to range between 75 and 81% of the body weight for lactating dairy cows. Milk contains 87% water and large concentrations of the electrolytes Na, K, and Cl. Water and macro-mineral need increases heavily under heat conditions to maintain homeostasis and homeothermy. Under thermal stress cows tend to have increased water content in the rumen as a result of an accelerated water turnover rate. Moreover, there is need to compensate additional evaporative water loss. Heat stress increases water consumption by at least five times than normal level in temperate weather and three times more in tropical weather. Animal may lose almost its entire fat and 50% of its body protein and survive; loss of ~10% of its body water can be fatal.
- Effect on the Milk yield: During hot and humid weather conditions, there is reduction in intake of the nutrients in dairy cow which are otherwise necessary for production of milk as well as for body maintenance. It has been established that reduction in milk yield during heat stress is mainly, due to less feed intake on one hand and increased maintenance requirement, which reduce feed efficiency on the other hand. Milk yield usually reduce 10-15% or more during this period. The lactating cows are affected more with heat load due to increased metabolically derived heat associated with milk production, increased rate of respiration and rectal temperature leads to hyperthermia and milk production is reduced proportionately. This may also be explained by the negative effect of heat stress on the secretory function of the udder. There is reduction in daily output, lactation peaks, milk fat production, casein composition, milk component levels and increase in SCC levels. Similarly, higher environmental temperature during last three months of gestation alters blood flow and prolonged hyperthermia interferes with normal

placental growth and endocrine function, which results in lower calf birth weight and hormonal alterations affect mammary development and lactogenesis. Reduced hormonal activity particularly T4 during pregnancy affects metabolic state of the dam at parturition and thus reduce mammary development prior to the initiation of lactation which ultimately leads to poor milk production.

Milk let down: Cortisol decreases milk protein synthesis and inhibits the release of oxytocin. Stressed cows have poor milk let down and more residual milk which predisposes them to mastitis. About 10-12% of milk remains as residual milk in udder of slightly stressed cows and in highly stressed cows it may go up to 15-17%. Residual milk is high in fat content hence when the fat rich milk is held back in the udder the fat percentage will be lower in the milk output.

- Effect on reproductive efficiency: Adverse effects of heat stress on reproduction include reduction in estrous activity, estrous duration, heat detection, follicular development, oocyte quality, semen quality, conception rate, pregnancy rate, uterine function, multiple ovulations and twinning, suppressed intensity of oestrus, a reduction in the strength of the preovulatory LH surge, a decreased secretion of progesterone, altered follicular development, decreased embryo development as well as fetal growth and reduced fertility. It is clear that heat stress has many effects on the reproductive axis, some are direct effects on the hypothalamus, the anterior pituitary gland, the uterus, the follicle and its oocyte and the embryo itself; other effects are indirect, probably mediated by change in the metabolic axis in response to reduced dry-matter intake.During this period, lower pregnancy rates occur either due to higher rate of fertilization failure or early embryonic death or low sperm output and poor semen quality due to inability of bull to maintain optimal scrotal and testicular temperature. Conception rate declined from 61 to 45% when rectal temperature 12 h post breeding increased 1°C.

  In buffaloes, summer anestrus is a major problem whose causes have been attributed to poor heat dissipation mechanism because of poor sweating rate, lower sweat gland density and volume, larger mass per volume ratio and rough and sparse hair coat and also black coat.

  Besides these some other impacts of heat stress on reproduction has been observed

  - Decreased uterine blood flow
  - Increased embryonic death

- Reduced placental mass
- Reduced fetal tissue growth
- Reduced mammary tissue growth
- Early calvings
- Light, weak or dead calves
- Lower colostrum immunoglobulin (IgG)
- Lower colostrum protein, fat, and lactose
- Lower calf blood protein levels
- More “quiet heats”
- Unsynchronized ovulations
- Fertility failure
- Decreased growth, size and development of ovarian follicles
- Abortion and retained placenta cases are more for cows calving during the summer.
- Cows calving during hot months show longer calving to conception intervals, more services per conception
- Heat stress during the dry period may alter the development of the placenta.

- Oxidative stress-

  Heat stress generally increases the production of free radicals, leading to oxidative stress. In dairy cows, oxidative stress has a negative impact on immune and reproductive functions: increased mastitis frequency and higher somatic cells counts in milk, decreased fertility, increased embryo mortality, post-partum retained placenta, and early calving, with consequences on the calves live weight, mortality and health.

- Effect on Health of Dairy cows: During hot and humid weather conditions, the animals become more vulnerable to diseases. There is an increase in the somatic cell counts (SCC) and a higher incidence of mastitis and increase in number of flies during summer aggravates the situation.

  Impacts of heat stress cow health

  - Suppressed immune function
  - Increased mastitis incidence: In dairy heifers, flies play instrumental role in the establishment of coagulase – negative staphylococcal teat canal colonization

which leads to intramammary infections (IMI) and persists throughout the lactation period.

- Increased retained placenta
- Higher ketone levels at calving
- Higher NEFA levels at calving
- Higher risk of acidosis: This is mainly due to decreased DM intake with lower proportion of forage and higher levels of fermentable carbohydrates, decrease in rumination, saliva in gut and buffering power due to increased CO2 expelled. Additionally, the decreased rumen pH impairs fibers digestion efficiency as rumen fibrolytic bacteria is affected due to drop in rumen pH (below 6.0). Acidosis is found to affect the animals overall health status, fertility and longevity.

- **Indirect effects:**
  - Poor feed and fodder quality with increased fiber content and low nutritive value

Ameliorative measures of heat stress reduction

As discussed, heat stress is a burden for the cow's performance and health that costs the dairy industry millions every year. Implementation of herd management techniques as early as possible is beneficial at production level. In order to prevent the effects of heat stress, economically feasible heat stress relief techniques can be used which include the use of fans, shades, foggers, misters, desert coolers, air conditioners, water bathing and adequate air circulation. Modifications in feeding strategies by either dietary fiber adjustment or the use of high-quality forage, supplemental protected fat and feeding at cool hours can greatly help in reducing the negative effect of heat stress on productive and reproductive performance.

Physical protection and shelter management

- Wind breaks: These are the barrier lowering the wind speed, deviating and splitting the air stream. Trees are an excellent natural source of shade on the pasture and cool the surrounding air which acts as windbreaks.
- Solar radiation is a major factor in heat stress can be blocked by use of properly constructed shade structures alone increases milk production remarkably. Permanent shade structures and portable shade structures can be constructed as per the convenience. Shade permits reduction of more than 30% of all the heat radiated on cattle and is the single most important contribution for lowering heat stress.

Besides these some of the protective measures are

- Proper grouping of animals
- Avoid overcrowding
- Good loafing area under which animals get rest at night and can retire when it is hot and humid.
- West side of shed to be protected with side covers / gunny bags / curtains
- Roof painting with radiating paints, white outside, black inside
- Attic / False ceiling construction
- Do not keep the animals in the holding area for long time. The holding area is a very crowded and poorly cooled area in many farms.
- The air flow over the cow housing area should be 4-5 mph.

Air temperature reduction measures

Air temperature of micro-environment can be lowered by air conditioning or refrigeration but the expenses of such types of air cooling make these impractical. The evaporative cooling pad (corrugated cardboard or similar material) and a fan system which uses the energy of air to evaporate water is a more economically feasible method to cool the micro-environment. Several cooling measures may be utilized to get rid of heat stress are mentioned below:

- **Mister and Fogger:** Fine mist (larger droplets than fog) injection apparatus or misters and foggers: They cool at high rate. This system is effective in arid climates. Mist can be easily blown away under windy conditions or when used with fans. If a mist or fog builds up on the cow's hair, it can trap a layer of air between skin and water holding in body heat. Mist and fogging nozzles are operated at high pressures and require regular maintenance. They often do not operate optimally in areas with hard water.
- **Sprinkler:** Cooling in hot and humid climates emphasizes shade, wetting the skin and forced drying of the cow's coat to maximize the cooling effect. Hence, sprinklers are a good option. The water is allowed to evaporate, pulling heat from the animal, just like sweating. Air movement across the wet hide, provided by fans, makes this system most efficient. Proper control is critical to ensure that the cow gets soaked to the hide along the topline while not getting wet to the point of having water running off the sides.
- **Wallowing:** Wallowing in buffaloes and pigs also give a good option when proper facilities are available. But this may cause an increased risk of disease incidence.

- Milking parlours with adequate holding pens can employ the use of subsequent sprinkling and forced air in the pens.
- **Zone cooling:** Cooled air or water can be blown over the head and neck region which causes a very faster cooling experience by the animals as the bloode flow to hypothalamus is cooled.
- In dairies with adequate drainage and housing, evaporative cooling can be provided above the feed bunks in addition to or instead of in the holding pen.
- Upper body sprinkling followed by forced-air ventilation reduces body temperature, increase feed intake and milk yield.
- Sprayers in parlour exit lanes.

Wallowing in buffalo:

Skin colour of buffalo and presence of few and less capacious sweat glands are the major reasons which make it difficult for them to maintain their body temperature in hot and humid environments. Wallowing is important to maintain the body temperature as well as protection from the insects. Wallowing is preferable during hottest hours of the day. They usually defecate or urinate when enter into the water for wallowing. Wallowing is learnt behaviour starts from its birth. They will seek shade and graze during cooling hours of the day if wallowing facility is not available. Artificially wallowing tank can be constructed for wallowing purpose.

Nutritional dietary manipulation

Evaporative heat loss through sweating, frequent urination and panting is the primary mechanism for heat loss at high environmental temperatures. Besides this following manipulations in feed and feeding system can help to reduce the heat stress

- Increasing the amount of feed available during the cooler period of the day, early morning or late evening. Feeding 60 to 70 percent of the ration between 8 pm and 8 am has successfully increased milk production during hot weather.
- Feeding bypass protein (fish meal) and bypass fats.
- Reduce the amount of fiber in the diet to minimize the metabolic heat production
- Soaking of concentrate in equal amount water for 20-30 minutes helps in better utilization of nutrients and reduces dustiness in concentrates.

- **Energy densification:** Increase the amount of energy by adding an energy-rich feedstuff such as maize, or other cereal and also fat to compensate the energy deficit due to lower dry matter intake.
- Minimize drastic change in ration.
- During heat stress rumen degradable protein should not exceed 61 percent of CP.
- Management of the dietary electrolyte balance is based on adding essential body salts and electrolytes to the drinking water and feed.
- Adding water to diets may help DMI during summer months. Water will soften fiber feeds and reduce dustiness and dryness of the diet increasing palatability and DMI. A three to five percent addition of water is recommended
- To reduce rumen acidosis high energy, more palatable diets, with high quality, highly palatable forages should be provided. On the other hand feeding of live yeast *Saccharomyces cerevisiae* CNCM I- 1077, improves rumen pH as a result reduce acidosis risk, improve fiber digestion and nitrogen utilization, increased feed efficacy, help in rumen microflora stabilization and helps in milk production.
- A well balanced (Total mixed ration) TMR will allow diets to be formulated at minimum fiber levels encouraging DMI and minimizing rumen fermentation fluctuations and pH declines.
- Use of anti-oxidants such as selenium enriched yeast (Alkosel® R397) help reducing the impact of heat stress on the oxidative balance, resulting in improved milk quality, immune and reproductive functions, prevention of retained placenta and reduced somatic cells
- Vitamin A, Vitamin E, niacin and selenium should be supplemented in diet during this period. Sometimes zinc and biotin may also play important role.
- Provision of fresh and cooled water all the time is most important. Water tanks should be located close to the feeding area to encourage both DMI and frequent drinking.
- Cows should be provided fresh, clean water free choice all times.
- An increase in the levels of deficient nutrients sodium (0.4 to 0.5%, Sodium bicarb or Sodium sesquicarbonate), potassium (1.5%, potassium carbonate, potassium sulfate/ magnesium sulfate and potassium chloride) and magnesium (0.3 to 0.35%, magnesium oxide, magnesium sulfate) and decrease in chloride (go down to 0.25-0.30 % in heat) may be helpful.

Breeding

- Overcoming unobserved or silent estrus by proper detection methods and regular visual observation
- Cooling hour insemination
- Artificial Reproductive Technologies like Estrus Synchronization and Hormone therapy
- Identification of Genes affecting hair coat characteristics and heat stress immunity and employing the methods for better selection for heat stress resistant cattle

Other managemental strategies:

- Avoid transporting livestock in hot weather
- Reduce biting fly populations (with improved sanitation, repellents and traps) which tend to cause cattle to bunch together
- Reduce parlor walking distance.
- Reduce time in holding area.
- Improve ventilation.
- In areas of extreme heat, it is even more important for cows to give birth in good body condition because after parturition their dry matter intake will be lowered by heat stress, as well as the usual low intake immediately after calving.
- Fly control.
- Under these conditions dairy farmers must go for artificial insemination rather than using natural service of heat stressed bulls.
- Teat dipping with germicidal dips is recommended.
- Handling cattle can elevate their body temperature by as much as 3.5 ^{0}F. Therefore avoid handling during intense heat.

Protection against heat: Animal can defend itself against heat by behavioural means, reducing body insulation, increasing evaporation, lowering heat production and increasing the reflectance of the hair coat to solar radiation.

- Decrease in Insulation: A reduction in body insulation is mainly achieved by an increase in the blood flow of the skin i.e., cutaneous vasodilatation and by reduction of vasomotor

tone. Vasodilatation is highest in body parts with high surface/volume ratio such as ears, legs and tongue.

Peripheral vasodilatation has compensatory splanchnic vasoconstriction. But the compensatory mechanism is not complete. Hence, there is slight hypotension, and reduced cardiac output. But the normalcy is maintained by an increase in blood volume.

- Some reduction in insulation of body is also achieved by seasonally induced hair shedding. Moreover, summer coat reflect more solar radiation due to smoothness and glossiness.
- Short, glossy and light colour hair coats are good reflectant, hence this type of breeds are more suitable for hot climate.

❖ Increase in cutaneous evaporation: In a thermoneutral environment, a certain amount of water is continuously evaporated from the skin. This "Insensible" water loss from skin is due to diffusion and its rate is determined by the Vapour Pressure gradient (ΔVP) between saturation at skin temperature and vapour pressure of air. But the cooling achieved in this way is negligible.

Sweating: The no. of sweat glands correspomds to the no. of hair follicles and is fixed at birth. So with the increase in age and size of the animal, the sweat gland density is decreased, but the sweating rate (sweat production per unit area of skin) does not change as there is corresponding increase in the sweating volume and discharge rate of individual glands. The intensity of sweating varies with body area, maximum on the neck and forequarters of the trunk and minimum on the underside of the trunk. In Zebu, sweating is highest in the hump area. Zebu cattle have higher sweating rate in severe heat compared to taurine cattle, but in mild heat it is lower in zebu. This is due to the fact that zebu cattle can alter their metabolic rate to a lower plane more efficiently than taurine cattle, so there is less need of high sweating rate to main the body temperature.

Cutaneous evaporation in warm environment is affected by air humidity; increase in humidity reduces water vapour gradient between the skin and air, there by depresses evaporation. A lower rate of evaporation augments the heat stress on the animals which in turn evokes a compensatory increase in sweating rate.

❖ Increased respiratory evaporation: Respiratory evaporation depends on the volume of air moved per unit of time over the moist surfaces of the respiratory passages (Respiratory Minute Volume or Ventilation). Ventilation is the resultant of frequency and depth of

breathing. In defense against heat, an increase in ventilation is effected by an increase in frequency and decrease in depth i.e. Fast and shallow breathing or panting. Under severe stress, this fast and shallow breathing goes over into slow and deep breathing. This results in elimination of more quantity of CO_2 leading to **respiratory alkalosis**. This labored breathing accelerates heart rate raising the concentration of lactic acid and by generating more heat, reduces the efficiciency of respiratory evaporative heat loss.

- Relation between Sweating and Panting: Sweating controls the amount of water loss, whereas panting the amount of air movement. Sweating and panting are complementary i.e. animals who are good sweaters (high sweating efficiency) are having less efficient panting mechanism and vice-versa.

Poor sweaters have warm skin, tends to have a higher respiratory activity, whereas profuse sweating animals have cooler skin, hence lower respiratory activity. This means that panting acts as a second line of defense, supplementing inadequate sweating.

- Decrease in Heat production: This is due to decreased feed intake and reduced thyroid activity. In severe heat stress, the basal metabolism increases (Van't Hoff's Law: 2-3 times increase in heat production with a 10 ^{0}C rise in tissue temperature, the temperature coefficient Q_{10} of mammalian tissue is of the order 2-3) and hence the heat production which consequently causes hyperthermia.
- Integration:

  Mild heat ►Peripheral vasodilatation ►Heat loss by radiation, convection ►Microclimate becomes warmer ►Sweating & Panting

  If this fails, the heat production will be reduced by decline in feed intake and metabolic rate.

  ` The physiological phenomena are simultaneously associated with some behavioural modification like scattering, wallowing, licking etc.

Cold stress

Production performance of the animal will also be affected when it is too cool because increased proportion of energy will be used for maintenance of body temperature and

productivity depends on the ability of the animal to keep normal and stable body temperature. But the impact of cold stress on nutrient utilization and animal performance in cattle has received less research attention. Dairy cattle are housed in the cowsheds that minimize the impact of environmental temperature fluctuations on the animals. But the animals housed under loose housing system needs attention to protect them from cold stress. The animals can be protected by providing comfortable micro environment. In different areas and during different parts of the year temperature varies from 0 to 40^{O}C and comfortable temperature varies from 18 to 27^{O}C, therefore protection is required from extremes on both sides.

The effects of cold stress on metabolic and physiological adaptations

- Increased dry matter intake to raise the heat production
- Increased rumination
- Increased gastrointestinal tract motility
- Increased rate of passage of feed and liquid in the rumen and digestive tract
- Increased basal metabolic rate and maintenance energy requirements.
- Loss of body weight.
- Use of body tissue to maintain energy levels causes the immune system to be depressed and less responsive to challenges.
- Increased body oxygen consumption
- Increased cardiac output
- Increased adrenalin, cortisol and growth hormone levels
- Increased lipolysis, glyconeogenesis, glycogenolysis
- Increased hepatic glycose output
- Decreased rumen volume
- Decreased dry matter digestibility
- Decreased insulin response to a glucose infusion
- Decreased temperature of skin, ears, legs
- For the dairy cows cold should be considered as a local problem. Direct chilling of the udder depends as much on the thermal properties of the floor as on the temperature.

Protective measures to prevent the effect of cold stress:

- Increase barn temperature- Supply of heating in the winter keep the calf healthy, less chances of calf pneumonia, diarrhea and mortality.
- Reduce humidity to ensure better ventilation, preventing excessive moisture in sheds, roof dripping and ground freezing phenomenon.
- Ventilation should be carried in afternoon.
- Less water should be used in winter barn to wash the ground and dry cleaning should be followed.
- In the afternoon sunlight cattle should be kept out of the barn.
- Bedding should be provided to protect them from cold floor.
- Waterers or water tanks should not be frozen.
- Lukewarm water should be provided for drinking purpose
- Cold weather increases feed needs of cows. Hay provides more heat during digestion than concentrate feeds.
- Eave inlets should not be closed. This will restrict the ventilation rate and create wet, damp conditions.
- Prevention of cold draught. Cows need dry, draught-free resting area.
- Having dry teats when the cow leaves the parlor is important. One way to lessen the risk is to dip the teats, allow the dip of about 30 seconds and then blot dry using a paper towel.
- Protect the animal from frostbite.

Effect of cold stress on calves:

Calves born in winter and early spring as well as wet and cold calves are more prone to cold stress or hypothermia. Precipitation adds to the negative effect on calf survival when temperature drops, so it is important to combat cold stress (hypothermia) in newborn calves.

Signs of cold stress:

- Rectal temperature is the most accurate method of determining if a calf is experiencing hypothermia.
- Mild hypothermia- Body temperature drops below $100^{O}F$.
- Severe hypothermia- Body temperature drops below $94^{O}F$. Vital organs are cold and impaired brain function results.

- Calf shivers to increase heat production and shunt blood from body extremities to the body core.
- Signs of life are hard to detect if temperature falls below $86^{O}F$.

Protective measures:

Protective measures include warm water bath, warm air or heat lamps and warm blankets.

- Blankets are most useful for calves less than 3 weeks of age that are not yet eating grain. Warm blankets should not be so hot that they cause skin burns or sweating during the day.
- Prevention of the radiant heat loss.
- Thick, dry straw or sawdust at resting area should be provided for better insulation.
- Wind drafts must be avoided because they encourage heat loss.
- Young dairy calves have very little stored fat they can use for warmth. To cope with cold stress by feed with extra energy should be provided.
- Additional amount of feed (starter, milk replacer, or milk) that a calf would need to eat to compensate for extra energy used to keep warm during cold weather.
- Calves less than 3 weeks of age increases the amount of milk or milk replacer to provided extra energy.
- Repeated changes in the calf's diet should not be done.
- Calves that are eating starter, especially those over 3 weeks of age have a lower LCT and can more easily cover their increased energy needs by voluntarily eating more grain is beneficial in terms of generating heat.
- In cold weather, provision of warm water three times per day for a minimum of 30 minutes each time in order to ensure calves have ample opportunity to drink.
- Closing air inlets restricts the ventilating rate and causes moisture to accumulate in the shed. As moisture accumulates, it will begin to condense on cold surfaces, and if the surfaces are below freezing, frost will form.

- In severe cold weather and during blizzard conditions, air inlets can be partially closed to reduce airflow blowing into the barn. The minimum inlet opening during severe cold weather is one-half inch for each 10 feet of building width. (There should be an inlet on each long side of the building.) When normal winter weather conditions return, eave inlets should be reopened to the standard one inch per 10 feet of building width on both

sides of the building. Of course, eave inlet adjustments are much easier if the inlets have been designed to be adjusted. Boards on hinges are the most common type of adjustable eave inlet.

Defense against cold:

- Insulation
  - Tissue Insulation:
    - This represents the thermal resistance to the flow of heat from body core to the skin surface. Decreasing the temperature of the superficial tissues of the body by vasoconstriction reduces the temperature gradient from the skin surface to the environment, therefore the heat loss.
    - Subcutaneous fat has also some insulating properties.
  - Hair coat Insulation: This represents the thermal resistance to the flow of heat from the skin to the surface of the hair coat. It depends almost entirely on the entrapped air, which occupies 95% of the volume of the hair coat. The insulation of the hair coat increases with increasing thickness of the coat, increasing hair density. In the individual animal hair coat, insulation can increase rapidly in piloerction.
  - Air insulation: Air insulation represents the thermal resistance to the flow of heat from the surface of hair (in non-hairy species from the surface of skin) to the environment. It caused by a thin film (layer) of still air (boundary layer) adhering to the body surface.
- Increase in heat production: To meet the thermostatic requirement, the body produces extra heat. The environmental temperature below which heat production begins to increase in defense against cold is termed as the Lower Critical temperature. The rise in heat production below the Lower Critical temperature occurs approximately linearly with fall in temperature until a point is arrived called as Summit Metabolism where no further rise in heat production is possible. Extra heat can be produced by increased muscular activity, increased feed intake, and increased heat increment, shivering thermogenesis.
- Nonshivering thermogenesis (NST): This is mainly effected by Brown fat in the neck and between the shoulders to generate body heat in animals or newborns that do not shiver. Brown fat contains numerous smaller droplets and much higher number of (Iron containing) mitochondria, so brown in colour. They contain more capillaries than white

fat, as there is greater need for oxygen than most tissues. Hormones (Conversion of T_4 to T_3 inside brown fat cells; T_3 increases cellular metabolic rate cause mitochondria to increase their metabolic activity and produce heat instead of ATP. Body heat is maintained by signaling the mitochondria to allow protons to run back along the gradient without producing ATP by an uncoupling protein 1 (**thermogenin**).

- Integration: The animal adapts itself to behavioural and physiological means. In behavioural adaptation, the animal reduces cold stress by seeking or creating a less cold microenvironment. In physiological adaptation, the animal reduces heat loss mainly by increasing its thermal insulation and by increasing heat production. Insulation and metabolic rate are complementary to each other. Most new born animals have a poor insulation and a high metabolic rate, while the reverse is true in adult animals. Metabolic adaptation is gradually abandoned in favour of insulative adaptation.

Acclimatization:

It is defined as an adaptive process resulting in a diminution of the physiological strain produced by the application of prolonged climatic stress. This refers to numerous physiological and morphological changes which enable the organism to live in an extreme thermal environment with less thermal discomfort.

Acclimatization to cold: Chronic exposure to cold produces

- Increase in voluntary food intake
- Rise in resting metabolic rate
- Augmented metabolic capacity
- Increase in hair coat thickness
- With advancing time of cold exposure, shivering thermogenesis is replaced by non-shivering thermogenesis with an alteration in hormone activity (thyroid and adrenal activity).

Acclimatization to heat: Prolonged exposure to heat causes

- Decrease in voluntary food intake
- Reduced in resting metabolic rate
- Augmented metabolic capacity
- Increase in hair coat thickness

Review questions:

1. Define the following:
    a. Thermoneutral zone
    b. Heat Stress
    c. Cold stress
    d. Upper critical temperature
    e. Lower critical temperature
2. What are adverse effects of the heat stress in dairy animals? Write the management practices to reduce heat stress.
3. What is acclimatization? What precautions should be taken to acclimatize against heat and cold?
4. What are the protective measures should be taken to cope up with cold in case of calf?

Chapter – 8.

CLEANING AND SANITATION OF DAIRY FARM AND EQUIPMENTS

Cleaning, disinfection and sanitation

Cleaning is a process to keep animal shed and equipments free of dirt, dung, marks, milk solids etc. by washing, wiping or brushing. On the other hand disinfection dairy farm and equipments implies the elimination of all micro-organisms (>99.99%) that are capable of multiplication and causing diseases. Prior to disinfection total cleaning is essential to remove the organic matter and bio-film that have a great power to reduce the effectiveness of disinfectants. Disinfectants are chemical agents that can kill pathogens on contact for a particular period of time from inanimate objects. The disinfectants do not work properly if the surface to be disinfected is not clean before applying the disinfectant. So cleaning prior to disinfection exposes the pathogens to directly contact with disinfectant. The cleaning and disinfection are two entirely separate procedures. The dairy farm and equipments must be cleaned first and after proper cleaning it can be disinfected. Sanitization is the process of reducing microbial numbers to a safe level but may not eliminate and mostly followed in milking equipments as it is difficult to kill all microbes. Cleaning of equipments done before sanitization for better result like disinfection.

Advantages of cleaning and sanitation

i. Proper cleaning and sanitation reduces chance of spread of diseases.
ii. Helps in providing the most favourable conditions of life in respect of water, air, well sanitized sheds etc.
iii. It increases the efficiency of animals.
iv. Prevents economic losses in farm as disease reduces productivity of animal and growth.
v. It makes life vigorous and productive by improving development and growth of animals.
vi. It markedly reduces the mortality in animals and rate of mortality and increases their life span.
vii. Prevents diseases occurrence and thus establishes conditions that ensure preservation of health.

viii. Minimizes contamination of milk and improve production of good quality milk and milk products.

Cleaning of dairy farm: Dry and wet cleaning methods are mostly preferred for proper cleaning of dairy building.

Dry cleaning: First dry cleaning (brushing, scraping, etc.) should be performed inside and outside the buildings. Inside the building dust and other dirt on floor as well as on ceilings, light fixtures, walls, air inlets etc. should be brushed, swept, vacuumed, scraped and wiped. Commercial vacuum cleaners, air blowers, wire brushes and low-speed mechanical scrapers may be useful. Manual scraping, hand sweeping and shoveling will be necessary around the perimeter, doorways, walkways, support poles and corners of most houses to ensure satisfactory cleaning. All operations should begin with the uppermost surfaces and proceed downwards to minimize possible contamination of previously cleaned areas.

Wet cleaning: After proper dry cleaning, wet cleaning is followed involve soaking, washing and rinsing. Detergents and other surfactants of alkaline pH (8.5-10) are often added to washing solutions to loosen debris and films, and improve the penetration of cleaning agents. A high-pressure washer is used preferably with warm water of 60°C. All the wet cleaning is performed systematically, from the back to the front of the building, and from the top to downwards, moving carefully from one short side of the house towards the other. If much water or dirt is collected on the floor, then cleaning should be stopped and water or dirt removed to avoid recontamination.

Disinfection

After proper cleaning of all rooms the disinfection should be commenced within 24 h. No single disinfectant is best for all purposes, hence to choose the right disinfectant; one must consider the characteristics of the wide variety of products available.

Selection of disinfectant

The lethal action of disinfectants for various pathogens like viruses, bacteria, fungi, protozoa, spore etc. mostly depends on the chemical composition of the disinfectant and the make-up of the organism. Disinfectants used in dairy farm should have the following characteristics-

- Higher germicidal property
- Less costly and readily available

- Active in presence of organic matter
- Non-toxic to animals and man
- Non-corroding and non-toxic
- Effective on fabric, crevices and metals
- No pungent odour
- Soluble in water

Disinfectant does not works instantaneously and it requires a certain contact period for effective action. Temperature and concentration of disinfectant influence the rate of killing of microorganisms. Always use recommended concentration of disinfectants. The activity of disinfectants is improved markedly if the temperature is increased. Organic matter interferes with the action of disinfectants by coating the pathogen and preventing contact with the disinfectant, forming chemical bonds with the disinfectant, thereby making it inactive against organisms or reacting chemically with and neutralizing the disinfectant.

Types of disinfectant and method of use

Chemical disinfectants can be divided into the following classes based on their chemical compositions which are described below.

Cresols and cresylic acid- Cresols and cresylic acid are liquid yellow or brown, coal tar derivatives. These are slightly soluble in water, hence generally emulsified with soap. They are effective against gram positive, gram negative, fungi but not effective against virus and spores. These are effective in acidic pH and commonly used to disinfect the floor, walls but not used in milking parlour due to bad odour. The cresolic compounds are used at 2-3% solutions for effective action.

Phenols- Like cresols phenols are coal tar derivatives which have pine-tar odour and become milky in water. Phenols are effective several types of bacteria and fungi but not against bacterial spore and virus. They also retain more activity in the presence of organic material than iodine or chlorine-containing disinfectants. It is toxic, corrosive and irritant so carefully used. It is used at 1-2% solution in animal buildings but not the milking parlour.

Washing soda: Washing soda or sodium carbonate is effective against virus like FMD. It has also good detergent property. Washing soda is commonly used for disinfection of farm building during FMD outbreak at 4% solution. It is also used for general cleaning of the floor, clothes etc.

Caustic soda or lye: Lye is sodium hydroxide, which is commonly used for cleaning of farm premises. It is a very effective disinfectant as it is an excelling agent and has powerful germicidal property. It is also highly destructive against FMD virus but not effective against T.B. organism. It is also effective against anthrax spore and used at 5% solution. For general cleaning the caustic soda is used at 2% solution.

Quaternary ammonium- Quaternary ammonium compounds (QAC) are colorless, odourless, non-irritating and deodorizing cationic detergent. Though the QAC has good disinfectant and detergent action, but inactivated in presence of organic matter. The efficacy of some QAC is also reduced by soaps or soap residues, so carefully select the product. Quaternary ammonium compounds are effective against bacteria and fungi but not on spores and viruses. It is mostly used for disinfection of dairy utensils, milker hands and towel for wiping udder. It is used at the rate of 0.1% solution or 0.5% cream to control udder infection (mastitis).

Hypochlorites- Chlorine compounds like Sodium hypochlorite are good disinfectants on clean surfaces, but are quickly inactivated by dirt. Chlorine is effective against bacteria and many viruses. These compounds are also much more active in warm water than in cold water and available chlorine in water should be 300ppm. Chlorine solutions can be somewhat irritating to skin and corrosive to metal. These compounds are kept in air tight closed container as deteriorate rapidly.

Lime (Calcium oxide)- Lime is produced by burning limestone. Lime may be Quicklime, hydrated lime and milk of lime. Lime is commonly used to disinfect animal houses, white washing, used for sprinkling on manure and animal discharge. Lime is used at 10-15% solution for effective disinfection.

Natural disinfecting agents: Sunlight acts as best natural disinfectant that reduces the pathogen load in the environment. The ultraviolet rays of sunlight have potent killing ability on microorganisms. Though the sunlight has potency to destroy microbes but only effective to outside of building or the open paddock in loose house but can't enter inside into the building through roof. However, during cleaning when the dirt is exposed to sunlight that kills the organisms.

Bleaching powder: • Bleaching powder is use in animal houses during outbreak of contagious diseases and for sterilization of water suppliers. Don't use in milking parlour because its strong

odour may taint milk. It is rapidly inactivated by organic materials. Recommended concentration of bleaching powder for effective use should not have less than 30% available chlorine.

Cleaning and sanitizing milking equipment

All equipments that come in contact with milk may have two kinds of deposits. One is organic deposit and another one is mineral deposit, the former one is produced by fat, protein and sugar present in milk and the later one formed by the inorganic salt present in milk or water. So all milking equipment and other facilities come in contact with the milk or any other contaminants like dirt and manure should be cleaned thoroughly before next milking. The purpose of cleaning of milking utensil is to remove milk soils, organic and mineral solids form equipment surfaces after the milk is removed and the purpose of sanitizing is to kill residual microorganisms present on these surfaces immediately prior to milking. Inadequate or improper cleaning or sanitizing or both allows bacteria to remain on equipment surfaces that subsequently grow and multiply. This results in increased bacteria counts in raw milk and reduces shelf life of milk.

Types of Soils: Organic soils consist of the major organic constituents present in milk like fats, proteins, and sugars. Soon after milking these soils should be removed from surfaces otherwise their adhesion to surfaces increases with time, dryness of the soils, and heating. Once the organic solid becomes dry and harden, it is difficult to remove. Mineral soils or inorganic salts of various minerals like calcium, magnesium, or iron present in milk or water, are generally precipitated by heat or alkaline conditions. Further, if cleaning agents are not compatible with water hardness conditions or are not used at recommended concentrations or temperatures then also enhance precipitation.

Cleaning agents and sanitizer for milking equipments

Cleaning agent for milk solids are selected on the basis of the water hardness and when the hardness ≥10 grains per gallon, it may be necessary to increase detergent concentration and use water softener. Usually an alkaline or chlorinated cleaner (alkaline cleaner with added chlorine) followed by an acid cleaner is used to remove the milk solids. Alkaline cleaners and chlorinated alkaline cleaner removes organic deposits whereas acid cleaner removes inorganic deposits. Alkaline cleaners dissolve milk fats, proteins and carbohydrates, and thus loosen and suspend other soil particles so that they can be removed by mechanical action like brushing or by circulation cleaning. Acid cleaners remove or prevent accumulated mineral deposits. The

common sanitizer used for milking utensils are chlorine, iodine and quaternary ammonium compound are commonly used to sanitize the equipments. A sanitizing solution is used just before milking to kill bacteria as cleaning does not properly remove microbes.

Cleaning and sanitization procedures

Cleaning and sanitization of milking equipments are done by the following procedures:

- Pre-rinsing of equipments, pipelines and bulk milk tank done with lukewarm water at 100-120 ^{0}F (38-49 ^{0}C) just after milking to prevent drying of milk solids. Too hot water causes Denaturation of proteins and form protein film on surface and too cold water cause fat crystallization and the formation of a greasy film on surfaces so these are avoided.
- Then washing and rinsing with alkaline detergent is followed. The temperature of the washing or cleaning solution should be 120-130 ^{0}F (49-54 ^{0}C). For pipeline washing the solution should be circulated for 6-10 minutes where as for other instruments soak them for 5 minutes. For washing of metal parts hard brush should be used.
- Remove the washing solution using clean tap water before adding acid rinse.
- Put the equipment in acid rinse or rinse the pipeline and bulk tank with lukewarm acidified water with temperature 100-120 ^{0}F (38-49 ^{0}C) and pH 3.0- 4.0 for 2-3 minutes. This should be done after every milking as it prevents mineral deposits and the lower pH is bacteriostatic.
- All equipments and utensils should be stored in a manner that permits water to drain and equipment to air dry. In pipelines the drain should be located at the lowest point in the system for proper drainage.
- Then just before next milking sanitize the milking equipments with sanitizer, drain well but do not wash.

Review questions:

[1] What is cleaning?

[2] What are disinfectants?

[3] What are the common advantages of cleaning and sanitation?

[4] What are the common characteristics of a good disinfectant?

[5] What are the common types of soil found in milking equipments?

[6] Write the procedure of cleaning and sanitization of milking equipments?

Chapter - 9

COMMON INSTRUMENTS / EQUIPMENTS USED IN THE DAIRY FARM

The following instruments are very essential for routine and day to day activity of the farm for welfare of the dairy animals.

1. Anti cow kicker
2. Body brush
3. Branding iron
4. Burdizzo castrator
5. Casting rope
6. Chaff cutter
7. Dehorner
8. Drenchers
9. Elastrator
10. Hair clipper
11. Hoof Knife/Hoof trimmer
12. Marking Harness
13. Milk analyzer
14. Milk can
15. Milking machine
16. Mouth gag
17. Muzzle
18. Nose ring/Nose lead
19. Probang
20. Tag applicator and Tags
21. Tattoing items
22. Trevis
23. Trocar and cannula
24. Weighing balance

Anti cow kicker: Cows commonly kick forward and out to the side. Anti cow catcher may be in the form of iron chain or durable simple rope. Anti cow kicking device is used during milking in the barn or cleaning or examining of the udder on cows that are chronic kickers. The device is put just above the hock joint, a joint between tarsal bones and tibia or the achilles tendon region. This restricts the lifting of the legs and prevents kicking. Sometimes the tail is also tide with the kicking device to prevent eye injuries when milking or examining the animal.

Brush: Brushes are generally used for grooming of body coat. Body brush is made up off stiff bristles and dandy brush made up stiff wire fibers. Brushes are used to remove the dirts and loose hairs from the body and to increase blood flow. Now brushes are fixed at the animal shed and when animal come in touch with it start rotating automatically.

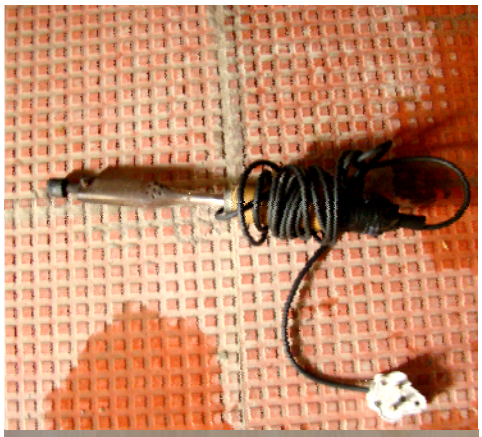
Branding iron: The branding instruments are made up of iron metal for easy transfer of heat both in hot and freeze branding. The branding iron consists of a particular number and after heating of freezing applied to the proper site. In hot branding it is applied for 3-5 seconds and in clod/freeze branding for 20-30secods.

Burdizzo castrator: Burdizzo castrator is used to castrate the male calves not required for breeding purposes. This device consists of a large clamp designed to break the blood vessels leading to testicles and reduces blood supply. Once the blood supply to the testicles is stopped, necrosis of testicular tissue occurs, and finally become rudimentary small size. When the operator castrate the animal he should crush the spermatic cords one at a time, leaving a space in between in order to maintain uninterrupted blood-flow to the scrotum.

Casting rope: Casting ropes are used to restrain the animal for health check up or any surgical procedure or for marking etc. Cotton rope is generally preferred as it is easy to make knots. Always keep more than two ropes while restraining an animal, one must be eight to ten meters long with 2.5-3 cm diameter for casting or securing the animal, the other smaller rope of 1-1.5cm diameter and 2 meter long to secure horn and legs.

Chaff cutter: Chaff cutter is used daily for cutting the fodder into smaller pieces. The fodders with thick stem are not generally preferred by the animals so chopping improves the acceptability of fodder. Chaff cutter may be hand operated manual chaff cutter or operated by electricity. The cutting capacity of hand operated chaff cutter is less compared to electrically operated, so in large farm later one is preferred more.

Dehorner: Dehorners are used to remove the horn bud in young cattle. The dehorner may be electrical or scoop or barne dehorner. Baren type dehorner used to cut the horn bud manually where as in electrical dehorner the base of the bud is destroyed with high temperature. Electrical dehorner is better than baren type dehorner as former one produces less pain.



Drenchers: Drenchers are used to give nutrition or medication directly down the throat and into the stomach of the animal. When the animals deny taking the medicine, then drenching is preferred to avoid the waste of medicines. The medicine is put inside the drench gun and then put inside the mouth slowly to prevent accidental entry of medicines to the trachea.

Elastrator: Elastrators are the instruments used to place the rubber band over the tail for docking purpose or base of scrotum for castration. The rubber band stops the blood flow to the distal part and causing it to die and fall off.

Hair clippers: Hair clippers are generally used to remove the excessive growth of hair from show cattle or from preputial orifice of bull. Clipper may also be used to prepare a place on animal's body for any surgical intervention or branding or tattoing. The hair clippers include comb to separate hair and limit dirt entrance, and cutter for clean, even and smooth cut.

Hoof Knife/Hoof trimmer: Hoof knife or trimmer are used to remove stones and other items from the hoof, sometimes used to remove the damaged or infected hoof material. These are also used to shape and trim excessive growth of hoof. Hoof trimmers work like scissor to cut the excess hoof simply place the cutting edge in desired location on the hoof and squeeze handles together

Marking Harness: Used to “mark” females, when mounted by male Harness is strapped on male, it locates the “marking” block on his chest floor When he mounts a female, the “marking” block leaves a “mark” on her back.

Milk analyzer: Electronic milk analyzers are commonly used in dairy farm to evaluate the composition of milk. Milk analyzer may only measure fat or if latest modified version are used then detail composition like percentage of fat, solids-non fat (SNF), density, added water, powder milk, non-fat and long storage milk can be measured.

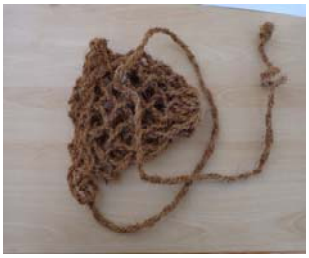
Milk can/milking pail: Milking pails are specially designed bucket with narrow mouth to prevent entry of contaminants while hand milking. Pail may be stainless, aluminum or plastic. Milking cans are also used for machine milking and prevent entry of contaminants. The capacity of pail and can varies depending on the milk yield of animal or the farm productivity.

Milking machine: Milking machines are used in large farm to save time and labour. The portable type of milking machine available in the market may be single clusters with single can or double cluster with double can. All the milking machine comprises following components like vacuum pump create vacuum or negative pressure, pulsator maintain alternate negative and positive pressure, teat cup together with claw called cluster. The teat cup is attached to teat and then milk flow to the claw and finally to milk can.

Mouth gag: Mouth gags are used for keeping the two jaws apart from each other for examination of mouth, teeth or for passing the probing into oesophagus or drenching medicines. Several types of gags are used in cattle and are

mostly made of metal. The bars of gag fit into the inter-dental space and prevent closing of mouth and bars should be covered with rubber or leather to prevent damage to gums. The gags are slightly curved longitudinally and while putting mouth gag the tongue should remain free.

Muzzle: Muzzles are used to envelope the mouth of animals to prevent from biting, self suckling, bedding eating and to prevent calves from suckling their mother. Muzzles are made up of simple rope, bamboo splits, wire netting or leather traps.



Nose ring/Nose lead/nose tong: The nose rings primarily used to control bull and sometimes called as "Bull nose ring". Bull nose ring has two semicircular pieces hinged together and made up of top grade aluminium, stainless steel or copper. Nose ring is fixed to the sensitive nasal septum to control the bull and other cattle. Nose led is used to hold the nasal septum which is more sensitive to control vicious cattle and bulls. The nose led is inserted into each nostril and lead rope is attached to chain and gives pressure. The more the rope pull, the more the pressure that is exerted on the nose.

Probang: Probang is a surgical tool about 30-40 cm long consisting of a flexible rod with a sponge in the end and generally used to remove foreign bodies or obstructions from the esophagus. The probang is also used to take rumen fluid to test the pH and microbial population. Probang is inserted into mouth and slowly through esophagus and if any obstacle is there then pushed into stomach.

Ear Tag applicator: Ear tag applicator are used to put the numbered tag or medication tag into ear. Several types and styles of ear taggers are available in the market but all have the basic design. The ear tag applicator has 2 components one for the male part or stud of tag inserted completely onto the applicator pin and remaining one for female part or button portion. Before tagging the animal, alignment of the tagger should be check by closing the jaw of the applicator to the point where the two halves meet; the stud should be centered with the hole.

Tattoing forceps or pliers: Forceps or pliers when squeezed together pierce the skin in the form of letters or numbers. Before applying check the proper number whether loaded or not and to confirm cardboard may be used. The tattoing letter should be sharp so that it will pierce the skin deeply enough to allow for the absorption of the tattoo ink.

Trevis: Trevis or crush is mainly used for controlling large animals for the purpose of treatment, and operations such as dehorning, docking etc. The trevis are also used for controlling animal during artificial insemination. Trevis is generally made of strong durable iron bars and fixed with the ground with cement concrete otherwise vicious animal can destroy easily. It consists of four posts put into the ground and cemented with two or more crosspieces at each side and end to prevent protect the person from kicking. The cross pieces at the front and rear end are removable.

Trocar and cannula: Trocar has a sharply pointed end and often three-sided, whereas cannula is a hollow cylindrical structure. These are commonly used to evacuate gas from the rumen in tympanitis and bloat condition. Trocar and cannula are fixed together and then inserted into abdomen by stabbing and after that trocar is removed leaving the cannula for aspiration of gas or rumen content.

Weighing balance: Weighing balances are used to measure the body weight of animal routinely as well as the milk yield. Weighing balance for body weight has standing platform and the weight is displaced electronic display

board. Milk can be weighed in portable platform type weighing balance or hanging type balance.

Review questions:

[1] Why marking harness used in dairy farm?

[2] How burdizzo castrator used for castration of bull?

[3] Why drenchers are used in dairy farm?

[4] Why anti cow kicker is used in cows and which place body it is put?

[5] What is the importance of milk analyzer?

[6] Why nose ring is used in bull?

Chapter – 10

FARM WASTE COLLECTION, UTILIZATION AND DISPOSAL

Farm waste includes animal excreta, milking parlour waste, bedding, feed residues and also animal mortalities that has been of no use and are required to be eliminated from the house. Dairy farm waste also used interchangeably as “dairy cattle manure” which is a complex material containing feces, urine, bedding, rain or other water, and milk house or washing wastes. Simply farm waste is called waste from animal habitat whereas sewage is the waste from all habitations. Sewage consists of mixture of solids and liquids waste like human and animal excreta, kitchen waste, road washings and industrial wastes etc. Generally in dairy farm the disposal of dead animals or carcasses is done separately to reduce chance of contamination and spread of disease, so this chapter will discuss the collection, utilization and disposal of farm waste except dead animals.

Intensification of dairy farming with more confined housing system, farm waste production becomes more significant as a factor which must be considered by the farm manager in planning and operation. If an adequate handling system is not followed then greater farm waste production in a more confined area is a potential source of pollution to nearby waterways, soil and as a whole the environment. Pollution can occur through runoff or rainwater from dairy farm or from runoff or rainwater from heavily manured fields as well as by effluent from milking parlors and wash rooms. The farm waste if not disposed properly then act as potential breeding place of flies and mosquitoes. Wastes from a dairy farm acts as a potential pollutants if not disposed of or utilized in a proper manner. So farm waste should be disposed properly without affecting its primary nutrients (N, P, and K) as well as other essential plant nutrients.

Types of dairy farm waste: Dairy farm or livestock farm has two types of waste.

Solid: Dung, spilled feed and left over fodder etc.

Liquid: Urine, wash water etc

Farm waste or manure collection

The manure can be collected in two alternative ways, a) collecting solid and liquid manure separately or b) flushing out solid and liquid manure together.

In first method the dung and other solid waste are lifted into wheelbarrows using shovels and then carried out of the shed. If the farm is larger size then scrapper can be used and waste is lifted into the tractor trolley and finally taken to the disposed place and properly disposed to reduce the environmental pollution. The liquid manure, washings from milk parlour and runoff water run out of the shed by a shallow 'U' shaped gutter or drain located longitudinally to the long axis of shed. Then liquid manure from different shed connected to main farm drain which may be closed or sub-terrain drain. Finally the drain conveys the liquid manure to collecting large tanks or cesspools located away from the human habitat as well as farm buildings.

The second method may be good for buffalo farm as buffalo dung contains more moisture compared to cattle and also the place where there is more rainfall then solid dung get missed with rain water and difficult to collect. If the animals are fed with more succulent high moisture fodder like berseem then they void watery dung. The liquid manure generally contains less than 5 percent total solids on wet basis and flows freely without any mechanical assistance to the storage tanks or ponds (lagoons). In these tanks or ponds beneficial organisms stabilize the material so that it can be spread on the land or used as flush water for a recycle cleaning system. This liquid manure can be directly treated to the fodder farm with or without treatment. While collecting manure in liquid for its disposal the settleable and suspended solid can be removed otherwise it may chock the drainage. Several types of traps and other devices are used to separate the solid waste. In summer condition as the urine volume excretion is less and water scarcity ids there so difficult to collect both solid and liquid manure together.

Methods of manure disposal

The primary objectives of manure disposal are:

- To prevent environmental contamination
- To prevent outbreak of disease.
- To prevent breeding of flies and mosquitoes.
- For hygienic management of animal housing.
- To conserves the maximum nutrients essential for the plant.

There are various methods of disposal of manure and this helps to prevent breeding of flies and mosquitoes and also conserve the fertilizer value of manure. There is no such single method of manure disposal that fulfill all objectives rather a combination different method

follows depending on the farm situation and climatic condition. The farm waste can be disposed and utilized by the following methods:

- Direct land application to land
- Conversion into compost
- Biogas production
- Vermicomposting
- Incineration and burial
- Aerobic oxidation of slurry
- Chemical method of manure disposal

Direct land application to land: Both liquid and solid dairy waste can be directly spread on the open fields if sufficient land is available. This method is oldest and cheapest method of recycling animal waste and waste is dried by direct sunlight that kills most of the microbes and prevent fly breeding and bad odour. In this method the end products are CO_2 and H_2O with an accumulation of N, S, P and minerals in the soil. However, this method is not desirable as it pollutes the environment and there is partial decomposition of organic matter leading to significant losses of nitrogen and energy.

Conversion into compost: Composting is a natural process in which micro organisms decompose the organic matter into compost or humus like substance. In composting process manure and bedding nutrients are converted into a more stable form that adds humic acid to the soil, increases beneficial soil organisms, improves soil tilth and aeration, and reduces raw manure odors. It is an oldest method practice for centuries by farmers who stock dung into piles or in pits. For composting solid waste is collected in piles or pit of 1.5 m deep and 3 x 4 m dimension or larger as per requirement (3 m^3/adult animal unit). During compositing frequent mixing or turning of waste is required. For composting a special type of manure pit called as Allnutt's manure pit which is designed to overcome the turning of manure.

In Allnutt's manure pit solid wall is constructed upto 4 ft height in three sides and towards open side gutter that contains strong solution of chemical to kill the larva. The surrounding walls and the partition wall on their inner side are provided with few inches ledge projection inwards to prevent the larval migration. The pit is divided into two compartments and in each compartment manure is packed alternately and no times the manure storage reach upto

ledge. To prevent falling of debris into the gutter a vertically sliding shutter is fitted to the front of each compartment. A roof either permanent or temporary is made to prevent the quick desiccation of manure or prevent rain water getting into the manure. After pilling within 24 hours temperature rises to 50 ^{0}C and within 3-8 days it reaches to 70 ^{0}C. Thereafter it falls to 50 ^{0}C.

Incineration and burial: These methods are not so common type of manure disposal but during contagious disease outbreak the manure is not used and disposed either by incineration and burial method. In incineration manure is burnt thoroughly to reduce it into ash. If burning is not possible then infected manure is buried deeply into the soil to restrict the spread of infection. There should be no water source near it and after putting manure a layer of 2-3 ft soil should be laid over it. A deep trench is needed to prevent upward migration of strongyles and fly larvae.

Biogas production: Biogas is a non-poisonous gas, with a characteristic odour which disappears on burning when mixed with air. It burns a non luminous blue flame without producing any smoke. In this process organic matter is first converted into volatile fatty acids and then by the action of anaerobic bacteria (methanigenic bacteria) converted to CH_4 and CO_2. The slurry produced after biogas production called digested slurry is valuable source of essential nutrients required by the plant.

Vermicomposting: Vermicomposting is a process of composting carried out by earthworms. Worms feed on the organic waste converting it into nutrient-rich end product called vermicompost or worm castings. Vermiculture is the latest technique and 100 times more efficient than the any other conventional techniques. The earthworm casts contain 2-5 times more organic matter, total nitrogen and exchangeable cations that the soil.

Aerobic oxidation: Liquid slurry can be disposed by keeping it in shallow ditches, lagoon, and tanks. Biological oxygen demand (BOD, defined as the amount of dissolved oxygen needed by aerobic microbes in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period) per acre is generally 20 for proper oxidation. For aerobic oxidation larger area is required and periodically solid sludge has to be removed.

Chemical methods: Chemical methods are commonly used when manure is used as fertilizer because it is not suitable to use manure contaminated with diseased organisms. This method prevents fly breeding and also controls parasites presents in manure. Chemical treatment of manure is only done to superficial layer of manure that controls the fly breeding. The common

chemicals used for fly and mosquito control are Hellebore, Borax, Sodium fluorosilicate, Benzene hexachloride (BHC) or Dichloro- Diphenyl trichloroethane (DDT) etc.

Review question:

[1] What are the different types of waste produced in a dairy farm?

[2] What are the common objectives of manure disposal?

[3] Which types of animal waste are buried?

[4] What is BOD?

[5] Describe Allnutt's manure pit?

[6] What is vermicomposting?

Chapter – 11

BIOGAS PRODUCTION AND VERMICOMPOSTING

Biogas production

Biogas is a fuel used as an energy source for light, heat or movement, produced from the breakdown of organic matter by anaerobic fermentation. The primary component of biogas is methane which is 55-70 percent, followed by 30-45 percent carbon dioxide and a lesser quantity nitrogen, hydrogen and hydrogen sulphide. Biogas is produced by an-aerobic (without oxygen) fermentation of organic waste by bacteria. The process of biogas production is called as "Bio-methanation" or "bio-conversion" or "bio-gasification". In dairy farm animal waste is considered as major problem for environmental pollution which acts as good source of biogas production. In general, each cattle or buffaloe on an average irrespective of their age produces 15 kg manure per day and to run a biogas plant of 1 m^3 capacity 25 kg dung required per day.

Advantages and disadvantages of biogas

Advantages of biogas

- Produces non-polluting and renewable source of energy.
- Efficient way of energy conversion from organic waste to methane.
- It saves time for firewood collection in village condition and reduces smoke production in the kitchen, and time consumed for cooking and cleaning of utensils.
- Produces activated sludge which is a good source of NPK fertilizer in its dry form or even replace chemical fertilizers.
- It improves the environmental quality and makes it more hygienic.
- Leads to self employment generation in the rural areas.
- Biogas plant can convert any types of organic-wastes can and efficiently convert to biogas.
- The technology is cheaper and much simpler than those for other bio-fuels like coal or fossil fuel or nuclear fuel.
- Dilute waste materials (2-10% solids) can be used as in animal feed materials.
- Anaerobic digestion inactivates several pathogens and parasites, and also quite effective in reducing outbreak of different water borne diseases.

- Biogas plants significantly lower green house gas from organic waste.
- The biogas slurry acts as rich source NPK fertilizer and contains approximately 4 times higher NPK than when ordinary dung is converted into Farm Yard Manure (FYM).

Disadvantages of biogas

- The process is not very attractive economically on a large industrial scale as initial cost for construction is high and to get back the returns farmer has to wait approximately 10 years.
- For regular maintenance and solving problems a skilled labour is always required, and also for feeding the biogas plant and handling slurry.
- It is very difficult to enhance the working efficiency of biogas systems.
- Dung quality directly influence the production of biogas, hence cattle should be stall fed instead of pasture grazing.
- Biogas contains some gaseous impurities that are corrosive to the metal parts of internal combustion engines.
- Biogas contains harmful gases like sulphur and carbon dioxide, not needed for energy production which increases the volume and hence increases cost of transport from one place to another.
- Biogas plant stop working under certain temperature and also at higher altitude (>2000 meters), hence not feasible to set at all the locations.
- Biogas plant has continuous demand for water supply to make fresh slurry.
- There is continuous supply of dung for regular production of biogas, so the herd strength of cattle should be constant which is not possible.

Factors affecting biogas production

There are several factors that affect the biogas production which are:

Temperature: The anaerobic digestion in biogas plant is carried out at two temperature levels. First one is mesophilic digestion where temperature ranges from 25 ^{o}C to up to 40 ^{o}C and the optimum digestion at 35 ^{o}C. The second one is the thermophilic digestion occurs at temperature ranges of 50- 65 ^{o}C.

Retention time: The retention time of slurry must be long enough to allow metabolism by anaerobic bacteria. In general the retention time is normally chosen to be 60 days during which around 70% biogas is produced and may be extend upto 80-100 days.

pH: The optimum pH for biogas production in the digester is 6.8-7.2 i.e. near neutral pH. The amidogens bacteria produce organic acids into the digester but methanogens buffered it by producing bicarbonate. This buffering capacity is altered in adverse environmental conditions by inhibition activity of methanogens.

C/N Ratio: For optimum functioning of methanogenic bacteria C/N ratio should be 20-30. If the ratio is very high then growth of methanogens populations increases and use N to meet their protein requirements and no longer react with the leftover carbon content of the substrate resulting in a low gas production. On the other hand, if the ratio becomes very low then there is ammonia accumulation which is toxic to methanogenic bacteria.

Toxicants: Toxicants like antibiotics and other residues in the manure inhibit the methanogenesis processes. Thus, reduces the production of methane and increases the concentrations of volatile acids.

Components and working principle of biogas unit

A typical biogas system consists of the following components:

- Reception tank/ manure collection tank
- Digester or fermenter
- Gas holder
- Outlet tank and slurry pit

Reception tank: Reception tank is also called as slurry mixing tank where dung is mixed either manually or mechanically. All the foreign materials settled down on the tank and regularly removed from the tank. The reception tank has sufficient space to provide space for storage of large amount of slurry at least for seven days.

Digester or fermenter: The digester or fermentation tank comprises of a cylindrical body, gasometer, inlet pit and outlet pit. The digester is generally made up of burnt-clay bricks and cement; whereas, cylindrical dome is made of metal sheets. The slurry is put inside the digester leaving 20-25% space free board for gas storage. In floating gas holder digester a continuous ledge is built into the digester to prevent the gas holder from going down when no gas is left in it.

Gas holder: Gas holder collects the gas after it leaves the digester. It may be a floating drum or a fixed dome on the basis of which the plants are broadly classified. The gas connection is taken from the top of this holder to the gas burners or for any other purposes by suitable pipelines

Outlet tank and slurry pit: An outlet tank is usually provided in a fixed dome type of plant from where slurry in directly taken to the field or to a slurry pit. In case of a floating drum plant, the slurry is taken to a pit where it can be dried or taken to the field for direct applications

Types of biogas plant:

Two simple types of biogas digester designs have been used commonly. First one is Chinese fixed dome digester and second one is Indian floating cover biogas digester. In both the digesters the digestion process is same but the gas collection method is different in each. In floating cover type digester, the water sealed cover of the digester rises as gas is produced and acts as a storage chamber, whereas in the fixed dome type digester has a lower gas storage capacity and requires good sealing to prevent gas leakage. Both type of biogas plant are suitable to use animal waste and dung.

Sludge/digested slurry

Anaerobic digestion markedly modifies the properties of the animal waste. Digested slurry contains all essential nutrients required for optimum growth of plants and contains contain nutrients like NPK, Zn, Fe, Mg, and Cu.

- Fermentation reduces the C/N ratio and thereby increases fertilizing effect.
- The nitrogen is suitable for the plant due to mineralization.
- Well-digested slurry is odourless and does not attract flies, so fly menace is reduces.
- Anaerobic digestion destroys most of the pathogens and worm ova.
- Compared to the raw organic material the digested slurry is finer and more homogeneous so easy to spread.
- In digested slurry about 20% of total Nitrogen is in NH3 form, and thus readily available to plants.
- The organic content of the digested slurry improves the soil's texture and increases its water holding capacity

VERMICOMPOSTING

Vermicomposting is a process of composting organic animal waste using earthworm or is a process of turning organic dairy waste into worm castings. The term vermicomposting or vermiculture is derived from the Latin ward vermis means worms. This process of composting speeds up the decomposition of organic waste and provides a nutrient-rich end product called vermicompost or worm castings. The earthworms consume all kinds of organic matter and are

able to eat the organic matter weighing equivalent to their body weight and produces excreta equivalent to 50% i.e. 1 kg of worms can consume 1 kg of residues every day and produces o.5 kg excreta per day. The excreta of worm called castings are rich source NPK (nitrate, phosphorus and potash), Calcium and Magnesium.

Advantages of vermicompost

There are many advantages of vermicompost:

- Vermicomposting provides efficient conversion of organic animal wastes into nutrient rich worm castings.
- Vermicompost is rich source of NPK and provides all essential nutrients required for healthy plant growth.
- Vermicompost is a source of beneficial micro flora such as Nitrogen fixers, Phosphorous solubilizers, cellulose decomposing micro-flora etc.
- Microbial activity vermicompost is 10-20 times higher than in the soil and organic matter ingested by the worm.
- Vermicompost is a rich source of earthworm cocoons that increase the population and enhance activity of earthworm in the soil.
- Vermicompost is free from pathogenic organism, toxic elements, weed seeds etc.
- Vermicompost reduces the pathogenic microbes and pest.
- It markedly reduces the toxicity of heavy metals.
- Vermicompost is a rich source of valuable vitamins, enzymes and hormones like auxins, gibberellins etc.
- It is stable and improves soil structure, texture, aeration, and water holding capacity and prevents soil erosion.
- Vermicompost is easily applied to soil, handled and stored and free from bad odour.
- It prevents nutrient losses and increases the efficient use of chemical fertilizers.
- It enhances the process of organic matter decomposition of in soil.
- Vermicomposting is a low cost easily adoptable technology.

Types of earthworm

Several types of earthworm are used for vermicomposting, the common type of worms are *Eisenia foetida* (redworm, red wiggler worm, red californian earth worm, panfish worm, trout

worm, tiger worm), *Lumbricus rubellus* (red earthworm) *Eudrilus eugeniae* (African night Crawler) and *Perionyx excavatus* (Indian blues, blues) are appropriate for vermicomposting.

The appropriate characteristics of appropriate vermicomposting species are:

- Worm should have high biomass consumption capacity together with higher conversion efficiency of ingested biomass to body proteins.
- Worm should have disease resistant capacity and have wider range of tolerance to environmental factors including adaptation to feed on a variety of organic residues.
- Worm should grow rapidly and produce large numbers of cocoons with short hatching time enabling faster composting of organic residues.
- Life cycle of the worm should be shorter such that mature or adult phase should be reach quickly.
- Always use a mixture of species rather using a single species.

Types of vermicomposting

The types of vermicomposting depend upon the size of production and composting structures. It may be small-scale where vermicomposting is done to meet the personal requirement. In small-scale vermicomposting farmer can harvest 5-10 tonnes of vermicompost annually. Another one is large-scale vermicomposting which is done for large scale production of vermicompost at commercial scale. In large scale production system 50-100 tonnes of vermicompost produced annually by recycling large quantity of organic waste.

Methods of vermicomposting

Different methods of vermicomposting are followed for recycling of organic waste, among them bed and pit methods more commonly used by farmers for small and large scale production.

Bed method: In this method composting is prepared on the pucca / kachcha floor by making bed of organic mixture. Bed method is easier to practice and maintain compared to pit method.

Pit method: In this method cemented compost pits is prepared below the ground. The top portion of the pit is covered with thatch grass or any other locally available materials. However, this method is not generally preferred because of poor aeration, water logging at bottom and more cost of production.

The quantity of raw materials required for the vermicomposting in cement ring of 3 ft in diameter and 1 ft in height or a pit or tank measuring 1.5 m × 1 m × 1 m is given below:

- ✓ Dry organic wastes (DOW) - 50 kg
- ✓ Dung slurry (DS) - 15 kg
- ✓ Rock phosphate (RP) - 2 kg
- ✓ Earthworms (EW) - 500-700
- ✓ Water (W) - 5 L every three days

The various ingredients for vermicomposting are used in the ratio of 5 : 1.5 : 0.2 : 50-75 : 0.5 of DOW : DS: RP : EW : W. In the tank or pit system 100 kg of raw material and 15-20 kg of cow dung required for each cubic meter of the bed.

Steps followed for vermicomposting

Generally 13 steps are followed while preparing vermicompost.

a. First cover the bottom of the ground (concrete, wooden, plastic or mud) with a polythene sheet.
b. Spread 15-20 cm layer of organic waste on the top of the sheet.
c. Sprinkle rock phosphate on top of the organic material (improve nutritional quality of compost).
d. Prepare cow dung slurry and sprinkle it as a layer on top of the mixture.
e. Fill the ring completely and evenly with the above material as layered.
f. Paste the top of the ring with cow dung or soil.
g. Allow the material to decompose for 15-20 days and after that put the earthworms on the cracks that developed.
h. Cover the ring completely with wire mesh or gunny bags to prevent birds from picking the worms.
i. Sprinkle water over the whole mixture regularly at 3 day intervals for 2 months for maintaining adequate moisture and body temperature of the worms.
j. After 2 months the compost is ready (black, quite lightweight and has a pleasant and earthy smell and do not water the compost for 2-3 days for easy shifting) and remove the ring, then heap the material in cone shape on the floor. Leave the heap undisturbed for 2-3 hours, to let the worms move slowly to the bottom.
k. Separate the upper portion of the heap.
l. Sieve the lower portion of the heap to separate the worms to reuse again for preparation of more vermicompost.

m. Pack the compost in bags and store them in a cool place. Prepare another pile about 20 days before removing the compost and repeat the process by following the same procedure as described above

Factors affecting vermicomposting

Several factors directly or indirectly affect efficient conversion of organic matter to worm casting in the compost pit.

- **Floor**: The floor should be compact enough to prevent migration of worm into the soil. The floor may be concrete, wooden or plastic and if mud floor is used then put polythene on the bottom.
- **Moisture:** The optimum moisture content for better composting ranged from 40 to 60 percent. Adequate amount of moisture is needed for better decomposition of organic waste otherwise decomposition process will be slow down with either too much or too little water.
- **Temperature:** The optimum temperature required in the vermicompost pit for better efficiency of worm should be 55- 85 ^{0}F. Higher or lower temperature reduces the activity of both microbes and earthworms.
- **Aeration**: Proper aeration of compost pit allows better growth and multiplication of earthworms. So the compost been should be constructed in such to allow adequate airflow and if require on the upper sidewall of the bins holes may be drilled for air circulation.
- **Acidity (pH)**: The pH of the compost material becomes lower due to decomposition of organic matter to organic acids, so to maintain optimum pH use ground limestone.
- The organic wastes used for vermicomposting should be free from plastics, chemicals, pesticides and metals etc.
- To avoid excessive during composting 15-20 days old cow dung should be used.

Nutrient content of vermicompost

The nutrients content in vermicompost depends upon the source of the raw material and the species of earthworm being used. If the raw material comprises waste from different source i.e. heterogeneous then wide range of nutrients available and from one source i.e. homogenous then only certain nutrients are available. The vermicompost is reach source of NPK besides other nutrients (**Table**: **Nutrient analysis of vermicompost**).

Nutrient analysis of vermicompost

Parameters	Content (%)
Organic carbon	9.8-13.
Nitrogen	0.51-1.61
Phosphorus	0.19-1.02
Potassium	0.15-0.73
Sodium	0.058-0.158
Calcium	1.18-7.61
Magnesium	0.093-0.568
Copper	0.0026-0.0048
Iron	0.2050-1.3313
Zinc	0.0042-0.110
Manganese	0.0105-0.2038

Review questions:

[1] What is biogas?

[2] What are the different factors affecting biogas production?

[3] What are the different advantages of digested slurry?

[4] Why vermicomposting is popular among farmers?

[5] Which points are generally considered while selecting vermicomposting species?

[6] What are the different factors affecting vermicomposting?

Chapter – 12

Signs of health- difference between healthy and sick animals, normal physiological parameters- temperature, respiration and pulse rate

Signs of healthy cattle

Animal is active and stays in group. It shows good appetite and when offered feed takes happily. Chewing of cud is a sign of good digestion. Nose is usually wet and bright. Skin is usually a good indicator of health. If you pinch the skin it should return to normal (flattened) in no more than 1-2 seconds. It should be glossy and bright without eggs of ticks, lice or mites. Eyes should be clear, bright and without excessive tear. Ears are usually warm but not too hot. Udder should be of normal size, color, and soft. Excessive redness or hardness is a bad sign. Urine should be clear and without smell. It is usually pale yellow in color and pH is alkaline (7.4). Vaginal discharge is healthy animal is indicative of estrous cycle. But it should be odorless and should occur only once in 21 days. Feces (cow dung) should be semi solid. Watery stool is sign of diarrhea. Movement of animal should be normal and straight. Rumination is another sign of good health. A cow should ruminate for seven to ten hours per day. Ruminating 40 to 70 times on a cud is normal.

Sickness in cows

Any deviation in the features of a healthy cow as mentioned above should be regarded as a sign of bad health. Loss of appetite and stopping rumination is the first sign of bad health.

Temperature: High temperature shows fever. Cold ears indicate milk fever or blood circulation problems.

Limpness: If animal is not putting weight equally on all the four legs it may be suffering with lameness.

Examination of rumen and Rumination: Examine the rumen. It is on the left side. It should be filled with feed. On pressing the rumen with fist you should feel contractive movement around 10-12 times in five minutes. If animal is not ruminating it should be taken as animal is not feeling well and taking fewer rations.

Neck: Neck should not be swollen. If it is swollen it means the manger is situated too low. Animal is forced to keep its head low during feeding which causes fluid accumulation.

Hooves: Healthy cows stand straight and still while eating. Tipping or walking with lame gait are signs of poor hoof health, from bad rations, poor floors or lack of hoof treatment.

Udder: Udder is examined for signs of engorgement, injury, redness, warmth etc. Four signs heat, redness, swelling and pain indicate inflammation of udder. To assess udder health, look carefully at the teats after milking. Good teats are flexible and naturally colored. Poor udder health is caused by hygiene problems, poor milking equipment installation or inadequate feed rations. Mastitis is very common problem in dairy animals. It is inflammation of udder.

Manure: the fresh dung should be neither too solid nor too watery. Undigested food particles should not be present in the feces.

Breathing: Faster breathing indicates heat stress or pain and fever.

Sickness of calves

Calves are innocent. They need proper care, love and affection of the herdsmen. They show some signs of abnormal feeling which needs to observed promptly and closely. Twice daily visit to calf shed is ideal.

Signs of a normal healthy calf: healthy claves will be very agile and active with wide open eyes. They run to your knees and will make playful attempts when approached by a person. Healthy calves rest in a curled-up position with feet tucked under and heads back along the body. They breath regularly appear relaxed, jumping and hopping. Some healthy calves may also rest flat on their sides.

Signs of sickness in calves:

General observation:

Calves standing or lying in the corner of the pen with head turned away from the other pen mates is an indicative of sickness. Sick calves show general disinterest, become listless and apathetic, lack vigour and often do not move when approached. Sick calves stand head down and ear dropped.

Nose color and dampness: Closely watch the calves individually. Look at the nose for any discharge or dampness. Little moisture is good but more liquid discharge and running nose should be considered as signs of abnormal health. Completely dry nose is an indication of sickness.

Body temperature: higher than normal body temperatures is a bad sign. Touch the ears and feel the temperature. It comes with experience. Normal body temperature of a calf is 39^{o}C or 102^{o}F.

Breathing: Notice breathing pattern. Too fast or too slow breathing is not good. Breathing should be rhythmic. Rattling voice produced during breathing or if its feels that animal is labour breathing, it should be considered as sign of bad health. Normal respiration rate in calves is 15-40 breaths per minute. While in cows and bull it is 10-30 breath per minute.

Signs of inflammation or swelling at naval area: any redness, swelling or hot area is indicative of inflammation. Touch the calf over the body. Look if animal avoids your touch. It may be due to pain or inflammation in that body part.

Normal range of physiological parameters (vital signs) in some domestic animal species

Animal species	Body temperature (^{o}F)	Respiration rate	Heart rate/Pulse rate	Estrous cycle length	Gestation period
Cow	102.0-103.0 F	35-40/min	70-80/min	21 days	290 days
Goat	100.2–103.8 F	15 - 30 /min	60 - 80 /min	18 - 23 days	150 days
Buffalo	99.5 – 102.0 F	12 to 16/ min	38 to 53/min	21 days	310-330 days
Sheep	102.3-103.8 F	10-20	70-80/min	16 days	150 days
Horse	99-100.5 F	8-16/min	30-40/min	21 days	335 days
Pigs	101.6-103.6 F	10-20/ min	60-80/min	21	115 days
Dogs	100-102.5 F	10-30/ min	70-120/min	4-6 months	62 days
Chicken (Poultry)	105-109.4 F	15-30/min	140-250/ min	25 to 26h (egg formation till laying)	21 days

Review questions:

1. How will you differentiate sick animal from healthy animals?
2. Do you think body size has any relation with pulse rate?
3. Do you think physical examination of animal may reveal the health status? Explain your views with proper logic
4. What do you understand by gestation period?
5. Calves need extra care. What precautions will you take for proper management of calves?

Chapter – 13

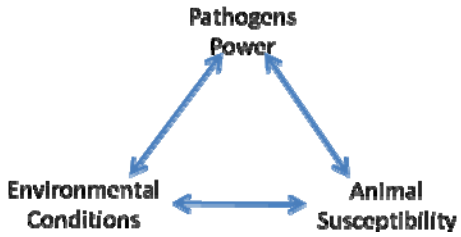
Common diseases: Infectious/ Contagious/Bacterial/Viral/Fungal/Parasitic, causes, mode of transmission and common signs and symptoms

Introduction

Any deviation from the normal healthy state which is uncomfortable to animal is called disease. The reasons for diseases can be broadly classified into three major categories based upon the involvement of causative agents. This may be due to (a) pathogenic microbes (bacteria, viruses, or fungi or parasites) or due to (b) injury inflicted by predator animals resulting into wound, or due to (c) improper management leading to malnutrition, overfeeding, or physiological imbalances. This chapter will mainly focus on the infectious diseases caused by pathogenic microbes.

Pathogenic microbes are opportunists which are always present in the vicinity of animals, in its environment and even within the body of animals. Whenever individual's immune response is compromised these pathogens raise their head and thrive on animal's body and in turn reach harm to animals by disturbing its physiology. It must not be forgotten that many of the microbes share the host among different animals, birds and human. While grazing they come in contact with these microbes and suffer with diseases. Milk and meat product from the affected animals can be potential source of disease to human. Such diseases which are transferred from animals to human are called zoonotic diseases.

There are three determinants of diseases in animals. 1. Pathogen power: It is the ability of pathogen to infect the animal. Sometimes it is also called virulence, infectivity or pathogenicity. If a pathogen is able to dominate the defense system (immune system) of animal's body, the disease occurs. 2. Environmental conditions: the environment in which both pathogen and animals lives is an important contributing factor in the occurrence of diseases. If the environment is clean, hygienic and sanitary there is less chance of the occurrence of disease. 3. Animal susceptibility: The third but most important factor is animal itself. A weak, unhealthy, malnourished animal is more susceptible to disease than a strong, well fed and properly maintained animal. The susceptibility of animal also depends on its genotype. Some animals are genetically more capable fighting with pathogens.



Interaction between host and pathogen

Nature has created all organisms in such a way that one is dependent on other whether it is a tiny microbe or a big intelligent human being. The dependence is beautiful till both parties are mutually benefited. But if in this interaction one becomes over demanding and starts exploiting the other, it becomes "dis-ease". Animals have evolved in such a way that to some extent they can control the infection. Once this natural control and containment over disease is breached, animals need to be treated by human intervention.

Definition of infectious diseases

Infectious diseases of cattle are those diseases which are caused by the entrance, growth, and multiplication of microorganisms in the body. It may or may not be contagious. A contagious disease is one which is communicated to other animals by coming in contact with the infected animals, utensils, water, feed, shed etc. Depending on the causative agent the infectious diseases can be classified in a. Bacterial b. viral c. protozoan and d. parasitic.

Bacterial diseases

Enteric diseases

Diseases of intestine are called enteric diseases. It may involve rumen, stomach (abomasum), small intestine, large intestine and colon separately or all together. Inflammation of these organs is common. Enteritis is the inflammation of small intestine. Rumenitis is inflammation of rumen. Colitis is inflammation of colon. Typhlitis is inflammation is cecum. Enterocolitis is used for the inflammation of both intestine and colon. Diarrhoea is the usual symptom in case of inflammation which is also called as scours. This is very common in calves and occasionally in adult animals. It is characterized by fever, and dehydration (severe loss of water). The animals become debilitated. Although, many organisms are involved in such enteric diseases the very common among them are E. cloi, and Salmonella

Calf Scours

It is also known as neonatal diarrhea. Calves up to the age of one month are mostly affected. It is responsible for around 40% of death observed in newborn calves in any farm.

Signs and symptoms: The disease is characterized by indigestion, fever, electrolyte deficiency and heart failure. If diarrhea continues unchecked, calves become glucose deficient (hypoglycemic) and their blood becomes excessively acidic (acidosis, due to loss of bicarbonate). Sometimes blood may come in stool. If the color of blood in stool is very red and fresh, it indicates site of infection in the lower intestinal tract. If the color of stool is blackish

which is due to the presence of digested blood indicates site of infection somewhere in the upper digestive tract.

Causative organism

Although bacterial infection is most common which includes *E. coli*, especially with K99 pili, *Campylobacter jejuni*, *Salmonella* spp., *Clostridium perfringens,* especially type C and D, but other organisms like viruses (Rota and Corona) and protozoa like Eimeria (Coccidiosis) and cryptosporidium are also involved. *Salmonella* spp., *Cryptosporidium* spp., and some enteropathogenic *E. coli* strains can be transmitted to human as well so necessary care should be taken by the handlers when handling calves with diarrhea or contaminated bedding.

Mode of transmission

Oro-fecal route is the mode of transmission. Animals may ingest infected materials which carries bacteria to the intestine of animals. If calves suckle contaminated udder and teats they get infection. Organisms buildup in manure, barns, sheds, corrals and bedding. Heavily infected animals shed bacteria in their dung which mixes up with feed or come in contact with the udder of dam finally finding way to calves during suckling.

Salmonella infection

There are three species of Salmonella which usually infects cattle: S. Dublin, S. Enteriditis and S. Typhi. They can be transmitted to human being as well. There are two clinical signs of salmonellosis in ruminants

1. **Enteric Salmonellosis:** adult cattle commonly suffer from this form the disease. The female animals reaching at their term are more susceptible. The infection remains localized to gastro intestinal tract and it rarely reaches to blood. Infected animals may harbor bacteria for a long time (chronic infection) with or without apparent clinical signs.

2. **Septicemic Salmonellosis:** This is the form of disease where bacteria reaches to blood stream and starts affecting other vital organs. Calves are very much susceptible for it. Failure of feeding colostrum, over-crowding, chilling, transport, and poor nutrition make young animals more susceptible. The disease usually progresses from mild enteric form to septicemic form eventually resulting into systemic disease with pneumonia, multiple joint infections (polyarthritis) and encephalitis-meningitis.

Salmonellosis is a zoonotic disease. Humans are at quite high risk of getting infection from the suffering animals. Salmonella typhimurium from cattle is the second most common isolate from human cases. Salmonella typhimurium PT DT104 has become an important food safety concern because of the increased incidence in both human and animal infections in India and the United States. It shows resistance to many antimicrobials, including chloramphenicol, its veterinary analog florfenicol, as well as streptomycin, the sulfonamides, and ampicillin. The most common

sources of infection are contaminated food and water. Rodents, birds, and other animals spread infection through their feces and their carcasses.

Clostridium infection

There are many species of clostridium which infects dairy cattle and show different signs and symptoms. Based on the symptoms produced by the infection of these bacterial species, the diseases are like Blackleg, red water, overeating disease, enterotoxemia and tetanus. All these are caused by Clostridium spp. many of these clostridium species are commonly found in harmless form in soil, feces or intestine of animals. They form highly resistant spores that can survive in the environment for very long periods. They are also present in the gastrointestinal tract and as spores in tissues of healthy animals. But under stress or immuno-compromised condition these spores germinate and grow rapidly and release toxins, quickly destroying tissue and often causing death. Conditions like grain engorgement, cuts, injury, bruises, abrasions, surgical wound, or ingestion etc. creates ideal condition for the growth of these pathogenic bacteria. Some of the clostridia species need anaerobic condition to grow which is easily available in the site of injury or wounds.

Hemorrhagic bowel syndrome (HBS)

Etiology: It is caused by *Clostridium perfringens* type A. There is excessive bleeding in intestine of adult and calves which is acute in origin and a serious threat to animal health. The feces are blood stained dark in color. The animal is anemic and dehydrated. Enteritis (inflammation of intestine) is common. The problem is more severe in calves with abomasal ulcers and hemorrhage. *Clostridium perfringens* Type A in calves, causes quick onset of abdominal distension with pain, bloat, depression and feed refusal. *Clostridium perfringens* Types C and D cause severe abdominal pain, diarrhea, depression and convulsions.

Signs and symptoms: Affected cattle have a history of sudden anorexia and depression, a pronounced reduction in milk production, abdominal distension and pain with kicking at the abdomen, and weakness progressing to recumbency. Clinical findings include depression, dehydration, an elevated heart and respiratory rate, and pale mucous membranes. The abdomen may be moderately distended on the right side, the rumen is atonic, and fluid sound may be elicited by succussion over the right abdomen. The feces are bloody and dark red but may be dry and scant. Distended and firm loops of intestine may be palpable on deep rectal examination. On laparotomy, a segment of the small intestine is dark red, distended with a serosal surface covered by tags of fibrin. The small intestine proximal to the affected segment and the abomasum are distended with gas and fluid.

Diagnosis: Diagnosis is mainly done by visual examination and the history of patient. Ultrasonography may aid in the diagnosis.

Treatment and Control: Fluid and electrolyte therapy is the common practice. Laparotomy with resection of the affected segment of the intestine can be recommended in valuable animals.

Even with such treatment, the case fatality rate is very high. No preventive strategies have been identified.

Tetanus

This disease is also called as lock jaw. Spasms of head muscles cause difficulty in prehension and mastication of food, hence it is called lockjaw.

Etiology: Tetanus is caused by *Clostridium tetani.*

Mode of transmission: This organism enters body mostly through cut, bruises, wound coming in contact with contaminated soil, utensil, nails, knife, broom etc. it produces toxin which is neurotoxic. The skeletal muscles tighten due to spasm especially in throat region and animal feels difficulty in breathing which finally leads to death. Castration, dehorning wounds, and trauma during calving are at severe risk.

Diagnosis: clinical diagnosis is usually done by observing the symptoms and associating it with the history of trauma, open wound, or accidents with nails, bolts, horse dung etc. Presence of toxin in the serum of patient is confirmatory diagnosis. In cases in which the wound is apparent, demonstration of the bacterium in gram-stained smears and by anaerobic culture may be attempted

Treatment and control: The treatment is by injecting penicilliln or and broad spectrum antibiotics. Injecting 50,000 IU of tetanus antitoxin directly into the subarachnoid space through the cisterna magna yields good result. Prevention is done by active immunization with tetanus toxoid. Toxoid should be given simultaneously with the antitoxin and repeated in 30 days.

Malignant Oedema

Malignant oedema results from wound contamination by soil, allowing entry of the clostridia.

Etiology: It is caused by *Clostridium septicu*m, along with C. *chauvoei, C. perfringens,C. sordellii* and C. *novy*i.

Signs and symptoms: This is characterized by extensive swelling, with accumulation of bloody or clear fluid. Tissue necrosis (death of tissue) at the site of infection is common which is sometimes very black in color. The wound site gives crepitating sound on pressing and it develops into gangrene. Deep puncture wounds, castration wounds and calving injuries are high risk. Infection can also occur via the umbilicus (navel) in newborn calves and following injections if proper aseptic technique is not used. Actual pathogenic substance in this case is also toxin which is absorbed in blood causing fever, weakness, trembling, and finally death.

Diagnosis: Diagnosis is based on history of the case and observing the clinical signs. Black wound which pits in upon pressing is indicative of the disease. Similarity to blackleg is marked, and differentiation made on necropsy is usually unreliable. Laboratory confirmation is the only certain procedure. Differential diagnosis must be made with anthrax. Diagnosis can be confirmed rapidly on the basis of fluorescent-antibody staining of *C. septicum* from a tissue smear. However, *C. septicum* is an extremely active postmortem invader from the intestine, and its presence in a specimen taken from an animal that has been dead for ≥24 hr is not significant. PCR can be used for direct identification and differentiation of clostridia associated with malignant edema.

Treatment and control: High dose of penicillin or other broad-spectrum antibiotics is indicated early in the disease. Injection of penicillin directly into the periphery of the lesion minimizes the spread of lesion. Supportive therapy with non steroidal anti inflammatory drugs (NSAID) (flunixin meglumine for cattle and horses) is recommended. Local treatment includes surgical incision of skin and fascia to allow drainage. Vaccination with Bacterins is common method of prevention. C. septicum is combined with C. chauvoei in a blackleg/malignant edema vaccine which is available in multivalent vaccines. Animal should be vaccinated before they are castrated, dehorned, or docked. In high-risk areas, annual vaccination should be indicated.

Blackleg

It is a disease characterized by blackening of leg muscles. It usually affects young cattle from 6 months to 2 years old which grow rapidly on a high plane of nutrition.

Etiology: It is caused by *Clostridium chauvoei.* Its spores lie dormant in the muscles of healthy animals. Outbreaks of blackleg occur in cattle on farms in which recent excavation has occurred or after flooding.

Signs and symptoms: In cattle, blackleg infection is endogenous, in contrast to malignant edema. Lesions develop without any history of wounds, although bruising or excessive exercise may precipitate some cases. Initially, there is a fever but, by the time clinical signs are obvious, body temperature may be normal or subnormal. Characteristic edematous and crepitant swellings develop in the hip, shoulder, chest, back, neck, or elsewhere. At first, the swelling is small, hot, and painful. As the disease rapidly progresses, the swelling enlarges, there is crepitation on palpation, and the skin becomes cold and insensitive with decreased blood supply to affected areas.

Diagnosis: A rapid undetected death of few animals in the herd should be suspected due to Black leg disease. Rapidly fatal, febrile disease in well-nourished young cattle, with crepitant swellings

of the heavy muscles suggests blackleg. The wound has a sweetish odor and is infiltrated with small bubbles.

Treatment/Prevention/Control: A multivalent vaccine containing antigens from *C. chauvoei, C. septicum* and, *C. novyi* is commonly used. Calves 3–6 months of age should be vaccinated twice, 4 wk apart, followed by annual boosters prior to the anticipated danger period (usually spring or early summer). In case of outbreak all animals in the herd should be injected with Penicillin (10,000 IU/kg, IM) for up to 14 days to prevent new cases. Carcasses should be destroyed by burning or buried deeply in a fenced-off area to limit spore contamination of the soil.

Black Disease

This is also called Infectious necrotic hepatitis. Black disease must not be confused with "black leg" as the causative organism for both are different.

Etiology: It is caused by Clostridium novyi. Black disease occur when there is damage to the liver - such as occurs with migrating liver fluke - that allows *Clostridium novyi* to multiply and produce toxin. The toxin causes severe liver damage and death.

Signs and symptoms: Usually, death is sudden with no well-defined signs. Affected animals tend to lag behind the flock, assume sternal recumbency, and die within a few hours.

Diagnosis: History is important as most cases occur in the summer and early fall when liver fluke infection is at its peak. Differentiation from acute fascioliasis may be difficult, but peracute deaths of animals that show typical lesions on necropsy should arouse suspicion of infectious necrotic hepatitis.

Control: Since, the disease is associated with liver fluke infection, fluke control is a must. The snails (Lymnea spp.) are the intermediate host for the flukes so snail control in water is good practice. Active immunization with aluminum hydroxide precipitated C. novyi toxoid is very effective. Long term immunity is produced by one vaccination. Pasture contamination should be minimized by proper disposal of cadavers (burning).

Enterotoxaemia

This disease is also known as **pulpy kidney or Overeating disease.** It is more common in sheep and goat than in cattle.

Signs and symptoms: The disease is characterized by diarrhea, bellowing, mania or dullness, blindness, convulsions and death. Animals are suddenly found dead in barn.

Etiology: This is caused by bacteria *Clostridium perfringens* type D which normally inhabits intestine without causing disease. Only when the immunity of animals goes down or when animals are switched to sudden changes in diet, grazing lush, rapidly growing pastures or young

cereal crops; or heavy grain feeding (as in feedlots) enables the bacteria to multiply rapidly. Fast multiplying bacteria produces lot of toxin which cannot be neutralized by circulating antibodies which leads to condition called as enterotoxemia. Excess of toxin finds way to blood circulation and animal exhibits symptoms of disease. A number of toxins are produced, but the most important toxin damages blood vessels and the nervous system.

Diagnosis: History of the case is important for diagnosis. Smears of intestinal contents reveal many short, thick gram-positive rods. Confirmatory diagnosis can be made by the presence of ε toxin in the small-intestinal fluid. A PCR based detection is possible which amplify the gene responsible for epsilon toxin production by type B or D.

Treatment/prevention and control: Immunization is the most effective method to prevent the diseases. Enterotoxemia can be controlled by reducing the amount of concentrate in the diet. Treatment with broad spectrum antibiotics is successful to some extent.

Botulism

Botulism is a common disease of dairy cattle. It is more a type of intoxication than infection which results from ingestion of toxin in food. Like tetanus toxin, botulinum toxin is a zinc-binding metalloprotease that cleaves specific proteins in synaptic vesicles.

Etiology: The causative organism is *Clostridium botulinum* (type A-G). In cattle D type is most common. It is present in decomposing animal and plant material. Again the organism produces toxin so even if the rotten material has been treated well to remove the bacteria sometimes toxins remains there. Animals get botulism by ingesting the toxin. The most common source of toxin is feed contaminated by carcasses such as those of mice or birds, decaying grass, hay, grain, or spoiled silage or chewing on bones.

Signs and symptoms: Botulinum toxin causes a flaccid (floppy) paralysis with progressive motor paralysis, disturbed vision and generalized progressive weakness. The animal cannot chew or swallow and will drool saliva. Paralysis of the respiratory muscles results in death.

Diagnosis: The motor paralysis is characteristic of the disease. Commonly, the diagnosis is made by eliminating other causes of motor paralysis. Confirmatory diagnosis can be made by feeding the suspected material to the mice. ELISA can be used for the detection of toxin in samples.

Treatment/Prevention and Control: Proper carcass disposal is very important for the control of the disease. Decaying grass or spoiled silage should be removed from the diet. Immunization of cattle with types C and D is effective preventive method. Supportive care in valuable animals is essential.

Mastitis

Mastitis is the most common and most threatening disease in dairy cattle. It is characterized by inflammation in udder. Since is milk is a very good medium for bacterial growth many different kinds of bacteria grow in udder (mammary gland) of the lactating animals. Immediately after milking the teat canals are open. If animals sit immediately after milking, open teats come in contact with soil or contaminated water on floor and bacteria gets chance to enter into udder. Sometimes udder is injured during fighting with other animals or bitten by stray animals. Wounded udder is also a predisposing factor for mastitis. The big problem in mastits is severe reduction in milk. Other animals easily come in contact with infected barn material, milking shed and milk handlers and thus are also under threat. It is a highly contagious disease. The treatments take long time with antibiotics. Injudicious use of antibiotics leads to development of resistant bacteria which further complicates the treatment.

Etiology: The causative organisms in mastitis are mainly bacteria but mycoplasmal, mycotic (fungal), or algal infection may exist simultaneously. The well recognized bacteria in mastitis are Streptococcus*, Staphylococcus aureus*, Mycoplasma and Pasteurella. Environmental Mastitis is caused by coliforms e.g. Escherichia coli, Micrococcus sp, Enterobacter sp., Nocardia, Citrobacter, Proteus, Pseudomonas, Serratia sp.,and Klebsiella sp. Also*, Staphylococcus aureus* mastitis in heifers often occurs before calving.

Signs and symptoms: Clinical mastitis is characterized by inflammation of udder with abnormal milk. (eg, color, fibrin clots). As the extent of the inflammation increases, changes in the udder (swelling, heat, pain, redness) increases. Clinical cases that include only local signs are referred to as mild or moderate. In severe cases there is systemic involvement which results in fever, anorexia and shock. If the onset is very rapid, as often occurs with severe clinical cases, it is termed an acute case of severe mastitis. More severely affected cows tend to have more serous secretions in the affected quarter.

Treatment: All 4 quarters of infected cows should be treated to ensure elimination of the pathogen and to prevent possible cross-infection of a noninfected quarter. Intramammary infusion products that contain amoxicillin, penicillin, and erythromycin are very effective.

Prevention

Ideal management is critical to prevent mastitis. Clean and dry bedding, clean and dry udders at the time of milking, and lack of teat-end lesions all have a positive effect on control. The single most important management practice to prevent transmission of infections is the use of an effective germicide (eg, 1% iodophor or 4% hypochlorite) as a postmilking teat dip. Bacterins made using core-antigen technology based on J5 mutant *Escherichia coli* can be helpful in reducing the incidence and severity of clinical mastitis caused by coliforms.

Leptospirosis

It is a contagious disease, which is caused by bacteria of genus Leptospira. There are over 200 different strains of Leptospira found worldwide, with infections being most prominent in areas that have a hot and humid climate. There are two strains of *Leptospira* that are frequently identified in dairy and beef cattle – 1) *Leptospira hardjobovis* ; 2) *Leptospira pomona*. Leptospirosis is considered an occupational hazard for many people who work outdoors or with cattle, for example farmers, veterinarians, abattoir workers, sewer workers etc.

Vibriosis

Vibriosis is also known as Bovine Venereal Campylobacteriosis, or BVC.

Etiology: It is caused by *Campylobacter fetus* or *Campylobacter jejuni.* . It is one of the most important infectious venereal diseases of cattle which results in infertility and abortion. It is spread by infected bulls when they mate susceptible cows and heifers or when semen of infected bull is used in artificial insemination. Animals usually harbor the infection without showing signs of illness. C jejuni is zoonotic and is one of the most common causes of enteritis in humans.

Signs and symptoms: Abortion in late pregnancy or stillbirths is the most conspicuous sign. Metritis and placentitis occurs with hemorrhagic, necrotic cotyledons and edematous or leathery intercotyledonary areas.

Diagnosis: The bacteria can be isolated from abomasal, uterine discharge or placental smears and seen in dark field or under fluorescent microscope. Identification of the species involved is important because in some areas C. jejuni is as common as C. fetus, and some vaccines do not include C jejuni. Strict hygiene is necessary to stop an outbreak.

Treatment/prevention and control: Tetracycline is used to treat the infection. The disease tends to be cyclical, with epizootics occurring every 4–5 years. Therefore, vaccination programs, which help prevent outbreaks, should be consistently practiced.

Brucellosis

It is also called as Contagious abortion or Bang's disease.

Etiology: Brucellosis is caused by bacterium *Brucella abortus*. This organism prefers to grow in milk, udder, uterus, lymph nodes, testicles and other accessory sexual gland.

Signs and symptoms: The symptoms include reduced milk production and reduced weight gain. Because of uterus infection it leads to abortion. In bulls, the most obvious clinical sign of this disease is epididymitis (inflammation of epididymis). It is a contagious disease which spreads by direct contact with infected animals or contaminated floor and materials coming in cantact with aborted fetuses, placental membranes, placental fluids, and the vaginal discharges. The chances of infection are high during calving or abortion. Bacteria persist for several weeks in environment and maintain virulence. It is a zoonotic disease as human beings coming in contact with the infected animals or material thereof can get the infection. Milk and colostrum from infected cows is a readily available source of infection for calves and the human population.

Diagnosis: Serum agglutination tests have been the standard diagnostic method. Serological tests of heifer for antibody against Brucella organism may sometimes be negative but actually the animals are positive for the organism. It remains hidden in heifer till she conceives and then the organism reaches to fetus causing abortion. It is strictly advised that person handling such cases of brucellosis should wear gloves and should use proper disinfectant for cleaning. Agglutination tests may also detect antibodies in milk, whey, and semen. An ELISA has been developed to detect antibodies in milk and serum. When the standard plate or tube serum agglutination test is used, complete agglutination at dilutions of 1:100 or more in serum samples of nonvaccinated animals, and of 1:200 of animals vaccinated at 4–12 months of age, are considered positive, and the animals are classified as reactors. Other tests that may be used are complement fixation, rivanol precipitation, and acidified antigen procedures.

Treatment/prevention and control: Prevention is the only best method as treatment is not much effective. Reactors must be culled from the herd to prevent the spread of disease. Any animal before its introduction to the new herd must be checked for seropositivity. Vaccination of calves with *B. abortus* Strain 19 or RB51 increases resistance to infection. Vaccines are also available which uses strain RB51. It is a rough attenuated strain and does not cause production of antibodies, which are detected by most serologic tests.

Anthrax

Anthrax is an acute infectious bacterial disease affecting livestock across all ages and classes of animals.

Signs and symptoms: Sudden death of animal with oozing of blood from natural orifices like nose, mouth, ear or anus should be considered as alarm for anthrax.

Etiology: The causative bacteria *Bacillus anthracis* forms highly resistant spores when they are exposed to the air. These spores can survive in soil for many years. Even the very old buried carcasses which have been exhumed accidently are potential threat of contamination. The spores germinate when eaten or inhaled by grazing stock. They then multiply quickly inside an animal,

invading the bloodstream in large numbers, causing fever and rapid death. The incidence of this disease is unpredictable. Summer and autumn are usually the risk periods but can occur in winter as well. Close grazing of paddock and lush pasture grazing should be suspected in cases of its origin.

Transmission: Aerosol contamination, inhalation while grazing contaminated stock is common as spores are alive for years in air. Blood to blood contact can transmit the bacteria.

Diagnosis: Sudden death of animal is indicative of anthrax. Oozing of blood from natural orifices is characteristic symptom of this disease.

Treatment: Antibiotics usually penicillin or tetracyclines are used to treat the diagnosed cases.

Prevention: Vaccination is very effective in preventing further disease from occurring in animals. However, full immunity takes 10 to 14 days to develop. Antibiotics treatment and vaccination should not be done simultaneously as induction of immunity is reduced by antibiotics

Johne's disease (JD)

This disease is also called as paratuberculosis due to its similarity with tuberculosis (Para = similar to or in parallel to).

Etiology: It is caused by *Mycobacterium paratuberculosis.* Bacteria usually grow in lymph nodes of the animal. These bacteria can live inside cells without being killed by antibiotics. Crohn's disease in human which is characterized by chronic idiopathic inflammatory bowel syndrome is sometimes linked to this organism.

Signs and symptoms: The symptoms of this disease are severe diarrohea with excessive loss of water and debility. This is a deadly problem, as it goes unnoticed for long time, and when it surfaces in the form of diarhhoea, it is often too late. Animals slowly lose weight.

Diagnosis: The tuberculus organisms are very difficult to grow in laboratory. So diagnosis of this disease is mainly based upon some immunological hypersensitivity reactions in the animal.

Treatment/prevention and control: Healthy animals should be protected from coming in contact with the infected animals. Good practice is that calves should be immediately weaned from mother. Animals shed should not be too much congested.

Anaplasmosis:

Anaplasmosis is a vector borne disease of cattle which is caused by the rickesttsial parasites *Anaplasma marginale* and *Anaplasma central.* The parasite grows in red blood cells of animal and destroys it. Therefore, the characteristic symptoms are anemia, fever, weight loss, breathlessness, uncoordinated movements, abortion and death. Advanced stage of disease in elder animals is more serious. Excessive movement or excitement leads to lack of sufficient osygen supply and the animal dies.

Transmission: Ticks are the vector which carries the causative organism form one animal to other. But the disease can also be transmitted by contaminated needles, dehorning equipment, castrating knives, tattoo instruments, biting flies and mosquitoes.

Diagnosis: The diseases can be diagnosed by observing the clinical signs. But the confirmative diagnosis can only be made by the examination of blood under microscope for evidence of the parasite.

Treatment: Usually tetracycline is the drug of choice which is effective only in early stage of the disease.

Prevention: A vaccine is available that reduces the severity of the infection. Tick infestation must be controlled using proper deworming program. Strict sanitation practices should be adopted during vaccinations and other procedures to stop the spread of the disease to healthy animals. Animals that recover from anaplasmosis are carriers and can spread the disease. Chlortetrcycline (CTC) is also used at the rate of 0.5 mg / pound of body weight daily during fly and tick season. It reduces the risk of anaplasmosis. CTC is also available as medicated feed, free choice salt-mineral mixes or medicated blocks.

Review questions:

1. What are the infectious diseases of dairy animals?
2. Mastitis is inflammation of udder. How do you recognize this disease? Write the name of causative organisms, its diagnosis, treatment and control masseurs.
3. What are the three determinants of disease in dairy animals?

Chapter – 14

Prevention and control of diseases – vaccination, deworming, quarantine etc

Animals suffer with many types of diseases. Some are mild in nature causing only little harm to the animal while others are of very serious nature which may even kill the animal. Abnormal health of animals results in poor performance which is finally a loss to the farmers. There is a famous adage "prevention is better than cure". If we prevent the disease from occurring it saves the animals from the agony and pain at the same time it saves unnecessary cost on treatment, medicine and management. Definitely, proper and wise management is the first step in prevention and control of disease. Nevertheless, some problems and disease cannot be stopped. For such cases there are case-specific or disease specific preventive measures. Farmers should follow these measures and provision for the prevention and control of diseases.

Prevention: It is an act of adopting method or set of methods to thwart the entry of disease into the herd.

Control: It is an act of blocking the spread of disease.

Both can be achieved by either vaccination, deworming, or by quarantine. Deworming is essentially a therapeutic approach where medicines are given to the animals to get rid of the existing infestations. Therefore, vaccination and quarantine are two main practices adopted for the prevention and control of diseases in animals.

Notifiable diseases: These are the diseases which are considered as potential threat to the animal welfare and society. It "must" be reported to the local office of the Animal Health or Veterinary Laboratories Agency. They can be endemic (those which are already existing in India) or exotic (those that are not normally present in that area) or zoonotic (those that can pass between animals and humans, such as rabies). Examples of notifiable diseases are

- anthrax
- Aujesky's disease
- bluetongue
- BSE (bovine spongiform encephalopathy)
- brucellosis (brucella abortus)
- contagious bovine pleuro-pneumonia
- EBL (enzootic bovine leukosis)

- foot and mouth disease
- lumpy-skin disease
- pleuropneumonia
- rabies
- rift-valley fever
- rinderpest
- bovine tuberculosis
- vesicular stomatitis
- warble fly

The most common endemic diseases of bovine are

- BVD and BVD2
- IBR
- Johne's disease
- certain forms of tuberculosis
- salmonella
- mastitis
- other viral, bacterial and mycoplasma pneumonia

Prevention and control of Brucellosis:

Brucellosis of cattle is also known as contagious abortion. It is caused by infection with the bacterium 'Brucella abortus.. Abortion in early phase is the common sign of this disease. The reproductive discharge carries bacteria. Milk from infected animal contains Brucella organism. It is zoonotic in nature**.** People can become infected by drinking untreated milk and by contact with infected animals. Pasteurization kills the bacteria completely.

Preventive measures:

- Wear gloves and dangri while handling the aborted fetal materials.
- Adopt strict guidelines to report such cases.
- The aborted materials should be properly incinerated and premise must be disinfected
- When animals are imported post-import check testing is must.
- Follow post-calving check testing

Prevention and control of tuberculosis in cattle

Bovine Tuberculosis (bTB) is a serious problem of cattle which is characterized by weakness, emaciation, difficulty breathing, enlarged lymph nodes and coughing. It is caused by Mycobaterium tuberculosis. This disease can spread to humans through

contaminated milk samples. Human consumption of milk (raw or pasteurized) from any animal testing positive for bTB is unethical. However, milk from the rest of the herd can still be used for human consumption - as long as it's heat-treated.

Preventive measures:

1. Every one to two year or when some animals are found suffering with bTB, there should be a tuberculin skin test.
2. Animal testing positive should be immediately culled or eliminated from the herd.
3. There should be routine testing for high health risk people like producers of raw milk, handlers of animals, or people consuming unpasteurized dairy products.
4. Pre-movement testing: There should be compulsory tests before cattle aged 42 days or more are moved from a high risk area to other areas.
5. Post-mortem testing: Animals must be checked post mortem for the presence of bTB so that necessary retrograde diagnosis and preventive measures could be made to trace the affected or susceptible herd.
6. Use gamma inteferon blood test to along with tuberculin tests to hasten the detection of positive cases in a large herd. It will help controlling the disease from spread.

Vaccination

Vaccination is a word derived from Latin language "vacca" which means cow. The cowpox material used for injections was then called *vaccine.* And the process of injecting it into animal or human is called vaccination. The principle behind vaccination is the introduction of pathogenic material in part or complete whose pathogenicity has been reduced by some mechanism, into a healthy animal so that body can form enough defense molecules (antibodies, defense cells, cytokines etc.) to counter the attack of the same pathogen. When body is exposed to small amount of foreign materials (pathogens) body's immunity is activated. Activated immunity lasts longer in the body which is capable of killing the pathogen.

Why is there need to vaccinate the animal

It is usually wise to prevent the disease from occurring than treatment. Cost incurred in treatment is usually more than the cost of prevention beside the pain and suffering of animal when diseased. Diseases reduce the production of animal. Vaccination stimulates the animal's immune system to produce protective antibodies that will help combat the invading disease organisms in the animal's body.

A large number of vaccines are available to prevent the occurrence of disease in dairy animals. Most common vaccines available commercially are killed or modified live vaccines. Although vaccination program is disease specific and vaccine specific, in general, most killed vaccines must be administered twice, two to four weeks apart. It takes approximately four to six weeks after the initial vaccination before the animal's body will be able to respond to exposure to disease. A modified-live vaccine contains the live pathogen whose virulence has been attenuated so that it may not make the animal sick. The animal responds to a modified-live vaccine more quickly and usually only one vaccination is required. Modified-live vaccines are typically not recommended for pregnant animals.

What should be the time of vaccination?

It depends on the type of diseases. Some vaccines are for routine purposes while others are for only during the time of threat or risk. Time of vaccination also depends on the age, productive and reproductive stage of animal, season etc. Vaccination takes its time to boost immunity. It is usually 4- 6 weeks after the vaccination that the protective immunity is generated in the body of animal. Reproductively active cows and bulls are at highest risk for reproductive diseases prior to and during the breeding season. Vaccination of breeding animals 30 to 60 days prior to breeding season is considered optimal for the prevention of reproductive diseases.

Colostrum is the rich source of antibodies

The first milk after parturition is called colostrums (in the village of India it is also called as Khees). It is yellowish in color and thick in consistency. It is very rich source of antibodies particularly the secretory IgA. Calves must be fed colostrums immediately after their birth. It provides readymade antibodies (passive immunity) to the calf which is easily absorbed by the gut of calf. It helps the calf to fight against pathogens in the early phase of its life. The cows which are vaccinated 30-60 days prior to calving produce high quality colostrum.

You should be careful about the storage, transportation and usage of vaccines

Modified live vaccines are usually heat sensitive. So it is desirable that vaccines should be stored and transported at low temperature ($4^{o}C$). Vials of vaccines must not be exposed to direct sunlight as UV rays destroy the modified live organism. Route of administration of vaccine into the body of animal plays important role in production of standing immunity. Most vaccines are administered under the skin (subcutaneously) or in the muscle (intra-muscularly). For beef cattle Beef Quality Assurance guidelines (BQA) recommend that the vaccine injections should be made only in the neck region so that the valuable body part should not be adversely affected.

Site of injection and size of the needle for the injection of vaccines

Intra-dermal (I/d), Subcutaneous (S/c), and intra-muscular (I/m) routes are popular mode of vaccine administration. Needle size is important. An 18-gauge, 1½-inch long needle should be

used for intra muscular injections on most cattle. A 1-inch needle can be used on smaller calves. An intramuscular injection should be administered at a right angle to the animal. A 16-18-gauge, ½- to ¾-inch needle should be used for subcutaneous injections. For the S/c injection skin should be tented (pulled away from the body) and needle should be inserted to the extent in an oblique angel where needle is free to move in 360^{o}. Intradermal injection is done just in the skin where it is very hard in the skin. I/m route of administration is quite deep below the skin into the muscles.

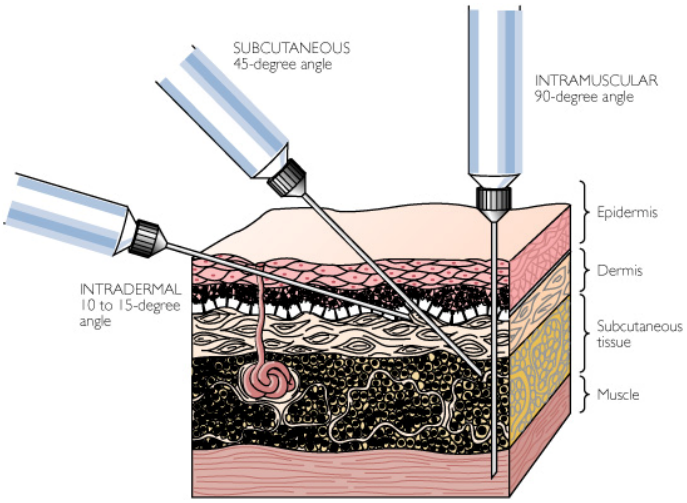


Fig. Route of administration of injectible vaccine into the body of animal

Vaccination schedule for some common disease in cattle

Although dose, route and time of vaccination are very unique to the manufacturers, some general guidelines are as following.

Vaccination schedule in calves and heifers

Recommended vaccine	Time to vaccinate
Black leg -7way	At 2-6 months and 12-16 months
IBR-BVD-PI_3 -BRSV	At 2-6 months and 12-16 months
Leptospirosis	Before breeding and every 6 months
Brucellosis	Heifers (4-12 months)
Optional	
Pasteurella	At 2-6 months and 12-16 months
Haemophilus somnus	At 2-6 months and 12-16 months
Vibriosis	Before breeding
Pinkeye	AS needed
E. coli for scours	Vaccinate springing heifers (twice 30 days before calving)

	Rota and Corona virus for scours	Vaccinate springing heifers (twice 30 days before calving)
	Anthrax	As needed
	Ringworm	As needed
	Warts	As needed
	Foot rot	As needed
	Diarrhea	As needed

Vaccination schedule in cows and bull

	Recommended vaccine	**Time to vaccinate**
	IBR	Annually
	BVD	Annually
	PI3	Annually
	BRSV	Annually
	Leptospirosis- 5 way	Annual (every 3 to 6 months in some areas)
	Optional Vaccines – Used as Needed	
	Vibriosis	Annual (30-60 days before breeding)
	Trichomoniasis	Annual (30-60 days before breeding) if needed
	Pinkeye	As needed
	Anthrax	Annually
	Black leg- 7 way	Annually
	Anaplasmosis	As needed
	Foot rot	As needed
	Mastitis	As needed, primarily for Staphyloccocus aureus
	Hairy heel warts	As needed
	E. coli for scours	Vaccinate dry cows and/or calves

Some common diseases of cattle, their symptoms and preventive measures

Diseases	Symptoms	Prevention
Clostridium infection (Blackleg 7-way)	• Sudden death • swelling in body parts	Vaccination at 2-6 months age with two vaccinations 2-6 weeks apart. Give booster annually
Vibriosis (Campylobacter)	• Abortion in early pregnancy • Several services per conception • irregular heat periods	Use A.I. and vaccinate yearly if a problem is identified
Leptospirosis	• Abortions **any time** • High fever • Poor appetite • bloody urine • Anemia • Ropy milk	Vaccination at 4-6 and 12-16 months followed yearly; Keep cattle away from other animals that can be carriers of Leptospira
Brucellosis	• Abortions **in last third of pregnancy** • Retained placenta • Several services per conception.	Calfhood vaccination at 4-12 months of age (4-8 months preferred); Practice A.I.
Bovine respiratory disease complex (BRDC) or shipping fever	• Respiratory disease • High fever • Nasal discharge, coughing, • Rough hair coat if severe;	Vaccination at 4-6 and 12-16 months, followed by yearly and before severe stress periods caused by viruses (IBR, BVD, PI3

			and BRSV) or bacteria (Mannheimia, Pasteurella)
	Warts	• Crusty cauliflower-like overgrowths of skin	Good sanitation and vaccination
	Foot rot	• A break in the skin or hoof, usually between • the toes, allowing bacteria to enter • Rapid progressive lameness • swollen foot, • Characteristic foul odor	Maintain clean, dry yards; dispose foreign materials that might cause a break in the skin or hoof, trim feet, vaccinate if chronic problem exists
	Ringworm	• Gray, circular, crusty patches on skin most often on head and shoulders	It disappears when animals are let out in spring sunshine.
	Diarrhea (scours), bacterial (E. coli, Salmonella, or viral Rotavirus or Coronavirus)	• High temperature, • Watery feces, • Sunken eyes • Skin fold test: Slow return to normal on being pinched up in skin.	Feed colostrum to calves. Individual stall is good for calves less than 2 months old. Do not overfeed. Do not overcrowd. Vaccination of dams in 3rd trimester with specific agent to build immunity; Vaccinate calves immediately at birth

	Hairy heel warts (foot warts)	• Reddened area between the toes on the back of the feet • Advanced raspberry-like lesions with protruding hairs	Dry environment; maintain closed herd; Antibiotic (Oxytetracycline) spray on the feet of infected cows; Vaccinate
	Anthrax	• Sudden death with bloody discharges from natural orifices, • Previous cases or outbreak of anthrax in that area	Vaccinate; Never open the carcasses suspected of dying due to anthrax
	Trichomoniasis	• Poor fertility, irregular heat periods	Use A.I., and vaccinate animals
	Mastitis	• Decrease in milk production • High bacterial load in udder, high somatic count in milk. • Swollen, red, hot and painful udder, • chronic cases may produce only flaky milk • Uneven quarter • Slow milking	Effective dry cow treatment in combination with regular use of a good teat dip after each milking; milking system of proper design and installation maintained regularly; follow well- managed milking procedures; in specific cases, vaccination may be helpful
	Pinkeye	• Inflammation of eye with cloudiness of cornea, Watery eye with reddening of eyeball and	Proper insect control, vaccination, isolate infected animals from the healthy; treat with antibiotics, commercial

	• swelling of eyelids	sprays, or patches on eye to prevent spread.

Review questions:

1. What do you understand by the term vaccination?
2. Why do you think prevention is better than cure? Can you explain this in context of dairy animals?

Chapter – 15

Culling, Quarantine, Disposal of dead animals, placenta, animal discharge and other exudates

Dairy animals also suffer with diseases like we human being suffer. Since animals usually live in herd and they eat and drink in common manger and pool, the diseased animals are threat to other healthy animals. The chances of spread of infectious disease increase. Hence, there are standards guidelines to keep such diseased animals away from the healthy one and in cases if animal dies we should know how to dispose-off the dead animal. Culling, quarantine and disposal of dead or diseased animal part is essential for a good animal husbandry practice.

Culling:

The word comes from Latin language word *"colligere" which means "to collect"*. In animal husbandry this means to collect the good ones so as to separate them from the bad ones. Over the time culling has been considered mainly as the removal of the undesirable animals from the desirable ones. This removal can be in any form like separating the animals, killing the incurably diseased animals or selling away the animals. Sometimes, in dairy herd some animals are unproductive. These animals usually underperform and total farm production comes down. In such situation it is desirable to cull the unproductive animals so that herd should contain only the good high productive animals. In dairy husbandry culling and selection are very important. We can consider these two events as two faces of one coin. When some animals are selected for their better characteristics it automatically means that those animals who are poor performers will be culled.

Quarantine:

The word has its origin in Latin language word *"quarantena"* which means *"forty days period"*. During the period 1348 to 1359 to prevent the spread of black death which killed around 30% of Asian and European population, people coming from outside were kept at the entrance of the city for 30 days (trentine) which was later increased to 40 days (quarantine) to observe that they don't develop the symptoms of disease and then only they were allowed to enter the city. The practice of quarantine since then is very common in human as well as in animals. The purpose of quarantine in animals is to segregate the suspected animals from the healthy stock till appropriate time so that disease could not be transmitted to healthy animals inadvertently. It is very mandatory during the new purchase of animals or immediately after the transport of animals from one place to other. It is important to remember that although its literal meaning is forty days alienation, the time to keep animals in isolation depends on incubation period of pathogen

involved in the diseases. For example, the quarantine time for FMD infected animals is 21 to 28 days.

Sometimes quarantine is done for cases where we know that animal is suffering with communicable disease but they can recover from the disease after some care and medication. Keeping such animals in quarantine prevents their contact with other healthy animals and thus stops further transmission of infection. Foot and Mouth disease (FMD) is a very common disease of dairy animals which is caused by virus. Saliva, hooves and skin of suffering animals is usually loaded with virus. In controlling an outbreak of foot-and-mouth disease it is important to reduce as much as possible the risks of transmission of virus from one premise to another during animal movement. Wind also spreads these viruses. So during outbreak of FMD it is essential that suspected as well as suffering animals should be quarantined. It is advised that in the event of an outbreak, an immediate total 72-hour ban on movements on or off farms within the 10 km area around an infected premises should be imposed (except for genuine emergencies), to allow initial epidemiological tracings to be carried out. In case of dairy animals quarantine is strictly followed with regard to FMD, particularly, when animals are moved from one place to other or from one country to other. Quarantine is usually applied

- To animals prior to import to an FMD-free country
- To animals prior to entry onto farms of high disease security
- To animals migrating through regions attempting to control FMD
- Within farms in endemic areas to separate infected from susceptible stock

Dead animal disposal

Dead animals must be disposed off properly so that they don't stay unattended in filed, barn or streets. It is usually difficult to know the exact cause of death specifically when the animal is undomesticated. The dead body left in open is an invitation to vultures and wild dogs. The severed body parts are scattered to far off places and they start rotting. Decaying fleshes serve as hot bed for the germination of pathogens and emits bad odour. Coming in contact to such rotten material or dead bodies is a severe threat of diseases in society. There is always a danger of contamination of water resources, fields and open public places. Therefore, throwing dead animals in open area or to leave them unattended is illegal and should be absolutely refrained. There are strict guidelines to properly dispose the dead animals.

Some of the common methods of dead body disposal for animals are as follows

1. Burial
2. Incineration
3. Daily Pickup
4. Freeze and Pickup
5. Landfilling

Burial

Burial is an old method of dead animal disposal practiced across the world. In this method dead body is buried in a pit and covered with soil. In ancient time when space was not a constraint, burial used to be done away from society so that people were not at risk of any accidental exposure. But with increasing population and decreasing space burial now seems a difficult method to adopt. Typically this method consists of digging a large pit or trench, inserting dead animals and covering them with one to two feet of soil. The biggest risk in such method is rain water flow into such pits. If covering has not been done properly, the carcass absorbs water and starts floating on surface. Bacterial load is usually heavy in such buried carcasses so water draining from these pits may contaminate ground water which a serious threat to human health. Apart from this, stray animals like dogs, foxes, pigs and rats snake, flies etc are attracted to these burial sites and they dig open the pits and trench.

Therefore, ideal burial place should be chosen away from the society or public places. The area should be marked and proper barricading must be done so that it is protected from wild animal's entry. Pits or trench should be very deep appropriate to completely cover the body. At least 3 feet of space must remain empty between the body and the top surface. A distance of at least 2 feet should be maintained between bottom of the trench and the seasonal ground water level. Pits should have a brim so as to prevent rainfall directly into the pit and also runoff from such pits should not be allowed to mix with ground water. It is desirable to cover the pits up to 2 feet above the top surface of pit. This prevents water to accumulate into pits. Covered area should be grassed to avoid soil erosion by wind or water. Proper marking of burial place and continuous monitoring is essential for its proper maintenance.

While selecting a suitable burial area the following criteria should be kept in mind

1. The distance of the burial site from the flood plain. It should be away from flood region.
2. Soil type. It should not allow infiltration of water to pit area
3. Rate of receiving of carcasses per year
4. Depth of seasonal high water table
5. No burial site should be flooded with surface water

According to Alberta Agriculture and Rural Development (ARD), Regulatory Services Division guidelines for destruction and disposal of dead animals, the following considerations should be made about pit or trench.

- At least 100 metres (300 ft) from wells or other domestic water intakes, streams, creeks, ponds, springs and high water marks of lakes and at least 25 metres from the edge of a coulee, major cut or embankment.
- constructed such that the bottom of the pit is 1.2 metres (4 ft) above the high water table
- At least 100 metres from any residences;
- At least100 metres from any livestock facilities, including pastures, situated on land owned or leased by another person;
- At least 300 metres from a primary highway;
- At least 100 metres from a secondary highway; and
- At least 50 metres from any other road allowance.
- The pit must be covered with a minimum of one meter of compacted soil
- Hydrated lime (quick lime) to speed up decomposition and deter scavengers and insect infestation

- A wooden or metal lid that is designed to exclude scavengers, if quicklime is applied to the dead animal in sufficient quantities to control flies and odour.
- The bottom of the pit must be at least one metre above the seasonal high-water table.

Incineration

This method is considered better than burial as it converts every part of body in ash. This is fast and can be done in small space. The chances of environmental contamination and infection to other organism are almost negligible. It doesn't result in decay of body so it is more acceptable by the society. Homemade incinerators are not permitted because the combustion rate in these incinerators is slow which pollutes air. It is desirable that the emission of particulate matter must be less than one pound per hour at the maximum rated capacity. A quality incinerator is custom designed and must pass through regulatory guidelines. The incinerator must be a package incinerator and have a rated capacity of 500 pounds per hour or smaller, and it must burn virgin fuel only (according to department of environment and health control, South Carolina). The ideal incinerator cannot exceed an opacity limit of 10 percent. Nowadays electrical incinerators are available which are very fast and nonpolluting. An incineration should be operated to meet the maximum requirements of 0.5 hour retention time in the chamber at 1400-1600^{o}F
Where incinerators are employed for dead animal disposal, they must:

1. where possible, be located so that prevailing winds carry exhaust fumes away from neighbors
2. have sufficient capacity so that all odor levels stay within tolerable limits;
3. be 50 m (160 ft) minimum from wells or domestic water intakes
4. be fire safe; and,
5. consume all material fed into them

Daily pick up and Freeze pickup

As soon as animals die they are picked up same day and sent for postmortem. After postmortem animals are disposed by any of the suitable methods discussed so far. Freeze pick method is more suitable for poultry because of its small size high death rate. Poultry farms are checked daily and any dead bird is picked and stored in freeze till a maximum of 7 days. The disposal vans visit these farms weekly and take away the carcasses.

Landfilling

Depositing dead animals in the local landfill is a practice that has been used by some producers for many years in other world countries but not in India. This method is common where the dead animal is large and death is occasional or there is a sudden catastrophic death of many animals.

Biosecurity

It is essential that the carcasses should be first examined postmortem. The knowledge about the cause of death helps owner, society and government to take appropriate measures to prevent further death. Another advantage of postmortem examination is that if animals died of natural death the carcasses can be directly sent to rendering industry where its body parts can be used for other industrial or research use. If animal has died under domestication it is taken-care by the owner. But sometimes, we come across stray animals found dead on streets or field. As a responsible citizen we should inform about it to the nearest veterinary hospital or animal care

center. In no case, we should leave it unattended. The person engaged in routine or occasional duty of dead body disposal should wear mask, gloves, goggles, cap and shoes and should not come in direct contact with discharge, exudates or any body part of the carcass.

Precaution

When you find a **wild** animal dead on street or somewhere, never deal with it. It is a serious issue. Immediately, inform to local veterinary clinic/ health department or nearest police station. You should never keep a dead animal in your premise for more than 48 hours. Mortalities must be kept in a secure and frozen state if not disposed of within 48 hours from the time of death.

Disposal of farm waste

Like any other industry dairy industry or animal farms also produce waste. These wastes include, dung, urine, hair, skin, bone, animal discharge during disease or pregnancy, placenta, clinics wastes (spent medicine, container, cotton, medicine wrappers, vials, bandages, needle, blades), waste forage, waste fruit and vegetables (including organic waste dumps), water etc. There should be proper system for hygienic disposal and management of these wastes.
Some other uncommon farm waste includes

1. Dead animals
2. petroleum products such as used motor oil;
3. paints and preservatives;
4. pesticides;
5. machinery and equipment including inert components, tires and restricted use
6. components such as batteries;
7. Farm structures such as old buildings including building components etc.

The farm animal wastes must be disposed according to their nature. For example, sharp edged solid materials like needle, blades, glass pieces etc. should be kept in a solid container. The cloths, cotton, wrapper and other similar materials should be collected and stored in separate container. Packaging materials that once contained toxic materials, such as pesticides and unused antibiotics need to be disposed of as per guidelines for the disposal of pesticide/antibiotics containers.
While disposing antibiotics utmost care should be adopted so that they should never be spilled or thrown in drainage, wash basin, or water store. Residual antibiotics are danger for development of resistant microbes in environment.
All plastic wastes should be collected and stored separately and sent for recycling.
Fodder waste is most bulky in any animal farm. Waste forage is a normal by-product of any livestock feeding system. It includes hay, waste silage and silage effluent. When hay is harvested, it is allowed to dry to less than 15% moisture. When it is stored and fed, it poses no environmental hazard. In most instances, wasted hay during feeding is incorporated with the bedding and manure. It is not advisable to burn waste forages since this can cause nuisance odours and contributes to air pollution.
The potential for waste by-product from silage feeding systems also exists. However, because silage is usually harvested and stored at a much higher moisture content than hay, there is also the potential for leachate or seepage waste from the storage area. Silage seepage can have a serious impact on surface and groundwater quality and can create odours.

Management options for waste forage include:

1. The amount of forage and fodder required for each year must be calculated carefully to avoid any wastage
2. Forage waste must be recycled for hay or silage formation. Or they can be used in mulching fields (It adds organic matter and protects against soil erosion.
3. Waste hay and silage can be used as compost, thereby making it easier to handle when applied on the land.

Live material/tissue/placenta or any material potentially contaminated with infectious agents

The materials which are considered live waste/blood/bones or tissue parts with possibility of bearing infectious materials in them are first autoclaved at 140C at 15 lbs pressure for half an hour. These wastes can be separated into hard and soft groups and then should be discarded in municipal wastes. Placental discharge is routine waste at animal farms. It comes out from uterus at the time of parturition along with the delivery of calves. It contains lot of water stained with blood. Blood is a fertile bed for the growth of microbes. Such blood mixed water should be boiled till 100^{o}C for half an hour and then properly put in municipal waste or recycled.

Review questions:

1. Why culling is needed in dairy farm?
2. Explain quarantine in dairy animals.
3. What are the methods of dead animal disposal?
4. What precautions should you take while handling dead animals or animal wastes?

Chapter – 16

Biotechnology in dairy health, production and reproduction (I)

Introduction:

Our knowledge about dairy animals is increasing at a faster rate. We rear animals for getting milk and other produce beneficial to the society. Every animal has a particular unique genotype which decides its production potential and its ability to survive in the changing environment. Over the time nature has imposed selection of particular genotype so that it can survive successfully. Recently, we have learnt to manipulate the genes in animals so that desired characteristics can be introduced into the animals from outside and the undesired traits can be eliminated from the animals. The art of manipulating genes is called genetic engineering. Traditionally, genes have been transferred across the animals by artificial insemination (AI) or cross breeding. In these methods good genotype is selectively used to produce high producing animals. Attempts are always to produce an offspring with elite characteristics. Now-a-days, the genetic engineering technology has become sophisticated. We can play with single gene at a time. Particular gene can be added to the genome or it can be deleted from the genome. For example, sometimes we want that a bad gene which causes genetic disease should be removed from the genome. Similarly, we can introduce some human gene for example human insulin gene in the genome of cows, buffalo or goat. The human insulin thus will be produced in cow's milk which can be purified for its application in human to treat disease like diabetes. In this chapter we will read about some of these technologies which are called biotechnology for dairy animals.

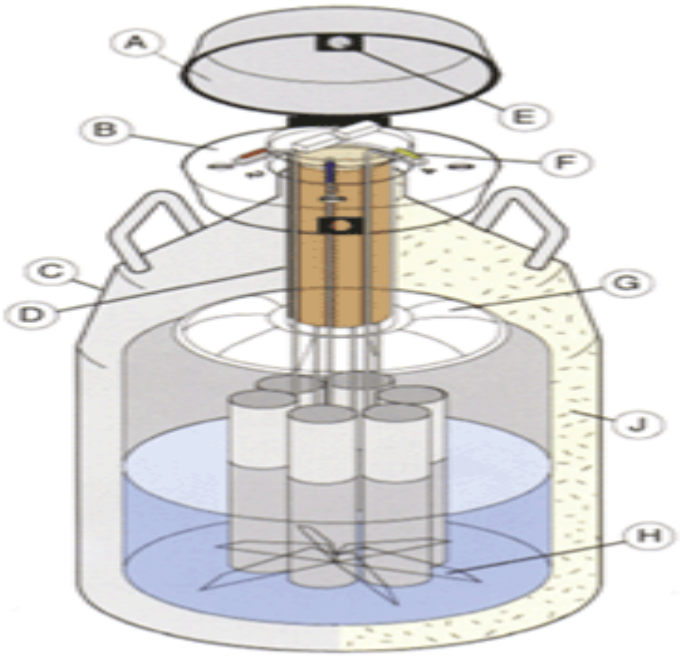
Artificial Insemination (AI):

Artificial insemination is the method of impregnating a female dairy animal (cow, she-buffalo or she-goat) with the semen from a bull by human being. It is so called because it is done by human. Otherwise, in nature bull usually mounts a cow when the later is in estrus (heat) this method is called natural service (NS). A cow is called in estrus when she is receptive for being mounted by the bull. It is important to know that the reproductive cycle in cow, buffalo and goat is of 21 days. In this cycle the estrus period is of only 20 hours in cows and buffalo and 12-36 hours in goat. If cow is mounted by the bull (natural service) in the period of estrus, estrous cycle enters into pregnancy. The gestation period in cow, buffalo and goat is of 290 days, 310 days and 150 days respectively. For artificial insemination, semen from the desired bull is collected manually by human being and filled in thin plastic straws and stored in liquid nitrogen which maintains very low temperature of -196C. Low temperature is very necessary to keep sperms viable in the semen. As such, number of sperms per ejaculate in cow is around 1200 million.

This number is too large to fertilize a single ovum. So fresh semen collected from the bull is usually diluted in a suitable medium and then filled in straws and stored. Ideally, 20-40 million sperm per ml should be present in the straw for a successful AI.

Liquid nitrogen

It maintains the temperature of -196C. The vapour maintains temperature around -180C. Semen is stored in straws at this temperature. Sperms remain alive for



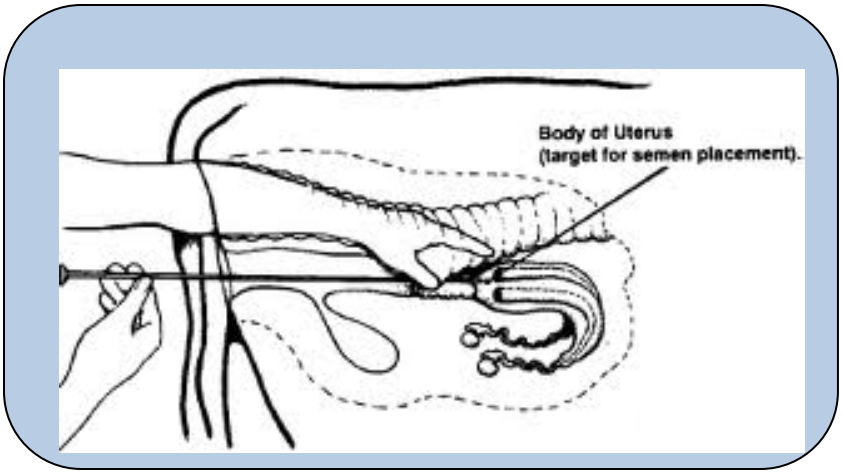
years.

Why AI is done?

In natural service usually one bull can fertilize a limited number of cows. This is very slow process. Since cows are reared for maximum production, any farm desires that maximum number of cows should be in the state of pregnancy. By AI large number cows can be impregnated with the single ejaculate from the good bulls. Sometimes, cows don't allow a bull to mount on her it may be because of physical incompatibility, disease or because of the absence of bull. In AI it is possible to dilute the semen and make several doses which can be stored in liquid nitrogen for later use.

How to do AI?

The most common method of AI in cows is recto-vaginal method. In this left hand is used to clean the rectum and insert in the rectum to palpate the below lying reproductive organs. With right hand semen gun is inserted through vagina till cervix and then semen is deposited.



Step wise protocol for AI

1. Restrain the animal in a comfortable situation.
2. Clean the whole rump area with water
3. Evacuate the rectum of the dung
4. Insert your left hand gently into the rectum as far as it can move smoothly.
5. Insert AI gun through vagina at an angle of 30o toward rectum
6. Feel the cervix with left hand and inset the tip of AI gun into the central hole of cervix.
7. Guide the AI gun towards the body of uterus and push the plunger of the gun to deposit the semen slowly.
8. Slowly take out the AI gun out of the vagina
9. Take out your hand from the rectum

Advantages of AI

1. It allows the wide spread use of semen of an elite bull. The semen can be used even if the bull is, insured, diseased or far located or even died long time back
2. Proper management of farm as a large number of animals can be served simultaneously.
3. Instead of transporting the bull semen can be transported which is easier and requires less expenditure.
4. Gender sorted semen can be used though AI to get either male or female progeny which is not possible with natural service
5. Many of the sexually transmitted diseases (venereal diseases) can be prevented as there is animal to animal contact
6. Because semen can be diluted and used in AI, it reduces the number of bull maintained at farm.
7. Sometimes cow doesn't allow the bull to mount. AI is the only option in such cases.

Limitations/demerits of AI

1. High skill and practice is needed to perform AI successfully.
2. Improperly done AI may lead to vaginal injury or if the AI gun is not sterile it may lead to infectious disease and later abortion
3. The detection of estrus is critical for successful AI. If the farmer misses heat detection AI cannot be done at proper time.

4. The maintenance of low temperature is a must which sometimes is not possible in remote areas

Precautions:

The reproductive tract of cow is very delicate. All procedures must be done gently. Atke following care while doing AI

1. Use full sleeve gloves
2. Properly clean the animals and the premise before AI
3. The AI gun and other materials should be sterile
4. No injury should be reached to rectum or vagina
5. Cervix is a complex structure. While passing the AI gun maintain patience and take extra care.
6. Never do AI in hurry.

Animal cloning

Animal cloning is an emerging area which promises to conserve endangered species and the production of good quality animals exactly similar to its genotype. In traditional approach of genetic improvement like cross breeding and artificial insemination (AI) the offspring receives the genetic makeup of both of its parents. It means, progeny will bear the characteristics of both the parents. But what if we want to produce an animal of exactly same genotype? Cloning is the method of producing animals which bear exactly same genotype. Two or more animals which are exactly similar in genotype are called as clones of each other. The very famous clones of sheep named “dolly” was the first example of such technology in large animals.

Principle of animal cloning

In normal method of producing offspring there is fertilization between sperm and ovum which has haploid number of chromosomes. The embryos thus produced have diploid number of chromosomes with each set coming from one parent. Therefore, the characteristics of such offspring will be mixture of mother and father (in animals it is mixture of dam and sire). Cloning makes it possible that the offspring can be produced without fertilization. The diploid cells of body can be used to produce whole new individual animal. Usually, cells present in the body of animal are in differentiated state. It means that cells have acquired some special characteristics by regulating the expression of proteins from its genome (the complete set of DNA in a cell). Once the cells are differentiated their ability to form a complete animal is lost. Embryonic stem cells can produce complete individual from a single cell. Such cells are called pluripotent cells. Pluripotent cells have their nuclear DNA in primitive state which expresses only those proteins which are necessary for keeping them in pluripotency. Now a-days techniques have been developed to convert differentiated cells into pluripotent cells. The method is called dedifferentiation or reprogramming. Five days before use, the nutrient level in the culture is

reduced so that the cells stop dividing and enter G0 of the cell cycle. The dedifferentiated cells under proper culture condition can form a complete organism. Therefore, a “diploid nucleus” is the important material for animal cloning. Clones can be produced from such diploid nucleus of stem cells or pluripotent cells or from differentiated cells after its dedifferentiation.

The isolated nucleus from such somatic cells requires a cytoplasmic space to grow. This space is provided in the form of enucleated oocyte. An enucleated oocyte is an oocyte whose nucleus has been removed. It offers cytoplasm (ooplasm) and relatively bigger space for nucleus to reside in. The method of fusion between somatic cell nucleus and enucleated oocyte is called somatic cell nuclear transfer (SCNT). The culture conditions are monitored and optimized which gives rise to replication of DNA and further division of cells result in 2 cell stage, 4 cell stage, 8 cell stage, 16 cell stage and finally morula. The morula is transferred into the uterus of a recipient cow called surrogate mother. In surrogate mother uterus the transferred morula further grows to become complete fetus and eventually born as clone of the animal which provided “the nucleus”. The whole process of animal cloning occurs in two step one inside the glass tubes and the other inside the mother’s womb. Entire process which takes place in glass tube is called in-vitro method and the process which takes place in the body of animal is called in-vivo.

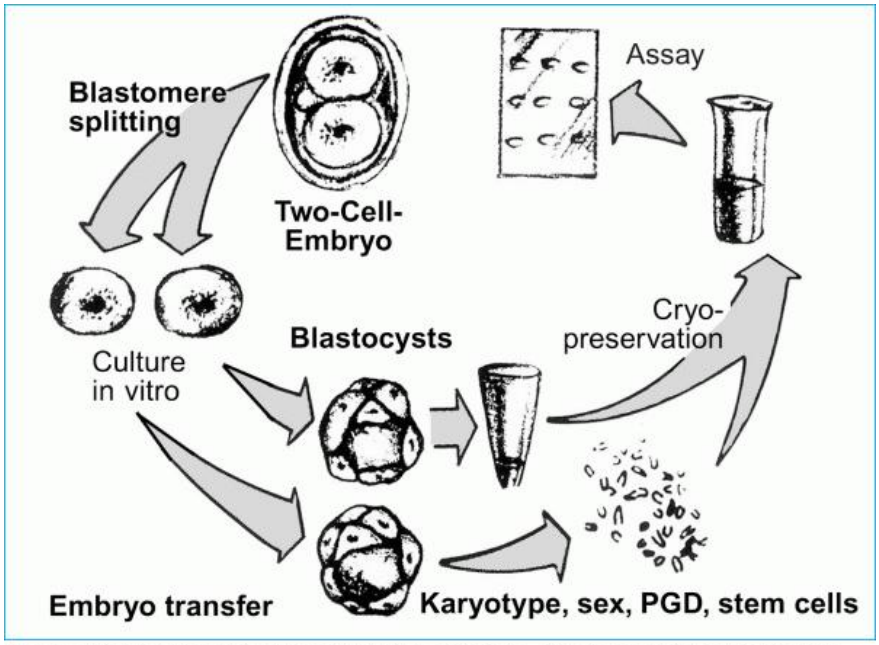
In-vitro process includes: 1. Isolation of somatic cells, 2. Culture of somatic cells. 3. Fusion of donor nuclei with enucleated oocyte, and further growth of fused cells till morula.

In-vivo process includes 1. Transfer of morula to the uterus of surrogate mother and 2. Further growth and development till parturition.

Schematic diagram of animal cloning

Cloning by embryo splitting:

Artificially splitting (separating) a single embryo at a very early stage of development into individual cells and allowing them to grow in to separate individual is called embryo splitting. In this method embryos can be produced by in-vitro fertilization or by embryo flushing from a super ovulation program. The cells in these embryos are pluripotent. The cells are separated by splitting. An embryo can be split in to two or more part. From each part a new animal can develop. Embryo splitting is a microsurgery like technique where embryos are kept under microscope and cut with a micro knife. Since all the cells of a single embryo have same genetic makeup, all offspring developed from these cells will be clones of each other. The only limitation with this method is that embryonic cells carry best pluripotency only up to 8 cell stage. So number of clones produced is limited by the number of good cells obtained from the splitting of embryo.



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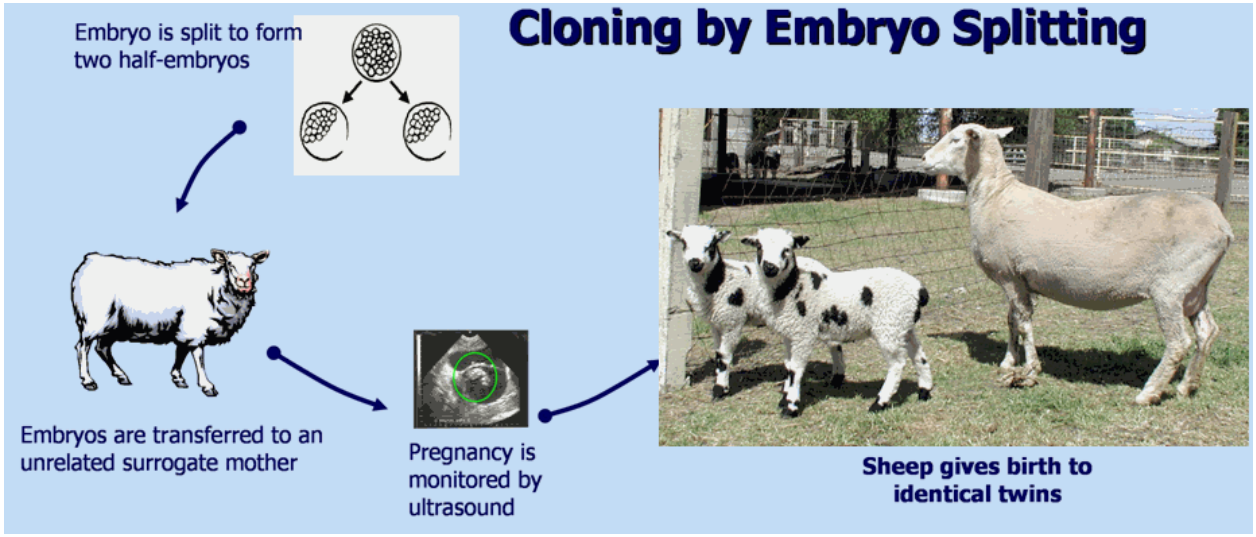


Cloning by somatic cell nuclear transfer (SCNT)

When clone is to be prepared from adult somatic cells which are differentiated cells, SCNT method is used. Somatic cells are harvested from any body part of the animal. It may be ear, skin or liver cells. Such animals from which nucleus is taken is called donor animal because the genetic makeup of cloned offspring will be of this animal. SCNT is a three step procedure.

a. production of enucleated eggs:

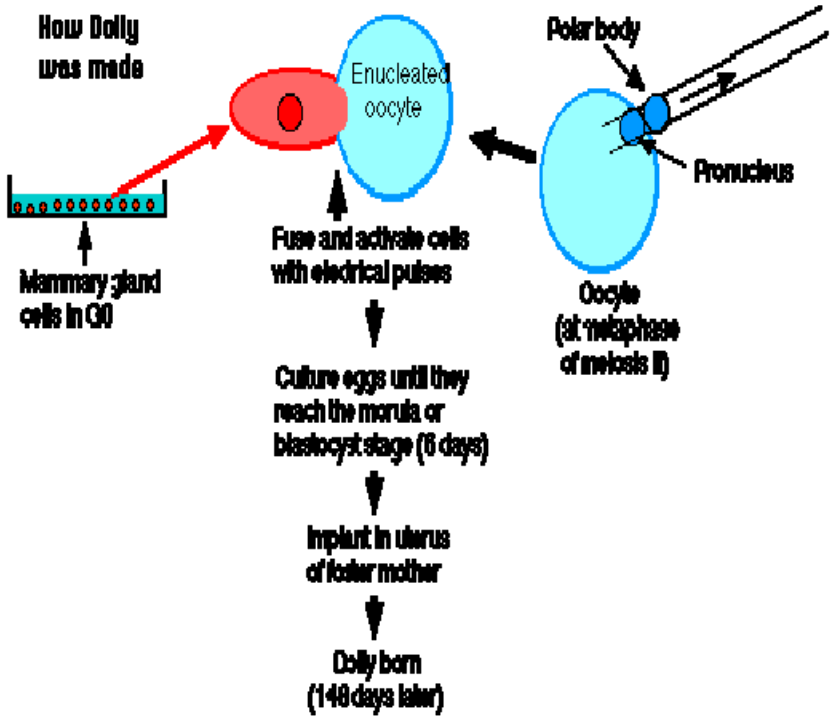
Oocytes are collected from live animals by ultrasound guided ovum pick up technique or from the ovaries collected from slaughter house. These oocytes are graded according to their quality. Only the best quality oocytes are used for further processing. With delicate microscopic needle nucleus is aspirated from the oocyte. The left oocyte has now only cytoplasm. This enucleated oocyte will serve as store house for growth and differentiation of new nucleus transferred into it.

b. Introduction of a new nucleus into enucleated oocyte

The nucleus is aspirated from a somatic cell which has been reprogrammed. This nucleus is then transferred into the enucleated oocyte by fine needle or by controlled electrofusion. The resulting cell is cultured in appropriate medium and grows till morula or blastocyst.

c. Embryo transfer to surrogate mother

Blastocyst cannot grow further in-vitro. It is transferred into the uterus of another female cow which is called surrogate mother. The surrogate mother is also called as recipient. The womb of recipient should be receptive for the coming embryo. It means it should be ready for the implantation of embryo in the uterus. For this recipient is treated with hormones like FSH and LH in parallel to the SCNT experiment. Hormonal treatment results in the formation of corpus leuteum (CL) which secrets progesterone which is essential for maintenance of successful pregnancy. The technology of transferring embryos in uterus is called embryo transfer technology (ETT)



Biopharming

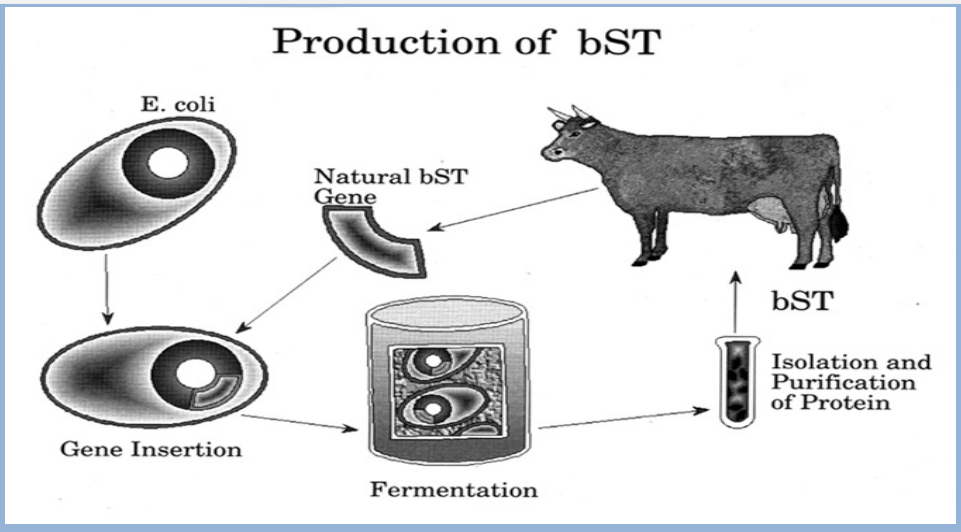
Recently, there has been tremendous increase in the demand of biomolecules like insulin, blood coagulation factor VIII and IX, growth hormone, albumin etc for various diagnostics and therapeutic purposes. Traditionally, the most common source of these molecules has been tissue and blood collected from the animals or human cadaver. The use of human and animal by-products has also been associated with the transmission of highly infectious and sometimes fatal diseases. Genetic engineering however, can be employed to produce these biomolecules in higher amount within short time. Many of the human genes have been cloned and expressed in bacteria. When bacteria grow in fermentor of large capacity like 100 and 1000 liters vats, it produces enough biomolecuels. The bacterial system of recombinant protein production is however, associated with inefficient and inappropriate pre and post translational modifications. Inadequate post translational modifications render the biomoleules unsuitable for use in human therapeutic purposes. The development of transgenic dairy animals is a better alternative to produce such biomolecules in a form which is closer to mammalian system. The desired protein gene can be cloned in cells derived from cow which can become integral part of cow genome. Under proper conditions the introduced protein can be expressed in milk of the cow. The process of of production of such pharmaceutically important proteins in animals is called biopharming (Bio+Pharmaceuticals). There is tremendous scope of using dairy animals for the production of such biomolecules. Many of the neutraceuticals and orally taken proteins can be produced in the milk of cows and goat which can be directly taken by the patients. Thus the whole cost of processing in purification of bio-molecules could be reduced. There are possibilities of genetically engineered antibody production in cow's milk which can confer stronger immunity to new born calves or the human baby fed on such milk.

Production of recombinant bovine somatotropin

Biopharming is the application of biotechnology where dairy animal is used to produce pharmaceutically important biomolecuels. But some molecules have been produced by the use of genetic engineering which are important for the good health and higher productivity of dairy animals. One such molecule is bovine somatotropin (bST). It is a growth hormone found in cattle which is secreted from anterior pituitary gland located at the base of brain. Normally, this hormone is important for growth and development of animals. When bST is injected in lactating cows (milk producing cows) from outside, it increases milk production. Traditionally, the only source of bST has been from pituitary gland recovered from the slaughtered animals. It was not sufficient to meet the demand. With the development in our understanding about genetic engineering and molecular biology it became possible to produce this protein hormone in E. coli. bacteria. The simple steps used in its production are typical of any recombinant DNA technology which has also been used for the production human insulin to treat diabetes and tissue plasminogen activator (tPA) protein to treat heart attack patients.

Method of production of (recombinant bovine somatotropin) rbST

1. Take out the pituitary gland from the slaughtered animals
2. Isolate RNA from the tissue
3. Prepare copy DNA (cDNA) from RNA using reverse transcriptase enzyme (these are molecular biology grade enzymes which can make DNA from RNA)
4. Carry polymerase chain reaction (PCR) to get many copies of the bST gene
5. Clone the bST gene in some plasmid vector and transfer it into E. coli by a process of transformation
6. Grow the tramsformed bacteria in culture tubes (Fermentation)
7. Collect the rbST protein from the medium or by lysis of cells and purify it.



Acceptability of animal biotechnology and awareness

There is lack of sufficient information about pros and cons of biotechnology in animal science. People are not aware about the possibilities of improvement in production potential of dairy animals. Sometimes there objections are genuine and sometimes based on myths. The biggest setback for the animal biotechnology comes from the long term impact of genetically modified animals on human health and environment. Some people have started realizing the socioeconomic potential of biotechnology. Therefore it is time to clear doubts and to create an atmosphere where informed decisions can be made on the questions about animal biotechnology and its acceptability. Students should think about the animal biotechnology its application, benefits and future impact. They should try to discover a balance between need and exploitation.

Review questions:

1. What is the difference between molecular cloning and Animal cloning?
2. What do you understand by Biopharming?
3. How will you produce recombinant bovine somatotropin?
4. What is embryo splitting?
5. Why do you think AI is required for better management of a dairy farm?
6. How will you know that the animal has been properly inseminated?
7. What are the advantages and limitations of AI?
8. Could you perform AI if the cryopreservation technique was not developed?

Chapter – 17

Biotechnology in dairy health, production and reproduction (II)

Introduction:

Molecular biology is the science of studying biological events at molecular level. As new technologies are being developed and discovered our ability to look at the things in detail is also increasing parallely. For example, initially it was not possible to look at the individual cells because of their small size. A bacterium is around 0.5-5 micron, viruses 0.1-0.3 micron, a human cell is around 10-20 micron and cow oocytes are around 100-120 microns. With the advent of microscope it became possible to look at these cells. Similarly our knowledge has increased in the molecular techniques like Polymerase chain reaction (PCR), molecular cloning of genes, Enzyme linked immuno sorbent assay (ELISA), recombinant expression of proteins, Microarray, proteomics, etc. All these technologies are being applied to animal science intensively at micro (10^{-6} meter) scale or nano (10^{-9} meter) scale of measurement. In this chapter we will learn the basic concept behind these techniques and a few applications in dairy animal health, production and reproduction.

Polymerase Chain reaction (PCR)

We must remember that all the cells of a dairy animal carry the same genetic makeup. A cell taken from liver has same genotype as that of a cell taken from skin or bone of the same animal. The difference is in the expression of proteins in each cell. Genetic diseases are due to abnormal DNA alteration. This is called mutation. If we want to detect such mutations we need to have the DNA of that animal in enough amounts. Deoxyribonucleic acid (DNA) is not visible with naked eyes. Cattle, buffalo and goat have 60, 50 and 60 diploid chromosomes respectively. The size of the bovine genome (the complete set of haploid DNA) is around 3 Gb (3 billion base pairs). It represents approximately 22,000 genes (the DNA which actually forms RNA or proteins). If mutation is located in a particular gene which results in abnormal protein you would like to target your attention on this piece of DNA. How can you do it? Especially when the sample is

scarce it is difficult to find enough DNA. PCR gives you the tool to amplify the target gene from a very scarce sample in as much quantity as you want.

Animal	*Scientific name*	Number of chromosome (2n)
Buffalo	*Bison bison*	48 (swamp buffalo) or 50 (Riverine buffalo)
Cat	*Felis catus*	38
Cattle (cow)	*Bos taurus, B. indicus*	60
Dog	*Canis familiaris*	78
Donkey	*E. asinus*	62
Goat	*Capra hircus*	60
Horse	*Equus caballus*	64
Human	*Homo sapiens*	46
Pig	*Sus scrofa*	38
Sheep	*Ovis aries*	54

Table shows the diploid number chromosomes in different animal species.

Principle of PCR:

Small amount of DNA can be amplified in to large amount by using two primers (18-24 nucleotides long oligonucleotide), thermostable DNA polymerase enzyme and free (deoxyribonucleotide phosphate) dNTPs. Three reactions denaturation, annealing and extension are repeated many times which results in exponential increase in the amount of target DNA. The whole reaction can be automated by using a machine called thermocycler or PCR machine. Usually following set of conditions are fed into machine. Denaturation is the step where double strand DNA is separated into single strands. It occurs at 94C. Annealing is the step where oligonucleotide primers bind to the complementary sequence present on single strand template DNA. In extension step thermostable DNA polymerase enzyme usually Taq DNA polymerase adds new nucleotides at the free 3'OH ends of olligonucleotde primers.

Steps	Name of reaction	Temperature	Time	
1	Initial Denaturation	94C	1 min	
2	Denaturation	94C	30-45 sec	Steps 2, 3 and 4 are repeated for 25-30 cycles
3	Annealing	60-65C	15-30 sec	
4	Extension	72C	30-60 sec	
5	Final extension	72C	5- 7 min	
6	Storage	4C	Till you take out the sample	

Application of PCR in Dairy animals

1. Y chromosomes specific gene can be amplified to say that the sample (embryo, meat, biopsy samples etc.) belongs to cow or bull.
2. PCR is used to amplify specific regions of micro or mini satellite DNA which help in identification of individual animal or its pedigree by DNA fingerprinting.
3. Some high quality determining genes called quantitative trait loci (QTLs) are linked to regions on DNA which serve as biomarker for these QTLs. These biomarker genes move along with the QTLs generation after generation. By PCR biomarkers are identified to predict the characteristics of animal
4. Genetic diseases which occur due to mutation in the gene can be identified by PCR
5. Bacterial, protozoan, viral, fungal and parasitic diseases can be diagnosed by amplifying DNA fragments specific to these organism.
6. PCR can be used to detect meat adulteration. If more than two species meat has been mixed you can amplify DNA specific to the suspected species.
7. Different animal breeds can be identified based on the differences in sequences.

Molecular cloning of genes (recombinant DNA technology)

This is an interesting area which has found immense application in modern medical diagnostics and therapeutics. The exact information about the gene sequence is essential for its manipulation. We have techniques which can cut DNA fragment into pieces, join them together, or can be moved from one cell to another. The complete method is called genetic engineering. We will see here in this chapter how gene cloning has been used intensively in improving dairy animal health, production and welfare. The desirable traits of animals like high production, disease resistance and better adaptation to stress can be improved by genetic engineering.

Steps in molecular cloning of gene

Amplification of the gene of interest

Mammalian gene contains exons and introns. Introns are the non essential part for protein. Therefore it is desirable that only exonic regions of the gene should be amplified. It results in decreased size of DNA to be handled. Messenger RNA (mRNA) represents such form of genes. RNA is isolated from tissue or blood cells. A copy DNA is made from it using reverse transcriptase (RTase) enzyme. This is called cDNA. cDNA is amplified into large number of copies by PCR.

Preparation of vector

Vectors are usually the genetically engineered plasmid DNA from bacteria. It is needed as a vehicle to carry the gene of interest from one cell to other. Inside the bacteria, these vectors can replicate, maintain its copy with bacterial division and express the protein from the gene of interest. The gene of interest is loaded on this vector. It is done by digesting (cutting) the vector DNA by restriction endonuclease enzymes. Vectors have multiple cloning sites (MCS). It harbors sites for many different restriction endonucleases. Therefore, depending on the need any restriction endonuclease can be used to prepare the vector. Vectors also contain selection marker genes which confer special characteristics to the transformed bacteria for selective growth.

Ideal characteristics of a good vector

i. It should be of smaller size (3-6 kb) for its easy manipulation

ii. There should be origin of replication (OriC) for its replication once it is inside the bacteria
iii. There should be multiple cloning sites (MCS) for a broad choice of restriction endonucleases
iv. There should be selection marker genes for the selection of transformed bacterial cells.

Preparation of insert (gene to be cloned)

Same enzyme is used to digest the ends of amplified PCR product also. Thus the ends of digested vector and digested gene to be loaded are compatible. Usually the gene themselves have no compatible restriction sites. For this, oligonucleotides primers used in PCR are designed to contain restriction sites.

Ligation

Digested vector DNA and digested PCR product are mixed in the presence of Ligase enzyme. Because of compatibles ends vector DNA and PCR product come closure and the liagse enzyme joins the two ends. Such vector which now contains the gene of interest is called recombinant DNA or recombinant plasmid (rDNA or rPlasmid).

Transformation

The final step is the introduction of rDNA into some bacteria. It is required for increasing the number of such rDNA molecules which could be later used for different purposes. The specially prepared E. coli bacteria called competent cells are mixed with rDNA. A brief heat shock at 42C for 60-90 sec results in entry of rDNA into the bacterial cells. Remember that not all the cells take up rDNA. Those which have taken up the rDNA are now called as transformed cells. The next task is to identify the transformed cells and selectively grow them in large amount so that our gene if interest should also multiply along with bacterial growth. This is done by selection.

Selection

Recall the 4th point of ideal characteristics of a good vector. Vectors contain antibiotic resistance gene (Ampicillin/kanamycin/tetracycline resistance gene). These genes destroy the common antibiotics present in the growth medium. For selection of transformed cells, it is grown on nutrient plates containing antibiotic. The cells which are not transformed i.e. which don't have

the rDNA will not be able to destroy antibiotic and hence, will not be able grow in the presence of antibiotic. But on the other hand, transformed bacteria will have rDNA. These cells can make those resistance proteins which will destroy antibiotic so they will grow in the plate. The colony appearing in such plates are used for further growth and to collect the cloned DNA.

Review questions:

1. What is PCR?
2. Can a human protein be expressed in the milk of cow? How?
3. What do you understand by vector? What is its importance in molecular biology?

Chapter – 18

Development of transgenic dairy animals and dairy animal's genomics

Traditional techniques of genetic improvement like artificial insemination (AI), cross breeding and embryo transfer technologies are precious but time consuming. Many of the desirable traits we cannot control as per our choice. We need to incorporate or delete specific traits without compromising other good traits. This is achieved by developing transgenic animals. A single gene or a set of genes are modified (introduced or deleted) in one animal which becomes integral part of its genome. Such animals are called transgenic animals. Their population then can be increased by animal cloning. Transgenic pigs, goat, cattle and sheep have been produced to confer special characteristic. A few examples where transgenic animals are in use are

- Using the mammary gland of dairy animal as a bioreactor to produce human pharmaceuticals in the milk of transgenic cows, goats, or rabbits.
- Resistance to bacterial, viral, and parasitic diseases such as mastitis and mad cow disease
- Reducing phosphorous excretion
- improving the nutritional value of meat, milk, and eggs as Increasing casein content in milk, Expressing lactase in milk (to remove lactose), Removing beta lactoglobulin form the milk of dairy animals

These are some proteins which have been expressed in the mammary gland of animals

- Erythropoietin
- Factor IX
- Factor VIII
- Fibrinogen
- Growth hormone
- Hemoglobin
- Insulin
- Monoclonal antibodies
- Tissue plasminogen activator (TPA)
- a1-antitrypsin
- Antithrombin III

Microinjection of foreign DNA into the pronuclei

In this method the desired DNA is injected into the pro-nuclei with micro needle. Pro-nucleus is a structure formed immediately after fertilization when two nucleus each from sperm and ovum fuses. The injected DNA integrates into the pro-nuclei genome. When such embryo grows into full calf it's all cells contain the foreign DNA. The integrated DNA is under the control of organ specific promoter. Therefore, the proteins will be made in that specific organ. For example, a gene that increases milk production in dairy cows was put into pig embryos. Several offspring of that transgenic pig inherited the cow gene and began to produce more milk, nursing litters that gained weight faster before weaning.

The most common method for producing transgenic animals is gene transfer by DNA microinjection. It involves the following steps:

1. DNA containing the desired transgene is amplified and cloned into a suitable vector (as described under the topic molecular cloning of gene) before insertion into the animal host.
2. The host animals (cows, pigs, or sheep) are induced to superovulate and their eggs are collected.
3. The eggs are fertilized in a laboratory dish.
4. Using a fine, hollow needle, a solution of DNA containing the transgene is injected into the male pronucleus of the fertilized egg (the nucleus of the sperm cell that entered the egg) before it fuses with the female pronucleus.
5. The transgenic embryos are grown in cell culture and then implanted into the uterus of a surrogate mother, where they complete their development.
6. Screening is performed to determine which of the offspring have inherited the transgene. The main drawback of DNA microinjection is its low success rate: only between 1 and 4 percent of microinjected eggs result in the live birth of a sheep, goat, or cow containing the transgene, and about 80 to 90 percent of transgenic embryos die during early development.

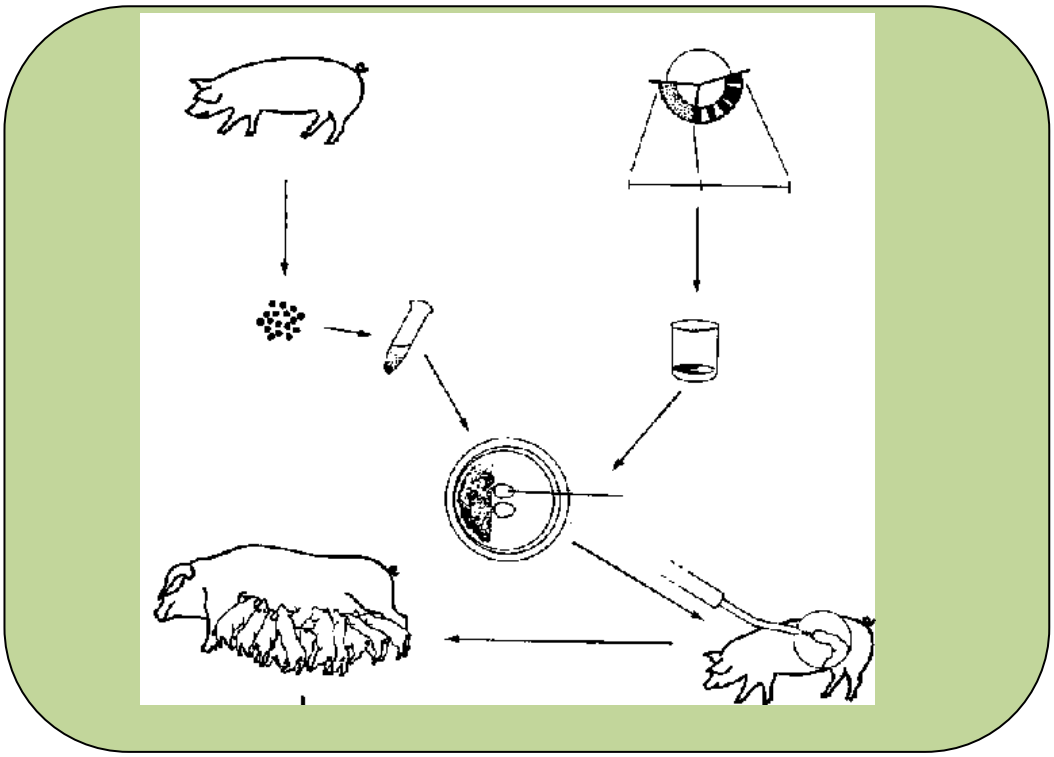


Fig 1: collection of embryos from a superovulted cow. Preparation of transgene constructs i.e. cloning in a suitable vector and to obtain highly concentrated DNA solution (1000 copies DNA per picoliter). Holding the zygote with a suction pipette and injecting the transgene into male pronucleus, Invitro culture and transfer of blastocyst into the oviduct of surrogate mother,

Gene transfer with retroviral-vector assistance

Retroviruses have RNA genome. It can readily enter into mammalian cells and make copy DNA using host machinery which integrates with host genome. The virus is genetically engineered for removing pathogenicity and making it suitable for use as vector. The transgene is loaded into the vector downstream to a mammary gland specific promoter. Because virus has own mechanism of entry into mammalian cells it enters into embryos during culture and the transgene is integrated into the host genome. Very little success has been obtained in domesticated animals using this method. However, in mice it has proved quite successful.

Gene transfer through production of germ-line chimeras

Working with pronucleus has advantage that transgene integrates with the single nuclear genome which then is transferred to every cell developing from it. It means that the transgene will be

present in the germ cells of the individual also and hence, will be passed on to next generation. This is the soul of the concept for producing a transgenic animal. Otherwise, the expression of transgene will remain limited to that target individual only and it will not be transferred to its progeny. The limitation of working with is pronucleus is its small size, delicate handling and very small capacity to take up foreign DNA. In addition, the transgene expression cannot be detected unless there is some signal associated with the transgene. To overcome these difficulties, an alternative method is to use stem cells which are part of growing embryos for the integration of transgene into morula or blastocysts. Stem cells expressing the transgene are mixed with the developing embryo in culture. Since stem cells give rise to all kinds of cells it is possible that some cells will give rise to germ cells also. Such embryos are called as chimera because genotype of every cell is not same. Some cells possess the transgene while other not. Up to 30 percent of the chimeras so produced are germ-line chimeras.

Other less commonly used methods of production of transgenics dairy animals are

Using liposome to deliver transgene into the growing embryo: transgene properly loaded on a suitable DNA vector is packaged in liposome. Liposome is a cationic lipid granule which can trap lot of DNA and enter through the membrane of mammalian cells. Blastocysts are suitable for transfection using liposome.

Sperm head-mediated gene transfer

This technique uses sperm's ability to transfer exogenous DNA into ovum during fertilization. This technique is simpler in comparison to other methods as it doesn't involve embryo handling, or micromanipulators. Its application is mainly limited to mice experiments. However, in cattle also this technique has been used albeit with little success. The delivery of exogenous DNA into ova mediated through sperm is a nonrandom event. The exogenous DNA interacts with DNA binding proteins (DBPs) of 30–35 kDa, present on the sperm surface. Seminal plasma is a complex mixture of proteins which also contains proteins called inhibitory factor 1 (IF1) that inhibits the interaction of exogenous DNA with DBPs. The most attractive part of this technique is that it can be associated with AI which is very common in dairy animals.

Dairy animal's genomics

The knowledge about the whole genome is essential for the understanding of genotype and phenotype of animals. Gene manipulation for removal or correction of deleterious gene or addition of a desirable gene to the genome of dairy animals is greatly dependent on the complete information about its genome. Exotic breeds of cattle give more milk (10,000 liters/annum) than our indigenous animals (2000 liters/annum). This is mainly because of the difference in their genotype. The size of bovine genome is around 3 Gb and of goat is around 2.66 Gb.

Many indigenous animals are at the verge of extinction. Their safety and survival in nature depends on our knowledge about their genome. The blind selection of animals exclusively for higher milk production traits has resulted in biased and narrowed gene distribution in natural population which may prove as threat for future generation. For example, the vast majority of Canada's milk supply comes from Holestein cows and within this 80% of the cows are bred to only 20 sire lines. We should not forget that a genotype lost from nature will never be recovered. It is an irreparable loss.

The way to preserve the diversity in genotype is to continue maintaining all kinds of dairy animals in our breeding program. Many animal genetic conservation programs are being operated by government agencies. Where it is difficult to maintain the animals as a whole, their DNA is preserved in a system called GenBank. The bank stores data about genetic sequence of animals along with semen, embryo and oocyte.

Research groups are actively engaged in sequencing the whole genome of dairy animals. The sequence data is stored in bioinformatics tools hosted by NCBI (National Center for Biotechnology information) GenBank, EMBL (European Molecular Biology Laboratory) and (DDBJ) DNA data bank of Japan. The complete information about bovine genome is maintained by USDA National Institute of Food and Agriculture and is hosted at the University of Missouri. The dedicated website on bovine genome is http://BovineGenome.org. The complete information about the buffalo genome is maintained by National Bureau of Animal Genetic Resources (NBAGR), India.

Establishment of cell lines of bovine origin

May of the studies cannot be performed in-vivo. For example, what is the effect of a drug on liver of animal? Every time the drug is given to animal biopsy of liver needs to be done. Similarly, if you want to know the functioning of mammary gland it is very difficult to work on in-vivo udder. Therefore, such studies are done on one time cells collected from the animal body part and growing them in-vitro in laboratory. The cell cultures directly obtained from the animal

which have limited life span are called as primary cell culture. They stop growing after 40-60 population doubling. But researchers have developed cell lines from dairy animals which has infinite life span. They are immortal. The benefit of such cell line is that they can be cultured and when not needed, can be stored (cryopreserved) in liquid nitrogen. Many of the studies like understanding the biology of milk production in mammary gland, drug metabolism in liver, functioning of kidney etc. can be easily done on these cell lines. Some examples of cell line which are of bovine origin are MDBK (Madin-Darby bovine kidney) cell line is an epithelial cell line obtained from kidney of cattle in 1982. Bovine corneal epithelium cell line BCE C/D-1b has been developed from a male cattle. Bovine tracheal cell line EBTr (NBL-4) has been prepared from embryonic tracheal cells. Similarly, NM1, NH, FBHE, CPA are endothelial cell line obtained from vascular tissue of bovine. Ch 1 Es is a fibroblastic cell line from normal fetal goat esophagus. The maximum number of cell lines has been obtained from human. MAC-T, BME65Cs and HH2a are some mammary epithelial cell line from bovine. BuMEC cell line is a mammary epithelial cell line developed by National Dairy Research Institute, Karnal, India which has been prepared from buffalo.

Review questions:

1. What is transgenics?
2. What is cell line? Can you explain the importance of cell lines in dairy science?
3. What is genomics and what can be done if you know the complete sequence of whole bovine genome?