



Training Manual

"Promoting Animal Health:
Key Livestock Concerns and
Practical Solution"

(28-31 July, 2025)



Directorate of Extension Education
Bihar Animal Sciences University, Patna-14



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(28-31 July, 2025)

Organized by:



Directorate of Extension Education
Bihar Animal Sciences University, Patna-14
National Academy of Veterinary Science
&
Brooke India

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Year of Publication: 2025**Publication No.: 62/2025/DEE/BASU****Instructions**

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Message

Livestock plays a pivotal role in ensuring rural livelihoods, food security, and economic resilience in India, especially in states like Bihar, where animal husbandry is integral to agrarian life. The health and well-being of livestock are directly linked to the prosperity of our farming communities, and it is our collective responsibility to ensure that veterinary services are equipped with the knowledge, skills, and tools needed to address the evolving challenges in this domain.

It is with great pleasure that I present this training manual, entitled ***“Promoting Animal Health: Key Livestock Concerns and Practical Solutions,”*** developed as part of a focused capacity-building initiative for the veterinary officers of the Animal & Fisheries Resources Department (AFRD), Government of Bihar. This training program, scheduled from **28th to 31st July 2025**, is being organized by the Directorate of Extension Education, Bihar Animal Sciences University (BASU), Patna, in collaboration with the National Academy of Veterinary Sciences (NAVS), New Delhi, and Brooke India.

This manual serves not only as a resource for this training but also as a practical guide for field application. It covers critical issues in animal health management, emerging diseases, welfare practices, and effective field-level interventions that can make a tangible difference in livestock productivity and farmer incomes.

I take this opportunity to extend my heartfelt appreciation to our esteemed partners, NAVS and Brooke India, for their invaluable contributions and steadfast support in advancing veterinary education and field capacity in Bihar as a part of *Continuing Veterinary Education (CVE)*. I am confident that the veterinary officers participating in this training will find the contents of this manual both insightful and applicable, enabling them to deliver more effective and impactful animal health services across the state.

Let us collectively strive toward the vision of healthier animals, more resilient farming systems, and empowered rural communities.

Dr. Umesh Singh
DEE, BASU, Patna

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1. Outreach and Extension Initiatives by the Directorate of Extension Education

Y.S. Jadoun, Umesh Singh and A.K. Thakur
Directorate of Extension Education (DEE)
Bihar Animal Sciences University (BASU), Patna-14

The Directorate of Extension Education (DEE) at Bihar Animal Sciences University (BASU), Patna, plays a pivotal role in translating scientific research and technological advancements into practical applications for farmers across Bihar. Acting as a vital link between the university's research ecosystem and the livestock farming community, the Directorate is dedicated to empowering farmers, rural youth, and stakeholders in the animal husbandry and veterinary sectors.

The core mandate of the DEE is to ensure the effective dissemination of validated knowledge and technologies related to livestock health, breeding, nutrition, and management. To achieve this, the Directorate conducts a wide range of farmer-oriented extension activities. These includes; capacity-building programs, on-farm demonstrations, village adoption initiatives, mobile advisory services, the *BASU Krishi Gyan Vahan*, awareness campaigns, and digital outreach efforts.

These initiatives are designed to promote scientific best practices in areas such as:

- Livestock health and disease prevention
- Breeding and reproductive management
- Nutrition and fodder cultivation
- Clean milk production
- Value-added animal products
- By leveraging both traditional and digital platforms, the Directorate ensures that the latest scientific innovations reach livestock owners at the grassroots level. This approach contributes significantly to enhancing animal productivity, welfare, and the economic well-being of rural communities.

Key Extension Activities

1. Farmer Training Programs

Regular training sessions are organized both on-campus and off-campus for a diverse group of stakeholders, including farmers, livestock keepers, veterinary officers, dairy professionals, livestock assistants, and rural youth. Major training themes

include:

- Scientific dairy farming and milk processing
- Veterinary diagnostic and therapeutic techniques
- Goat and poultry farming management
- Fodder production and silage preparation
- Clean milk production practices
- Animal health management and vaccination protocols

Field-Level Demonstrations and Farmer Interface

a) FLDs and OFTs

Frontline Demonstrations (FLDs) and On-Farm Trials (OFTs) to evaluate and popularize livestock technologies across farming systems.

b) Demonstration Units at KVK, Jamui

The Directorate of Extension Education (DEE), Bihar Animal Sciences University (BASU), Patna, has taken a significant step towards strengthening practical agricultural education and skill development by establishing multiple demonstration units at the newly established Krishi Vigyan Kendra (KVK) in Jamui. These include dedicated units **for goat, poultry, pig, and cattle rearing, offering vital hands-on training and experiential learning** opportunities to farmers, students, and extension workers.

In addition to livestock units, DEE has also developed essential infrastructure to support comprehensive agricultural extension activities. A nursery demonstration unit has been set up to promote horticultural practices and plant propagation techniques. Two functional borewells have been installed to ensure a reliable water supply for farm operations and irrigation needs. Furthermore, a farm implement shed has been constructed to house agricultural tools and machinery, enabling mechanized demonstrations and equipment familiarization.

To provide continuous support and advisory services to the farming community, a **Kisan Paramarsh Kendra (Farmers' Advisory Center)** has been established. This center serves as a hub for information dissemination, farmer-scientist interactions, and on-the-spot solutions to agricultural challenges. Moreover, a seed production unit has been initiated to facilitate the production and distribution of quality seeds, contributing to improved crop productivity and sustainability in the region.

These developments at KVK Jamui underscore BASU's commitment to integrated, field-livestock based agricultural education and its vision of empowering

rural communities through science-led integrated farming practices.

c) New KVK at Jamui

Directorate of Extension Education (DEE) at Bihar Animal Sciences University (BASU), Patna is instrumental in establishing a new KVK, extending the university's presence and outreach in tribal and underdeveloped regions.

Animal Health and Awareness Camps: Organizes **free veterinary health camps** in remote and rural areas.

Services include:

- o Deworming
 - o Disease diagnosis and treatment
 - o Infertility and reproductive disorder treatments
- Also conducts awareness campaigns on zoonotic diseases and hygienic livestock practices.

Farmer-Scientist Interaction Programs: Arranges interactive sessions between university experts and local farmers.

Aims to:

- o Solve field-level livestock problems
- o Collect feedback for research and extension improvements
- o Promote collaborative learning and experience sharing

Collaboration and Networking

Directorate of Extension Education, Bihar Animal Sciences University (BASU), Patna have strong collaboration, linkages and networking with; BAMETI, Animal and Fisheries Resources Department (AFRD), NABARD, COMFED, JEEViKA, Bihar Livestock Development Agency (BLDA), ICAR-RCER & ICAR-ATARI, National Commission for Women (NCW), New Delhi, Dairy Development Department, Bihar.

These linkages have facilitated joint training programs, funding, innovation dissemination, and field demonstrations.

Information, Education, and Communication (IEC) Activities

Publication and Distribution of Extension Literature

- o Publishes leaflets, booklets, manuals, and newsletters in regional languages for easy understanding.
- o Topics include disease management, fodder production, breeding

techniques, and value-added dairy products.

Audio-Visual Aids

- o Produces educational videos and slide presentations on animal husbandry practices.
- o Broadcasts programs through Doordarshan, All India Radio, and local cable networks.

Use of ICT Tools

- o Provides information through mobile apps, SMS services, and WhatsApp groups.
- o Maintains an online knowledge updates on livestock management at University website

Organization of Exhibitions, Fairs, and Events;

Livestock and Agriculture Fairs (Pashu Melas)

- o Hosts exhibitions to showcase latest technologies, breeds, and innovations.
- o Offers platform for farmers to interact with scientists and companies.
- **World Veterinary Day, World Milk Day, and Other Celebrations**
- o Organizes events to spread awareness on livestock health, nutrition, and productivity.
- o Involves school children, farmers, and stakeholders for community participation.
- **Participation in State/National Exhibitions**
- o Represents BASU in regional and national agri expos and fairs.
- o Demonstrates university innovations and farmer success stories.

Flagship Programs and Initiatives Directorate of Extension Education

Directorate of Extension Education (DEE) at Bihar Animal Sciences University (BASU), Patna, implemented numerous innovative extension programs aimed at bridging the gap between research and client system of livestock farmers of the state.

a) Cattle Expo-2023

Organized Bihar's landmark Cattle Expo, promoting livestock technologies, breed improvement, and farmer-scientist interaction.

b) Pashupalan Darshika – Hindi Magazine

To strengthen knowledge dissemination among livestock farmers and rural

communities, a Hindi magazine titled '**Pashupalan Darshika**' has been launched as a **quarterly** publication. This magazine is specifically designed to cater to the informational needs of Bihar's rural population, with a focus on promoting best practices in animal husbandry, veterinary care, livestock management, and allied agricultural activities.

'**Pashupalan Darshika**' serves as an accessible and practical resource, offering expert insights, success stories, seasonal advisories, and scientific recommendations in a language that is both familiar and easy to understand for farmers. The publication aims to bridge the gap between research institutions and the grassroots level by translating technical knowledge into actionable guidance. By empowering farmers with up-to-date and relevant information, the magazine contributes significantly to improving livestock productivity, health, and income generation in rural Bihar.

This initiative reflects a broader commitment to inclusive extension services and the use of regional languages as a medium to enhance outreach and impact across farming communities.

c) e-Kisan Samadhan

A digital initiative leveraging WhatsApp groups for quick advisory delivery, real-time interaction with farmers, and dissemination of weather, disease alerts.

e-Kisan Samadhan is a digital extension initiative launched by the **Directorate of Extension Education, Bihar Animal Sciences University (BASU), Patna**, designed to provide real-time, science-based livestock advisory services to farmers through modern communication tools. The program primarily operates through **WhatsApp groups**, making it easily accessible even to farmers in remote and rural areas. It leverages **live interactive webinars**, expert-led audio-visual sessions, and regular **video uploads** on dedicated platforms to disseminate practical knowledge related to **animal health care, nutrition, breeding, disease prevention, and scientific livestock management**.

Through this initiative, farmers receive timely solutions to their field-level challenges directly from veterinary and animal husbandry experts. The platform also facilitates two-way communication, allowing farmers to ask questions, share field observations, and adopt improved practices based on expert feedback. By combining digital technology with expert outreach, **e-Kisan Samadhan** plays a vital role in **empowering livestock farmers and rural youth**, enhancing productivity, and promoting sustainable livestock-based livelihoods. It stands as a model for **inclusive, ICT-driven agricultural extension**, effectively bridging the gap between research institutions and grassroots communities.

d) BASU Krishi Gyan Vahan: A Mobile Knowledge Dissemination Initiative
Directorate of Extension Education (DEE), Bihar Animal Sciences University (BASU), Patna has started a unique initiative "**Krishi Gyan Vahan**", under 4th Krishi Road Map, Govt. of Bihar, a mobile extension, and outreach service aimed at bridging the knowledge gap between researchers, extension personnel, and farmers across Bihar. This initiative plays a crucial role in technology dissemination, awareness creation, and capacity building among livestock and crop farmers, particularly in remote and underserved regions.

The **Krishi Gyan Vahan** is a well-equipped vehicle carrying:

- Audio-visual aids (TV, PA system, projector)
- Training materials, leaflets, and brochures
- Models and samples for demonstration
- Veterinary medicines and diagnostic kits

Teams comprising **BASU scientists, veterinary officers, and subject matter specialists (SMSs)** from **KVKs** accompany the van during field visits. The Vahan follows a pre-determined schedule covering different blocks and panchayats, in collaboration with the **AFRD, KVKs and ATMA**, and other allied departments.

e) Village Adoption Program

Adopted Dariyapur Village of Naubatpur block Patna under a participatory rural extension model focused on dairy and poultry development, with the objective of transforming it into a model village. The initiative aimed at holistic livestock development, creating a cascading impact in nearby areas by enhancing income levels and generating employment opportunities.

Farmer FIRST Project BASU

Farmer FIRST Project BASU Strengthens Rural Livelihoods Through Integrated Crop-Livestock Development Approach. The **Farmer FIRST Project**, operating under the **Directorate of Extension Education, Bihar Animal Sciences University (BASU), Patna**, is making significant strides in enhancing rural livelihood security through an integrated crop-livestock development approach. As part of the ongoing outreach, two villages—**Sidhauli** and **Senduari** in **Hajipur Block, Vaishali District**—have been adopted under the project.

Conclusion:

The Directorate of Extension Education at Bihar Animal Sciences University (BASU), Patna, plays a vital role in translating scientific research into practical

solutions for farming communities across Bihar. Serving as the university's outreach arm, it bridges the gap between innovation and application through farmer training, awareness campaigns, on-field demonstrations, and partnerships with government and NGOs.

Focused on improving livestock productivity, profitability, and sustainability, the directorate tailors its programs to the evolving needs of rural stakeholders. By promoting emerging technologies and practical skills, it empowers farmers, encourages innovation, and fosters a culture of continuous learning and self-reliance in the livestock sector.

2. Blood Transfusion in Farm Animals

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Blood transfusion therapy in veterinary medicine has advanced significantly, particularly for large animals like cattle. Although not as commonly performed as in small animals, blood transfusion in farm animals (cattle, buffaloes, sheep, goats, and horses) can be a life-saving intervention under critical conditions such as hemorrhage, severe anemia, or blood loss from parasitic infections. Despite its therapeutic potential, the procedure must be conducted with a thorough understanding of bovine blood groups, immune responses, and appropriate handling practices to ensure clinical success and minimize adverse reactions.

Indications of Blood Transfusion in Cattle

Blood transfusion is primarily indicated when the oxygen-carrying capacity of the blood is compromised. Common conditions that necessitate transfusion in cattle include:

1. **Severe hemorrhage:** Due to trauma, surgery, gastrointestinal bleeding, or obstetric complications.
2. **Anemia:** Often associated with parasitic infestations like *Babesia*, *Theileria*, or *Anaplasma*; also seen in cases of chronic disease or immune-mediated hemolysis.
3. **Hypovolemia with anemia:** Where rapid volume expansion with red blood cells is needed.
4. **Neonatal Isoerythrolysis:** Incompatibility between dam's antibodies in colostrum and the calf's red cells.
5. **Surgical support:** In major procedures involving significant blood loss.
6. **Toxemia or septicemia:** With hemolysis or capillary leak syndrome leading to anemia.

According to Braz-Ruivo and Divers (2001), a transfusion is typically warranted when the packed cell volume (PCV) falls below 12%, or if the total hemoglobin is under 5 g/dL, especially if the animal exhibits clinical signs like tachycardia, pale mucous membranes, weakness, or collapse.

Procedure of Blood Transfusion in Cattle

1. Selection of Donor

An ideal donor should:

- ❖ Be healthy, disease-free (particularly free from hemoparasitic infections).
- ❖ Be of similar breed and preferably the same herd.
- ❖ Have a PCV > 30%.
- ❖ Be vaccinated and dewormed.
- ❖ Be negative for bovine viral diarrhoea (BVD) and leukosis virus.

Adult bovines can safely donate 10–15 mL/kg body weight of blood, which amounts to approximately 4–6 liters in a 500 kg cow.

2. Collection of Blood

- ❖ Use aseptic technique.
- ❖ Collect blood from the jugular vein into a sterile blood collection bag containing anticoagulant (citrate-phosphate-dextrose-adenine, CPDA, or acid citrate dextrose, ACD).
- ❖ Monitor for clotting or hemolysis.
- ❖ Blood should be used fresh (within 4 hours) or stored at 4°C for up to 21–28 days depending on anticoagulant used.

3. Recipient Preparation

- ❖ Assess PCV, total protein, and vital signs.
- ❖ Establish IV access (usually jugular vein).



Fig. 1. Collected blood in CPDA

- ❖ Ensure the animal is calm and restrained.
- ❖ Check crossmatch if available (especially in repeat transfusions).

4. Administration

- Start with a slow rate of transfusion (0.1 mL/kg/hr) for the first 15–30

minutes while monitoring for any adverse reaction.

Volume Required (L)= Body Weight (Kg) x Blood Volume (ml/Kg)x (Desired PCV –Actual PCV)

Volume to transfuse (L)=
$$\frac{(\text{Desired PCV}-\text{Recipient PCV})\times\text{Body Weight (kg)}\times\text{Blood Volume (mL/kg)}}{\text{Donor PCV}}$$

- If no reaction occurs, the rate can be increased up to 10–20 mL/kg/hr.
- Total transfusion volume is usually 10–20 mL/kg depending on severity of anemia.

Table 1. Standard Blood Volume in Animals (total amount of blood circulating in the body, typically expressed as mL per kg of body weight).

Species	Blood Volume (ml/Kg)
Cattle	65-70 ml/kg
Buffalo	65-70 ml/kg
Horse	70-75 ml/kg
Sheep	60-70 ml/kg
Goat	60-70 ml/kg
Pig	60-70 ml/kg
Dog	80-90 ml/kg

Bovine Blood Groups

Cattle have a highly complex blood group system. There are 11 recognized blood group systems in bovines: A, B, C, F, J, L, M, R, S, T, and Z. Among these, the **B and J systems are the most clinically relevant.**

1. B System

- Most polymorphic, with over 60 different antigens.
- Responsible for most antigenic differences and incompatibility.
- Difficult to match completely due to variability.

2. J System

- Unique in that the J antigen is not inherited but acquired from serum lipoproteins.
 - Animals negative for J antigen are more likely to develop antibodies upon transfusion.
- **Buffaloes:** Similar to cattle but less studied; incompatibility is rare in the first transfusion.
- **Sheep:** Seven blood group systems; crossmatching is recommended, especially in valuable animals.

- **Goats:** Few antigens; transfusions generally safe with first-time donors.
- **Pigs:** 16 blood group systems; high risk of reactions if not crossmatched.
- **Horses:** Have 8 blood group systems (A, C, D, K, P, Q, U, and T); the Aa and Qa antigens are most immunogenic. Cross matching is highly recommended.

Due to this variability, routine crossmatching is not widely practiced in field conditions, but it becomes crucial in repeat transfusions or in valuable animals.

Crossmatching Procedure

Materials Required

- ✓ Sterile syringes and needles
- ✓ Anticoagulated blood (preferably with EDTA or citrate)
- ✓ Centrifuge and test tubes
- ✓ Saline (0.9% NaCl)
- ✓ Water bath or incubator (37°C)
- ✓ Microscope or agglutination viewing card (optional)

Step-by-Step Procedure

Step 1: Collect Samples

- Collect 5–10 mL of whole blood from both donor and recipient into anticoagulant tubes (EDTA or citrate).
- Label tubes clearly as donor and recipient.

Step 2: Preparation of RBC Suspension

- Centrifuge both blood samples at 1500–2000 rpm for 5–10 minutes to separate plasma and packed RBCs.
- Remove plasma from each and keep it in clean, labeled tubes.
- Wash the packed RBCs three times with 0.9% saline.
- Add saline, mix gently, centrifuge, and discard supernatant.
- Prepare a 2–5% suspension of washed RBCs in saline.

Step 3: Perform Crossmatches

a. Major Crossmatch

To perform a major crossmatch in cattle, begin by mixing two drops of recipient plasma with one drop of donor red blood cell (RBC) suspension (typically a 2–5% saline-washed suspension of packed RBCs) in a clean test tube. Gently mix the contents and incubate the mixture at 37°C for 15 to 30 minutes to allow any potential antigen-antibody reaction to occur. After incubation, centrifuge the tube at 1000 to

1500 revolutions per minute (rpm) for 1 to 2 minutes to separate the cells from the plasma. Carefully examine the supernatant and sediment. The presence of hemolysis (indicated by a pink to red coloration of the supernatant) or agglutination (clumping of RBCs) suggests an incompatible reaction between the donor's red cells and the recipient's plasma antibodies. These changes can be observed either visually or under a microscope. A clear supernatant and uniformly dispersed red cells indicate a compatible crossmatch, and transfusion may proceed safely.

b. Minor Crossmatch

- Mix:
 - 2 drops of donor plasma
 - 1 drop of recipient RBC suspension
- Incubate and examine as in the major crossmatch.

Optional Controls:

- Autocontrols: Mix recipient's own plasma and RBCs (to rule out autoagglutination).
- Saline control: Mix recipient plasma with saline (to rule out non-specific agglutination).

Interpretation of Results

Observation	Interpretation
No hemolysis or agglutination	Compatible
Agglutination present	Incompatible
Hemolysis in tube	Incompatible

- **Compatible crossmatch:** Safe to proceed with transfusion.
- **Incompatible:** Avoid transfusion or consider alternative donor.
- Even weak agglutination should be considered significant.

Limitations of Crossmatching in Cattle

- ❖ Does not identify specific blood group antigens.
- ❖ May miss low-titer antibodies that can still cause delayed reactions.
- ❖ Requires centrifuge and incubator, which may not be available in field settings.

- ❖ In field situations, a simple slide agglutination test can be a quick alternative:

Field Adapted Slide Agglutination Test (Simplified Method)

Materials:

- Clean microscope slide
- Capillary blood (from donor and recipient)
- Saline solution
- Mixing stick or pipette tip

Procedure:

1. Place 1 drop of recipient plasma and 1 drop of donor whole blood (with RBCs) on the slide.
2. Mix gently and observe for clumping/agglutination.
3. Agglutination = Incompatible.

In conclusion, crossmatching is a vital safeguard, especially for repeat transfusions, young calves, or valuable breeding stock. It is a relatively simple technique that can prevent serious and sometimes fatal transfusion reactions. Even under field conditions, simplified agglutination tests can offer critical insight into donor-recipient compatibility and should be employed wherever feasible.

Clinical Significance of Blood Transfusion

Transfusion provides immediate support to critically ill animals. Benefits include:

- Restoration of oxygen-carrying capacity.
- Improved perfusion and reduced lactate accumulation.
- Stabilization of heart rate and respiratory rate.
- Support for surgical patients or those with hemolytic crisis.

However, improper technique or incompatibility can cause more harm than benefit. Transfusion remains a valuable emergency tool, particularly in tertiary veterinary hospitals or organized dairy units.

Adverse Reactions to Blood Transfusion

Transfusion reactions are generally classified into **immunologic** and **non-immunologic** types.

1. Immunologic Reactions

- ✓ **Acute hemolytic reaction:** Due to incompatible transfusion; rare but fatal.
- ✓ **Febrile non-hemolytic reaction:** Most common; presents with fever, tachycardia, restlessness.
- ✓ **Urticaria and anaphylaxis:** Rare; seen more in hypersensitive individuals.

2. Non-Immunologic Reactions

- ✓ **Bacterial contamination:** Due to poor asepsis; may cause sepsis.
- ✓ **Iron overload:** Seen in multiple transfusions.
- ✓ **Hypocalcemia:** Due to citrate toxicity, especially with rapid transfusion.
- ✓ **Volume overload:** In young or compromised animals.

Management of reactions includes stopping transfusion, administering antihistamines (e.g., diphenhydramine), corticosteroids, and supportive care.

Precautions During Blood Transfusion

1. **Proper donor selection:** Screen for diseases and compatibility.
2. **Use sterile techniques:** Avoid contamination during collection and administration.
3. **Avoid rapid transfusion initially:** Start slow to monitor reaction.
4. **Observe the recipient:** Monitor temperature, pulse, respiration, mucous membrane color.
5. **Avoid mixing drugs with blood:** Incompatibility can cause hemolysis.
6. **Use within 4 hours if not refrigerated:** Stored blood should be used within expiry.
7. **Avoid repeated transfusion without crossmatching:** Sensitization can occur.

Limitations and Field Considerations

In rural or field conditions, blood transfusion is challenging due to limited access to blood typing, storage facilities, or sterile equipment. In such scenarios, fresh whole blood transfusion using aseptic techniques and donor from the same herd may be the only viable option. Veterinarians must rely on clinical signs and basic hematology (PCV, hemoglobin) to make decisions. Education and awareness among dairy farmers and paramedics about the potential and procedure of transfusion can improve its usage in rural practice.

Conclusion

Blood transfusion in cattle is a potentially life-saving but underutilized procedure. Understanding the indications, procedural steps, and risks associated with transfusion is critical for its successful application. Although bovine blood group complexity poses a challenge, careful donor selection, proper administration, and monitoring can reduce adverse reactions. It is an essential skill in modern bovine

clinical practice, particularly in managing anemia, hemorrhage, and critical medical conditions.

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3. Understanding Equine Behaviour

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Equines-horses, donkeys, and mules-are often grouped together in human care and working environments. However, they are distinct in their behaviour, biology, and social needs. Understanding these differences is crucial for ensuring their welfare, improving handling, and building compassionate human-animal relationships.

Horses: Social, Sensitive and sophisticated

Horses are long-lived, social prey animals that have evolved to live in complex and cooperative groups. Their behaviour is shaped by the need to stay safe from predators and maintain strong social bonds.

- **Social structure:** Horses live in large herds made up of smaller, stable sub-groups. Their social lives are built around long-term, enduring relationships, often based on mutual grooming, cooperation, and social support.
- **Egalitarian dynamics:** Contrary to the common myth of a rigid dominance hierarchy, horse social structures are fluid. While dominance behaviours do occur, they are often expressed through subtle displacement or avoidance rather than aggression. Horses are cooperative, form alliances, and show reconciliation after conflicts—acting more like diplomats than dictators.
- **Emotionally attuned:** Horses are remarkably sensitive to the emotional and attentional states of both their herd mates and humans. They can recognise individual people and other horses by sight and sound, and they remember both positive and negative experiences for over 10 years. Unfortunately, bad memories tend to stick—highlighting the importance of compassionate, fear-free handling.
- **Flight before fight:** As prey animals, horses are quick to detect danger and more likely to flee than fight. They're highly neophobic—wary of new things—and rely on social reassurance from their companions to explore unfamiliar environments.

Donkeys: Adaptable and resources-defensive

Donkeys share equine features but behave quite differently from horses due to their evolutionary background and ecological niche.

- **Territorial lifestyle:** In the wild, donkeys evolved in arid, resource-scarce

environments. Unlike horses, they don't form large herds. Males (jacks) hold territories, and females (jennies) travel more freely, often with young or in loose groups.

- **Flexible social bonds:** Free-ranging donkeys don't typically form long-lasting social bonds. However, in domestic environments where they may face isolation, donkeys often form very strong attachments—to the point that separation can cause extreme stress or even death. Their social needs are real, though they may express them differently than horses.
- **Assertive nature:** Donkeys are generally more dominant in their interactions. Jennies show unique behaviours during estrus, such as ear-pinned jawing. They are closely related to wild asses of North Africa and are highly adaptable, adjusting their social structures to suit changing conditions.

Mules: The hybrid enigma

Mules—hybrids of a male donkey and a female horse—combine traits from both parent species. Their behaviour, like their genetics, is a fascinating mix.

- **Hybrid vigour:** Mules are known for their strength, endurance, and intelligence. They often outperform both horses and donkeys in learning tasks, such as navigating mazes or adjusting their behaviour based on outcomes.
- **Quick learners:** Studies suggest that mules and donkeys adapt their behaviour more quickly than horses. This flexibility can make them appear “stubborn,” but in reality, they may simply be more discerning and less predictable in their preferences. This can challenge handlers who are used to horses, where behavioural patterns are often more consistent.
- **Understudied yet valuable:** While most behavioural research has been conducted on horses (and to a lesser extent donkeys), mules remain less understood. Despite this, their unique abilities and needs deserve more attention—especially in working environments.

Why it matters?

Equine handlers, owners, and professionals often feel most familiar with horses, as they are the most studied and widely kept. However, many communities—especially in rural and arid areas—rely heavily on donkeys and mules. Understanding the distinct behavioural tendencies of each species helps improve their welfare, reduce conflict, and foster trust-based human-equine partnerships.

Whether it's the deep bonds of a horse herd, the quiet resilience of a donkey, or the intelligent determination of a mule, these animals offer much more than utility—they

offer connection, communication, and companionship.

Compassionate handling in animals

Compassionate handling is a fundamental aspect of animal welfare that emphasizes respect, empathy, and responsible interaction between humans and animals. It goes beyond simply managing animals to actively ensuring their emotional and physical wellbeing. In contrast to inhumane handling—which causes unnecessary psychological or physical suffering—compassionate handling minimizes harm and promotes positive experiences for animals.

Animals are sentient beings with the ability to feel pain, fear, pleasure, and comfort. Their welfare is influenced not just by physical conditions like food and shelter but also by how they are treated by humans. Good handling contributes directly to good welfare by creating a sense of safety and comfort, leading to both emotional and physical benefits for the animal.

What is compassionate handling?

Compassionate handling involves interactions that:

- **Avoid or minimize suffering**
- **Enhance comfort and safety**
- **Promote animal wellbeing**
- **Support positive human-animal relationships**

It's not only about physical restraint or control but includes tone of voice, body language, timing, and the handler's awareness of animal behaviour.

Key competencies for a compassionate handler

To practice compassionate handling, an individual should possess:

- **Communication skills** – To effectively engage with other caretakers and stakeholders.
- **Welfare advocacy** – To prioritize and champion the animal's interests.
- **Understanding of animal behaviour** – To read body language and emotional cues.
- **Handling expertise** – To apply safe and species-appropriate techniques.
- **Ethical governance** – To act responsibly within organizational or societal frameworks.

Principles of welfare-friendly handling

Safe and humane handling practices ensure:

- **Animal comfort**
- **Human safety**
- **Efficiency of work routines**

This includes using appropriate tools like halters or lead ropes of the right size, applying correct lifting or restraint techniques (e.g., throat hold, leg lifts, or twitches when necessary), and avoiding actions that instil fear or cause pain.

Behavioural modification techniques to improve handling

Understanding and applying behavioural modification techniques helps animals adapt to handling and reduces stress:

- **Systemic desensitization:** A technique to reduce an animal's sensitivity to triggers that cause reactivity. It involves gradually exposing the equid to a feared but harmless object or situation in small, controlled steps (shaping plan). The stimulus is introduced at low intensity or short duration, ensuring the equid stays calm without triggering fear or defensive behavior.
- **Flooding (not recommended):** Flooding is traumatic and associated with poor results. Flooding occurs when the equid is secured so they cannot escape and then directly exposed to the feared stimulus until reaction stops. This can result in the animal becoming overwhelmed and freezing with fear or worsen the problem behaviour.
- **Counter-conditioning:** A method to replace unwanted behavior by associating a more positive behavior with a desirable outcome. This process pairs the feared stimulus with a pleasant stimulus, creating a new, positive association. The pleasant stimulus triggers relaxation and positive emotions, replacing fear and withdrawal behaviors. Counterconditioning is often combined with gradual exposure to the feared stimulus (systematic desensitization) for effective results.
- **Positive Reinforcement:** Reinforcement encourages behaviors by linking them to specific consequences, increasing the likelihood of repetition. Positive reinforcement rewards desired behavior with a pleasant outcome, such as a treat or praise.
- In contrast, **negative reinforcement** involves applying an unpleasant stimulus that stops when the unwanted behavior ceases or the desired behavior occurs (often called "pressure-release" training). Note: Negative reinforcement is distinct from punishment, as it focuses on encouraging positive actions rather than penalizing negative ones.
- **Extinction:** Extinction involves eliminating the positive reinforcement that

sustains an unwanted behavior. If the animal benefits from the behavior, removing the reward ensures the behavior is no longer associated with a positive outcome, leading to its eventual cessation. Strong associations may require time and consistency to break. This method can result in frustration and an "extinction burst" – a temporary increase in the undesired behavior before it diminishes.

4. Embryo Transfer Technology in Bovines

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Embryo transfer (ET) technology in bovines is a reproductive technique which is generally used to propagate desirable genetic traits by transferring embryos from a superior donor cow to recipient cows. It's a one of the most important component of assisted reproductive technologies aimed at increasing the reproductive rate of females of superior genetic merit, especially in dairy cattle. In cows generally one ovum is ovulated during estrous cycle of animal and one successful conception confirmed at the end. However for the ET programme multiple embryos are recovered with help of hormonal administration. So we got multiple embryos and transferred these embryos to different recipient cows and got many calves from one donor cow in a year.

Steps Involved In Embryo Transfer: there are many steps involved in ET programme. These are as follows:

1) Selection of donor 2) Selection of recipients 3) Estrus synchronization of donor and recipients 4) Superovulation (SOV) of donor (release of multiple eggs at single estrus) 5) Artificial insemination of donor 6) Embryo collection 7) Evaluation of embryos 8) Transfer of embryos.

1. Selection of Donor: Donor cow in ET programme is selected on the basis of given criteria below

- ✓ Superior individual performance
- ✓ Good productive performance of offspring
- ✓ Regular Cyclicity
- ✓ Ovaries must be free (No adhesions)
- ✓ Intact tubular genitalia (free from any abnormalities)
- ✓ Younger (4-8 years of age)
- ✓ Healthy and have good body weight
- ✓ Must have calved at least 60 days back (best 90-100 days postpartum)
- ✓ Normal postpartum history
- ✓ A history of no more than two breeding per conception
- ✓ Previous calves having been born at approximately 365 day interval

2. Selection of Recipients: Recipients cow in ET programme is selected on the basis of given criteria below

- ✓ Healthy, free from infection and have good body weight.
- ✓ Regular cyclicity.
- ✓ Intact genitalia (free from any sort of abnormalities)
- ✓ Must have good cyclic CL of desired stage at the time of embryo transfer
- ✓ Exhibit calving ease, and that have good milking and good mothering ability.

3. Estrus Synchronization of Donor

The donor cow should be synchronized to bring into estrus or should have palpable CL on the ovary from the natural estrus. For this, any of the synchronization protocols can be used viz. Ov-synch, Co-synch, select synch hybrid synch, heat synch, PG protocols etc.

4. Superovulation of Donor Cow

Procedure for increased ovulatory response by administration of hormones (gonadotropins) to produce several ova instead of one which is normally produced at each estrus. This large number of ova is later on fertilized and embryo produced can be transferred to the recipients. The basic principle of superovulation is to stimulate extensive follicular development through the use of a hormone preparation, which is given IM or SC with FSH activity. For optimum response gonadotropin treatment is initiated during mid luteal phase of estrus cycle i.e. on days 9-14 of estrous cycle (Day 0 is estrus). Donor cows can be superovulated repeatedly at approximately 6-8 weeks interval. Generally FSH hormone is given morning and evening at 12 hours interval in 8 divided doses intramuscularly for superovulation.

5. Insemination of Donor (A.I.)

Donor should be inseminated artificially 2-3 times at 12 hours interval after the onset of estrus. This is required because ovulation can occur over an extended time period. Fresh semen is preferred. If frozen semen then use double insemination dose at each insemination.

6. Embryo Recovery

Embryos can be collected by Non-Surgically by Trans Cervical Method. It involves 2 ways or 3 ways Foley or Woerllein catheter which allows flushing fluids to pass into the uterus and at the same time allows fluids to be returned from the uterus to a

collecting receptacle. A small balloon near the end of catheter can be inflated just inside the uterine horn to prevent the flushing fluid from escaping through the cervix. Collection of bovine embryos should be made at 6-8 days post-breeding at compact morula or blastocyst stage. The best flushing medium for embryo collection in most of the species is modified Dubecco's phosphate buffer saline. NS can be used in its absence.

Give large doses of intrauterine antibiotics to prevent infection. Injection of PGF2 α is also recommended to speed recoveries of ovaries and to prevent pregnancy, if viable embryos are not dislodged by the flushing.

7. Evaluation of Embryos

After collection and before transfer to the recipients, the embryos are evaluated under stereozoom microscope at 50 to 100x magnification. Day 7 bovine embryos (compact morulla or blastocyst) are about 150-190 μ m in diameter and are still within the zona pellucida. Embryos are graded based on following characteristics

- ✓ Compactness of the cells
- ✓ Regularity of cells
- ✓ Variation in cell size
- ✓ Colour and texture of cytoplasm
- ✓ Presence of vesicles, extruded cells, cellular debris

8. Transfer of Embryo (Introduction to Recipients)

Recipients should be in estrus within 12 hrs. of the donor so that is should possess good CL at the time of transfer. To maximize success rate of transfer, the recipient's estrus should be in synchrony with that of the donor. For the process of transferring embryos the recipient is palpated to determine the presence and location of the CL (Rt. Ovary vs. Lt. Ovary). Recipient is administered an epidural anesthesia (2% Lignocain) to relax the muscles in the pelvic area.

Flushed embryos after inspection are loaded into ET straw. If the embryo is frozen it is thawed in warm water bath (92 $^{\circ}$ F) for <30s and placed in ET gun and covered with sterile sheath. The ET gun is passed through the vagina, cervix and into the uterine horn on the side as the CL. The embryo is deposited 1/3 the way up to the uterine horn. The pregnancy rate will be high when day of estrus of recipients and donor are within 24 hours. The embryos are typically transferred on day 7 of the estrous cycle to the recipients.

Advantages of ETT

- ✓ Increase the number of offspring sired from superior females.
- ✓ Results in faster genetic progress.
- ✓ Obtain offspring from old or injured animals incapable of breeding or calving naturally.
- ✓ Increase farm income from sale of embryos.
- ✓ Export/import of embryos is easier than with live animals

5. Ectoparasites and their Management in Farm Animals

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Ectoparasites are organisms that live on the external surface of host animals, feeding on blood, tissue fluids, or skin debris. In farm animals, they are of significant veterinary and economic concern due to the direct harm they cause, such as irritation, dermatitis, anemia, and in severe cases, death, as well as their role as vectors of infectious agents including protozoa, bacteria, and viruses. The impact of ectoparasites on livestock productivity and welfare is profound, affecting milk yield, weight gain, hide quality, and overall health. Understanding their biology, life cycle, impact, and control measures is essential for effective management.

Classification and Biology of Ectoparasites:

Ectoparasites affecting farm animals can be broadly classified into insects (flies, lice, fleas) and arachnids (mites and ticks). These parasites vary in their feeding behavior, host specificity, and life cycle characteristics. Some are permanent residents like lice and mites, completing their entire life cycle on the host, while others such as ticks and many flies are temporary, attaching only for feeding.

Common Ectoparasites in Farm Animals:

1. Ticks: Belonging to the Ixodidae (hard ticks) and Argasidae (soft ticks) families, ticks are obligate blood feeders and vectors of diseases like babesiosis, theileriosis, and anaplasmosis. *Rhipicephalus microplus*, a major ectoparasite of cattle, transmits *Babesia bovis* and *B. bigemina*. Ticks cause direct damage through blood loss, irritation, and secondary infections.

Life Cycle Stages: Egg → Larva (Seed Tick) → Nymph → Adult

Egg: Female ticks lay thousands of eggs on the ground, often in grassy or wooded areas. The eggs hatch into larvae within a few weeks, depending on environmental conditions.

Larva (Seed Tick): The larval stage, also known as a seed tick, has six legs and is very small. Larvae climb onto vegetation and wait for a host animal to pass by. Once on the host, they feed on blood for a few days before dropping off to molt into the nymph stage.

Nymph: The nymph has eight legs and looks like a smaller version of the adult tick. It also waits for a host to attach to and feeds on blood. After feeding, it drops off the host and molts into an adult.

Adult: Adult ticks have eight legs and are larger than nymphs. They seek out a new host, feed on blood, and the females become engorged with blood before dropping off to lay eggs, thus completing the cycle. The entire life cycle can take several months to years, depending on species and environmental conditions.

2. Mites: Mites such as *Sarcoptes scabiei*, *Psoroptes ovis*, *Chorioptes bovis*, and *Demodex bovis* cause mange, a severe dermatitis resulting in pruritus, hair loss, and skin thickening. Transmission often occurs via direct contact and contaminated environments.

Life Cycle Stages: Egg → Larva → Nymph → Adult

Egg: Female mites lay eggs on or under the skin of the host animal. The eggs hatch into larvae within a few days.

Larva: The larval stage has six legs and is very small. Larvae feed on the skin or burrow into it, causing itching and irritation. They then molt into nymphs.

Nymph: Nymphs have eight legs and resemble adults but are smaller. Like the larvae, nymphs continue to feed on the host's skin. They go through several molts before becoming adults.

Adult: Adult mites are responsible for reproducing and laying eggs, continuing the cycle. The entire life cycle of mites can be completed in as little as two weeks under favorable conditions.

3. Lice: Lice are either chewing (e.g., *Bovicola bovis*) or sucking (e.g., *Haematopinus eurysternus*, *Linognathus vituli*). Heavy infestations cause anemia, pruritus, and can indicate underlying health issues. Lice are more prevalent in colder months.

Life Cycle Stages: Egg (Nit) → Nymph → Adult

Egg (Nit): Female lice lay eggs, known as nits, on the hair shafts of the host animal. The nits are tiny and firmly attached, making them difficult to remove. After about a week, the eggs hatch into nymphs.

Nymph: The nymph stage passes through three molts before becoming an adult. Nymphs resemble adults but are smaller and not yet sexually mature. They feed on skin debris or blood, depending on whether they are biting or sucking lice.

Adult: Adult lice are fully developed and begin reproducing shortly after their final molt. Adult lice live for about a month, during which time they can lay hundreds of

eggs. The entire life cycle of lice typically takes about three weeks.

4. Flies: Various species of dipteran flies are among the most problematic ectoparasites affecting farm animals. Horn flies (*Haematobia irritans*) and buffalo flies (*Haematobia exigua*) are hematophagous ectoparasites commonly found on grazing cattle. They persist on the animal's body, primarily on the back, shoulders, and underbelly, where they inflict repeated bites, leading to irritation and restlessness. These flies also serve as mechanical vectors for pathogens causing mastitis, such as *Staphylococcus aureus*. Stable flies (*Stomoxys calcitrans*) are blood-sucking insects with painful bites that target the lower limbs of cattle. They breed in moist, decaying organic matter and are associated with reduced feed intake, lower weight gain, and decreased milk production. Face flies (*Musca autumnalis*) are primarily nuisance pests that feed on facial secretions and are important mechanical vectors of *Moraxella bovis*, the causative agent of infectious bovine keratoconjunctivitis or pinkeye. Their presence exacerbates disease transmission due to their abrasive feeding behavior and the irritation they cause around the eyes and muzzle.

Life Cycle Stages: Egg → Larva (Maggot) → Pupa → Adult

Egg: Female flies lay eggs in moist organic material, such as decaying vegetation, manure, or open wounds on animals. The eggs hatch into larvae within a day or two.

Larva (Maggot): The larval stage, commonly known as a maggot, feeds on decaying organic matter or living tissue in the case of certain parasitic species. After several days of feeding, the larvae move to a dry location to pupate.

Pupa: The pupal stage is when the larva transforms into an adult fly. This stage lasts from a few days to several weeks, depending on environmental conditions.

Adult: Adult flies emerge from the pupal case and are ready to reproduce within a few days. Adult flies have a short lifespan but can lay hundreds of eggs, leading to rapid population growth.

5. Fleas: Fleas are small, wingless insects that jump from one host to another. They are particularly problematic in poultry farms, but they can also affect cattle, goats, and sheep. Common species include *Ctenocephalides spp.* and *Pulex irritans*.

Life Cycle Stages: Egg → Larva → Nymph → Adult

Egg: Female fleas lay eggs on or under the skin of the host animal. The eggs hatch into

larvae within a few days.

Larva: The larval stage has six legs and is very small. Larvae feed on the skin or

burrow

into it, causing itching and irritation. They then molt into nymphs.

Nymph: Nymphs have eight legs and resemble adults but are smaller. Like the larvae,

nymphs continue to feed on the host's skin. They go through several molts before becoming adults.

Adult: Adult mites are responsible for reproducing and laying eggs, continuing the cycle.

The entire lifecycle of mites can be completed in as little as two weeks under favorable conditions.

Myiasis-Causing Flies:

Certain fly species cause myiasis, a condition where fly larvae invade and feed on the living tissues of the host. *Hypoderma lineatum*, *Hypoderma bovis*, and *Cochliomyia hominivorax* are notable examples. These parasites cause the formation of warbles or cyst-like swellings under the skin, leading to tissue damage, secondary infections, pain, hide devaluation, and reduced weight gain. Severe infestations can also result in systemic illness and even death.

Other Dipterans:

1. **Mosquitoes:** Female mosquitoes of the family Culicidae are vectors of several zoonotic and animal diseases, including Rift Valley fever, which affects both cattle and humans. These insects breed in stagnant water and are most active during dawn and dusk.

2. **Black Flies (*Simulium spp.*):** These blood-feeding flies swarm cattle in large numbers and can cause simuliotoxicosis, a potentially fatal condition resulting from severe allergic reactions to the flies' saliva.

3. **Biting Midges (*Culicoides spp.*):** These tiny flies are efficient vectors of bluetongue virus, which can cause severe disease outbreaks in cattle and sheep, particularly in tropical and subtropical regions.

4. **Sand Flies (*Phlebotomus and Lutzomyia spp.*):** These small insects transmit vesiculoviruses and trypanosomes and are significant ectoparasites in tropical and subtropical climates.

5. **Tsetse Flies (*Glossina spp.*):** Found predominantly in sub-Saharan Africa, these flies are the biological vectors of *Trypanosoma spp.*, causing African animal trypanosomiasis (nagana), a disease that severely limits livestock productivity.

Pathogenesis and Economic Impact:

Ectoparasites inflict damage both directly and indirectly. Direct effects include skin irritation, allergic dermatitis, blood loss, and inflammation due to feeding. Indirectly, ectoparasites serve as vectors for various pathogenic agents, leading to diseases that further compromise animal health. Infestations often result in decreased feed intake, reduced weight gain, diminished milk yield, poor reproductive performance, and hide damage, all contributing to substantial economic losses. In countries like Brazil, the annual financial burden due to ectoparasitic infestations in cattle alone is estimated at over \$6 billion, underscoring the urgency for effective control measures.

Diagnosis of Ectoparasitic Infestation:

Accurate and early diagnosis is key to effective management. Several diagnostic methods are employed:

1. **Direct Observation:** Routine visual inspection of animals can reveal ectoparasites like ticks, lice, and flies.
2. **Skin Scrapings:** Deep and superficial skin scrapings help detect burrowing and surface mites, respectively.
3. **Hair Plucks and Tape Impressions:** Useful for detecting lice, eggs, and surface mites such as *Cheyletiella* spp.
4. **Biopsy and Histopathology:** Applied in chronic or unclear skin conditions to detect deeply embedded parasites or associated pathology.
5. **Serological Tests (ELISA):** Employed to detect antibodies against specific ectoparasites like *Sarcoptes scabiei* and *Psoroptes ovis*.
6. **Environmental Sampling:** Techniques such as blanket dragging or light traps are used to collect free-living ticks and flies from the environment.

Management and Control Strategies:

Effective control of ectoparasites in farm animals demands an integrated and sustainable approach comprising the following strategies:

1. Chemical Control:

Various chemical classes, including organophosphates, pyrethroids, macrocyclic lactones (e.g., ivermectin, doramectin), and insect growth regulators, are used for controlling ectoparasites. These chemicals are administered through pour-ons, sprays, dips, or injectables. However, the extensive and repeated use of such agents has led to the development of resistance in many ectoparasite species. Therefore, it is crucial to rotate chemical classes periodically and integrate other control methods to sustain efficacy and reduce environmental impact.

2. Biological Control:

Natural enemies like entomopathogenic fungi (*Metarhiziumanisopliae*, *Beauveria bassiana*) and parasitoid insects can significantly suppress ectoparasite populations in the environment. Biological larvicides, such as *Bacillus thuringiensis israelensis*, are particularly effective against immature stages of flies breeding in organic matter, contributing to long-term fly population control.

3. Immunological Control:

Immunoprophylaxis using vaccines offers an eco-friendly and sustainable alternative. For example, the Bm86 antigen-based vaccine has shown promising results against *Rhipicephalus microplus* ticks by reducing infestation levels and fertility of female ticks.

4. Genetic Control:

Genetic approaches include the sterile insect technique (SIT), which involves the release of sterilized male flies to interrupt the breeding cycle. Selective breeding programs for livestock with inherent resistance to ectoparasites can also contribute to long-term management with reduced chemical dependency.

5. Environmental Management:

Good sanitation practices, such as the regular removal of dung, maintaining dry bedding, and eliminating stagnant water sources, are essential to disrupt ectoparasite breeding cycles. Modifying shelters to improve ventilation and separating livestock from potential wildlife reservoirs further reduces the risk of infestation and disease transmission.

6. Integrated Parasite Management (IPM):

IPM employs a holistic strategy that combines chemical, biological, environmental, genetic, and immunological tools for ectoparasite control. Emphasis is placed on monitoring parasite burdens, minimizing chemical usage, delaying resistance development, and optimizing animal health and productivity while ensuring environmental sustainability.

Conclusion

Ectoparasites pose a major challenge to farm animal health, productivity, and welfare. Their management requires comprehensive strategies combining good husbandry, regular monitoring, targeted chemical use, and alternative control

methods. Sustainable integrated approaches not only safeguard animal health but also contribute to public health and environmental safety.

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6. Laboratory Diagnosis of Parasitic Infections: Collection of Clinical Samples, Faecal Examination, Blood Smear Preparation, and Skin Scraping Techniques

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Laboratory diagnosis is the cornerstone of effective veterinary parasitology. Accurate identification of parasitic infections requires meticulous collection and examination of various clinical samples, including faeces, blood, and skin scrapings. These procedures help detect endoparasites (such as helminths and protozoa) and ectoparasites (such as mites) that affect animal health and productivity. This chapter outlines standard methods for collecting clinical samples, conducting qualitative and quantitative faecal examinations, preparing blood smears, and performing skin scraping examinations, all of which are essential diagnostic tools in both field and clinical settings.

1. Collection of Clinical Samples

The success of laboratory diagnosis depends significantly on the quality of the collected samples. Use sterile containers and label all specimens accurately with the animal ID, date, and type of sample. Samples should be collected prior to treatment and sent to the laboratory without delay.

Faecal Sample Collection

- Use a clean, dry, leak-proof container for sample collection.
- Fresh samples (examined within 1–2 hours) are ideal.
- If delay is expected, preserve the sample in 10% formalin or other suitable preservatives.
- Rectal swabs may be used in the absence of fresh faeces.
- Avoid contamination with urine, water, or soil.

Blood Sample Collection

- Critical for diagnosing haemoparasites and for serological and haematological investigations.
- Common venipuncture sites:
 - **Jugular vein** in cattle, sheep, goats, horses

- **Coccygeal vein** in cattle
- **Ear or saphenous vein** in pigs and dogs
- Clean the site with 70% alcohol before collection.
- Use sterile syringes or vacuum collection tubes.
- Collect in:
 - **EDTA tubes** for haematology
 - **Plain tubes** for serum
- Mix gently to avoid clotting. Label appropriately.

Faecal Examination

Faecal analysis aids in diagnosing gastrointestinal parasitism by identifying eggs, larvae, and cysts.

Qualitative Faecal Examination

a. Direct Smear

Useful for detecting motile protozoa and helminth eggs.

Procedure:

- Place a drop of saline on a clean slide.
- Mix a small amount of faeces (match head size) into it.
- Prepare a thin smear, optionally with iodine.
- Place a coverslip and examine under microscope (10× and 40×).

Floatation Method

Detects light-weight eggs like those of nematodes and cestodes.

Procedure:

- Mix 2 g of faeces with 10–15 ml of floatation fluid.
- Strain and pour into a test tube.
- Form a convex meniscus and place a coverslip.
- After 10–15 minutes, transfer coverslip to slide and examine.

Sedimentation Method

Used for detecting heavier eggs such as trematodes.

Procedure:

- Mix 2 g faeces in water and strain into centrifuge tube.

- Centrifuge at 1500 rpm for 2–3 minutes.
- Discard supernatant; examine sediment under microscope.

Quantitative Faecal Examination

a. McMaster Technique

Calculates eggs per gram (EPG) to estimate infection intensity.

Procedure:

- Weigh 2 g of faeces and add 28 ml floatation fluid.
- Strain and fill McMaster chamber.
- Let stand 5 minutes.
- Count eggs under low power and multiply by 50 for EPG.

Stoll's Dilution Technique

Used for dense egg burdens.

Procedure:

- Mix 0.1 g faeces with 10 ml distilled water.
- Centrifuge 1 ml of suspension at 1500 rpm for 2–3 minutes.
- Discard supernatant.
- Examine sediment and calculate EPG.

Blood Smear Preparation

Used to detect haemoparasites such as *Babesia*, *Trypanosoma*, and *Anaplasma*.

Thin Blood Smear

Procedure:

- Collect blood from ear or tail vein.
- Place a drop near slide end and spread with another slide at 30–45°.
- Air dry, fix in methanol for 1 min.
- Stain with 1:10 Giemsa for 30 min.
- Rinse and examine under oil immersion.

Thick Blood Smear

Procedure:

- Place a large drop of blood in the center and spread in a circle.
- Air dry (do not fix).

- Stain with diluted Giemsa for 30–45 minutes.
- The hypotonic stain lyses RBCs (laking), enhancing parasite visibility.
- Rinse and examine under microscope.

Wet Blood Film (Wet Mount)

Used for rapid detection of motile parasites (e.g., microfilariae, trypanosomes).

Procedure:

- Place a drop of fresh blood on slide.
- (Optional) Add saline.
- Cover with coverslip.
- Immediately examine under 10× and 40× objectives.

Skin Scraping Examination

Skin scrapings are essential for diagnosing ectoparasitic infestations, particularly mites causing mange.

Procedure:

- Restrain the animal properly.
- Apply a drop of liquid paraffin on the lesion.
- Using a sterile scalpel blade, gently scrape the affected area until slight capillary bleeding occurs (to retrieve deep-burrowing mites).
- Collect the scraping on a clean glass slide.
- Add another drop of liquid paraffin on the sample.
- Cover with a coverslip.
- Examine under low (10×) and high (40×) magnification.

Conclusion

Efficient and accurate diagnosis of parasitic infections begins with proper sample collection and continues with skillful examination using standard laboratory techniques. Mastery of faecal, blood, and skin diagnostics enhances disease detection and contributes significantly to improved parasite control and animal health management.

7. Farriery in Equines

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Farriery is the skilled practice of equine hoof care, focusing on the trimming, balancing, and shoeing of hooves to ensure the health and functionality of a horse's feet. A farrier combines the knowledge of a blacksmith (working with metal shoes) and a veterinarian (understanding the anatomy and physiology of the lower limb) to care for equine hooves effectively.

Objectives of Farriery

- Protect hooves from wear and tear
- Prevent slipping and improve grip
- Correct hoof deformities and imbalances
- Support treatment of lameness conditions like laminitis and navicular disease
- Maintain hooves in sound and fit condition

Trimming and Shoeing

- **Trimming** involves reshaping and levelling the hoof to a healthy form, supporting normal movement and posture.
- **Shoeing** helps enhance hoof function, reduce lameness, and accommodate different working conditions. Horseshoes are shaped and nailed onto the hoof accordingly.

Essential Farriery Tools

- **Hoof knife, cutter, and pincer** – for trimming and removing shoes
- **Anvil and hammers** – for shaping shoes
- **Rasper and clincher** – for levelling hooves and securing nails
- **Shoe nails and horseshoes** – to attach and adjust footwear

Proper use of tools and techniques is vital to ensure safe, welfare-friendly farriery practices that promote the overall wellbeing of equines.

8. Antimicrobial Resistance: Mechanism and Combat strategies

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Antimicrobial resistance (AMR) has become a public health crisis in the 21st century. The antibiotics and other antimicrobial agents are losing their effectiveness against a number of pathogens. AMR occurs when microorganisms such as bacteria, viruses, fungi, and parasites evolve mechanisms to survive exposure to antimicrobial agents. This not only compromises our ability to treat infectious diseases but also threatens medical procedures like surgeries, chemotherapy, and organ transplantation that rely heavily on effective antimicrobial prophylaxis.

AMR is not a problem confined to hospitals or developed nations; it is a global issue that affects human health, veterinary practice, agriculture, and the environment. It demands a holistic approach that addresses the biological, environmental, and social factors contributing to its emergence and spread. AMR arises naturally over time due to genetic mutations and selective pressure, but the process has been greatly accelerated by human practices. The overuse and misuse of antibiotics in healthcare, animal farming, and agriculture exert selective pressure on microbial populations, encouraging the survival and proliferation of resistant strains. Resistant microbes can spread between individuals, communities, and even across continents, facilitated by travel, trade, and poor sanitation.

The consequences of AMR are severe: prolonged illnesses, increased healthcare costs, treatment failures, and higher mortality rates. Diseases that were once easily curable—such as Hemorrhagic septicemia, tuberculosis, BQ, and other common infection are now becoming increasingly difficult to treat due to drug resistance.

Mechanisms of Antimicrobial Resistance

Microorganisms have evolved a variety of sophisticated mechanisms to resist antimicrobial agents. These mechanisms can be intrinsic or acquired and often work in combination, making treatment particularly challenging.

1. Enzymatic Degradation or Modification: One of the most common mechanisms of resistance is the production of enzymes that inactivate antibiotics. For example, many bacteria produce beta-lactamases, enzymes that break down the

beta-lactam ring in penicillins and cephalosporins, rendering them ineffective. Extended-spectrum beta-lactamases (ESBLs) and carbapenemases can degrade a broader range of beta-lactam antibiotics, including those considered last-resort drugs. Other examples include aminoglycoside-modifying enzymes that phosphorylate, acetylate, or adenylate the antibiotic molecule, thus preventing it from binding to its target.

2. Alteration of Target Sites: Some microbes acquire mutations in the genes encoding the target of the antibiotic, thereby reducing drug binding and efficacy. For instance, changes in penicillin-binding proteins (PBPs) can reduce the effectiveness of beta-lactam antibiotics. Mutations in ribosomal RNA can lead to resistance against macrolides and tetracyclines. In the case of fluoroquinolones, mutations in DNA gyrase or topoisomerase IV enzymes alter the drug's target site, preventing it from inhibiting bacterial DNA replication.

4. Efflux Pumps: Efflux pumps are transmembrane proteins that actively transport antimicrobial agents out of the microbial cell, reducing the intracellular concentration of the drug. These pumps can be specific to one class of antibiotics or capable of exporting multiple types, contributing to multidrug resistance.

5. Reduced Permeability: Gram-negative bacteria possess an outer membrane that serves as a barrier to many antibiotics. They can reduce the uptake of antibiotics by altering the porin channels through which these drugs enter the cell. Loss or modification of porins can dramatically decrease drug accumulation inside the bacterial cell.

6. Biofilm Formation: Biofilms are structured communities of microbial cells surrounded by a self-produced extracellular matrix. Microorganisms in biofilms exhibit increased resistance to antibiotics and the host immune response. The matrix impedes drug penetration, while cells in the inner layers often enter a dormant state that makes them less susceptible to antimicrobial agents.

Spread of Resistance Genes

Resistance can be passed from one organism to another through vertical transmission (cell division) or horizontal gene transfer (HGT). HGT is a major driver of the rapid spread of AMR across species and genera and can occur via:

- **Conjugation:** Transfer of plasmids containing resistance genes through direct

contact between bacterial cells.

- **Transformation:** Uptake and incorporation of free DNA fragments from the environment.
- **Transduction:** Transfer of resistance genes via bacteriophages (viruses that infect bacteria).

Mobile genetic elements such as plasmids, transposons, and integrons play a key role in facilitating the horizontal transfer of resistance determinants, contributing to the global spread of AMR.

Drivers of Antimicrobial Resistance

Numerous factors contribute to the development and dissemination of AMR, including:

- **Overuse and misuse of antimicrobials** in both human medicine and veterinary practices.
- **Inappropriate prescriptions**, such as using antibiotics for viral infections.
- **Lack of adherence** to treatment regimens by patients.

Use of antibiotics as growth promoters in livestock and aquaculture.

- **Poor infection prevention and control practices** in healthcare settings.
- **Environmental contamination** from pharmaceutical manufacturing and agricultural runoff.

Future Strategies to Combat AMR

Tackling AMR requires a multifaceted, interdisciplinary, and international approach. Below are the key strategies for mitigating the threat of antimicrobial resistance:

1. Antimicrobial rationale use Programs (ASPs)

The aim to optimize the use of antimicrobials to improve patient outcomes and reduce resistance. Key components include:

- Developing and enforcing guidelines for appropriate antibiotic use.
- Monitoring antibiotic prescription patterns.
- Educating healthcare providers and patients.
- Implementing diagnostic stewardship to ensure the right drug is used at the right time.

2. Development of New Antibiotics

The antibiotic development pipeline has dried up due to high costs and low profitability. Renewed investment in R&D is essential. Strategies include:

- Focusing on narrow-spectrum antibiotics to target specific pathogens.
- Exploring new sources such as marine organisms and microbial metabolites.
- Investigating novel targets and mechanisms of action.

3. Alternatives to Conventional Antibiotics

Several non-traditional therapies are under development, including:

- **Phage therapy:** Using bacteriophages to selectively kill antibiotic-resistant bacteria.
- **Antimicrobial peptides (AMPs):** Short peptides with broad-spectrum antimicrobial activity.
- **CRISPR-Cas systems:** Gene-editing tools to disrupt resistance genes.
- **Vaccination:** Preventing infections reduces the need for antibiotics.
- **Probiotics and microbiome modulation:** Enhancing host immunity and competitive exclusion of pathogens.

4 Public Awareness and Education

Educational campaigns targeting healthcare workers, farmers, and the general public are critical. Key messages include:

- Importance of completing prescribed antibiotic courses.
- Risks of self-medication.
- Hygiene practices to prevent infection.

Conclusion

Antimicrobial resistance represents a complex and escalating threat to global health, food security, and economic development. The ability of microbes to rapidly evolve and share resistance traits has outpaced the development of new antimicrobial agents. Without immediate and sustained action, the world could face a future where routine infections become deadly once again. A comprehensive, multisectoral strategy rooted in the One Health framework is essential. This includes promoting responsible antimicrobial use, investing in research and development, strengthening surveillance, improving diagnostics, and educating the public. The fight against AMR is a collective responsibility that requires cooperation at local, national, and global

9. Basics of Ultrasonography and its Interpretation in Bovine Reproduction

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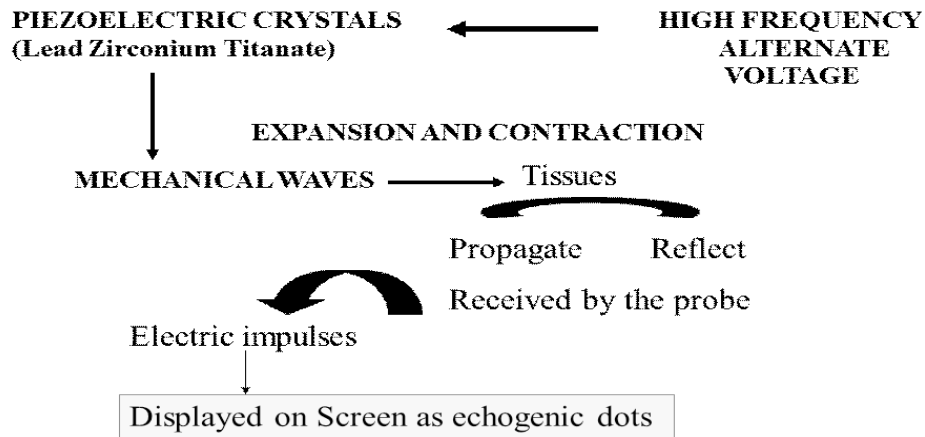
Ultrasonography has transformed the field of bovine reproduction by enabling real-time, non-invasive, and accurate diagnosis of various physiological and pathological conditions of the reproductive tract. This article provides an in-depth overview of the fundamental principles of ultrasonography, types of ultrasound equipment used in bovine practice, and detailed interpretation protocols for reproductive diagnostics. Emphasis is placed on its applications in estrus detection, follicular monitoring, pregnancy diagnosis, pathological evaluation, fetal sexing, and reproductive performance optimization in dairy and beef cattle. Interpretation techniques, image orientation, anatomical landmarks, and practical challenges in the field are thoroughly discussed. The integration of ultrasonography with modern reproductive technologies and future prospects including Doppler and AI-assisted systems are also covered. This article aims to serve as a reference for veterinarians, researchers, and students striving to enhance reproductive efficiency through ultrasonographic techniques.

The use of ultrasonography in veterinary medicine has witnessed exponential growth over the last two decades, particularly in bovine reproduction. With increasing demands for dairy and meat productivity, precise reproductive management has become pivotal. Traditional reproductive examinations like rectal palpation, though useful, often lack specificity and may result in misdiagnosis. Ultrasonography offers real-time imaging of reproductive organs and dynamic reproductive events with improved accuracy, safety, and repeatability. This article delves into the basics of ultrasonographic principles, its clinical applications in bovine reproduction, and interpretation of ultrasonographic findings, thereby enabling veterinary professionals to apply this tool effectively in both clinical and field settings.

1. Principles of Ultrasonography

Sound waves of frequencies greater than audible to human ear (greater than 20,000 Hz) are called ultrasound. Frequencies between 2 to 10 MHz are used in diagnostic ultrasound. Selection of frequency is inversely related to the depth of the tissue from scan surface. Diagnostic ultrasound works on pulse-echo principle.

TRANSDUCER (Ultrasound Probe)



1.1. Generation of Ultrasound

Ultrasound waves are high-frequency sound waves (>20 kHz) generated by piezoelectric crystals within a transducer. When an electrical current is applied, these crystals vibrate and emit sound waves. As the transducer is placed in close contact with the body surfaces through a coupling medium (gel), a portion of the ultrasound beam reflected back towards the source in the form of echo which is converted into visual image by the computer of the ultrasound machine. The same crystals detect the returning echoes after the waves reflect from tissues of different densities.

1.2. Image Formation

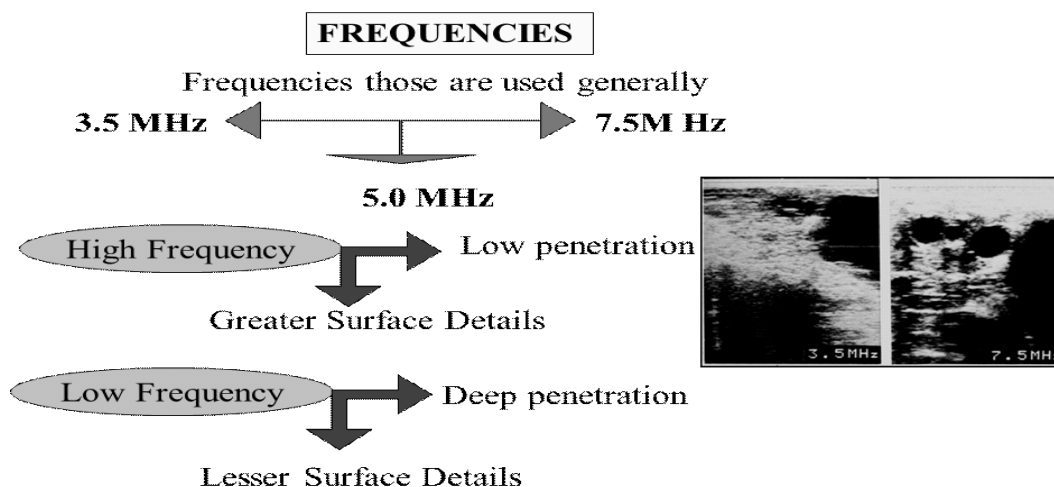
Ultrasound machines interpret the time it takes for echoes to return and their intensity to create a two-dimensional image (B-mode). Stronger echoes (from denser tissues) appear brighter, while weaker echoes (from fluids) appear darker.

1.3. Modes of Ultrasound

- **B-Mode (Brightness Mode):** Standard imaging for reproductive structures.
- **M-Mode (Motion Mode):** Used in cardiovascular imaging.
- **Doppler Mode:** Measures blood flow, useful for evaluating ovarian activity and placental function.
- **3D/4D Mode:** Rare in bovine practice but used in research.

1.4. Frequency Selection

- **5.0–7.5 MHz:** Suitable for deep imaging, e.g., transrectal exam of adult cows.
- **7.5–12.0 MHz:** High-resolution imaging for superficial structures, ideal for small ruminants or early pregnancy.



Transducers used in bovine reproductive work are typically linear or convex rectal probes with a frequency of 5–7.5 MHz.

2. Ultrasonographic Equipment in Bovine Reproduction

2.1 Types of Ultrasound Machines:

- **Portable/Field Ultrasound Units:** Battery-operated, rugged, lightweight.
- **Trolley-Based Systems:** Used in research or stationary clinics with high-resolution imaging.

2.2 Types of Probes:

- **Linear Probe:** Common for transrectal examination; offers a rectangular field of view.
- **Convex Probe:** Offers a wider field of view; less commonly used transrectally.
- **Sector Probe:** Suitable for small anatomical spaces.

2.3 Probe Care and Handling:

- Clean with non-corrosive disinfectants.
- Use of protective sheaths during rectal exams.
- Avoid impact or exposure to extreme temperatures.

3. Ultrasonographic Anatomy of Bovine Reproductive Tract:

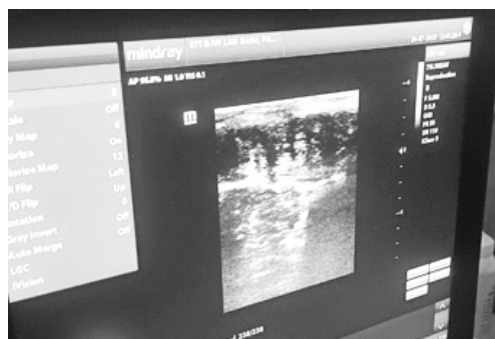
Understanding normal anatomy is essential for interpretation.

3.1 Identification of Reproductive Structures

Urinary Bladder: Although urinary bladder is not the part of reproductive organ but due to its easy visibility it is landmark during sonography of reproductive organs. It is easily recognized as an anechoic vesicular structure (black) and taken as a reference point for scanning of reproductive organs. Uterus lies anterior and ventral to the urinary bladder

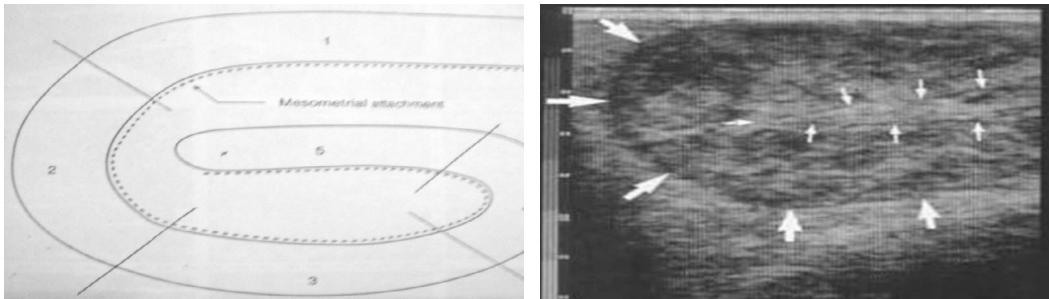


Cervix: Cervix is a cylindrical and mobile structure (7-10 cm long, 3-4 cm diameter) with variable size and location depending upon age (parity) and reproductive status (postpartum or cycling). The lobulated appearance is due to three to four rings of cervical mucosa. Normal non-pregnant cow exhibits cervix in the pelvic cavity above the urinary bladder. For sonography, maintain the probe ventrally on the pelvic floor until the cervix is localized. Stabilizing cervix with other fingers may help in visualization. The cervical structures that can be identified include the cervical rings and a central hyperechoic line which represents the cervical canal, the image of cervix look as 'M' or 'W' during USG. Immediately cranial to cervix usually in the midline, appear the body and uterine horns.



Uterus: Normal non-gravid uterus is difficult to scan and hard to distinguish from intestinal loop (In small animals). The uterus appears as a well-defined tubular structure, with a hypoechoic to anechoic lumen. The lack of an echogenic center and peristalsis during real time scanning help differentiate the uterus from bowel.

- Non-pregnant: tubular, uniform echogenic wall
- Pregnant: fluid-filled horn with hypoechoic content



Ovaries:

- **Follicles:** Anechoic (black), round, thin-walled structures measuring 3–20 mm in diameter
- **Corpus Luteum (CL):** Hypoechoic to echogenic, heterogeneous structure, mixed echogenicity; central cavity in early luteal phase
- **CH (Corpus Hemorrhagicum):** Echogenic with central hypoechoic zone
- **Cysts:** Thin-walled, large (>25 mm), anechoic or hypoechoic



Follicles- Black

Mature CL with Central cavity

Follicular Cyst

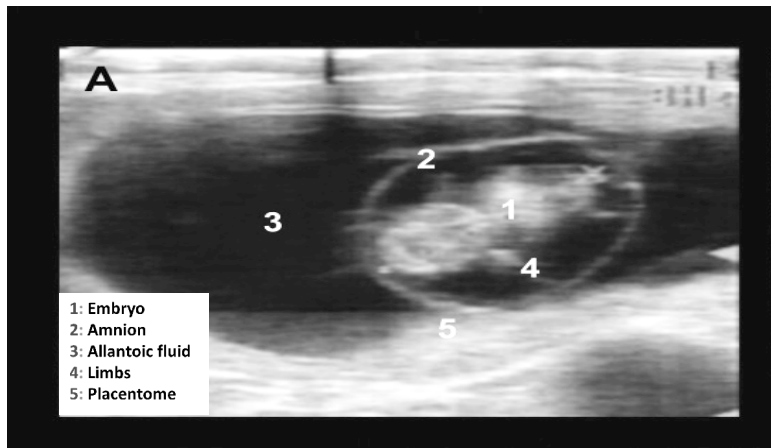
4. Pregnancy Diagnosis:

4.1 Early Diagnosis

- As early as **26–30 days** post-insemination.
- Look for anechoic fluid with echogenic embryonic vesicle.

4.2 Fetal Landmarks by Gestational Age

Gestational Age	Structure Visible
Day 28–30	Anechoic embryonic vesicle; Embryo with heartbeat
Day 35–40	Limb buds, head, yolk sac
Day 60–80	Fetal movement, placentomes



5. Main Field Applications of USG in Large Animal Reproductive Management

5.1 Estrus Detection and Synchronization Monitoring

- Follicular growth can be monitored, size of about 15-16 mm in absence of CL indicate the preovulatory follicle. Uterine tone and turgidity indicated by presence of vascularity are also seen during estrus.
- Confirmation of ovulation – absence of preovulatory follicle in second consecutive sonography at 12-24 h interval.



Pre-ovulatory follicle

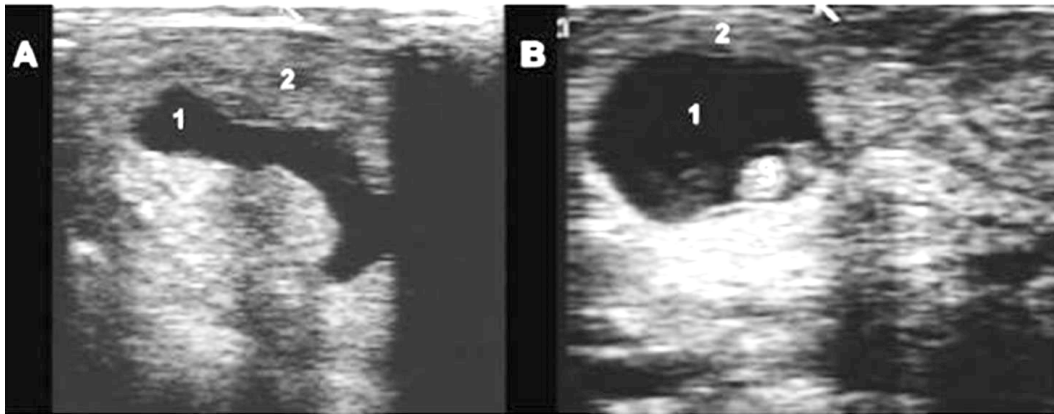
Pre-ovulatory follicle

12 hours later, Ovulation has occurred

5.2 Early Pregnancy Diagnosis

- Accurate from Day 25–28 post-AI
- Heartbeat, limb movement, crown-rump length measurement
- Differentiation from pseudopregnancy, mucometra
- Detecting twins

Differential diagnosis of mucometra (A) & early pregnancy (B) (7.5 MHz; depth 5 cm)

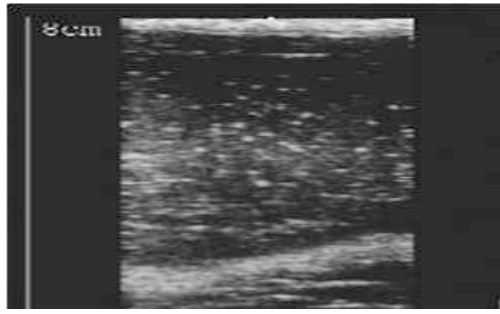
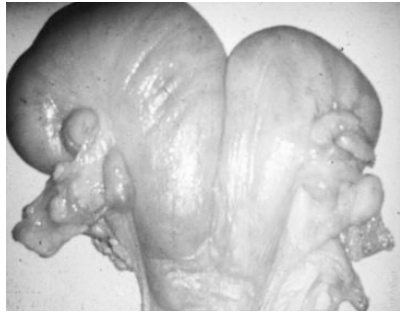


1: Accumulation of clear anechogenic content 2: Uterine wall 3: Embryo



5.3 Diagnosis of Reproductive Pathologies

- Pyometra: Echogenic fluid with debris in uterine lumen
- Mucometra/Hydrometra: Anechoic fluid without debris



- Mummified fetus
- Fetal ascites

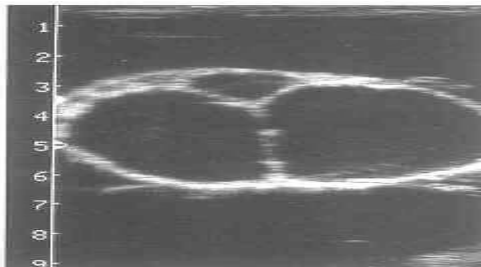
Pyometra



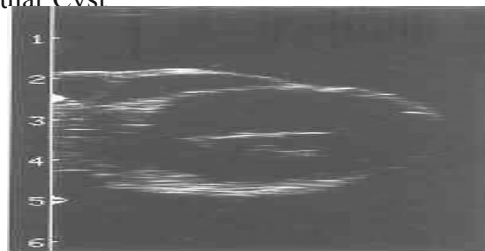
Mummified fetus

Ascitic fetus

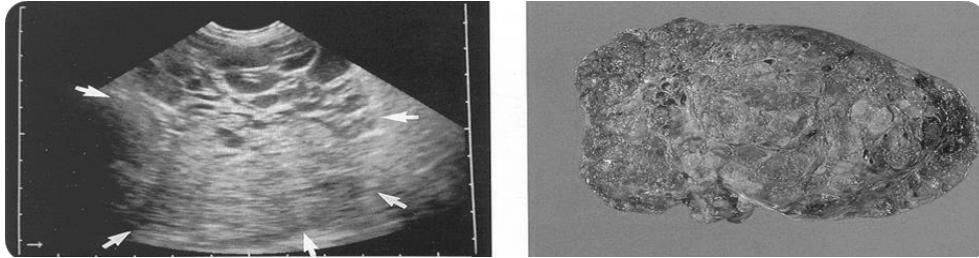
- Ovarian cysts: Persistent large follicles or luteal cysts
- Ovarian tumour



Follicular Cyst



Luteal Cyst



Ovarian Tumour

Advantages of Ultrasonography in Reproductive Practice

- Non-invasive and animal-friendly
- Early and accurate diagnosis
- Real-time functional assessment
- Improves reproductive efficiency and reduces calving interval

Limitations and Constraints

- High initial cost of equipment
- Operator-dependent interpretation
- Requires skilled personnel and training
- Limited field utility in extreme weather or remote areas

Recent Advances

- **Color Doppler Ultrasonography:** Assesses blood flow to CL, uterus, and fetus
- **3D Ultrasound:** Advanced structural evaluation
- **Automated follicular tracking:** AI-based interpretation

Recommendations for Clinical Practice and Training

- Incorporate ultrasonography into standard reproductive examination protocol
- Participate in hands-on training on USG
- Integrate with herd health and fertility monitoring programs

Conclusion

Ultrasonography has become an indispensable tool in bovine reproductive management, offering enhanced diagnostic precision, timely therapeutic interventions, and improved herd fertility. Its practical utility spans from estrus synchronization to pregnancy monitoring and treatment of reproductive pathologies.

With advancements in technology and field adaptation, it is imperative for veterinary professionals to gain competence in ultrasonographic skills. Future innovations promise even greater accuracy, automation, and accessibility in rural dairy setups.

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10. Surgical Management of Common Abdominal Disorders in Bovine

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Abdominal cavity, the largest body cavity, is separated from thoracic cavity by diaphragm and connects to pelvic cavity. Its dorsal wall comprises lumbar vertebrae, muscle and diaphragm. Lateral wall consists of oblique and transverse muscles, abdominal tunic, ilia with iliocostalis muscle, and lower ribs. Ventral wall includes recti, muscle aponeurosis, abdominal tunic and xiphoid cartilage. The cavity has 5 openings: Hiatus aorticus, Hiatus oesophagus, Foramen vena cavae and two inguinal openings. Before surgery, knowledge of abdominal wall muscles is essential: The muscles encountered to open the abdominal wall are external oblique, internal oblique, rectus abdominal and transverse abdominal muscles. Main surgical approaches include: Ventral midline approach through linea alba for minimal bleeding; Paramedian approach lateral to linea alba for better examination; Flank approach through dorsoventral incision; Paracostal approach with curvilinear incision near last rib; and Ventral midline-Paracostal combined approach for better organ visualization.

Traumatic Reticulo-peritonitis and Traumatic Reticulo-Pericarditis

This condition is the most common surgical pathology in the bovine gastrointestinal tract, occurring in intensively fed cattle as an occupational disease. It is caused by the ingestion of hard materials, such as wire, nails, screws, and other objects, into the reticulum, where they cause reticulitis. The foreign objects after ingestion may: (i) Travel to the floor or ventral ruminal sac causing no harm (ii) Get wedged inside reticular wall forming painful ulcers (iii) Move to omasoabomasal orifice and expel with faeces (iv) During increased abdominal pressure, pierce into the pericardial sac (v) Travel to liver, spleen or lungs Clinical signs: In acute cases, symptoms appear suddenly with grunting, reduced appetite and decreased milk yield. The animal shows thoracic kyphosis, lumbar lordosis, and stiffness of forelegs. Bloat may occur, temperature remains normal except during peritonitis. Pain tests include: (i) Grasping thoracic vertebrae causes ventral spine curvature (ii) Pressure behind xiphoid process determines pain location (iii) Laboratory shows leucocytosis with lymphopenia, neutrophilia and left shift.

Treatment: (i) Non-surgical: (a) Use of antibiotics (b) Use of magnet bolus when

foreign body hasn't penetrated deeply. (ii) Surgical: Rumenotomy is performed. Left sub-lumbar fossa between last rib and tuber coxae is prepared aseptically. Operation uses local infiltration analgesia or para lumbar nerve block. A vertical incision is made between tuber coxae and last rib until reaching peritoneum. After affixing Weingarh's frame and grasping rumen wall, it is incised dorsally and extended ventrally. Remove some rumen contents to explore floor and retrieve foreign body. Search reticulum for penetrating bodies. Using magnet helps collect metal pieces. Close rumen wound with Lembart suture using No. 2 or 3 chronic catgut. Suture muscle layers continuously with same material. Close skin with interrupted or mattress suture using silk. Apply antibiotic ointment until suture removal at 8-10 days. Administer systemic antibiotics and analgesics for 5 days.

Abomasal Displacement:

Abomasum moves under rumen between rumen and left body wall, 3 weeks before to 4 weeks after parturition. Gas accumulation and ketosis inhibit abomasal motility. Clinical Signs: Cases show appetite loss, decreased milk yield and scanty faeces. Temperature varies with possible dehydration. Ketosis occurs. Left paralumbar fossa appears distended. Auscultation reveals high-pitched tinkling over last ribs. Treatment: (i) Manipulative Treatment: Rolling the animal. (ii) Surgical Treatment: (a) Right Ventral approach: Incision behind xiphoid. Abomasum drawn from under rumen, sutured to peritoneum. (b) Right Flank approach: Incision in paralumbar fossa. Abomasum drawn right after gas removal. Omentum sutured with peritoneum. (c) Utrecht method: Left flank incision behind last rib. Gas released, omentum drawn. Abomasum moved to normal position. U-shaped suture creates adhesion between omentum and peritoneum. Abomasal displacement to right occurs as: (a) Simple distention (b) Dilation with left torsion (c) Dilation with right torsion Causes: Simple distention occurs after ulceration from damaged silage or sand. Dilation with torsion causes much left displacement. Clinical Signs: In moderate dilation, animal shows poor appetite, scanty faeces, and ketosis. Rumen movements weaken. In right displacement, enlarged abomasum causes apathy and anorexia. Faeces vary from normal to black. Right flank shows dome-shaped distention with splashing sounds. Surgical procedures: Incision made in right paralumbar fossa. Gas released from exposed abomasum. Torsion corrected when present. Abomasum sutured after emptying. Fixation to body wall or pyloromyotomy may be performed.

Intussusception:

Invagination of intestine distally into adjacent portion. More common in dairy

animals. Iliocolic junction is most common site. Causes: (i) Abnormal intestinal motility (ii) Intestinal mucosal irritation from parasites, infections and inflammatory disorders (iii) Vigorous peristalsis (iv) Intestinal wall lesions like neoplasm and chronic inflammation Intussusception causes strangulated obstruction due to vascular congestion. Clinical signs: Palpable cylindrical abdominal mass. Dehydration, depression and right side abdominal distention occur. Treatment: Requires surgical resection and anastomosis.

Volvulus:

Axial rotation of intestine causing peracute obstruction. Treatment requires surgical resection and anastomosis.

Caecal impaction

It shows signs of intestinal obstruction: depression, emesis, abdominal tenderness and congested mucosa. Palpation reveals abnormal mass. Surgical Procedure: Caecum is isolated through midline incision. Iliocolic artery branches are divided between ligatures. Ilicaecal fold is divided, caecum freed from ileum. Doyen forceps clamp proximal caecum, which is removed and closed by inverting suture.

Atresia ani:

There is a depression where the anus should be with normal sphincter. The anus is absent with perineal bulging due to accumulated faeces. Surgical procedure: An incision is made at the bulge and the blind end of rectum is exposed and drawn to the new anal orifice. The rectal walls are sutured to levator ani muscle and blind end to subcutaneous tissue. It is opened and sutured around the skin and mucous membrane.

Rectovaginal fistula:

Faeces may pass from vagina. Surgical Procedures: After perineal midline incision, the tract between rectum and vagina is identified and separated. Vaginal roof is closed linearly. Abnormal rectum is excised, normal rectum brought to new orifice with retention sutures.

11. Biosecurity Measures for Disease Control and One Health

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Biosecurity refers to measures taken to check the spread or introduction of harmful organisms to human, animal, plant and environment. The term was originally used in defence where it was defined as “the prevention of misuse through loss, theft, diversion or intentional release of pathogens, toxins and any other biological hazardous materials”. Later, in 1980s the term "biosecurity" was used in animal health and production systems where it was defined by the U.S. Association of State Departments of Agriculture as “the vital work of strategy, efforts and planning to protect human, animal and environmental health against biological threats”. As the time passes, the concept of biosecurity has been embraced widely and integrated into strategic frameworks across various sectors.

Biosecurity aims to protect human, animal, plant and environment health from risk of transmission and spread infectious agent. *Food and Agriculture Organization of the United Nations (FAO, 2007)* defines biosecurity as “**Biosecurity is a strategic and integrated approach that encompasses policy and regulatory frameworks to analyze and manage risks in sectors of human health, food safety, animal life and health, and plant life and health, including associated environmental risks.**” However, in the context of animal health and production, biosecurity is defined as a set of management and physical measures aimed at minimizing the risk of introduction, establishment, and spread of diseases, infections, or infestations within, into, or out of an animal population. In other way *this can be defined as* set of preventive measures aimed at protecting animals, humans, and the environment from the introduction, spread, or release of harmful biological agents (e.g., viruses, bacteria, parasites). Hence, it focus on (i) Preventing entry of infectious agents/diseases into farms (i.e bioexclusion), (ii) Controlling spread within farms (i.e biocontainment) and (iii) Managing outbreaks when they occur (i.e biomangement).

Biosecurity is widely concerned with food safety, zoonoses, the introduction and transmission of animal diseases, plant diseases and pests. It is also concerned with the release and management of living modified organisms (LMOs) such as genetically modified organisms (GMOs) etc.

The concept of biosecurity and biosafety are closely related to each other, however they differ in their focus and application. Though biosecurity and biosafety are two sides of the same coin, biosafety mainly ensures the safe use and containment of biological agents, whereas biosecurity ensures that these agents do not spread into or out of animal populations or the environment. Moreover, both are essential for prevention of disease, research integrity, and global health security. As per world health organization biosafety can be defined as “It is the containment principles, technologies and practices that are implemented to prevent unintentional exposure to pathogens and toxins, or their accidental release.” In other way, Biosafety refers to the practices and procedures used to handle and contain infectious agents in laboratories or research settings, ensuring the safety of personnel, environment, and public health. It involves the measures to safeguard the handler under a laboratory conditions or working environment.

The basic difference between Biosecurity and Biosafety

Feature	Biosecurity	Biosafety
Purpose	Prevent entry and spread of diseases	Prevent exposure or accidental release of pathogens
Context	Used in farms, livestock units, borders, etc.	Used in labs, hospitals, and research facilities
Focus	Managing external and internal disease threats	Containment of hazardous biological materials
Scope	Animal, human, plant health, and environment	Laboratory and clinical settings
Risk Source	From outside the system (animals, people, feed)	From within the lab (samples, cultures, waste)
Measures include	Quarantine, disinfection, fencing, surveillance	PPE, biosafety cabinets, autoclaves, BSL classification
Related fields	Veterinary science, agriculture, border control	Microbiology, molecular biology, biotechnology

Biosecurity at animal farms: Maintaining biosecurity at farm level refers preventive measures adopted or implemented to protect animals from infectious diseases by reducing the risk of disease introduction, infection transmission, and spread. These

measures are mainly adopted if any new animal or herd is being introduced in a farm. Following biosecurity measures can be adopted at animal farm

1. Controlled access to farms

- Fencing the farm perimeter to prevent entry of unauthorized people, animals and wild animals.
- All the vehicle entering the farm must go through a disinfectant wheel dips.
- Farm must maintain a visitor register and restrict farm access to essential personnel only.
- Use protective clothing, boots, and gloves for visitors and workers.

2. Maintenance of Personal Hygiene and Staff Management

- Handwashing and footbaths facility at all entry/exit points should be ensured.
- Farm workers should wear clean farm-dedicated clothing and footwear to minimize risk.
- Training of workers for basic hygiene practices and signs of common diseases.
- Movement between different animal sheds should be restricted.

3. Quarantine measures and Animal Movement

- Isolate new or returning animals for at least 2–4 weeks before introduction.
- Avoid purchasing animals from unknown or high-risk sources.
- Keep records of all animal purchases, sales, and movements.

4. Feed and Water Safety

- Store feed in rodent- and bird-proof containers.
- Provide clean, wholesome and uncontaminated water.
- Avoid feeding raw waste that could carry pathogens.

5. Disease Monitoring and Health Management

- Carry out routine vaccination and deworming of animals.
- Regularly monitor animals for signs of disease.
- Isolate sick animals.
- Maintain health records of all animals.

6. Pest, Rodent, and Vector Control

- Use traps and baits to control rats and rodents.
- Remove stagnant water to prevent mosquito breeding.

- Install nets or screens to keep out wild birds and flying insects.

7. Cleaning and Disinfection

- Clean animal housing, feeding, and watering equipment.
- Use appropriate disinfectants regularly on floors, walls, and tools.
- Disinfect equipment and tools between uses and between sheds.

8. Proper waste and carcass disposal

- Remove and dispose of dead animals immediately through burial, burning, or rendering.
- Manage manure and farm waste to avoid contamination of feed or water.
- Maintain proper drainage systems to prevent accumulation of waste and urine.

9. Documentation and Record-Keeping

- Keep up-to-date records of:
 - Animal health and treatments
 - Movements in and out of the farm
 - Vaccinations and deworming
 - Visitor and vehicle logs

10. Training and Awareness

- Conduct regular biosecurity training for staff and animal handlers.
- Display biosecurity posters and instructions on farm premises.
- Update biosecurity protocols based on current disease risks.

Challenges in Implementation of Biosecurity at Farms

Implementation of biosecurity measures on animal farms is essential but there are challenges that we often face at farm, which may significantly hinder disease prevention efforts and compromise animal and public health. These challenges may be:

1. Lack of Awareness and Training to the farmers

- Many farmers are not fully aware or not at all aware about the biosecurity and its importance in animal farming.
- The poor infrastructure for veterinary extension services leading to poor knowledge transfer.
- Workers and handlers may lack formal training on hygiene and disease

control protocols.

2. Economic Constraints and Infrastructure Limitations

- Marginal or Small-scale farmers may lack resources to invest in biosecurity infrastructure (e.g., fencing, disinfection units).
- The farmers are reluctant in spending on preventive measures when there is no active outbreak.
- Cost of quarantine facilities, vaccines, PPE, and diagnostic tests may be prohibitive.
- Many farms do not have basic infrastructure like separate quarantine areas, proper drainage, or carcass disposal pits.
- Shared use of equipment, water sources, or labor between farms increases disease risk due to poor socioeconomic conditions.

4. Cultural/Behavioral Barriers and Poor Enforcement & Regulation

- Farmers usually adopt traditional practices such as open grazing, mixing herds, and use of untreated waste which may contradict with biosecurity guidelines.
- Reluctance to report disease due to fear of culling, stigma, or economic loss.
- Low compliance with disinfection or PPE uses due to discomfort or inconvenience.
- Inadequate monitoring by animal health authorities.
- Weak implementation of livestock movement regulations, especially in rural and border areas.
- Limited surveillance systems for early detection and reporting of diseases.

4. Lack of Standard Operating Procedures (SOPs)

- Many farms operate without any written biosecurity plans or SOPs.
- No defined procedures for visitor control, animal introductions, or outbreak response.

5. Movement and Trade of Animals

- Frequent and unregulated movement of animals for trade, fairs, or grazing increases exposure risk.
- Lack of traceability systems makes it difficult to track disease sources.

6. Environmental and Wildlife Interface

- Contact with wildlife or stray animals is common, especially in open or backyard systems.
- Farms located near forests or wetlands are more vulnerable to zoonotic spillover.

7. Inadequate Waste Management

- Improper disposal of dead animals, manure, and wastewater leads to environmental contamination and disease spread.
- Carcasses often left in the open, attracting scavengers and vectors.

8. Seasonal and Climatic Factors

- Monsoon flooding or drought may disrupt regular farm operations and hygiene.
- High humidity can increase pathogen survival and vector population.

One Health

One Health recognizes the interconnectedness between human, animal, and environment which has emerged as a framework to tackle emerging disease challenges such as zoonoses, antimicrobial resistance (AMR), food safety and environmental health crises at global and regional levels. The concept of One Health is not new for scientific community. Over 2500 years ago it was recognized by Hippocrates that there is a link between and environmental health. Later in 18th century Dr. Edward Jenner who developed the vaccine for small pox from cow pox virus, during 19th century Robert Koch, a German physician who studied Anthrax in animals and Louis Pasteur, a French chemist who created the first vaccines for zoonotic disease rabies and anthrax formed strong evidence for interrelatedness between animal, human and environmental health which form the pillar of one health one medicine.



Three pillar of one health in mitigating public health challenges of emerging diseases.

One health has travelled long distance and reached to current definition as an “integrated and unifying approach that aims to sustainably balance and optimize the health of people, animals, and ecosystems”. This can also be defined as collaborative, multisectoral, and transdisciplinary approach—working at the local, national, regional, and global levels—with the goal of achieving optimal health outcomes that recognize the interconnection between people, animals, plants, and their shared environment.

The one health approach is considered beneficial as it promotes inter departmental collaboration to tackle health challenges at the interface of human, animal and environment. It plays a catalyzing role in better preparedness and surveillance across the veterinary, human health and environmental sector. In the recent past the concept of one health has gained the prominence as a strategic framework for tackling complex health challenges at the interface of human, animal, and environment, with the increase in emergence of zoonotic diseases, antimicrobial resistance (AMR), and the health impacts of climate change. During international ministerial conference on Avian and pandemic influenza held in December 2007 at New Delhi it was agreed that there is a need to have better understanding of different causes and drivers of disease emergence and spread. It was also envisioned in the conference to have cooperation among the discipline and sectors with a focus on emerging infectious diseases at the junction of human- animal- ecosystem. Adopting

One Health approach to optimize zoonotic disease prevention and control programs can make the efficient use of resources—such as finances, infrastructure, and personnel. In the last few decades a series of high-impact epidemics underlined the global vulnerability to emerging infectious diseases. The first pandemic of the 21st century, severe acute respiratory syndrome (SARS), during November 2002 infected more than 8,000 individuals and causing 774 fatalities across 29 countries (Pasley, 2020). Later, in 2009 H1N1 influenza pandemic (Swine flu) revealed the novel strains of influenza viruses which can traverse borders. After a decade the emergence of SARS (Severe Acute Respiratory Syndrome), Middle East Respiratory Syndrome coronavirus (MERS-CoV), was identified in June 2012 was isolated from the sputum of a patient in Saudi Arabia who had died from acute pneumonia and renal failure (Zaki *et al*, 2012). Subsequent nosocomial outbreaks of the MERS-CoV were documented, and international travel facilitated the spread of MERS-CoV beyond the Arabian Peninsula, elevating it to a global public health concern. Viral haemorrhagic fevers, such as Ebola outbreak in West Africa (2014–2016) resulted in over 11,000 fatalities further highlight that environmental encroachment, wildlife contact, and inadequate health infrastructure to escalate regional epidemics into

international emergencies. Further, the Zika virus epidemic across Latin America (2015–2016), Nipah virus infection highlighted the role of animal in the spread and transmission of vector borne zoonoses. The very recent pandemic of highly transmissible and pathogenic novel coronavirus (COVID-19) emerged in early December 2019 emphasizes the interconnectedness of human, animal and environmental health.

Although awareness of the One Health approach is growing nationally and internationally, inadequate communication and coordination among the stakeholders remain an obstacle in its effective implementation. However, the Tripartite organizations—the Food and Agriculture Organization (FAO), the World Organization for Animal Health (WOAH), and the World Health Organization (WHO)—have demonstrated the application of multisectoral One Health approach through inter-agency collaboration.

While One Health systems-based approaches are an effective method of building sustainable coordination and collaboration across sectors, initiating coordination through a zoonotic disease-specific program that uses a One Health approach to initially focus on a few key priority diseases, such as Rabies elimination program in dog which has been implemented successfully in Goa (India). A generalized one health framework is recommended to improve multisectoral collaboration and thereby enhance the prevention and control of zoonotic diseases. This framework include series of five steps and their activities which provide structure to develop capacity to coordinate zoonotic disease programming across sectors in a country. The steps for coordinating the activities in one health frame work is 1) Engagement: Establishment of One Health interest by identifying and engaging stakeholders. Whether developing a One Health systems-based or zoonotic disease-specific program the process begins with recognizing that a multisectoral, One Health approach can optimize resources and improve human, animal and environmental health outcomes. 2) Assessment (Mapping infrastructure): In order to develop realistic and achievable plans for One Health systems or zoonotic disease-specific programs, the available infrastructure must be assessed. Infrastructure mapping can help visualize mechanisms of informal and formal communication, collaboration, and coordination within and between sectors. 3) Planning: This involves developing a multisectoral, one health strategic plan. Identify the gaps or weaknesses during the assessment and make strategy to enhance collaboration across government. 4) Implementation: This involves soliciting, acquiring, and allocating resources. Officials that are preparing to implement the plans should have an in-depth understanding of the tasks associated with building their One Health

system or zoonotic disease-specific program. In many instances, public health, veterinary, and environmental laboratories address the same One Health challenges independently, without harmonizing their methods, technologies, or analytical approaches—often resulting in duplicated efforts. Adopting a multisectoral One Health approach to laboratory systems/ government setup can minimize costs and enhance response times by promoting the sharing of physical resources and data. When detection and diagnostic procedures for zoonotic pathogens are similar across human, animal, and environmental samples, sharing personnel and resources can offer significant advantages. 5) Monitoring and Evaluation.

12. Haemoprotozoan Diseases and Its Management In Farm Animals

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Hemoprotozoan parasites pose a serious threat to the livestock population in terms of mortality, reduced milk yield and lowered draft power. The most important hemoprotozoan diseases of livestock are enlisted below:

1. Anaplasmosis
2. Babesiosis (Piroplasmosis)
3. Trypanosomiasis (Surra)
4. Theileriosis

Anaplasmosis

Etiology

- ❖ It is also known as Gall sickness, a non-contagious rickettsial disease caused by *Anaplasma marginale*; a rickettsial group of organism.
- ❖ They infect the RBC of sheep, goat and cattle.
- ❖ The disease is principally transmitted through tick bites (Ixodes) and also through Tabanus flies.
- ❖ It may also spread mechanically by infected hypodermic needles and instruments.
- ❖ The disease is severe in exotic and crossbreds. Indian breeds of cattle are carriers. The incubation period varies from 20-125 days.

Symptoms:

- ❖ In the early stages of the disease, cattle may appear lethargic, be anorexic, have decreased milk production, and develop fever.
- ❖ There are pale or icteric mucous membranes.
- ❖ Other signs include depressed rumination, constipation with dark brown mucous-covered feces, dry muzzle, and weight loss.
- ❖ Infected cattle subsequently develop varying degrees of anemia, which can be fatal if untreated.
- ❖ Cattle having the signs of anaplasmosis should be handled with caution because of cerebral anoxia can cause aggressiveness.

- ❖ Severe anemia coupled with stress may precipitate sudden death and abortions may occur due to fetal anoxia.
- ❖ If animals survive the initial infection, they generally become carriers

Note: There is no evidence of hemoglobinemia and hemoglobinuria.

Confirmation:

- ❖ Examination of blood smears by Giemsa or Leishman's stain.
- ❖ Direct and indirect FAT (Fluorescent antibody technique)
- ❖ CFT (Complement Fixation Test)

Treatment:

- ❖ Oxytetracycline is the treatment of choice for this disease.
- ❖ For treatment of acute disease, administer 11 mg/kg intravenously once daily for 3–5 days.
 - ✓ Injection Oxytetracycline HCl (Inj. Terramycin, Inj. Loxy, Inj. Brioxy), Inj. Oxytetracycline dihydrate (Inj. Intamycin) may be used intravenously.
- ❖ Long-acting tetracycline @20 mg/kg IM—four times at 3-day intervals is also effective.
 - ✓ Long acting Tetracycline like Oxy LA, Terramycin LA, Intamycin LA by deep IM route for 5-7 days; IV administration of Oxytetracycline along with DNS is highly effective in the treatment of this disease.
- ❖ Imidocarb dipropionate (5.0 mg/kg IM in two doses at 14-day intervals) will sterilize infected cattle.
- ❖ Whole blood transfusions also may be necessary when anemia is judged to be life-threatening in acutely infected cattle.
- ❖ Supportive therapy includes:
 - ✓ Oral liver tonic like Ferroliv (Excell), Tefroli (TTK) *etc.* @ 10-15 ml orally BID for sheep and goat, and @ 50 ml orally BID for cattle and buffalo.
 - ✓ Ayurvedic liver protective and stimulant powder like Livol, Vetliv @ 50 g orally BID may be recommended.
 - ✓ Oral multivitamin syrup like Vimeral (Virbac) @ 10 ml daily or Ambiplex (Alembic) @ 20-25 ml for 10 days in feed or water may be recommended.
 - ✓ Injectable liver extract with B-complex *viz.* Inj. Belamyl (Sarabhai Zydus), Inj. Stronic (Vetnex), Inj. Pepsid (Concept), Inj. Ferroliv

(Excell) @5-10 ml thrice in a week by IM route may be recommended.

Control

- ❖ Vector control
- ❖ Husbandry practices must be modified.
- ❖ Common use of instruments for veterinary procedures must be disinfected.
- ❖ Stress should be minimized.
- ❖ Use of killed vaccines, there are two commercially available vaccines (Anaplaz[®] and Plazvax[®]) against anaplasmosis. Two injections given at 4-6 weeks apart with annual boosters are recommended. This is a killed vaccine, which will prevent the death loss but not the disease

Babesiosis (Piroplasmosis)

Etiology

- ❖ They are intra-erythrocytic parasites of domestic animals and are characterized by high fever and intravascular hemolysis leading to cause haemoglobinuria, anaemia and jaundice.
- ❖ The disease is transmitted by ticks particularly one host ticks Genus: *Boophilus* although transmission may also occur via blood-contaminated needles or instruments
- ❖ The organisms found as singly or in pairs inside the red blood cells.

Host Affected:

S.No.	Species	Host
1.	<i>B. bigemina</i> , <i>B. bovis</i> , <i>B. divergens</i> , <i>B. microti</i>	Cattle
2.	<i>B. motasi</i> , <i>B. ovis</i>	sheep and goats
3.	<i>B. caballi</i> , <i>B. equii</i> (<i>T. equii</i>)	Equines
4.	<i>B. trautmanni</i>	Pigs

Note: 1. *B. bovis* can replicate within the endothelium of the brain and cause “cerebral babesiosis”

2. *B. bigemina* & *B. microti* has an important zoonotic potential

Symptoms:

- ❖ Initially in acute condition there is a fever of greater than 40° C (104° F) for

several days before other signs appear. Then this is followed by inappetence, depression, polypnea, weakness, and a reluctance to move.

- ❖ Hemoglobinuria (red water) is present with having dark red to brown in colour of urine and produces a very stable froth.
- ❖ Anemia and jaundice develop, particularly in prolonged and severe cases and death may occur due to anemic anoxia.
- ❖ Cerebral babesiosis is highly fatal in spite of chemotherapy and is manifested by incoordination, followed by posterior paralysis or mania, convulsions, and coma.
- ❖ **“pipe-stem” feces in cattle** including above signs, caused by *B. divergens* reveal the spasm of the anal sphincter, causing the passage of feces with great force in a long, thin stream, even in the absence of diarrhea.

Confirmation:

- ❖ Simplest method to confirm infection is by laboratory examination of Giemsa stained thick blood smears collected after pricking the tip of the tail or margin of the ear from sick animals at the height of fever.

Treatment:

There are two aspects to treatment: firstly, treatment with a babesicidal drugs and secondly, the need for supportive therapy such as blood transfusion and fluid replacement.

- ❖ Diminazine accturate is the drug of choice. Injection Nilbery (Intas) @ 8–10 mg/ kg body weight or 1 ml/10 kg body weight) by deep IM Injection. Protonil (Excell), Inj. Berenil RTU (Intervet) @ 1.5 g for 100 kg body weight (average dose 4-5 g) for adult cattle) by deep IM injection along with Inj.
- ❖ Imidocarb (1 to 3 mg/kg) successfully used to treats both (*B. bigemina* and *B. bovis*) infections.

In equine:

- ✓ Imidocarb 2.2 to 4.4 mg/kg given IM once is effective. If necessary, lower dosages can be repeated at 24- to 72-hour intervals for two treatments.
- ✓ Diminazine accturate @ 3.5 mg/kg IM every 48 hours (two treatments) weight is also effective.
- ✓ Oxytetracycline when administered IV at @ 5 to 6 mg/kg, once daily for 7 days, is effective against *T. equi* but not against *B. caballi*.

Supportive therapy:

- ✓ Transfusion Therapy:
If anemia is severe, a whole blood transfusion is indicated and transfusing one-fourth to one-third of the total blood volume is adequate.
Note: The normal total blood volume is about 8% of the body weight i.e.
(0.08 x body weight in kilograms) = The total blood volume in liters.
- ✓ Injectable vitamins (Hivit/Conciplex) and liver extracts with B-complex (Stronic/ Ferroliv) may be used.
- ✓ IV administration of fluids like Inj. Intalyte/ Inj. Rintose can be administered.
- ✓ Antioxidants e.g. Vitamin E (Inj. E-Care-Se @ 10 ml one or two injections by IM route and if necessary corticosteroids can be administered.
- ✓ Good nutrition and shade is also necessary.

Prevention and Control:

- ❖ Tick control is the ideal control method.
- ❖ Control of ticks by the use of Cypermethrin, Flumethrin, Deltamethrin etc. (e.g. Clinar, Cyprol, Tick kill, Butox etc.) at recommended dose should be used.

Trypanosomiasis (Surra)

- ❖ The species of genus trypanosoma are found in blood streams and tissues of vertebrates.
- ❖ All species are transmitted by arthropod vectors in which transmission is either cyclical or noncyclical with exception *Trypanosoma equiperdum* which is a venereal disease.
- ❖ In cyclical transmission, the intermediate host is arthropod in which the trypanosomes multiply, undergoing a series of morphological transformations. If the infective stages accumulated in mouth part for transmission to vertebrate host when feeding the process is known as anterior station development and the various species of trypanosomes which use this process are considered as a group, *the Salivaria*. The species of this parasite are transmitted by blood sucking arthropods generally, by tse-tse fly.
- ❖ If the multiplication and transformation occurs in the gut and the infective forms migrate to the rectum and are passed with the faeces: then this is known as posterior station development and the trypanosome species are grouped together as the *Stercoraria*.

- ❖ Some important species of trypanosomes under *Salivaria* and *Stercoraria* group causing different diseases in animals are listed below:

Group: Salivaria				
S.No	Species	Host	Intermediate host	Disease
1.	<i>T. vivex</i>	Cattle, Sheep, Goat, Horse and Deer	Tse tse flies	Lymphoid enlargement, anaemia and Cell degeneration and inflammatory infiltrates particularly occur in skeletal muscles, CNS and myocardium.
2.	<i>T. congolense</i>	All domestic animals , Zebra and Antelopes	Tse tse flies	“Nagana”in cattle which is characterized by anaemia, emaciation, lymph adenopathy, and haemorrhages in the cardiac muscles and kidneys.
3.	<i>T. brucei</i>	Cattle , sheep, goat dogs an equines	Tse tse flies and mechanically, by tabanids and stomoxys	In equines the disease may be acute or chronic. often accompanied by oedema of the limbs and genitalia.
4.	<i>T. gambiense</i>	Man	Tse tse flies	Humal trypanosomiasis/ Gambian sleeping sickness
5.	<i>T. rhodesiense</i>	Man and Antelopes	Tse tse flies	East African Sleeping sickness
6.	<i>T. evansi</i>	Cattle, buffalo sheep, goat, pig camel and horses	Tabunus, stomoxys, Lyperosia, ticks and Vampire bat.	“Surra”in cattle and “Tibersa”in camel
7.	<i>T. equinum</i>	Equines	Biting flies (Tabanids)	“ Mal de caderas”in equines
8.	<i>T. equiperdum</i>	Equines	Coitus	“Dourine” a venereal disease of equines
Group: Stercoraria				
S. No	Species	Host affected	Intermediate host	Disease
1.	<i>T. theileri</i>	Cattle , zebu, bison and Antelopes	Tabanids	They are often referred as non - pathogenic trypanosomes
2.	<i>T. melophagium</i>	Sheep	Sheep Ked (Melophagus ovinus)	
3.	<i>T. cruzi</i>	Man	Kissing bugs	Chagas disease

- ❖ In non-cyclical transmission, the disease is essentially transmitted mechanically in which the trypanosomes are transferred from one mammalian host to another by the interrupted feeding of biting insects, notably tabanids and Stomoxys.

Trypanosomiasis (Surra)

Etiology:

- ❖ The disease is caused by *Trypanosoma evansi*, a monomorphic extracellular parasites, occurring in blood plasma and lymph.
- ❖ The disease is transmitted mechanically by the Tabanus and other biting flies during monsoon and post monsoon season because of high vector density in these seasons.
- ❖ But the disease may also occur throughout the year and can flare up any time due to a number of various contributing factors such as inclement weather, poor feeding, immunosuppression, parturition and infected syringe and needles etc.
- ❖ “Surra” word is derived from hindi word which means “rotten”. It was first reported by Sir Griffith Evans in 1918 in India in the blood of horses and camel.
- ❖ It affects mainly Cattle, buffalo, sheep, goats, pig and equines.

Symptoms:

Depending upon the intensity of the disease, symptoms vary in peracute, acute, subacute and chronic.

In Peracute form:

- ❖ Affected animals die quickly within 2-3 hr of showing nervous symptoms and may confused with other diseases involving the nervous system such as anthrax, H.S, nervous form of ketosis, snake bite and cyst or tumour in the brain.

In Acute form:

- ❖ Animal appear dull and sleepy with staggering gait, high rise of temperature ,starring eyes (wide open eyes).
- ❖ Breathing is difficult and with effort and noise.
- ❖ There is circling movement with nervous excitement and striking the head against hard object, stamping of feet, frequent micturation, and salivation, twitching of muscles, shivering of body, followed by coma, collapse and death.

Subacute and Chronic: Animals are dull and sleepy, lacrimation from eyes, emaciation, and rapid pulse, intermittent fever, oedema of legs, diarrhoea and death from exhaustion.

Diagnosis

- ❖ Demonstration and identification of trypanosomes in the blood remains the basis of a definitive diagnosis. Microscopic examination observation of fresh blood can be easily carried out by wet mount of blood, thin blood smear, thick blood smear but have low sensitivity, but it is easy to conduct in field and less instruments required.
- ❖ Concentration methods like Hematocrit Centrifuge Technique or dark ground Buffy Coat Method increase the sensitivity of the test.
- ❖ Card Agglutination test used to detect immunoglobulin M therefore, early infections can be diagnosed by this test, whereas, ELISA is generally used to detect immunoglobulin G, so used for established infections.

Treatment

- ❖ The following drugs may be used Trypanosomiasis in Domestic Animals

Drug	Host	Species	Action	Dose (mg/kg) & Route
Diminazene aceturate	Cattle	<i>vivax, congolense, brucei</i>	Curative	3.5–7 IM, SC
Isometamidium chloride	Cattle	<i>vivax, congolense</i>	Curative and prophylactic	0.25-1 IM (deep)
Quinapyramine sulfate	Horses, camels, pigs, dogs	<i>vivax, congolense, brucei, evansi, equiperdum, simiae</i>	Curative	3.5, SC

- ❖ Antihistaminic injection (like Avil, Zeet, Chlorazin), IM for 2-3 days
- ❖ IV infusion of Rintose/Intalyte or 10-20 per cent. Dextrose or 25 per cent Dextrose solution is recommended as a supportive therapy because Trypanosomes produce hypoglycaemia.
- ❖ Neurotropic B-vitamins like Inj. Polyvet, Inj. Nuroxin-12, Inj. Tribivet by IM route is indicated.

Control

Trypanosomiasis in farm animals can be controlled by using insecticides, prophylactic drugs, and other methods:

- Insecticides: Used to control tsetse flies, which spread trypanosomiasis. Insecticides can be applied by spraying, dipping animals, or using insecticide-impregnated screens.
- Prophylactic drugs: These drugs can be given to animals to prevent trypanosomiasis.
- Quarantine and euthanasia: If an outbreak is detected early, infected animals can be quarantined, moved, or euthanized.
- Habitat alteration: Tsetse fly habitats can be destroyed by removing vegetation.
- Traps: Traps can be used to reduce tsetse fly populations.
- Chemical collars: Collars that store and release chemicals that repel tsetse flies can be used on cattle.
- Resistant breeds: Some breeds of cattle and water buffalo are resistant to trypanosomiasis.

Drug resistance is a major problem with trypanosomiasis control. To monitor drug resistance, blood examinations should be performed frequently on treated animals.

Theileriosis

Theileriosis is a widespread hemoparasitic diseases of cattle caused by intracellular hemoparasites of the genera Theileria, and is the most prevalent in tropical and subtropical countries. It affects a variety of wild and domestic animals and is transmitted trans-stadially by the tick vectors. Cattle are infected by many species of Theileria, of which *T. annulata* and *T. parva* are the most economically important tick-transmitted pathogenic species causing bovine theileriosis, while *T. mutans*, *T. taurotragi* *T. orientalis/buffeli*, and *T. velifera* are considered milder and or non-pathogenic to domesticated ruminants. *T. annulata* and *T. orientalis* are the two main species found in India that infect bovines and transmitted by *Hyalomma anatolicum* and *Haemaphysalis* species respectively. Among these two, *T. annulata* causing tropical theileriosis, widely considered to be more pathogenic than *T. orientalis* which is generally considered to cause benign theileriosis or mild form of theileriosis. However, some strains of *T. orientalis*, can cause fatal disease. Sometimes other hemopathogen co-infections are also frequent present.

Life Cycle of *Theileria annulata*

The genus *Theileria* comprises tick-transmitted protozoa characterised by schizonts in lymphoid cells and piroplasms in red blood cells of the vertebrate host. There are three stages in the life cycle of *T. annulata*: release of infectious sporozoites during tick feeding, invasion of sporozoites into leukocytes and schizont, development and maturation of schizonts to merozoites for subsequent infection of red blood cells to form piroplasms. During a next feeding cycle, larval or nymphal vector ticks ingest piroplasms and the released parasites undergo syngamy in the tick gut, forming a zygote, the only diploid stage. The zygote divides into motile kinetes that infect the tick gut epithelial cells and migrate to the haemolymph and subsequently infect the salivary glands. After moulting and commencement of feeding by the tick, sporogony results in the multiplication of sporozoites in the salivary gland acini before injection into the feeding site by nymphs or adult ticks. The life cycle of *T. orientalis* is essentially similar to that of other *Theileria* species, except that the schizonts do not induce transformation and fatal lymphoproliferation. The non-transforming *Theileria* are regarded as being benign but still able to cause disease as a result of anaemia induced by the piroplasm stage.

Clinical Signs and Symptoms

Theileia spp. is classified into 2 groups. In the first group include *T. parva* and *T. annulata*, proliferate in lymphocytes but in the second group, *T. orientalis* is seen in erythrocytes that causes hemolytic anemia. The incubation period (between tick attachment and onset of fever) of tropical theileriosis or Mediterranean theileriosis is on the average 2 weeks and the severity of disease depends on the susceptibility of the animal, strain virulence and quantity of sporozoites inoculated. The clinical manifestation of Bovine Tropical theileriosis varies from peracute to acute to subacute to chronic forms. In typical acute infection, the disease starts with high fever and lymphadenopathy, which is preceded by swelling of the regional lymph gland draining the area where the infective ticks are feeding. The commonly seen general symptoms associated with febrile infectious diseases soon follow as listlessness, accelerated pulse and respiration rate, swollen eyelids and lachrymation. In the early stages the appetite may remain normal, but at the last anaemia and icterus may also occur. The polymorphic symptoms with different frequencies are associated with tropical theileriosis. The major clinical manifestations commonly seen is pyrexia, generalized lymphadenopathy, anaemia, anorexia, cachexia, and respiratory distress, coughing, petechiae in conjunctiva, oral and nasal mucosa and unilateral or bilateral exophthalmia in experimental and

natural acute calf theileriosis. Petechiae on the visible mucosae usually represent an unfavourable prognosis. Further, there is documentation of clinical cerebral form of bovine theileriosis "Turning Sickness" in an adult cow. The uncommon symptom of cutaneous skin nodules are sometimes also present in clinical cases of tropical theileriosis. There is evidence for neonatal infections with *T. annulata*. In severe cases, diarrhoea or dysentery and systemic changes are also seen. In fatal infections, the animal remained in recumbancy for a variable number of days with hypothermia and in emaciated state. Death usually occurs one to two weeks after the onset of clinical signs but in hyperacute cases the animal may die as early as 3 days after the first obvious symptoms are noticed. The animals that survive the acute disease become carriers of *T. annulata* piroplasms and play an important role as reservoirs for the maintenance of the parasite life cycle. In sub-acute and chronic forms of the tropical theileriosis the symptoms are swelling in lymph node, haemorrhages on visible mucous membranes, reduced milk yield, anaemia and jaundice. The chronic form of disease is rarely occur and affected cattle are recumbent, emaciated and show intermittent fever. During the course of the diseases there is evidence of severe aplastic anaemia, and in the late stage of infection the animal may show clinical signs of severe dyspnoea, recumbency and finally death due to widespread destruction of the immune system.

Diagnosis

The case history, clinical signs and lesions are often indicative of theileriosis and a non-specific clinical signs like fever, anaemia, icterus and swelling of peripheral lymph nodes give rise to a presumptive diagnosis of acute *T. annulata* infection. Hence, the detection of this haemoparasites is highly beneficial in early diagnosis. Traditionally, microscopic examination of Giemsa stained blood smears is considered to be the "gold standard" for demonstrating parasites in smears especially in acute phase of disease. It is comparatively inexpensive. The diagnosis of acute theileriosis is performed by demonstration of schizonts in Giemsa stained lymph node biopsy smears under microscope, while chronic form is difficult to diagnose because of low number of piroplasm in erythrocytes. The presence of schizonts in peripheral blood smear is rare, but if it is present, indicates a poor prognosis. The conventional techniques have a lack of clear morphological distinction (schizonts and piroplasms) between the different theileria species which complicates the species differentiation.

Serological tests like the indirect immunofluorescent antibody test (IFAT) and enzyme-linked immunosorbent assay (ELISA) can be used to detect circulating

antibodies. IFAT is considered as one of the gold standard test for parasite diagnosis by OIE, but significant cross-reactivity between closely related species limits the specificity of the IFAT. ELISA is generally used for serodiagnosis and epidemiological study of theileriosis. It is less labour-intensive, easy to perform and capable of screening large sample in a short period of time. The ELISAs developed for tropical bovine theileriosis include the *T. annulata* merozoite surface 1 antigen (Tams1) and the *T. annulata* macroschizont stage protein (TaSP), used for serodiagnostic purpose.

DNA based molecular assays such as conventional PCR, nested-PCR, real-time PCR and loop-mediated isothermal amplification (LAMP) assay have been used for direct confirmation of the presence of parasite genomic material.

Treatment

Currently, parvaquone and buparvaquone are the best theilericidal drugs belong to the hydroxynaphthoquinones family. Parvaquone (@ 20 mg/Kg BW, IM) is mainly active drug against schizontes. Buparvaquone (@ 2.5 mg/Kg BW, IM) is active against both schizontes and piroplasmes. Its efficacy after single injection is estimated to 92%. A second dose may be require after 72 hour if no clinical improvement is observed. In cattle with low packed cell volume (PCV) and high parasitaemia, the injection of theilericidal drug may lead to a massive erythrocytes destruction and in several cases the treated animal die due to very low PCV. So, there is need to estimate both parasitaemia and PCV and then to decide whether to implement a blood transfusion. The transfusion is needed when their PCV is lower than 15% or 5gm/dL of blood. Long-acting antibiotic (Oxytetracycline/marbofloxacin) is found to effective in early cases and also recommended in order to prevent frequent secondary infections, mainly respiratory tract. In the case of hypotony of the rumen, stimulators of the rumen are indicated since the indigestion can lead to the death of the diseased animal.

Injection of non-steroid anti-inflammatory drugs are also require due to the presence of a generalized inflammatory state and high concentrations of proinflammatory cytokines.

Medicinal plants such as flowers of *Calotropis procera*, commonly known as Akman, Mudar, Aakonda, Akon, can be effectively used to treat subclinical bovine theileriosis. *Peganum harmala* commonly known as Harmal or Wild rue, can also be used to treat bovine theileriosis at the dose of 5 mg extract /kg per day intramuscularly for 5 days.

Nano lipid-based drug delivery systems has been attempted to overcome the challenges encountered with failure in treatment or resistance and unwanted toxicity in the treatment of parasitic diseases. A solid lipid NPs loaded with buparvaquone (BPQ) for targeted delivery has reported to shown a promising approach for targeted and improved delivery in theileriosis.

Prevention of Tropical Theileriosis

Prevention is the best mean to control *T. annulata* infection because of high costs of theilericidal drugs, the high prevalence of carrier state infection and the high costs of treatment. For effective control two types of action require:

- Control of the vector tick
- Vaccination against *T. annulata*

Any of these control options should be implemented based on benefit-cost analyses. In India, Rakshavac T (a live schizont grown in lymphoblast cell culture and attenuated by prolonged in-vitro passage) is the only one vaccine that is commercially available for use by farmers. When given @ 3ml SC route to calves above two months of age, it can give to have immunity for up to 3 years. It has been suggested that the most economical way to control theileriosis in India is to vaccinate calves and to reserve buparvaquinone for treating clinical cases.

13. Novel Approach for Prevention and Control of Mastitis in Cattle

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Mastitis, an inflammation of the mammary gland, is one of the most prevalent and economically damaging diseases in dairy animals. It negatively affects milk yield, alters milk quality, and can cause irreversible damage to udder tissue. Mastitis not only reduces farm profitability but also impacts animal welfare, milk safety, and consumer trust. Therefore, preventing mastitis is essential for maintaining productivity, profitability, and sustainability in the dairy sector.

Effective mastitis prevention begins with proper management during the dry period, a crucial phase between lactations when the udder undergoes recovery and regeneration. This is the time when cows are highly susceptible to new intramammary infections (IMI), especially just after dry-off and shortly before calving. Dry Cow Therapy (DCT) is a scientifically proven strategy to reduce the risk of IMI during this period.

Dry Cow Therapy

Traditionally, DCT with antibiotics involved the blanket treatment of all quarters in all cows at dry-off, regardless of infection status. This approach was effective in treating existing subclinical infections and preventing new infections. However, the blanket use of antibiotics has contributed to the development of antimicrobial resistance (AMR), raising serious public health and regulatory concerns. As a result, many countries have now restricted or banned prophylactic antibiotic use in livestock, pushing the dairy industry to seek alternative solutions.

In response, non-antibiotic DCT methods such as internal teat sealants have gained importance. These products form a physical barrier within the teat canal, preventing bacterial entry without contributing to AMR. Teat sealants are especially effective in cows without existing infections, making them a key tool in Selective Dry Cow Therapy (SDCT), where only infected quarters receive antibiotics, and healthy ones are treated with sealants alone. Recent advancements include synthetic and natural nanoparticle-based sealants, which offer enhanced efficacy and biocompatibility.

Synthetic Teat Sealants

Synthetic teat sealants play a vital role in Dry Cow Therapy (DCT) as a non-antibiotic alternative to prevent new intramammary infections during the dry period. These sealants are typically composed of bismuth subnitrate suspended in a sterile, viscous mineral oil base, which forms a physical barrier within the teat canal, mimicking the natural keratin plug. This barrier effectively blocks the entry of mastitis-causing pathogens, especially during the critical periods immediately after drying off and before calving. Synthetic sealants do not have antimicrobial properties themselves but are highly effective in maintaining udder health when used alone in uninfected cows or in combination with antibiotics in selective DCT programs. Their use significantly reduces reliance on antibiotics, supports udder health, and contributes to combating antimicrobial resistance in the dairy industry.

Nanoparticle-impregnated Teat Sealants

The future of non-synthetic, natural, or nanoparticle-impregnated teat sealants in dry cow therapy is highly promising, as they offer a sustainable and eco-friendly alternative to traditional products. These sealants are being developed using biocompatible natural polymers like chitosan, guar gum, or plant-based oils, often enriched with antimicrobial nanoparticles such as silver, zinc oxide, or curcumin nanoparticles. Such formulations not only create an effective physical barrier but also provide targeted antimicrobial action without relying on conventional antibiotics, reducing the risk of antimicrobial resistance. Their enhanced retention, biodegradability, and minimal residue risk make them ideal for organic and export-oriented dairy systems. Ongoing research focuses on improving their safety, efficacy, and scalability, positioning them as next-generation tools for mastitis prevention and advancing the goal of responsible antibiotic stewardship in the dairy industry.

Platelet-Rich Plasma (PRP) Intramammary Infusion (IMI)

Platelet-rich plasma (PRP) intramammary infusion (IMI) is emerging as a promising alternative or adjunct therapy for treating mastitis in cattle, offering both antimicrobial and tissue-healing benefits without contributing to antibiotic residues in milk. PRP contains a rich mix of growth factors, cytokines, and antimicrobial peptides that help modulate immune responses, reduce somatic cell counts and inflammation markers, and accelerate tissue repair within the mammary gland. Studies indicate that PRP-IMI can be effective in both acute and chronic cases, sometimes outperforming antibiotics alone and reducing recurrence rates of mastitis, making it particularly suitable for organic dairy systems or situations where

minimizing antibiotic use is important. While results are encouraging, especially for subclinical and Gram-positive mastitis, further large-scale research is needed to standardize protocols and confirm long-term efficacy across diverse farming conditions.

Stem Cells Therapy

Stem cell therapy, particularly using mesenchymal stem cells (MSCs) derived from sources like bone marrow and adipose tissue, is emerging as a promising approach for the treatment of mastitis in cattle. These stem cells offer a multifaceted mode of action: they can modulate immune responses, promote tissue regeneration, and directly combat mastitis-causing pathogens such as *Staphylococcus aureus* and Enterobacteriaceae. When administered—either intravenously, intramammarily, or in combination—MSCs have demonstrated significant reductions in somatic cell counts and bacterial loads in milk, indicating both anti-inflammatory and antimicrobial effects. Additionally, stem cell therapy supports the repair of damaged mammary tissues, addressing aspects that conventional antibiotics cannot, thus potentially restoring milk production and reducing the risk of recurrence. While studies show that a single dose can yield noticeable benefits, repeated administrations may be required for sustained therapeutic effects. Though still in the early stages of research and relatively costly, stem cell therapy holds the promise of reducing reliance on antibiotics, minimizing economic losses, and providing a sustainable solution for mastitis management in dairy herds.

Ethnoveterinary Medicine

Ethno-veterinary medicine (EVM) involves the use of traditional plant-based remedies and natural substances with known anti-inflammatory and antimicrobial properties for the prevention and treatment of mastitis in cattle. EVM approaches typically include the topical application or oral administration of herbal preparations, such as extracts, juices, pastes, or decoctions derived from locally available plants, which have been used for generations by farming communities. These methods are particularly valuable in organic and low-residue dairy systems where minimizing the use of synthetic antibiotics is crucial. The use of EVM can help manage mastitis outbreaks, reduce somatic cell counts, and promote udder healing while lowering the risk of antibiotic resistance. Additionally, some studies have highlighted the effectiveness of specific plants and formulations in alleviating pain, reducing inflammation, and speeding up recovery in affected animals, though further scientific validation and standardization are encouraged to optimize outcomes and

ensure consistent efficacy and safety.

Vaccination for Prevention of Mastitis

Vaccines play a supportive role in the prevention and control of mastitis in dairy cattle by stimulating the immune system against common pathogens responsible for udder infections, such as *Staphylococcus aureus*, *Escherichia coli*, and *Mycoplasma bovis*. Commercially available vaccines—including polyvalent products like Startvac, *E. coli* J5 bacterins, and specific *S. aureus* or *Mycoplasma* formulations—are typically administered during late gestation or early lactation. Research shows that while vaccination reduces the incidence, severity, and recurrence of clinical mastitis, and can boost immune responses, it does not fully prevent new intramammary infections in all cases. The benefits of vaccination may include a reduction in clinical symptoms, lower somatic cell counts, and, in some trials, improved milk yield and reduced culling or mortality rates among vaccinated cows compared to controls. However, the effectiveness can vary depending on factors like herd management, pathogen prevalence, and vaccine type, making vaccination most beneficial as part of a broader mastitis control program rather than a standalone solution.

Nutrition

Proper nutrition plays a pivotal role in mastitis prevention by supporting the immune defenses of dairy animals and maintaining udder health. Both energy balance and the supply of specific micronutrients—such as vitamin E, selenium, vitamin A, β -carotene, zinc, and copper—are critical for optimal immune function. Cows in negative energy balance, typically during the transition period around calving, are at elevated risk for mastitis due to suppressed immune responses and increased susceptibility to infections. Deficiencies or imbalances in essential vitamins and minerals can compromise leukocyte function, antibody transport, and the integrity of mammary tissue, all of which are crucial for resisting pathogens. Research demonstrates that supplementing diets with antioxidants like vitamin E and selenium, as well as maintaining appropriate calcium-phosphorus ratios, can reduce mastitis incidence and the severity of clinical cases. Additionally, contaminated or poor-quality feed, as well as metabolic diseases induced by dietary imbalances, can further predispose cows to mastitis. Probiotic supplementation and strategies that enhance gut health are also emerging as valuable nutritional approaches. Ultimately, a balanced, stage-appropriate ration, careful transition period management, and attention to micronutrient status should be key elements of an effective mastitis

control program, complementing good hygiene and management practices.

Teat Dipping

Teat dipping is a highly effective and essential practice in the prevention of mastitis in dairy animals. It involves applying a disinfectant solution to the teats immediately after milking, which helps to kill or reduce the mastitis-causing bacteria on the teat skin and teat end, thereby preventing new intramammary infections. Post-milking teat dipping has been shown in numerous studies to reduce new infections by 50% or more, particularly against contagious pathogens like *Staphylococcus aureus*, and to lower somatic cell counts, an indicator of udder health. The most common teat dip solutions include iodine, chlorhexidine, and chlorine compounds, which must be applied thoroughly to cover the entire teat surface touched by the milking liner. Proper application, including complete coverage and consistent use at every milking, is critical to achieve the full benefits. In addition to improving udder health, teat dipping also improves milk quality and reduces the incidence and severity of mastitis, making it a cornerstone of mastitis control programs worldwide.

Sensor and Artificial Intelligence (AI)

Sensor and artificial intelligence (AI) tools play a transformative role in the detection, management, and prevention of mastitis in dairy cattle. Modern sensor systems—such as in-line milk analyzers, electronic 3D motion detectors, and biosensors—continuously monitor vital indicators like somatic cell count, electrical conductivity, temperature, milk composition, and even changes in cow movement or behavior. These systems enable rapid, often real-time detection of mastitis, even in its subclinical stages, allowing for early intervention and minimizing production losses. AI and machine learning algorithms take sensor data to a new level by learning patterns associated with the onset and origin of mastitis. They can classify the disease as contagious or environmental, identify the likely causative pathogen, and predict case outcomes with high accuracy—sometimes exceeding traditional diagnostic methods. These tools use large volumes of data from herd management systems and sensors, supporting timely, data-driven decisions on treatment or herd interventions. Furthermore, AI-powered solutions enhance monitoring by providing benchmarks, automating diagnostics, and guiding prudent antimicrobial use, contributing both to animal welfare and farm profitability. As dairy operations grow in scale, such integrated technologies are becoming essential elements of effective and sustainable mastitis control programs.

The prevention and control of mastitis require an integrated, multifaceted

approach combining nutrition, hygiene practices, vaccination, and technology. Consistent measures such as proper teat dipping after milking, maintenance of clean housing conditions, and effective milking routines form the foundation of mastitis control programs. Adequate nutrition—focusing on energy balance and critical micronutrients such as vitamin E, selenium, and zinc—strengthens immune defenses, reducing susceptibility to infection. Vaccination against major pathogens, while not a complete solution, adds another layer of protection, especially when tailored to herd-specific risks. The adoption of modern sensor and AI tools allows for early detection, precise monitoring, and data-driven interventions, elevating the effectiveness of traditional methods. Ultimately, sustainable mastitis management hinges on the integration of these strategies, continual education of farm staff, and regular evaluation of herd health protocols to adapt to changing challenges. A proactive, holistic approach supports animal welfare, enhances milk quality, and secures the profitability of dairy operations.

14. Latest Advancements in Animal Nutrition for Farm Animals

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The field of animal nutrition has advanced significantly in the last two decades, driven by the need to optimize productivity, improve animal health, reduce environmental impact, and ensure food safety. Innovations such as nutrigenomics, nanotechnology, precision nutrition, and smart feeding systems have revolutionized livestock feeding strategies. The integration of novel feed ingredients, protected nutrients, and AI-assisted feeding has improved nutrient utilization, minimized losses, and boosted economic returns for farmers. Few of the recent advances in animal nutrition are as follows:

1. Protective Nutrients

Protective nutrients are dietary components that prevent the degradation of essential nutrients in the rumen and allow their targeted release in the intestine. They include bypass protein, bypass fat, protected methionine, and choline. These nutrients ensure improved bioavailability and support productive and reproductive performance in farm animals.

1a. Bypass Protein

Bypass (rumen undegradable) protein is a protein fraction that escapes rumen degradation and is digested in the small intestine, thus ensuring high amino acid availability for high-producing animals. Bypass protein plays a critical role in optimizing the productivity and reproductive efficiency of high-producing ruminants. It ensures that high-quality, digestible protein reaches the small intestine, directly benefiting growth, milk production, and overall animal health. With various manufacturing methods and commercial products available, bypass protein supplementation should be tailored to the animal's nutritional needs, stage of production, and farm economics. When used correctly, bypass protein is not just a supplement but a strategic tool for sustainable and profitable dairy farming.

- **Natural Sources:** Maize gluten meal (60-70%), fish meal (65-75%), Cotton seed meal (45-55%), Groundnut cake (treated) (50-60%), Soyabean meal (treated) (55-65%).
- **Benefits:** Improved milk yield and Composition, growth rate, and

reproductive efficiency and reduces nitrogen waste.

Methods used to protect protein from degradation in the rumen:

- **Heat Treatment:** Heating oilseed cakes (e.g., soybean, groundnut, cottonseed) to 140–160°C alters protein structure, making it less degradable by rumen microbes.
- Care must be taken not to overheat, which can reduce digestibility in the small intestine.
- **Formaldehyde Treatment:** Proteins are treated with a formaldehyde 0.5–1% of protein, which cross-links amino acids, making them rumen-resistant. Used under strict regulation and has proven to be effective. Common in India for protecting groundnut cake, soybean meal, or cottonseed meal.
- **Encapsulation or Coating:** Some advanced commercial feeds use fat or polymer coating to protect protein. These are more expensive and less commonly used in field conditions.
- **Tannin Treatment:** Tannins (natural compounds found in plants like Acacia) can bind proteins and protect them in the rumen. Tannin-treated feeds are considered more natural and safer.

Key Considerations When Using Bypass Protein

- **Balance with Degradable Protein:** Bypass protein should be part of a well-balanced ration. Rumen microbes still need degradable protein to function.
- **Ensure Adequate Energy:** Protein cannot be used efficiently without sufficient energy (often supplemented with bypass fat).
- **Stage-Specific Feeding:** Most effective during early lactation, late gestation, and in growing animals.
- **Avoid Overuse:** Excess bypass protein may be wasted or reduce feed palatability.

1.b. Bypass Fat (rumen-protected fat)

High-producing dairy cows, especially in early lactation, experience negative energy balance (NEB). During this time, the energy demand for milk production exceeds the energy intake from the feed. This leads to mobilization of body fat, causing weight loss and potential metabolic disorders like ketosis or fatty liver. Therefore, there is a need of bypass fat in ruminant's diet. Bypass fat provides high energy without interfering with rumen fermentation. It bypasses the rumen and is digested in the intestines. There are various types of bypass fat, commonly produced through:

Calcium salts of fatty acids (CaSFA), Prilled fat (fat in bead form), Hydrogenated fats, Formaldehyde-treated fats. Commonly used raw materials in the production of bypass fat include: Palm oil, Soya oil, Cottonseed oil, Tallow (animal fat). Advantages of using bypass fat include enhanced energy density, improved milk fat content, better reproductive performance.

Commercially Available Bypass Fat: ByPro Fat – Kemin Industries, Megalac – Volac (UK), Rupro-Fat – Natural Remedies Pvt. Ltd. Fat-Pro – Berg + Schmidt, MaxFat – Avitech Nutrition, DynaFat – Dyna Biotech

Application: Bypass fat is commonly used in the transition and peak lactation phases in dairy cows. Typically recommend incorporating 150-500 grams of bypass fat per day for high-yielding cows, depending on production targets. Ration formulation containing bypass fat should consider the cow's lactation stage, body condition, milk yield, and overall health.

Animal Category	Dose/Day
Lactating Cow (15–25 L/day)	150 –300 grams/day
High-yielding Cow (>25 L/day)	300 –500 grams/day
Transition Cow (Pre- & Post-calving)	200 –300 grams/day

Challenges:

- **Cost:** Bypass fat is relatively expensive compared to traditional energy sources.
- **Quality Control:** Low-quality bypass fat can fail to bypass the rumen or may have undesirable effects on digestion.
- **Balanced Diet:** It should be used as part of a balanced ration. Overuse can result in energy-protein imbalance or even interfere with dry matter intake.
- **Stage of Lactation:** The benefits are most pronounced during early lactation and transition periods.

1c. Protected Starch

Protected starch resists ruminal degradation and releases glucose in the small intestine. Unlike regular starch, which is fermented by rumen microbes into volatile fatty acids (VFAs), bypass starch directly provides glucose to the animal. Bypass starch is a valuable nutritional tool for high-yielding, early lactation, or transition dairy animals, providing a direct glucose source that enhances milk production,

fertility, and overall energy balance. Its strategic use can reduce metabolic disorders, support reproductive performance, and promote efficient nutrient utilization. For best results, bypass starch should be used alongside a balanced ration under the guidance of a qualified animal nutritionist.

Importance of Bypass Starch in Dairy Animals

- i. Improved Energy Supply (Glucose Source):** Glucose is essential for milk synthesis, especially lactose production, which drives milk volume. Rumen-protected starch increases glucose availability, improving milk yield and quality.
- ii. Supports High-Producing Dairy Cows:** High-yielding cows often experience a **negative energy balance (NEB)** postpartum. Bypass starch helps meet the increased energy demands during early lactation without causing rumen acidosis.
- iii. Better Reproductive Performance:** Adequate glucose supports ovarian activity and helps restore reproductive cyclicity, improving conception rates and reducing days open.
- iv. Reduces Risk of Acidosis:** Since bypass starch is not fermented in the rumen, it lowers the risk of sub-acute ruminal acidosis (SARA), which is common when feeding high levels of fermentable carbohydrates.
- v. Enhanced Body Condition Recovery:** It provides a direct energy source to help cows regain body condition after calving, improving health and productivity.

Commercially Available Bypass Starch Products: Bypro-Starch® (Vetline India), ypass® (Animal Health India), StarchPro™ (Concept Agrotech), Rumistar® (DSM Nutritional Products)

Recommended dose: Bypass starch is usually fed to dairy cows in early lactation or animals under negative energy balance.

Animal Type	Dosage (per day)
High-yielding cows	200 – 500 g per day
Medium producers	100 – 300 g per day
Transition cows	250 – 400 g per day
Calves	25 – 100 g per day (as per need)

Chelated minerals are bound organic molecules—typically amino acids or peptides. This chelation process improves the stability, absorption, and bioavailability of the

minerals in the animal's digestive system, making them more effective than traditional inorganic forms like sulfates or oxides. Common chelates are zinc-methionine and copper-lysine. Chelated mineral mixture improves absorption, immunity, reproduction, and growth.

Chelated mineral mixture are used in mineral premixes for dairy, poultry, and swine to reduce deficiencies and improve performance. Chelated minerals are an essential component of modern dairy nutrition, offering superior absorption, improved productivity, and better health outcomes compared to inorganic forms. Their regular use helps in optimizing milk yield, fertility, immunity, and overall performance of dairy animals

1.e. Protected Methionine

Bypass amino acids (also called rumen-protected amino acids) are essential amino acids that are specially coated or chemically treated to resist breakdown in the rumen and instead get absorbed in the small intestine. This ensures that the animal receives the actual bioavailable form of key amino acids like methionine and lysine, which are often limiting in typical dairy rations. Protected methionine ensures availability of this limiting amino acid beyond the rumen, crucial for milk protein synthesis. Encapsulated or chemically protected methionine are commercially available. Bypass methionine is usually supplemented in high-performance dairy cattle rations.

1.f. Protected Choline

Choline is vital for fat metabolism and liver health. Protected choline bypasses rumen degradation and reaches the liver. It prevents fatty liver, enhances milk production and is essential in transition cow diets (3 weeks pre- and post-calving).

1g. Slow-Release Urea

Slow-Release Urea, also called Rumen-Protected Urea or Controlled-Release Urea, is a form of urea that is coated or chemically treated to reduce its solubility. This allows it to be gradually hydrolyzed in the rumen, providing a steady supply of ammonia to rumen microbes over time. This synchronized nitrogen availability supports better microbial protein synthesis, improving digestion and animal performance. Recommended Dose of Slow-Release Urea in lactating Cow is 50–100 grams/day. Commercial SRU Products are Optigen® (Alltech); Starea® (IFFCO Kisan)

2. Nano Mineral Mixture

Nano minerals are trace minerals such as zinc, copper, selenium, iron, and manganese that have been processed into nano-sized particles (20–100 nanometers in size). Due to their ultra-small size and larger surface area, these minerals exhibit higher bioavailability, better absorption, and improved physiological effects compared to traditional (inorganic or organic) mineral sources. Nano minerals are absorbed more efficiently through the intestinal lining, resulting in better utilization and lower excretion so require in lower dose. Nano zinc, nano selenium, Nano copper, Nano chromium, Nano iron are commercially available.

3. Use of Artificial Intelligence (AI) in Nutrition

AI tools help monitor feed intake, body condition, health parameters, and predict feed formulation needs.

Technologies: Smart sensors, automated feeders, machine learning for ration formulation.

Benefits: Optimized feed efficiency, early disease detection, labor reduction.

Application: Precision dairy farms use AI for real-time feeding and health management.

4. Precision Feeding

Precision feeding involves customizing nutrient supply according to the specific requirements of individual animals or groups. Conventional feeding systems are often inefficient and wasteful because they do not account for individual variation among animals. Overfeeding protein, for example, may lead to increased nitrogen excretion, while underfeeding energy can suppress milk yield or growth

Tools: Electronic ID, feed intake monitors, automated feeders such as Inraporc : Automatic and Intelligent Precision Feeder (AIPF).

Benefits: Minimizes feed wastage, improves efficiency, and reduces pollution.

Application: Widely adopted in poultry and dairy farms for better resource use.

5. Probiotics, Prebiotics, Postbiotics, and Eubiotics:

Probiotics: Probiotics are live microorganisms—mainly bacteria and some yeasts—that, when administered in adequate amounts, confer health benefits to the host animal.

Importance of Probiotics in Livestock

- i. Improved Digestive Health: Probiotics help maintain a balanced gut

microflora. They promote the growth of beneficial bacteria and inhibit the growth of harmful pathogens like *E. coli* and *Salmonella*.

- ii. **Enhanced Nutrient Absorption:** By stabilizing the gut environment, probiotics increase the efficiency of digestion and nutrient absorption, especially of fiber and protein.
- iii. **Better Immunity:** Regular use of probiotics strengthens the immune system, making animals more resistant to infections and reducing the need for antibiotics.
- iv. **Prevention of Diarrhea and Gut Disorders:** Probiotics are particularly effective in calves to prevent scouring (diarrhea), which is a common cause of mortality in young animals.
- v. **Increased Milk Production and Quality:** In dairy animals, probiotics help improve feed conversion efficiency, leading to increased milk yield and better fat and SNF (solids-not-fat) content.
- vi. **Reduction in Antibiotic Use:** With increasing concern over antibiotic resistance, probiotics offer a natural alternative to maintain animal health without drug residues in milk or meat.

Prebiotics: Non-digestible food ingredients that stimulate beneficial bacteria. Mannan-oligosaccharides (MOS), fructo-oligosaccharides (FOS) are example of prebiotics

Postbiotics: Bioactive compounds produced by probiotics, having antimicrobial and immune-modulating effects.

Eubiotics: A combination of probiotics, prebiotics, essential oils, and organic acids promoting gut eubiosis.

Synbiotics: A combination of probiotics (beneficial live microorganisms) and prebiotics (non-digestible food ingredients that promote the growth of beneficial microbes). When used together, they have a synergistic effect in promoting gut health and overall well-being in dairy animals. Examples of Commercial Synbiotic Products are BioSyn® *Contains:* Lactobacillus + FOS + MOS *Dose:* 10–20 g/day for adult cattle; RumenWell Synbiotic® *Contains:* Yeast culture + MOS + enzymes *Dose:* 15 g/day for dairy cows; ProBioSyn® *Contains:* Probiotic blend + Inulin + vitamins *Dose:* 10 g for calves, 20 g for adult cattle

6. Nutrigenomics

Nutrigenomics is the study of the interaction between nutrients and genes, and how dietary components influence gene expression and animal performance. It aims to personalize animal nutrition by understanding how nutrients regulate metabolic pathways and impact traits like growth, milk production, immunity, and disease resistance. Nutrients act as signaling molecules that can upregulate or downregulate specific genes.

Applications: Identifying feed ingredients that enhance expression of genes for milk yield. Customizing diets to optimize immune response or stress resistance. Use of genetic biomarkers to design precision feed.

Practical Application:

- In dairy cattle, methionine and choline supplementation has been shown to regulate hepatic genes involved in fat metabolism.
- In poultry, selenium and vitamin E have gene-modulating effects improving antioxidative responses.

Conclusion

The integration of scientific innovation into animal nutrition is transforming livestock production. Technologies like protected nutrients, AI, nanominerals, and eubiotics offer farmers precise, sustainable, and profitable ways to nourish animals. These advancements not only ensure better productivity and animal welfare but also reduce the environmental footprint of livestock farming.

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15. Recent Advances in Veterinary Surgery

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Veterinary surgery has evolved significantly in the last two decades due to advancements in technology, biomaterials, minimally invasive techniques, diagnostic imaging, and anaesthetic monitoring. Modern veterinary surgery now mirrors human surgical practices, focusing on precision, reduced invasiveness, rapid recovery, and improved patient safety.

Key areas of advancement include:

- **Veterinary Anaesthesia and Analgesia**
- **Veterinary Diagnostic Imaging**
- **Veterinary Orthopaedics**
- **Soft Tissue Surgery**

Recent Advances in Veterinary Anaesthesia

Anaesthesia in veterinary practice has become safer and more sophisticated due to advanced drug protocols, monitoring tools, and multimodal analgesia.

Anaesthetic Agents and Protocols

- **Dexmedetomidine** (highly selective α_2 -agonist) for sedation and analgesia with reduced cardiovascular side effects.
- **Alfaxalone** – neurosteroid anaesthetic with minimal respiratory depression.
- **Remimazolam** – ultra-short acting benzodiazepine, safer for compromised patients.
- **Balanced anaesthesia**: Combination of drugs (e.g., opioid + benzodiazepine + dissociative) for reduced drug dose and enhanced safety.
- **Multimodal analgesia** – combining NSAIDs, opioids, local anaesthetics, NMDA antagonists (e.g., ketamine) for better pain control.
- **Use of constant rate infusions (CRI)** with drugs like lidocaine, fentanyl, or ketamine for prolonged analgesia.
- **Dexmedetomidine**: Highly selective α_2 -agonist, providing profound sedation and analgesia.

Target-Controlled Infusion (TCI) & Total Intravenous Anaesthesia (TIVA)

- TCI allows precise control of plasma drug concentration (e.g., propofol TCI).
- TIVA protocols with propofol or alfaxalone reduce exposure to inhalant anaesthetics, minimizing adverse effects.

Local and Regional Anaesthesia

- **Ultrasound-guided nerve blocks** (e.g., brachial plexus, femoral-sciatic nerve blocks).
- **Epidural anaesthesia** with opioids or α_2 agonists for prolonged analgesia in large animals.
- **Liposomal bupivacaine** for sustained-release local analgesia.

Advanced Monitoring

- Capnography, pulse oximetry, blood pressure (invasive and non-invasive), ECG, and temperature monitoring have become standard.
- Depth-of-anaesthesia monitoring using bispectral index (BIS).
- Mechanical ventilation and high-flow oxygen therapy during lengthy surgeries.

Recent Advances in Veterinary Diagnostic Imaging

Modern imaging techniques have revolutionized veterinary diagnostics by improving preoperative planning, intraoperative guidance, and postoperative follow-up.

Digital Radiography (DR) and Computed Radiography (CR)

- Superior image quality and instant viewing.
- Teleradiology for remote consultation.

Ultrasonography

- 3D and 4D ultrasonography for dynamic assessment of tissues.
- Contrast-enhanced ultrasonography (CEUS) for evaluating blood flow and perfusion.
- Elastography to assess tissue stiffness (e.g., liver fibrosis, tumors).

Advanced Imaging Modalities

- **Computed Tomography (CT)** – essential for 3D bone reconstruction, spinal disorders, and surgical planning.

- **Magnetic Resonance Imaging (MRI)** – gold standard for soft tissue, brain, and spinal cord evaluation.
- **Positron Emission Tomography (PET-CT)** – emerging in veterinary oncology.

Intraoperative Imaging

- **C-arm fluoroscopy** for orthopaedic fracture fixation.
- **Endoscopy and arthroscopy** for minimally invasive diagnostics.

Recent Advances in Veterinary Orthopaedics

Veterinary orthopaedics has moved towards biomechanically sound fixation methods, biologics, and minimally invasive techniques.

Advanced Fracture Fixation

- **Locking Compression Plates (LCP)** – better stability, minimal periosteal damage.
- **Polyaxial locking plates** – allow variable screw angles.
- **Intramedullary interlocking nails** with improved designs for large breed dogs.

Joint Surgery and Arthroscopy

- Arthroscopy – gold standard for diagnosis and treatment of joint diseases (e.g., OCD, ligament injuries).
- TPLO (Tibial Plateau Leveling Osteotomy) and TTA (Tibial Tuberosity Advancement) for cranial cruciate ligament rupture.
- Custom 3D-printed implants for complex joint reconstructions.

Regenerative Orthopaedics

- **Platelet-Rich Plasma (PRP)** and **Stem Cell Therapy** for osteoarthritis and tendon injuries.
- **Bone graft substitutes** – hydroxyapatite, calcium phosphate, and bioactive glass.

Recent Advances in Soft Tissue Surgery

Soft tissue surgery focuses on minimally invasive approaches, enhanced wound healing, and better hemostasis.

Minimally Invasive Surgery

- Laparoscopy and thoracoscopy for spaying, liver biopsy, gastropexy, and thoracic exploration.
- Single-incision laparoscopic surgery (SILS) and robot-assisted surgery in advanced centers.

Advanced Wound Management

- Negative Pressure Wound Therapy (NPWT) – promotes faster healing in chronic wounds.
- Laser-assisted wound debridement and therapy (e.g., CO₂ lasers, diode lasers).
- Tissue adhesives and fibrin glues for wound closure.

Surgical Stapling and Energy Devices

- Ligasure and harmonic scalpel for bloodless surgeries.
- Endoscopic staplers for gastrointestinal and thoracic surgeries

Future Trends in Veterinary Surgery

- 3D printing for custom prosthetics and surgical planning.
- Artificial intelligence (AI) integrated with imaging for preoperative decision-making.
- Tele-surgery and robotic-assisted surgeries (e.g., da Vinci system prototypes for veterinary use).
- Bioprinting of tissues for reconstructive surgery.
- Enhanced recovery after surgery (ERAS) protocols to minimize hospital stay.

Conclusion

Veterinary surgery is undergoing a technological revolution, integrating advanced anaesthesia, imaging, orthopaedics, and minimally invasive techniques. Veterinary surgeons and postgraduate students must adapt to these emerging trends to provide evidence-based, safe, and efficient surgical care. Continuous learning, hands-on training, and collaboration with human medical advancements will further elevate veterinary surgical standards.

16. Reproductive Disorders and their Management in Farm Animals

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Reproduction is the backbone of productivity in livestock farming. Any discontinuation to ongoing reproductive activity, directly affects herd fertility, milk production, calving intervals, and ultimately the profitability of farm enterprises. Despite advances in reproductive technologies, reproductive disorders remain a major challenge in both landless or marginal farmers opting livestock in India. This lecture will explore a brief discussion on the etiology, pathogenesis, clinical manifestations, diagnosis, and evidence-based management of major reproductive disorders in livestock

Classification of Reproductive Disorders

Reproductive disorders can be broadly categorized based on involvement of reproductive organ.

1. Ovarian Disorders

- Ovarian cysts
- Anovulation
- Persistent corpus luteum (PCL)
- Oophoritis

2. Uterine Disorders

- Metritis (acute, subacute, chronic)
- Endometritis
- Pyometra
- Mucometra
- Uterine prolapse

3. Cervical and Vaginal Disorders

- Cervicitis and vaginitis
- Vaginal prolapse
- Pneumovagina
- Tumors (fibroma, leiomyoma)

4. Tubal and Infundibular Disorders

- Salpingitis

- Blockage of oviducts

5. Periparturient Disorders

- Dystocia
- Retained fetal membranes (RFM)
- Postpartum hemorrhage
- Uterine rupture

6. Miscellaneous / Endocrine Disorders

- Repeat breeding syndrome (RBS)
- Early embryonic mortality
- Silent estrus
- Freemartinism

Etiopathogenesis of Major Disorders

2.1 Ovarian Cysts

- **Etiology:** Disruption of hypothalamic-pituitary-ovarian (HPO) axis; often associated with stress or high milk yield in dairy cows.
- **Types:** Follicular cysts, luteal cysts.
- **Clinical Signs:** Irregular estrous cycle, nymphomania (follicular), anestrus (luteal).
- **Diagnosis:** Per rectal palpation, ultrasonography, serum progesterone levels.
- **Management:** GnRH followed by PGF2 α (Ovsynch protocol), manual rupture (only in selected cases).

2.2 Endometritis

- **Etiology:** Postpartum bacterial contamination, poor hygiene during parturition.
- **Forms:** Clinical and subclinical.
- **Diagnosis:** White side test, Metrichick®, endometrial cytology, ultrasonography.
- **Management:** Intrauterine antibiotics, systemic antibiotics, uterine flushing, prostaglandin therapy.

2.3 Repeat Breeding Syndrome

Repeat Breeding Syndrome refers to the condition where a **sexually mature, cycling female animal** fails to conceive after **three or more consecutive services** (either artificial insemination or natural mating) despite **apparent normal estrous cycles, absence of detectable anatomic or infectious abnormalities**, and mating

with proven fertile males or insemination using good-quality semen. This condition poses a significant economic burden due to extended calving intervals, increased insemination costs, reduced lifetime productivity, and premature culling. RBS is most commonly encountered in high-yielding dairy cattle, although it is also reported in buffaloes, does, ewes, and sows under intensive production systems.

Etio-pathogenesis

Condition is multifactorial, and its pathogenesis involves complex interactions between physiological, pathological, nutritional, immunological, and managemental factors.

1. Ovarian Dysfunction

- **Anovulation or delayed ovulation** leads to mistimed AI and fertilization failure.
- **Silent heat** due to low estrogen expression often goes undetected.
- **Luteal insufficiency** causes inadequate progesterone levels, resulting in early embryonic loss.

2. Subclinical Uterine Infections

- Often undetectable on routine clinical examination.
- Pathogens such as *E. coli*, *Trueperella pyogenes*, and *Mycoplasma* cause a hostile uterine environment.
- These infections alter uterine cytokine profiles and impair embryo implantation.

3. Early Embryonic Mortality

- Embryonic losses before maternal recognition of pregnancy (Day 15–17 in cows).
- Causes: defective oocyte, sperm abnormalities, immune incompatibility, or luteal dysfunction.

4. Nutritional Deficiencies

- Deficiency in energy, protein, and micronutrients (Zn, Cu, Se, Vitamin A and E).
- **Negative energy balance (NEB)** in early postpartum cows impairs follicular development and delays cyclicity.

5. Immunological Causes

- **Sperm antibodies** in the uterine lumen or cervicovaginal mucus.
- Repeated inseminations may lead to isoimmunization and rejection of sperm or embryo.

6. Iatrogenic and Managerial Factors

- Improper timing and technique of AI.
- Insemination during mid-estrus or late estrus leads to aged oocyte fertilization.
- Use of substandard semen or improper semen thawing protocols.

Clinical Features and Presentation

- History of normal estrous behavior and regular cycles.
- No visible genital abnormalities or systemic illness.
- Failure to conceive after three or more services.
- In dairy cows, a tendency for longer calving intervals and reduced milk yield.
- May present with mild uterine discharge in cases of low-grade endometritis.

Diagnosis

A stepwise approach is essential for accurate identification of the underlying cause:

Diagnostic Tool	Purpose
Reproductive history and service record	To identify AI timing errors or postpartum complications
Per rectal and vaginal exam	To rule out anatomical defects, uterine tone
Transrectal ultrasonography	To assess ovarian structures (follicle, CL, cysts), uterine contents
White side test / Metrichex®	Screening for subclinical endometritis
Uterine cytology or swab culture	For identification of microbial pathogens
Serum progesterone assay (Day 10–12 post-AI)	To evaluate luteal function
Semen re-evaluation	To rule out semen quality issues
Estrus detection records	Evaluate accuracy and timing of AI

Management Strategies

Management must be individualized based on diagnostic findings. General strategies include:

Hormonal Treatment Protocols

Protocol	Use
Ovsynch	For ovulation synchronization and timed AI
CIDR (Controlled Internal Drug Release)	Induces cyclicity in anovulatory or silent heat animals
GnRH at estrus	Induces ovulation and ensures synchrony with insemination
PGF2α	Used in luteal phase or in cases of pyometra/persistent CL

Therapeutic Management

- **Intrauterine infusions** of cephalosporin or metronidazole for subclinical endometritis
- **Systemic antibiotics** based on culture sensitivity
- **Uterine flushing** with antiseptic solutions (e.g., Lugol's iodine, normal saline)
- **hCG or GnRH therapy** at estrus to induce ovulation
- **NSAIDs (e.g., flunixin meglumine)** post-insemination to suppress prostaglandin-induced luteolysis

Reproductive Techniques

- **Double insemination** (at 12 and 24 hours) to overcome delayed ovulation
- **Fixed time AI** to increase fertilization chances
- **Use of embryo transfer** in genetically superior but repeat breeding cows
- **AI under ultrasound guidance** in problem breeders

Nutritional Interventions

- Correction of NEB using **rumen-protected fats**
- Supplementation with:
 - Zinc, Copper, Selenium, Manganese
 - Vitamins A, D3, and E
 - High-quality bypass protein and mineral blocks

Preventive Measures

- Maintain AI timing precision and estrus detection accuracy
- Conduct routine postpartum exams (within 30–40 days of calving)
- Monitor Body Condition Score (BCS)—ideal 3.0–3.5/5
- Ensure calving hygiene and uterine health management
- Implement reproductive health monitoring programs at herd level

Diagnostic Approach to other common reproductive disorders

1. Clinical History & Reproductive Record Review
2. Physical Examination
3. Per Rectal and Vaginal Examination
4. Ultrasonography (Transrectal/Transabdominal)
5. Endocrinological Assays (Progesterone, Estrogen, LH/FSH)
6. Microbiological Culture and Sensitivity

7. Uterine Biopsy and Histopathology (in mares)

Section 4: Principles of Therapeutic Management

Disorder	Recommended Treatment
Ovarian cyst	GnRH → PGF2 α
Metritis / Endometritis	Intrauterine cephalosporin, PGF2 α
Anestrus	Hormonal protocols (CIDR, Ovsynch)
RFM	Manual removal (if >24h), oxytocin, antibiotics
Pyometra	PGF2 α ; consider uterine lavage
Vaginal Prolapse	Buhner's suture post-replacement

Role of Biotechnology in Diagnosis and Management

1. Ultrasound-guided follicular aspiration and embryo transfer
2. Ovum Pick Up (OPU) and In-vitro Fertilization (IVF)
3. Genetic screening for inherited reproductive abnormalities
4. Hormone assay kits and biosensors
5. AI synchronization protocols (CIDR, PRID, Crestar)

Prophylactic Measures

- Strict biosecurity and hygiene during calving
- Routine postpartum reproductive check-ups
- Timely deworming and vaccination
- Balanced nutrition and BCS (Body Condition Score) monitoring
- Training of AI technicians to ensure proper timing and technique

Conclusion

Reproductive disorders in farm animals, though multifactorial in origin, are largely preventable and manageable with timely diagnosis, structured treatment protocols, and sound herd management practices. A holistic approach integrating animal husbandry, nutrition, disease control, and reproductive biotechnology is essential for sustainable livestock production.

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बिहार पशु विज्ञान विश्वविद्यालय, पटना के अधीन बिहार पशु चिकित्सा महाविद्यालय, पटना एवं संजय गाँधी गव्य प्रौद्योगिकी संस्थान, पटना में शैक्षणिक सत्र 2025-2026 में नये पाठ्यक्रम शुरू किए जा रहा है, नामांकन हेतु विवरणी निम्नवत् है:-

बिहार पशु चिकित्सा महाविद्यालय, पटना

कोर्स का नाम	अवधि
बी.एस.सी. (पोल्ट्री प्रोडक्शन)	3 वर्ष (6 सेमेस्टर)

पैरा वेटेनरी साइंसेज

कोर्स का नाम	अवधि
डिप्लोमा इन वेटेनरी एंड लाइवस्टॉक डेवलपमेंट (डी.वी.एल.डी.)	2 वर्ष (4 सेमेस्टर)
डिप्लोमा इन वेटेनरी लेबोरेटरी टेक्नोलॉजी (डी. वी. एल. टी.)	2 वर्ष (4 सेमेस्टर)
सर्टिफिकेट कोर्स इन आर्टिफिशियल इन्सेमिनेशन	3 माह

पोस्ट ग्रेजुएट डिप्लोमा

ऑनलाईन - वेटेनरी होम्योपैथी, एथोवेटेनरी मेडिसिन, वन हेल्थ,
ऑफलाईन - बोवाइन क्लिनिकल प्रैक्टिस, कैनाइन एंड फेलाइन क्लिनिकल प्रैक्टिस ।

एडवांस ट्रेनिंग कोर्स ऑन इम्पोर्टेंट वेटेनरी क्लिनिकल प्रोसीजर
अवधि: 3 सप्ताह, प्रवेश क्षमता: 6

सर्टिफिकेट कोर्स

वेटेनरी फॉरेंसिक साइंस, सीमन हैंडलिंग एवं आर्टिफिशियल इन्सेमिनेशन, मॉलिक्यूलर डायग्नोसिस ऑफ इन्फेक्शंस डिजीजेस,
वेटेनरी डायग्नॉस्टिक इमेजिंग, एम्ब्रायो ट्रांसफर टेक्नोलॉजी (आईवीएफ) इन बोवाइन।

ऑनलाइन पाठ्यक्रम

फीड एवं फॉडर टेक्नोलॉजी पर ऑनलाइन शार्ट कोर्स
प्रसार एवं उद्यमिता विकास पर ऑनलाइन शार्ट कोर्स

संजय गाँधी गव्य प्रौद्योगिकी संस्थान, पटना

कोर्स का नाम	अवधि
बी.टेक. (एफ.टी.)	4 वर्ष (8 सेमेस्टर)

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