ANIMAL HUSBANDRY AND FISHERIES
RESOURCES DEPARTMENT
GOVT. OF BIHAR

Training Manual

Training Program
"Veterinary Interventions in Goat Productivity and Health Enhancement "

(10 to 12 December, 2025)

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


प्रशिक्षण स्थल
प्रसार शिक्षा निदेशालय


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PATNA


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BASU's Extension Initiatives for Enhancing Livestock Farming in Bihar

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Directorate of Extension Education
Bihar Animal Sciences University (BASU), Patna

Prologue:

The Directorate of Extension Education (DEE) of Bihar Animal Sciences University (BASU) plays a pivotal and transformative role in strengthening the livestock sector of Bihar by delivering a wide spectrum of extension and outreach services aimed at improving knowledge, skills, and practices at the grassroots level. The Directorate acts as a crucial link between the scientific innovations generated by research institutions and their practical adoption by livestock farmers, rural entrepreneurs, and front-line functionaries. Its efforts are directed toward accelerating technology-driven livestock development and ensuring socioeconomic growth of rural households that depend heavily on dairy, small ruminants, backyard poultry, and other animal-based enterprises.

The primary objective of DEE is to bridge the research–extension–farmer continuum by disseminating advanced livestock production technologies, sustainable management practices, and skill-enhancing interventions in a farmer-centric manner. By utilizing the expertise and infrastructure of its constituent veterinary colleges, livestock farms, Veterinary Clinical Complexes (VCCs), Krishi Vigyan Kendras (KVKs), ATIC (Agricultural Technology Information Centre), and various outreach centers, BASU provides direct support to farmers through advisory services, problem-solving field visits, on-farm demonstrations, and exposure to innovative techniques. These integrated extension approaches ensure that farmers not only gain technical knowledge but also receive practical guidance and continuous follow-up support to effectively improve livestock productivity and profitability.

Directorate organizes a range of extension interventions such as farmer training programs, vocational courses for rural youth, demonstrations of new technologies, farmers' fairs and exhibitions, village adoption initiatives for holistic

livestock development, and doorstep advisory services. The deployment of the mobile advisory platform "BASU Krishi Gyan Vahan" has further strengthened real-time outreach by providing immediate veterinary services, farm consultations, and learning opportunities in remote and underserved areas.

In addition, DEE places strong emphasis on awareness generation, information dissemination, and communication through publications in local languages, radio and TV programs, social media, and ICT-enabled digital extension platforms. Such diversified communication channels ensure wider access to knowledge and bridge information gaps among farmers with varying levels of literacy and resources.

Through continuous capacity building, participatory technology transfer, and empowerment of livestock farmers, DEE significantly contributes to enhancing animal productivity, securing livelihoods, and achieving the broader goal of rural development in Bihar. Its efforts align with state and national priorities to make livestock farming more sustainable, resilient, market-oriented, and profitable, thereby playing a key role in the socio-economic upliftment of millions of livestock-dependent families across the state.

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

2. Field-Level Demonstrations and Farmer Interface

a) Establishment of KVK- Jamui

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

b) FLDs and OFTs

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

c) 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 f**or 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.

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

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

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

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

5. 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.

6. **Information, Education, and Communication (IEC) Activities**
   - **Publication and Distribution of Extension Literature**
     - Publishes leaflets, booklets, manuals, and newsletters in regional languages for easy understanding.
     - Topics include disease management, fodder production, breeding techniques, and value-added dairy products.
   - **Audio-Visual Aids**
     - Produces educational videos and slide presentations on animal husbandry practices.
     - Broadcasts programs through Doordarshan, All India Radio, and local cable networks.
   - **Use of ICT Tools**
     - Provides information through mobile apps, SMS services, and WhatsApp groups.
     - Maintains an online knowledge updates on livestock management at University website
7. **Organization of Exhibitions, Fairs, and Events;**
   - **Livestock and Agriculture Fairs (Pashu Melas)**
     - Hosts exhibitions to showcase latest technologies, breeds, and innovations.
     - Offers platform for farmers to interact with scientists and companies.
   - **World Veterinary Day, World Milk Day, and Other Celebrations**
     - Organizes events to spread awareness on livestock health, nutrition, and productivity.
     - Involves school children, farmers, and stakeholders for community participation.
   - **Participation in State/National Exhibitions**
     - Represents BASU in regional and national agri expos and fairs.
     - Demonstrates university innovations and farmer success stories.

8. 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 Distric**t have been adopted under the project.

Epilogue:

The extension services of Bihar Animal Sciences University (BASU) play a pivotal role in strengthening the livestock sector across the state. By integrating scientific research with field-level outreach, BASU ensures that modern and practical knowledge reaches livestock farmers in an accessible and farmer-friendly manner. Through its extensive network of veterinary colleges, clinical complexes, training centres, and collaborative programs, BASU equips farmers with improved skills, updated technologies, and reliable advisory support. These efforts not only enhance livestock health and productivity but also promote sustainable livelihoods, rural entrepreneurship, and economic growth in Bihar. Ultimately, BASU's extension initiatives bridge the gap between innovation and practice, empowering livestock farmers to adopt better management strategies and secure a more prosperous future.

Feeding Strategies for Goats at Different Physiological Stages

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1. Introduction

Goat farming has always been an integral part of the rural landscape of India. From dry desert villages to hilly tribal settlements, goats are often the first choice of livestock for small and marginal farmers. Their ability to thrive on shrubs, tree leaves, and even crop residues makes them one of the most adaptable animals in the country. Because feed accounts for nearly two-thirds of the total cost of goat production, understanding what to feed, when to feed, and how much to feed becomes essential for profitable farming. In India, where the availability of fodder changes with the seasons, feeding management has to be both practical and economical.

2. Unique Behaviour and Physiology

Goats have several digestive adaptations that allow them to thrive on a wide variety of feed, including low-quality roughages and browse plants that other ruminants may avoid. They are **ruminants**, like cattle and sheep, but with certain distinctive features:

2.1 Natural Browsers and Selective Feeding: Unlike cattle and buffaloes that graze close to the ground, goats naturally **browse** on shrubs, bushes, and tree leaves. They prefer tender, digestible portions of plants and are quite selective. Their ability to selectively browse allows them to consume highly digestible and nutrient-rich plant materials. This behaviour helps them survive even in areas where grass is scarce.

2.2 Efficient Fiber Utilization: The rumen of goats empties faster than in cattle or sheep. This rapid turnover allows them to process fibrous feeds efficiently and tolerate higher amounts of low-quality roughage.Goats can extract nutrients from

coarse, fibrous feed due to their effective rumination and microbial fermentation in the rumen.

2.3 Higher Feed Intake: Goats are known for their relatively high feed intake compared to other ruminants of similar body size. On average, a goat consumes 3–4.5% of its body weight in dry matter per day**,** although this can vary depending on factors such as age, body size, breed, and physiological stage (e.g., growth, pregnancy, lactation). Young growing kids generally have a higher feed intake relative to their body weight to support rapid growth, while lactating does may consume the maximum feed to meet the high energy and protein demands of milk production.

This high feed intake is facilitated by their **efficient rumen system**, which allows them to process large amounts of fibrous material quickly. Additionally, goats are selective feeders, preferring high-quality plant parts, which further enhances nutrient absorption and utilization. Their ability to eat a diverse range of feeds—including grasses, legumes, shrubs, and crop residues-ensures they can maintain a high intake even when high-quality fodder is limited.

2.4 Ability to Detoxify Anti-Nutritional Compounds: Many shrubs and tree leaves contain secondary compounds like tannins. Goats have rumen microbes that can detoxify these compounds, enabling them to feed on plants that may be toxic to other animals.

2.5 Adaptation to Feed Scarcity: Their digestive system allows them to survive on sparse forage and browse, making them ideal for arid, semi-arid, and hilly regions where feed quality and quantity are variable.

3. Feeding Systems

3.1. Intensive Feeding System

In the **intensive system**, goats are fully stall-fed and do not graze outside. All their nutritional requirements—green fodder, dry fodder, and concentrates are provided within the shed or farm. This system allows the farmer to closely monitor

feed quality, quantity, and animal health, which ensures faster growth, higher milk production, and better reproductive performance. Concentrates and legume fodders are usually given according to the age, weight, and physiological status of the goats. Although the intensive system demands higher investment in feed and labour, it is ideal for commercial goat farms near urban areas, where productivity and uniformity are prioritized.

3. 2. Extensive Feeding System

In the **extensive system**, goats rely almost entirely on natural grazing, browsing shrubs, trees, and crop residues available in common lands. Minimal or no supplementary feeding is provided. This method requires low input, making it suitable for resource-poor farmers or regions with abundant grazing land. However, productivity is often low due to seasonal variations in fodder availability and inadequate nutrient intake. Goats under this system are hardy and adaptable but may experience slower growth rates, lower milk production, and longer kidding intervals compared to semi-intensive or intensive systems.

3.3 Semi-Intensive Feeding System

The **semi-intensive system** combines grazing with supplemental feeding at home. Goats are allowed to graze freely on pastures, roadsides, or fallow land for part of the day, and are provided with concentrates, dry fodder, or green fodder in the evening or morning. This system balances cost and productivity, as goats utilize natural forage while still receiving essential nutrients through supplementation. It is widely practiced by smallholder farmers in India, offering a practical way to maintain good growth and milk yield without the high feed cost associated with intensive systems.

3.4 Tethering

Tethering in goats is a traditional method of managing grazing where individual animals are tied with a rope or chain to a fixed peg, tree, or stake, allowing them to feed within a defined radius. This practice is commonly followed by small and marginal farmers who have limited landholding or wish to prevent goats from

straying into crop fields. Tethering helps in utilizing nearby roadside grasses, bund vegetation, and fallow land without the need for fencing. However, it requires constant supervision to avoid entanglement, injury, or attack by predators and dogs. The rope length must be adequate to permit natural movement, access to shade, and comfortable grazing. Regular shifting of tethering points ensures fresh forage availability and reduces the risk of soil erosion or overgrazing. While economically convenient, tethering must be practiced with care to ensure the welfare, safety, and productivity of goats.

4. Feed Resources

4.1 Green Fodder

India has a rich variety of grasses and legumes suited for goat feeding.

- **Legumes**: Berseem, lucerne, cowpea
- **Non-legumes**: Sorghum, maize, Napier, guinea grass
- **Tree leaves**: Subabul, Babool, Neem, Banyan, mulberry, jack fruit

  Tree leaves are particularly valuable during drought or fodder scarcity.

4.2 Dry Fodder

Wheat straw, paddy straw, gram bhusa, groundnut haulms, and arhar straw are widely available and are excellent for stall-fed goats.

4.3 Concentrates

Common ingredients include maize, wheat bran, rice bran, broken rice, groundnut cake, mustard cake, and soybean meal.

Example Concentrate Mix

- Maize/broken rice: 35%
- Wheat bran: 40%
- Oil cake/dal chunni: 20%
- Mineral mixture: 2%
- Salt: 1–2%

4.4 Water

A goat may drink 2–5 litres of water per day. Lactating goats need even more.

5. Feeding Management for Different Categories of Goats

Proper feeding is essential at every stage of a goat's life, as nutrient requirements vary with age, growth, reproductive status, and milk production. Tailoring the diet according to these physiological stages ensures healthy growth, reproductive efficiency, and optimal productivity.

5.1 Kids (0–3 Months)

The first few months of a goat's life are critical for survival, immunity, and future performance. Colostrum feeding within the first hour after birth is essential, as it provides antibodies that protect the kid from infections and strengthens the immune system. After colostrum, milk should be fed regularly, either from the dam or as a replacement, in small, frequent meals.

From about two weeks of age, kids should be introduced gradually to creep feed—a specially formulated feed designed to meet the high protein and energy needs of young goats. This helps in smooth weaning and encourages rumen development. Clean and fresh water must always be available to aid digestion and hydration. Most kids are ready for weaning between 8–12 weeks, depending on growth and health, after which they can transition to green fodder, dry fodder, and concentrates.

Feeding schedule for a kid from birth to 90 days:

Age of kids	Dam's milk or cow milk (ml)	Creep feed (grams)	Forage, green/day (gm)
1-3 days	Colostrum-300 ml, 3 feedings	-	-
4-14days	350 ml, 3 feedings	-	-
15-30 days	350 ml, 3 feedings	A little	A little
31-60 days	400 ml, 2 feedings	100-150	Free choice
61-90 days	200 ml, 2 feedings	200-250	Free choice

Creep feeding: Creep feeding is a practice of providing highly nutritious feed to young kids while they are still suckling. It is called "creep" feed because it is offered in a specially designed feeding area or "creep" that only kids can access, preventing

adult goats from consuming it. The main objective of creep feeding is to supplement milk with additional nutrients so that kids grow faster, develop strong immunity, and adapt to solid feed before weaning. Creep feed is typically introduced from 2 weeks of age, gradually increasing the quantity as the kid grows. Kids can continue on creep feed until weaning at 8–12 weeks.

Importance of Creep Feed

- Provides extra protein and energy to support rapid growth.
- Improves rumen development, allowing earlier and smoother weaning.
- Reduces mortality by enhancing immunity and body condition.
- Ensures that kids are healthier and heavier at weaning, which increases their survival and future productivity.

Composition of Creep Feed

A good creep feed should be palatable, digestible, and nutrient-rich, including:

- *Cereal grains*: maize, wheat, or rice (30–35%)
- *Bran*: wheat bran or rice bran (25–30%)
- *Protein sources*: soybean meal, groundnut cake, or other oil cakes (25–30%)
- *Molasses*: 3–5% to improve taste and intake
- Mineral mixture 2% and common salt 1 %

5.2 Growing Goats (3–12 Months)

This is a critical growth phase, as kids grow into young adults and require adequate nutrients for proper body development. High-quality green fodder should be offered freely to ensure sufficient energy and fiber intake.

In addition, a moderate amount of concentrates (150–250 g/day) can support faster weight gain and better body condition. Supplementation with a mineral mixture is important to strengthen bones, enhance immunity, and prevent deficiencies that could affect growth and reproductive development. Proper feeding during this stage ensures that goats reach their optimal body size and health by the time they become sexually mature.

5.3 Breeding Bucks

The health and nutrition of breeding males directly affect fertility and the quality of offspring. Bucks should be fed a diet rich in energy and protein to maintain stamina, libido, and sperm quality. A typical feeding regimen includes 4–5 kg of green fodder daily along with 400–600 g of concentrate. During the breeding season, energy demands increase, so concentrate feeding should be increased by 20–25% to support active mating and prevent weight loss. Adequate mineral supplementation, especially calcium, phosphorus, and trace elements, is crucial to maintain reproductive health.

5.4 Pregnant Does

Nutrition during pregnancy not only supports the doe but also ensures the healthy growth of the developing fetus.

Feeding does during the first four months of pregnancy:

- Pregnant animals should be allowed in good quality pasture 4-5 hours per day.
- Their ration must be supplemented with available green fodder at the rate of 5 kg per head per day.

Feeding does during the last one month of pregnancy:

- In this period fetal growth increases 60 – 80 per cent until parturition and lack of enough energy in the feed can cause pregnancy toxaemia in does. So during this period animal should be allowed in very good quality pasture 4-5 hours per day.
- In addition to grazing, animals should be fed with concentrate mixture @ 250 –350 g/animal/day.
- Their ration should be supplemented with available green fodder at the rate of 7 kg per head per day.

Feeding does at kidding time

- As kidding time approaches or immediately after kidding the grain allowance should be reduced but good quality dry roughage is fed free choice.
- It is usually preferable to feed lightly on the day of parturition, but allow

plenty of clean, cool water.

- Soon after kidding the doe must be given just enough of slightly warm water.
- After parturition the ration of the doe may be gradually increased so that she receives the full ration in divided doses six to seven times in a day.
- Bulky and laxative feedstuffs may be included in the ration during the first few days.
- A mixture of wheat bran and barely or oats or maize at 1: 1 proportion is excellent.

5.5 Lactating Does

Milk production is highly demanding, and the nutrition of lactating does directly affects both milk yield and kid growth. Providing ample green fodder and legume leaves is crucial for energy and protein intake. Concentrate feeding should be proportional to milk yield, generally around 350 g of concentrate per litre of milk produced. Fresh water must always be available, as lactating does require more hydration. Proper feeding during lactation ensures that the doe maintains body condition, produces sufficient milk, and is ready for the next reproductive cycle.

5.6. Feeding non pregnant does

- If the availability of pasture is good no need to supplement with concentrate mixture in poor grazing condition animals may be supplemented with 150 – 200 g of concentrate / animal/day

6. Conclusion

Feeding management is the backbone of successful goat farming in India. Goats, with their natural browsing ability can thrive on a wide variety of feeds. Still, providing a balanced diet and feeding according to the physiological needs of the animals can significantly enhance productivity. With proper feeding strategies, farmers can ensure healthier goats, better milk and meat production, and improved incomes.

Non-Conventional Green Fodder and their Importance in Goat Feeding

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Introduction:

Goat rearing is a critical component of India's livestock sector, especially for small and marginal farmers in rainfed and resource-poor regions. India has one of the largest goat populations in the world and remains the world's top producer of goat meat (chevon). According to the 20th Livestock Census (2019) and DAHD estimates (2023–24), the goat population of country is 148.88 million (second-largest species after cattle), which contributes ~27% of India's total livestock population. Goat meat production is ~1.57 million tonnes annually and India ranks 1st globally. Goat milk production is ~6.2 million tonnes (approx. 3–4% of total milk pool). The major goat-producing states are Rajasthan, Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal, Maharashtra. India holds 34 registered goat breeds (ICAR–NBAGR). Goats provide regular income through milk, meat, manure and sale of young stock, making feed security essential for sustaining livelihoods. Non-conventional fodders help reduce feed costs, which typically account for 70% of total goat rearing expenditure. However, the productivity of goats is highly constrained by year-round fodder scarcity, particularly during summer and drought periods when conventional forages (maize, sorghum, cowpea, Napier) become limited. To bridge this gap, non-conventional green fodders, particularly tree leaves, aquatic plants, cactus species, and crop by-products, play a vital role in low-cost, sustainable, and climate-resilient goat feeding systems across India.

India faces chronic seasonal shortages of conventional green fodder and concentrates for small ruminants. Non-conventional (alternative or unconventional) green fodders, including certain tree/shrub leaves, aquatic macrophytes, succulent cacti, green crop residues and by-products can fill feed gaps, improve nutrient supply (especially protein), reduce feeding cost and increase resilience of goat production systems in arid, semi-arid and peri-urban areas (ICAR-IGFRI, 2019). This write-up

describes the major non-conventional green fodder options, their nutritional value, practical uses, benefits and constraints for goat feeding in the Indian context.

What is meant by "non-conventional green fodder"?

Non-conventional green fodders are forage resources not normally included as mainstream cultivated fodder (e.g., sorghum, maize fodder, Napier). They include tree and shrub leaves (browse), succulent plants (cactus/Opuntia), tree leaves (jack fruit, banyan, mulberry, plum, etc), fast-growing tree fodders (moringa, sesbania, leucaena), aquatic macrophytes (azolla, duckweed), crop residues used green or as cut-and-carry, and agro-industrial green by-products. These resources are often locally available, require low input, and can be especially valuable in feed-scarce seasons.

Major Non-Conventional Green Fodders Used for Goats in India:

1. Fodder Tree Leaves (Browse Species)

Tree leaves are a natural component of goat diets due to their browsing behaviour. Many indigenous trees produce biomass even during dry months, making them ideal emergency and supplemental fodder.

Jamun (*Syzygium cumini*) Leaves

- Nutritional Profile: Moderate crude protein (12–16% DM), good fiber, rich in minerals (Ca, P, Fe), and beneficial phytochemicals.
- Benefits: Highly palatable; supports rumen health; useful during dry seasons due to evergreen nature.
- Usage: Fed fresh; can be lopped lightly from farm bunds and homestead trees.

Jackfruit (*Artocarpus heterophyllus*) Leaves

- Nutritional Profile: Good CP content (14–18% DM), digestible fiber, and high palatability for goats.
- Benefits: Commonly used in eastern and southern India; improves growth and supports milk production when used as supplement.

- Usage: Fresh or slightly wilted; abundant availability from homestead orchards.

Banyan (*Ficus benghalensis*) Leaves

- Nutritional Profile: Moderate CP (~12% DM), high fiber, good mineral profile.
- Benefits: Evergreen; provides green fodder throughout the year; widely available along roadsides and farm bunds.
- Limitation: Latex content requires gradual introduction.
- Evidence: Ficus species are well-documented browse trees in arid and semi-arid goat diets, improving fiber intake and rumen activity.

Mulberry (*Morus alba*) Leaves

- Nutritional Profile: High CP (18–28%), good amino acids, high digestibility (55–70%).
- Benefits: Excellent protein supplement; improves growth rate and feed conversion; suitable for cut-and-carry systems; supports milk yield.
- Usage: Fresh leaves or leaf meal; grown as hedge or silvopasture.

Babool (*Vachellia nilotica / Acacia nilotica*) Leaves

- Nutritional Profile: Rich in CP (12–18%), minerals, and tannins.
- Benefits: Excellent drought-hardy fodder; readily available in arid and semi-arid regions; goats tolerate tannins better than cattle.
- Limitation: High tannins at excessive levels may reduce digestibility; mix with other fodders.

Kikar (*Acacia karroo / Acacia spp.*) Leaves

- Nutritional Profile: Moderate to high protein (14–20%) depending on species.
- Benefits: Highly drought-resistant; good emergency green fodder; supports basal roughages.
- Limitation: Tannins require balanced inclusion.

2. Other Common Fodder Trees

Opuntia (Cactus pear / prickly pear)

- Description & use: Succulent cladodes (pads) of Opuntia spp. are drought-tolerant, can be produced on marginal lands and fed fresh or ensiled to small ruminants. They supply water and fermentable carbohydrate but are low in protein and fiber (variable), so need protein supplementation.
- Benefits: Excellent drought-season green feed and water source; reduces seasonal weight loss; suitable for arid/semi-arid goat systems.
- Limitation: Low crude protein must be supplemented; spines require de-spining or use of spineless cultivars; high moisture can limit dry matter intake if fed alone (Pastorelli et al., 2022).

Moringa (*Moringa oleifera*)

- Description & use: Leaves are high in crude protein, vitamins and minerals and can be fed fresh, dried (leaf meal) or as silage. Integration around homesteads or on farm bunds is common.
- Benefits: High CP (often ~20–30% on DM basis), good amino-acid profile, improves milk yield and quality in lactating goats when used as supplement; suitable for cut-and-carry systems.
- Limitation: Leaves are best used as a supplement (not sole feed) due to potential anti-nutritional factors at very high inclusion rates; drying or silaging reduces handling constraints (Leitanthem et al., 2022).

Azolla (free-floating aquatic fern)

- Description & use: Azolla pinnata and related species are fast-growing, protein-rich aquatic ferns that can be cultivated in small shallow ponds and harvested frequently. They can be fed fresh or sun-dried and mixed into total mixed rations.
- Benefits: Very rapid biomass production, high crude protein (20-30% on DM), minerals and vitamins; can replace part of concentrates and reduce feed cost; suitable for smallholders with limited land.
- Limitation: Requires water and simple management (pH, nutrient input);

potential microbial contamination if not managed hygienically; best used as partial replacement rather than sole feed (Chekola et al., 2024).

Duckweed (Lemna / Wolffia)

- Description & use: Duckweed species are tiny, fast-multiplying aquatic plants with high crude protein (often 20–40% on DM) and can be grown on small wastewater or nutrient-enriched ponds and fed fresh or dried.
- Benefits: Excellent protein supplement, high productivity per unit area, useful in peri-urban and integrated systems (wastewater nutrient recycling). Studies indicate improvements in growth and rumen parameters when used as supplement.
- Limitation: Need controlled production to avoid contamination and balance diets; palatability varies and may require gradual introduction (Sosa et al., 2024).

Prosopis juliflora (mesquite) - pods and leaves

- Description & use: Prosopis is an invasive shrub/tree common in arid regions of India. Pods (and to some extent leaves) have been used as emergency feed (pods are sweet and energy-rich). Farmers sometimes use pods as a supplement in dry seasons (Sirohi et al., 2014).
- Benefits: Readily available in arid zones; pods are palatable and can partially replace concentrates in dry periods.
- Limitation & caution: Prosopis is an invasive species with ecological costs; some reports indicate variable effects on animal health and needs careful processing (pods may require grinding or mixing); long-term ecological management considerations are important.

Leucaena, Sesbania, Glyricidia and other tree/shrub fodders

- Description & use: Fast-growing leguminous trees/shrubs (e.g., Leucaena leucocephala, Sesbania grandiflora, Glyricidia sepium) are used as cut-and-carry protein fodders. They are widely advocated in agroforestry and silvopastoral systems. High-protein (23–28% CP) fodder tree; excellent

growth booster; contains mimosine—safe for goats at moderate inclusion.

- Benefits: High protein, good forages when used as supplements; improve nitrogen in diets and allow reduced concentrate use; integrate with cropping systems to provide year-round supply.
- Limitation: Some (e.g., Leucaena) contain secondary compounds (mimosine) though goats are generally tolerant; tolerance varies by species and inclusion level — appropriate feeding strategies and, where necessary, detoxification practices are required. Research supports their utility but urges managed use. (Research Gate)

3. Crop-byproducts and other green wastes (banana pseudo-stem, sweet potato vines, vegetable residues)

- Description & use: Many horticultural residues and vegetable trimmings are fed as fresh green fodder in peri-urban systems (banana pseudo-stem, sweet potato vines, sugarcane tops, vegetable market wastes).
- Benefits: Reduce waste, supply bulk and some nutrients, low cost. Useful in mixed feeding systems and for smallholders near markets.
- Limitation**:** Nutrient composition is variable; risk of foreign material or pesticide residues; require processing and care to avoid mycotoxins or spoilage.

Importance of Non-conventional Green Fodder in Goat Production Systems:

- Seasonal buffering: Non-conventional fodders provide green feed during lean seasons (summer/dry period), reducing body-weight loss and mortality.
- Cost reduction: High-protein, low-cost options (azolla, duckweed, Moringa, tree leaves) can reduce concentrate dependence and improve profitability.
- Resource efficiency & sustainability: Many options use marginal lands, homestead spaces or wastewater nutrients (duckweed), contributing to circular resource use.
- Adaptation to climate variability: Drought-tolerant options (Opuntia, Prosopis) improve feed security in arid and semi-arid zones.
- Smallholder applicability: Low input, locally producible fodders are

accessible to resource-poor farmers and fit cut-and-carry systems favored by goat keepers.

Practical Feeding Considerations:

Fodder Type	Suggested Inclusion	Remarks
Mulberry leaves	15–30% of diet DM	High protein; improves growth
Jackfruit leaves	15–25%	Good digestibility
Jamun leaves	10–20%	Evergreen; mix with other fodders
Babool/kikar leaves	10–15%	Tannin content; use moderately
Banyan leaves	10–20%	Introduce gradually due to latex
Opuntia pads	Up to 20% DM	Add protein source
Moringa leaves	10–20%	Rich CP; excellent supplement
Azolla/Duckweed	5–15%	Mix with concentrate

(NDDB, 2012)

Note:

- Values indicative; adjust based on availability and animal response.)
- Introduce latex-containing leaves (banyan, peepal) gradually.
- Mix tannin-rich leaves (babool, kikar) with other fodders.
- Opuntia requires de-spining or feeding spineless varieties.
- Aquatic fodders must be produced hygienically to avoid contamination.
- Combine multiple species for balanced nutrition.

Practical Recommendations for Adoption in India:

- Use as supplements, not sole feeds. Many non-conventional fodders are best used to partially replace concentrates or to add protein and minerals to basal roughages. Always balance for protein and energy.
- On-farm production: Promote homestead planting of Moringa, Sesbania and Leucaena and small ponds for Azolla/duckweed near livestock units. These fit small landholdings and reduce transport costs.

- Processing and quality control: Drying, ensiling or mixing with other feeds can reduce anti-nutritional factors and extend shelf life. De-spining and chopping increase intake and safety (Opuntia).
- Hygiene & safety: Monitor aquatic fodders for contamination; avoid plant parts from pesticide-sprayed fields; introduce new feeds gradually.
- Extension & farmer training: Demonstrations, simple extension manuals and local trials will increase farmer confidence and correct usage (optimal inclusion rates, combinations).
- Ecology & policy caution: While Prosopis pods are useful locally, large-scale encouragement of invasive species is not advised—use existing stands cautiously and pair with restoration plans.

Limitations and Research Needs:

- Standardized feeding recommendations: More region-specific dose/response studies on inclusion levels for goats (growth, reproduction, milk) are needed.
- Anti-nutritional management: Research into simple, low-cost treatments to detoxify problematic species or to reduce secondary compounds.
- Economics and scaling: Studies on cost-benefit and supply chains for peri-urban production systems (azolla/duckweed production enterprises) would help adoption.
- Environmental impacts: Evaluate large-scale use of invasive species and water demands of aquatic systems in water-scarce regions.

Conclusion:

India's large goat population and the rising demand for goat meat and milk require nutritionally secure and cost-effective feeding systems. Non-conventional green fodders including mulberry, jackfruit, jamun, banyan, babool, kikar, subabul, sesbania, opuntia, azolla, duckweed, and horticultural residues play a crucial role in bridging the fodder deficit, ensuring resilience during lean seasons, and sustaining productivity. Their availability, adaptability, and nutritional richness make them indispensable to the future of goat farming and rural livelihoods in India. Integrating

these fodders into feeding strategies will significantly enhance goat productivity while reducing dependence on commercial concentrates, leading to sustainable, low-cost and climate-resilient goat production systems.

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Scientific Goat Farm Management Integrating Poultry and Horticulture

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Scientific goat management with poultry and horticulture represents an integrated farming system (IFS) that combines sustainable and highly efficient approach to agriculture, particularly for small and marginal farmers. This model maximizes resource utilization, Efficiency, Profitability, diversifies income streams, enhances food security, and reduces environmental impact through effective waste recycling.

Key Principles of an Integrated Scientific Goat Farm Management System

The core principle of this integrated model is practices, where the waste products of one enterprise becomes a valuable input for another.

- **Goats** are a primary component, valued for their low input requirements, adaptability to diverse conditions, and quick returns.
- **Poultry** (chickens, ducks) offer a quick, steady income source via eggs and meat, while also providing pest control benefits and valuable manure.
- **Horticulture** includes growing fruits, vegetables, and fodder crops that provide feed for the livestock, food for the farm family, and a market source of income.
- **Vermicomposting** is crucial for converting goat manure, poultry litter, and crop residues into nutrient-rich organic fertilizer, which improves soil fertility and reduces the need for synthetic chemicals.

Synergistic Benefits

Integrating these components creates a highly resilient and productive agroecosystem.

- **Resource Efficiency:** Goats can graze on shrubs and agricultural by-products, while chickens forage on leftover feed and insects in shared areas, optimizing land use.
- **Nutrient Cycling:** Poultry manure and goat faeces are combined in

vermicomposting units, producing high-quality organic fertilizer for horticultural crops, thus minimizing dependence on external inputs and reducing costs.

- **Economic Resilience:** Diversified income streams from goat milk/meat, poultry eggs/meat, and horticultural products (fruits, vegetables) provide financial stability and a year-round cash flow, mitigating the risks associated with single-enterprise farming.
- **Environmental Harmony:** The system promotes sustainable soil health, reduces greenhouse gas emissions through organic waste recycling and agroforestry, and minimizes soil erosion, contributing to an eco-friendly farming approach.

Scientific Management Practices

Successful integration requires scientific planning and management for each component.

- **Housing:** Construct goat and poultry housing adjacently, potentially with a small opening to allow chickens to scavenge leftover goat feed, enhancing hygiene and resource use.
- **Feeding:** Grow high-yielding fodder crops like Bajra Napier grass and legumes as intercrops or border plantings to ensure year-round availability of nutritious feed, reducing external feed costs.
- **Health and Breeding:** Implement regular vaccination schedules, deworming protocols, and proper breeding management for both goats and poultry to maintain health and productivity.
- **Waste Management:** Systematically collect all animal waste and crop residues for efficient processing in vermicomposting units, ensuring the timely application of the resulting organic manure to horticultural plots.

By adopting these scientific management practices within an integrated framework, farmers can achieve enhanced productivity, improved livelihoods, and sustainable agricultural systems.

Goat is good converter of herbs, shrubs, trees, thorny grasses, garbages, and farm with kitchen wastes. It is a vertical browser and five star animals with an excellent biological converter of unused products of human into milk, meat, hides, fibers and manures. It play a vital role in the economy, nutrition, livelihood, and

sustainability of farming systems, especially in developing countries. Goats are important because they offer economic returns & livelihood support, nutritious milk and meat, adaptability to tough climates, high reproductive efficiency, low input requirements and contribution to sustainable farming systems. It is fastidious in food habit, mobile upper lips helps to graze wide varieties of herbs, shrubs and grasses. It has very good feed conversion efficiency about 48% feed is converted into their metabolic activities in comparison to 35% of cows. It takes dry matter even 11% of their body weight however, cattle takes 2.5% of their body weight. Goat is poor's man cow, because of well adaptation and good yield in low inputs. It is a poor man's cow. Goat utility comprises hair, Meat and Dairy products. Its hair is used for rope making, skins are in great demand for leather for gloves & shoes, mohair from Angora goats and Pashmina from Kashmiri goats are greatly prized for the manufacture of high-class dress fabrics shawls. The intestines of goats & sheep are used to make "Catgut". Goat milk naturally has small, fine (2 micron) fat globules, well-emulsified, which means the cream remains suspended in the milk, instead of rising to the top, as in raw cow milk; therefore, it does not need to be homogenized that contains essential amino acids and digestibility coefficient of protein of goat is 85%. It Has 9 minerals more in number than any other milk and biological value of goat milk protein is about 67.5%. It is rich in natural antibiotics because it graze and browse wide range of vegetation's, not horizontally, but vertically hence have immense therapeutic value for people suffering from dyspepsia, Dengue, pyloric stenosis, peptic ulcers, liver dysfunction, Jaundice, Insomnia, Biliary disorders and ultimately enhances immunity. The importance of goat can be understood under the following headings:

The goat keeping has following advantages:

1. Financial investment is small. Goat gives more production per capital investment. The money required to purchase a doe is relatively small. A good doe is expected to milk for six to ten years. At the end of this she may be sold for full salvage value.
2. The building and equipment needs are less. The goat is small animal and can be housed in an inexpensive house, hut or verandah. In our country, the goat requires shelter from rain and hot sun. A wooden box or an old bucket can be used

as manger.

3. Returns start earlier. Markets for goat meat are well established and no religious taboo. A doeling can be bred at the age of 12 months, i.e. when it weighs 35 kgs. The income from milk starts at about 16 to 18 months.
4. Goats are prolific. Exotic goats are fairly prolific. Twins are common on an average an exotic doe produces 1.6 to 2.0 kids. The tropical goats like those of India produce triplets and quadruplets. The sexes are equally distributed.
5. Goats require less feed. A doe will consume about one-fifth as much feed as a cow. In case of buffalo, it may be one-sixth to one-eight.
6. Goat milk is easily digested. Compared to the milk of other animals, goats milk approaches nearest to human milk in fat and protein. The fat globules of goat's milk are small and it makes soft curd which is easily digested. The milk is recommended for infants, invalids and convalescents. Especially given to T. B. patients. Its milk being alkaline has medicinal value and recommended for patients suffering from pyloric stenosis, alyspepsia, Peptic ulcers, allergic eczema and infertile diarrhea. Its milk is also preferred in liver dysfunction, jaundice, biliary disorders, acidosis or insomnia.
7. Goats help in solving unemployment. The village women and children can easily manage goats, which are docile by nature. So the family members who are not employed can earn by goat keeping.
8. Goat provides stable income. Goat provides a daily stable income, which is useful for the family.
9. Goat manure increases crops. IT also contributes 85 thousand MT manure per year, which is rich in N & P than cow. Goat manure maintains and builds up soil fertility. Goat manure is turned back to soil, as it is never used for fuel.
10. No prejudices against slaughter. In India, there are no prejudice against goat slaughter. As such, males and uneconomic females can be easily disposed off. Moreover, there are usually no intermediaries for marketing. Hence, better price is realized.
11. The pashmina production ranges from 100 to 450 gm / goat. IT is sold between 180 to 500 dollars / kg. Cashmere carpets are magnificent and may cost 3000 dollars / sq. meter. The annual production of pashmina is more than 80 MT.

12. Goat is more tolerant to hot climate than other farm animals.
13. They have got increased digestibility of crude fiber with poor quality roughages.
14. Hairs of goats are used for rugs, rope, and hide for leather products.
15. Goats forms an excellent experimental animals for physiological and biochemical research.

FAO, 1997.

Goat Farm integrating poultry and Horticulture







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Importance of Goat Farm Management integrating poultry and Horticulture

1. Economic Importance

- Goats require **low initial investment** and generate **quick returns**, making them ideal for small and marginal farmers.
- Income from sale of **milk, meat, kids, manure, skin**, and breeding stock.
- High demand for goat meat (**chevon**) ensures stable market prices.
- Goat farming supports **rural employment** and livelihood security.

2. Nutritional Importance

- Goat milk is highly nutritious, rich in **calcium, protein, vitamins (A, B, D)**, and minerals.
- Easier to digest and suitable for people with **cow milk intolerance**.
- Goat meat is lean, high-protein, and low in cholesterol—considered a **healthy red meat**.

3. Livelihood Security for Poor Farmers

- Goats act as a **"poor man's cow"**, providing continuous income even in drought and hardship.
- Ideal for **landless, marginal, and women farmers** due to easy handling.
- A reliable source of **financial resilience** in difficult times.

4. Adaptability & Climate Resilience

- Goats survive well in **harsh climates**—drought, heat, hills, semi-arid regions.
- Can consume **low-quality forage**, shrubs, and tree leaves.
- More **disease resistant** than large livestock.

5. Role in Farming System

- Goats help in **weed control** and bush management during grazing.
- Goat manure is excellent organic fertilizer: rich in **nitrogen, phosphorus, potassium**.

- They help in **crop-livestock integration**, improving farm sustainability.

6. Reproductive Efficiency

- Short gestation period (150 days)
- Possibility of **twins or triplets**, increasing herd size quickly
- Early maturity and faster turnover make goat farming highly profitable.

7. Cultural & Social Importance

- Goats have cultural significance in festivals and traditional ceremonies.

The scientific management is an act of regulating and supervising or directing of an enterprise/business by an effective utilization and coordination of resources such as capital, plant, materials, and labor to achieve defined objectives with maximum efficiency.

Management

The management of goat mainly comprises-Feeding, Breeding, Heeding, Housing, protecting kids and health management.

1. Housing Management

- Provide well-ventilated, dry, and raised housing to avoid dampness and diseases.
- Maintain 1.2–1.5 sq. m space per adult goat.
- Use slatted floors or raised bamboo floors to reduce parasite load.
- Ensure proper drainage and sunlight exposure.
- Separate housing for kids, does, bucks, pregnant and sick animals.

2. Feeding & Nutrition

Balanced Diet

- Offer a diet containing green fodder (60%), dry fodder (20%), concentrates (20%).
- Provide good quality leguminous fodder (berseem, Lucerne, cowpea).
- Allow daily browsing/grazing for 4–5 hours if possible.

Minerals & Supplements

- Provide mineral mixture (10–15 g per goat/day).
- Add common salt (5 g/day).
- Ensure continuous clean drinking water.

Special Feeding

- Pregnant does: extra concentrates 200–300 g/day.
- Lactating does: extra 300–500 g/day.
- Kids: creep feed from 15 days of age.

3. Breeding Management

- Follow scientific breeding plan:
    - Breeding age:
        - Does: 12–15 months
        - Bucks: 10–12 months
    - Breeding season: avoid peak summer for better conception.
- Maintain 1 buck for 20–25 does.
- Practice record keeping for heat symptoms, pregnancy, and kidding.
- Avoid inbreeding.

4. Health & Disease Management

Regular Vaccination

- **PPR:** at 3 months; booster yearly
- **Enterotoxaemia (ET):** at 3 months; booster annually
- **Goatpox:** at 3 months; booster every 2–3 years
- **FMD:** twice yearly
- **HS (Haemorrhagic Septicaemia):** once yearly

Deworming

- Deworm **every 3–4 months** depending on season.
- Rotate dewormers to prevent resistance.
- Do **fecal examination** periodically.

Routine Check-Ups:-

- Weekly body inspection (coat, hooves, injuries).
- Hoof trimming every 3–4 months.
- Quarantine new or sick animals for **14 days**.

5. Kid Management:-

- Ensure **colostrum feeding within 1 hour** of birth.
- Maintain warm, clean bedding for kids.
- Navel dipping with tincture iodine.
- Vaccinate kids as per schedule.
- Weaning age: **3 months**.
- Take care of new born kids by providing guard rails.
- Treat / disinfect the naval cord with tincture of iodine as soon as it is cut with a sharp knife.
- Protect the kids from extreme weather conditions, particularly during the first two months.
- Dehorn the kids during first two weeks of age
- Male kids should be castrated for better quality meat production.
- Vaccinate the kids as per the recommended schedule
- Wean the kids at the age of 8 weeks.
- Proper selection of kids on the basis of initial body weight and weaning weight should be initiated by maintaining appropriate records for replacing the culled adult stock as breeders.
- Additional feed requirements of lactating does must be ensured for proper nursing of all the piglets born.

6. Record Keeping: Scientific records help in selecting high-performance animals. Maintain records for:

- Breeding
- Kidding
- Health & vaccination
- Growth weight

- Feed consumption
- Mortality and sales

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7. Biosecurity Practices

- Restrict farm visitors.
- Footbath at entry point.
- Clean feeders and waterers daily.
- Dispose of dead animals scientifically.
- Maintain proper hygiene and waste management.

8. Marketing & Financial Management

- Sell goats at **optimal body weight and market demand** periods.
- Maintain cost and profit analysis.
- Build tie-ups with traders and local markets.
  Goat classified based on utility like meat, milk and fibers.

Management of buck :

The buck must be kept away from the others. It should be given enough of exercise to kept the animal in active condition. Regular grooming must be carried. The buck usually consume more feed than a doe. Balanced concentrate and good fodder should be provided. During breeding season, it is necessary to feed more concentrate.

Certain aspects of Breeding, Feeding and Selection of bucks, Care of repeat breeder and pregnancy diagnosis:

Breeding :

- ✓ Check the tattoo or tag number of the individual animal to facilitate better recording.
- ✓ Provide best grazing facilities to the breeding stock.
- ✓ Improve the physical condition of the flock (flushing) at least 4 weeks before tupping. It will increase the chances of implantation / conception.
- ✓ Remove the hair around the vulva for easy mating

- ✓ Check the breeding records before starting the mating.
- ✓ Extra growth of hooves to be trimmed.
- ✓ Selection of foundation stock is very important.
- ✓ Cull out uneconomical.
- ✓ If horned bucks insist on spending their energy in fighting, discourage them by rubbing a little kerosene or other foul smelling agent along the nose, head and back.
- ✓ Observe heat detection. Properly by use of teaser / apronised or vasectomized buck
- ✓ Age at puberty is 7 months to 1 year.
- ✓ Save the buck from summer sterility.
- ✓ Daily exercise is must essential for the breeding buck.
- ✓ Buck may be used for mating when attains maturity at about 15 months age.
- ✓ Use always a pure bred buck on the farm.
- ✓ Best time for breeding Indian goat is May - June. So that goats will kid during October - November.
- ✓ Bucks of 18 to 24 months age may be used to serve 25 - 30 does / breeding season. When attains full maturity at 2 or 2 ½ years of age may be allowed to serve 50 - 60 does / breeding season.
- ✓ Doeling will kid for the first time at the age of 17 to 18 months.
- ✓ Buck should not allowed to serve a doe more than once at a time.
- ✓ Duration of oestrous and oestrous cycle is 36 hrs and 19 days.
- ✓ The gestation period is of 145 - 150 days.
- ✓ Signs of heat are Swelling & redness of genital opening, shaking tail, restless, loss of appetite, bleat.
- ✓ August - November is the best time for kidding.
- ✓ The average life span of goat is 12 years.
- ✓ Buck should not be housed with does.
- ✓ Bringing the teaser buck near the females for a short time every morning is generally helpful in picking up the doe in heat / silent heat / shy breeders.
- ✓ In exotic goats the breeding season is from September - February.

Marketing:-

The marketing of goats and goat products in the Topics is very variable, and depends on location and prevailing production conditions. Primitive production trends tend to be associated with primitive marketing conditions. Whereas, a highly organized goat enterprise will have regular marketing channels and markets, which will help, recover the production investment. Additionally, these aspects are complicated in the Tropics by the presence of intermediaries or dealers.

Conclusion:-

Integrating goats, poultry, and horticulture is a scientifically proven approach to sustainable agriculture. The model enhances productivity per unit area, increases profitability, and ensures environmental harmony. It provides a viable pathway to improve rural livelihoods and achieve nutritional security.

Recent Advances in Goat and Sheep Management Practices in Bihar

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1. Introduction

Bihar, with its primarily agrarian economy and significant rural population, has long relied on small ruminant farming (goats and sheep) as a critical source of livelihood, nutrition, and insurance against crop failure. The state boasts a substantial population of goats (chiefly the Black Bengal breed) and sheep (such as the Muzaffarnagari and local types), contributing significantly to meat production and rural income. Historically, management practices were traditional, extensive, and largely subsistence-oriented, characterized by low productivity, high disease incidence, and unorganized marketing. However, the past decade has witnessed a conscious shift, driven by government initiatives, research interventions, and growing market demand, leading to noteworthy advancements in the sector. This note outlines the key recent advancements in goat and sheep management in Bihar, focusing on breed improvement, healthcare, nutrition, housing, and institutional support.

2. Advancements in Breed Improvement and Genetic Upgradation

- **Promotion of Elite Indigenous Breeds:** There is a renewed emphasis on the systematic rearing and propagation of the **Black Bengal goat**, renowned for its superior meat quality, adaptability, high prolificacy, and low feed requirements. Government farms and selected farmers are being developed as nucleus breeding units to produce purebred stock for distribution.
- **Selective Cross-Breeding Programs:** To enhance growth rates and body weight, controlled cross-breeding initiatives using superior bucks like **Sirohi, Jamunapari, and Boer** with local non-descript goats are being promoted under supervised schemes. Similarly, for sheep, **Muzaffarnagari** rams are being used for upgrading local flocks to improve mutton yield.
- **Establishment of Breeder Farms and Buck/Buck Ram Distribution:** The

state, through the **Animal and Fisheries Resources Department** and institutions like the **Bihar Veterinary College (BVC), Patna**, has strengthened its network of breeder farms. Regular **Buck/Buck Ram Melas** (fairs) and subsidized distribution programs ensure that quality genetic material reaches farmers in remote blocks, improving the genetic pool of village flocks.

3. Advancements in Healthcare and Disease Management

- **Mass Vaccination Campaigns:** Systematic state-wide campaigns against **PPR (Peste des Petits Ruminants)**, also known as goat plague, and **Foot and Mouth Disease (FMD)**, have been scaled up. These are often coupled with deworming drives, drastically reducing mortality rates, especially in young stock.
- **Strengthening of Veterinary Infrastructure:** The establishment of **Mobile Veterinary Units (MVUs)** and the augmentation of **Block Animal Health Centres** have improved access to timely healthcare in rural areas. Telemedicine consultations are being piloted in some districts.
- **Focus on Parasite Control:** Awareness about integrated parasite management (IPM) has increased. Recommendations for strategic deworming based on season and life stage, along with improved pen hygiene, are being disseminated through Krishi Vigyan Kendras (KVKs) and frontline workers.
- **Capacity Building of Paravets:** Extensive training programs for **Pashu Sakhis** (female livestock friends) and **Pashu Mitras** (livestock friends) have created a cadre of community-level service providers who can administer first aid, vaccinations, and basic healthcare advice.

4. Advancements in Nutrition and Feeding Practices

- **Promotion of Cultivated Fodder:** To address the perennial shortage of green fodder, especially during summer, farmers are being encouraged to grow high-yielding, nutritious varieties like **Napier hybrid, Guinea grass, Cowpea, and Berseem**. Fodder seed mini-kits and demonstrations are

provided.

- **Urea Molasses Mineral Block (UMMB) Lick and Feed Supplements:** The use of UMMB licks, which provide essential minerals, vitamins, and non-protein nitrogen, is being promoted to balance the nutrient deficit in grazing-based systems. Concentrate feeding, tailored to pregnant, lactating, and growing animals, is gaining acceptance among semi-intensive farmers.
- **Feed Formulation and Storage:** KVKs and State Departments are demonstrating low-cost feed formulations using locally available ingredients like maize, mustard cake, and bran. Training on proper feed storage to prevent aflatoxin contamination is also part of extension messages.

5. Advancements in Housing and Management

- **Scientific Shelter Design:** The traditional practice of night sheltering within the owner's dwelling is gradually giving way to the construction of **raised, slatted floor sheds (RCC or bamboo)**. These "Bhattar Chhaan" designs keep animals dry, improve hygiene, reduce parasite load, and facilitate manure collection. Subsidies are often available under various schemes.
- **Manure Management and Bio-gas:** The emphasis on stall-feeding and proper housing has enabled the collection of dung for composting and bio-gas production, adding an additional revenue stream and promoting cleanliness.

6. Institutional and Marketing Advancements

- **Formation of Farmer Producer Organizations (FPOs):** Small ruminant-based FPOs are being promoted to aggregate produce, achieve economies of scale in input procurement, and strengthen bargaining power in the market. This is a significant step towards formalizing the value chain.
- **Market Infrastructure and Linkages:** Efforts are being made to develop **dedicated livestock markets** and link farmer groups with modern abattoirs and meat processing units in nearby states. The "Bihar Goshala Ayog" also plays a role in market facilitation.
- **Access to Credit and Insurance:** Linkages with banks for livestock loans

under **Kisan Credit Card (KCC)** and schemes like **National Livestock Mission (NLM)** have improved. **Livestock insurance** schemes, though with modest coverage, are being popularized to mitigate risks.

- **Skill Development:** The **Bihar Skill Development Mission** and other agencies offer short-term courses in goat and sheep farming, covering all aspects of scientific management, creating a new generation of skilled entrepreneurs.

7. Challenges and the Way Forward

Despite these advancements, challenges persist: the predominance of small, scattered holdings; occasional vaccine shortages; high concentrate feed costs; the threat of disease outbreaks; and the need for stronger cold chain and meat processing infrastructure within the state.

The way forward lies in:

- Consolidating and intensifying the breed improvement program.
- Strengthening the livestock extension system with digital tools.
- Promoting entrepreneurship in fodder seed production, meat processing, and value-added products (e.g., leather, manure compost).
- Ensuring convergence of various state and central schemes (NLM, RKVY, MGNREGA for shed construction) for maximum impact.

8. Conclusion

Recent advancements in goat and sheep management in Bihar reflect a transition from neglect-based, extensive systems to a more conscious, productivity-oriented, and science-backed approach. The synergy between government policy, research institutions, and a growing entrepreneurial spirit among farmers is driving this change. While the journey towards a fully organized, high-productivity small ruminant sector is ongoing, the foundational pillars of improved genetics, health, nutrition, and marketing are being firmly established. Sustained efforts in this direction hold the potential to transform small ruminant farming into a powerhouse of rural prosperity, nutritional security, and sustainable agriculture in Bihar.

Parasitological Diagnostic Technique

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Introduction

Parasitological diagnostic techniques play a crucial role in the detection, identification, and evaluation of internal parasitic infections in animals. These procedures assist veterinarians in assessing the type and extent of parasitic burden, monitoring the effectiveness of anthelmintic therapy, and planning appropriate control and prevention strategies. Gross and microscopic examinations of faecal samples remain the cornerstone of routine parasitological diagnosis, enabling the detection of various parasitic stages such as eggs, larvae, cysts, and adult helminths. By employing methods like direct smear, flotation, and sedimentation, accurate and reliable findings can be obtained to safeguard animal health and productivity. The main parasitological techniques are outlined below:

1.Gross examination of faeces:

Faeces are examined grossly for the presence of adult (*Toxocara vitulorum*), immature stage (Amphistomes) or gravid proglottides (tape worms) or larval stage of insects (*Gasterophilus intestinalis*, *Oestrus ovis* etc.). All the information regarding quantity, colour and presence of blood or mucus in faeces, consistency should be noted.

(a) 10-20 gm of faeces is spread in a large petridish for this purpose.

(b) Nematode or segments of tapeworm or immature nematode are searched with the camel hair

brush. The parasitic stages are identified with or without staining.

2. Microscopic examination of faeces:

It is done for knowing the kinds of infection without going into intensity. It is helpful in comparing the efficacy of anthelmintic, determining the correct interval

between anthelmintic treatment, assessing efficacy of control programs and to know the drug resistance etc. It is determined by following techniques:

(A) Direct smear method: This is simple and quick test that can be performed at field condition easily. This test cannot indicate severity of infection and usually fails to detect low grade infections. In case of heavy infection this method is very successful. This method is useful in detecting delicate worms as protozoan trophozoites, ciliates and larvae of nematode which get destroyed or distorted by concentration media and also for heavy eggs as trematodes ova.

Procedure:

- 2-4 gm. of faeces is comminuted with pestle and mortar.
- A loop-full of the material is transferred to a slide with the toothpick or glass rod.
- Mix with a few droplets of water or normal saline to form a uniform suspension.
- Spread it on the slide and apply a cover slip
- Under low power, examine the slidemicroscopically.
- In case of doubt low power can be adjusted by high power.

This method, however, suffers from the drawbacks that:

1. Quantitative results cannot be obtained.
2. It is effective only where the concentration of parasite stages is high i.e. heavy parasitic infections.
3. It is most of the times difficult to identify them since they are partially covered by debris.

Parasite found with the direct smear method:

Cestode and trematodes eggs (mainly in birds)

Coccidia and helminth eggs (if high numbers are present)

(B) Concentration method:

This method is useful in case of light infection. They are more sensitive than direct smear method and based on difference in specific gravity. Following techniques have

been dealt under it:

i. Floatation method:

Principle: This technique is based on Specific gravity.This technique is useful in demonstration of protozoan cysts and heminth ova like Ascarids*, Strogyles, Oxyurids ,Strongyloides , Trichuris* species and eggs of nematode and cestodes.When parasitic eggs or protozoan cysts are suspended in a liquid with a specific gravity higher than that of the eggs, the eggs will float up to the surface. Nematode and cestode eggs float in a liquid with a specific gravity of between 1.10- 1.20. Trematode eggs, which are much heavier, require a specific gravity 1.30-1.35.

Equipments:

- ❖ Mortar & Pestle
- ❖ A tea strainer (preferably nylon)
- ❖ Measuring cylinder
- ❖ Test tube
- ❖ Microscope
- ❖ Glass slides
- ❖ Coverslips
- ❖ Balance or teaspoon
- ❖ Flotation fluid

Procedure

- Put 2 gm of faeces into mortar & pestle.
- Pour 20 ml saturated salt solution (flotation fuid) in to mortar & pestle.
- Mix (stir) faces and floatation fluid thoroughly.
- Place the test tube in a test tube rack or stand.
- Pour the resulting faecal suspension through a tea strainer in a test tube Fill the test tube up to the tip with solution. Gently top up the test tube with the suspesion, leaving a convex meniscus at the top of the tube carefull place a coverslip on top of the test tube.
- let the test tube stand for 30 minutes by which all the eggs would have floated up and adhered to the coverslip.
- Carefully lift off the coverslip from the tube, together with the drop of fluid adhering to it, and immediately place the coverslip on a microscope slide and

examined the fluid film under low power microscope.

- This method is useful for the majority of nematodeeggs but is not suitable for egg of trematodes and most cestodes.
- For the diagnosis of cyst forming gastrointestinal protozoa, a drop of 1% aqueous eosin or Lugol's iodine is mixed with the prepared faecal smear.

Common saturated solution used in floatation technique are Sodium chloride (Sp. gr.-1.20), Sugar-Sucrose (Sp. gr.-1.12-1.30), Zinc sulphate- 30% (Sp. gr.-1.18), Magnesium sulphate – 35% (Sp. gr.-1. 28) etc. Saturated solution of sodium chloride and magnesium sulphate are used for nematode eggs and saturated solution of zinc chloride or zinc sulphate are used in trematode eggs. For the eggs of *Strongyles, Strongyloides,Trichuris,Oxyuris, Ascaris*, *Moniezia* sps and Coccidial oocysts saturated solution of NaCl is very good.Saturated solution of $MgSo_4$ isgood for detection of Metastrongyle and Strongyles eggs.For Cryptosporidial,Coccidial oocysts and eggs of helminthic parasite Sucrose is best.For detection of Nematode larva and Protozoan cysts $ZnSo_4$ is good.Rarely used chemicals for Flotation method are Sodium Nitrate, Glycerine, Conc. Sodium nitrate.

ii Sedimentation method:

This technique is successful in demonstrating majority of the trematodes eggs.

Procedure:

- A small quantity (3-4gm) of faecal material mixed with water and then homogenized it in a mortar and pestle.
- For removal of coarse, fibers or debris material straining through a sieve can be done.Then pour it into a plastic container of 30 ml capacity.
- Fill the tube upto the brim with water.
- Centrifuge the test tube at 2000 to3000 rpm for 5 to 10 minutes.
- Discard the supernatant and a drop of water is mixed with a little sediment.
- Take on a glass slide, place a cover slip on the top and examine under the microscope.
- This method improves the clarity due to elimination of all the coarse particulate matter.

- In presence of eggs of fluke a drop of methylene blue is added to the faecal smear, it makes them appear as yellowish brown objects against blue background.
- In case of thin-shelled eggs, a drop of 2% Eosin when added will stain all the substances except the thin shelled eggs, which stand out clear against the pink background.
- The eggs of Schistosome can be detected by following procedure -
- In a suitable container take approximately 10 gm of faeces from small animals or 30 gm. of faeces from large animals.
- Treat it overnight with 0.4 N NaoH and then filter through a tea trainer to removecoarse material
- Wash the sediment thrice with 1.7 % saline Solution.
- Then examine the sediment under low magnification for the presence of Schistosome eggs.

Chemicals used for preservation of Faecal samples

(i) Collected faeces should be preserved in 10% formalin for few days and 70 % ethyl alcohol may be used for longer period of preservation.10 % formalin is prepared by taking Formalin (40% formaldehyde-10 ml + Water-90 ml).

(ii) 2.5 % Potassium dichromate solution is used for *Eimeria* oocysts.

Conclusion

Parasitological diagnostic methods provide valuable insight into the parasitic status of animals and support informed veterinary decision-making for disease management. Each technique—whether gross examination, direct smear, flotation, or sedimentation—has its own specific application and diagnostic advantages depending on the type and intensity of infection. Proper selection and implementation of these methods help in effective diagnosis, strategic deworming, evaluation of drug resistance, and improved parasite control programs. Overall, these diagnostic tools form an essential foundation in veterinary parasitology for ensuring better animal health and enhancing livestock productivity.

PROFORMA FOR DESPATCHING OF SAMPLE

MATERIAL

Species of host :----------

Sex / breed :----------

Age of species :----------

Clinical sign /symptoms :----------

Sample/ material :----------

Name of preservative used :----------

Date and time of dispatch :----------

Examination required :----------

Owner's address :----------

Treatment given :----------

Signature ofVeterinary officer with stamp

Mobile no. ----------

Email ----------

Address----------

Pregnancy Diagnosis in Goats

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Introduction

Pregnancy diagnosis is a vital component of reproductive management in goat production systems. Early and accurate detection of pregnancy allows farmers and veterinarians to optimize nutrition, adjust housing and management strategies, identify reproductive failures, and plan future breeding. Goats, being seasonal or non-seasonal breeders depending on breed and climate, require precise reproductive monitoring to maintain high kidding rates. A variety of methods *viz.* clinical, biochemical, hormonal, and imaging-based - are employed for pregnancy detection, each with its own advantages and limitations.

I. Physiological Basis of Pregnancy in Goats

a. Estrous Cycle Overview

- Goats are polyestrous, with a cycle length of **18–21 days**
- Estrus phase lasts for about **24–48 hours**
- Ovulation occurs **12–36 hours after onset of estrus**
- The **corpus luteum (CL)** is essential for the maintenance of pregnancy throughout gestation.

b. Gestational Physiology

- Gestation length: **145–155 days**
- Maternal recognition of pregnancy occurs around **Day 16**, where the embryo secretes **interferon-tau (IFN-τ)** to prevent luteolysis.
- Progesterone from the **corpus luteum** is essential throughout pregnancy.

Understanding this physiology helps in determining the appropriate timing and selection of diagnostic methods.

II. Methods of Pregnancy Diagnosis in Goats:

Pregnancy diagnosis methods in goats can be broadly categorized into:

1. **Behavioral Methods**
2. **Clinical Examination**
3. **Hormonal Assays**
4. **Biochemical Tests**
5. **Ultrasonography**
6. **Advanced and Emerging Techniques**

Each method varies in accuracy, timing, invasiveness, and practicality.

1. Behavioral Signs

a. Non-return to Estrus

- It is a practical field indicator. Doe does **not return to heat** 18–21 days post-breeding.
- However, false positives may occur due to:
- Silent heat
- Persistent CL
- Early embryonic loss
- Seasonal anestrus

Accuracy: Low to moderate

Use: Preliminary screening only

2. Clinical Examination Methods

a. Abdominal Palpation

Rarely practiced in goats due to small size and risk of false findings. Effective only in late gestation.

b. Ballottement (After 90–100 Days)

- Fetus may be felt by gently pushing the abdomen with fingertips.
- Limited accuracy as fat or ingesta may mimic fetal movement.

Clinical methods alone are insufficient for early pregnancy diagnosis.

3. Hormonal Methods

a. Progesterone Assay

- **Sample**: **Milk or blood**

- Timing: **18–21 days post-breeding**
- A high progesterone level suggests the presence of a functional CL and thus, possible pregnancy.

Limitations:

Cannot differentiate between pregnancy and:

- Pseudopregnancy
- Persistent CL
- Early embryonic loss

Cannot confirm viability of embryo

Accuracy: 70–90% (good for ruling out pregnancy)

4. Pregnancy-Specific Protein Tests

These include detection of **pregnancy-associated glycoproteins (PAGs)** produced by trophoblast cells.

Pregnancy-Associated Glycoproteins (PAGs)

- Detectable from **Day 28–30 post-mating**
- Commercial ELISA kits available
- Good accuracy for both early and late pregnancy

Advantages

- Non-invasive
- Highly sensitive
- Reflects placental function

Limitations

- PAGs may persist **up to 2 months postpartum**, causing false positives if test is done early after kidding.

Accuracy: >95%

*** It is the best method for blood-based pregnancy confirmation.**

5. Ultrasonography – The Gold Standard

Ultrasound is the most widely used and **most accurate method** for pregnancy diagnosis in goats.

a. Transabdominal Ultrasonography

Timing:

- **From 30 days onwards** for reliable results
- Best window: **45–90 days**

What can be detected?

- **Day 30–35:** Anechoic fluid-filled uterine sac
- **Day 35–40:** Fetal heartbeat
- **Day 45–50:** Limb buds, fetal movements
- **Day 60 onwards:** Placentomes, multiple fetuses

Advantages:

- High accuracy
- Allows assessment of:
- Fetal number (single, twins, triplets)
- Fetal viability
- Estimated gestational age
- Detection of fetal abnormalities and mummification

Accuracy: 95–100%

b. Transrectal Ultrasonography

Useful for early diagnosis: Day 20–30 post-breeding

- Requires experience
- Useful in small ruminants with small abdomen
- Higher resolution due to proximity

Accuracy: 90–95%

6. Other Diagnostic Techniques

a. Doppler Ultrasonography

- Detects blood flow, fetal heartbeats
- Useful from **35–40 days**

b. Radiography

- Used only in late pregnancy
- Can identify mineralized skeletal structures
- Not commonly used due to costs and radiation concerns

III. Diagnosis of Pregnancy-related Disorders

Accurate pregnancy diagnosis also helps detect the following:

a. Pseudopregnancy (Hydrometra/Cloudburst)

- Common in goats
- Characterized by:
- Persistent CL
- Accumulation of uterine fluid

• Diagnosis:

- Ultrasonography: Fluid-filled uterus with **no fetus or placentomes**
- Progesterone levels are high (false positive)

• b. Early Embryonic Mortality

- Detected via:
- Drop in progesterone
- Absence of fetal heartbeat on follow-up scans

Table: Comparative Summary of Pregnancy Diagnosis Methods in Goats

Method	Day of Detection	Accuracy	Advantages	Limitations
Non-return to estrus	18–21	Low–Moderate	Simple	Low specificity
Progesterone assay	18–21	Moderate	Easy	False positives
PAGs	28–30	High	Excellent accuracy	May give false positives postpartum
Transrectal US	20–30	Very high	Early diagnosis	Experience needed
Transabdominal US	30^{+}	Very high	Fetal viability & numbers	Equipment needed
Abdominal palpation	90^{+}	Low	Inexpensive	Low accuracy

Best Practices for Pregnancy Diagnosis in Goats

- Perform **ultrasound** wherever possible for reliable results.
- If using progesterone/PAG assays, choose correct timing:
- Progesterone: **Day 18–21**
- PAGs: **Day 30^{+}**

Combine **behavioral monitoring + hormonal assay + ultrasonography** for herd management.

- Conduct at least **two scans**:

1. Early pregnancy (30–40 days)
2. Mid-gestation (60–90 days) to confirm fetal viability and number

Conclusion:

Pregnancy diagnosis in goats is an essential tool in reproductive management, enabling producers to optimize herd productivity. While behavioral signs provide preliminary indications, laboratory-based assays and ultrasonography offer accurate confirmation. **Ultrasound remains the gold standard**, providing detailed information on fetal health, number, and gestational age. Veterinarians must select appropriate diagnostic techniques based on stage of gestation, equipment availability, and expertise to ensure effective reproductive performance in goat herds.

Common Bacterial and Haemoprotozoan Diseases of Goats and Their Control Strategies

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Introduction

Goats (*Capra hircus)* rank among the most versatile livestock species globally, providing meat, milk, fiber, and hides while thriving in diverse agroecological zones, particularly in developing regions. However, their small size, communal grazing habits, and close human interaction expose them to a spectrum of infectious diseases, with bacterial and haemoprotozoan pathogens posing significant threats. Bacterial diseases often manifest as localized or systemic infections causing abscesses, respiratory distress, or septicemia, while haemoprotozoan diseases, transmitted primarily by arthropod vectors, lead to hemolytic anemia, fever, and reproductive losses. These conditions contribute to high morbidity (up to 50% in unmanaged flocks) and mortality (10-30% in outbreaks), resulting in economic losses exceeding millions annually in goat-rearing economies like those in India, Africa, and Latin America.

Understanding these diseases requires knowledge of their etiology, epidemiology, clinical signs, pathology, diagnosis, and control. Bacterial agents thrive in unhygienic environments, exacerbated by overcrowding and poor nutrition, whereas haemoprotozoans exploit vector abundance during humid seasons. Effective control integrates biosecurity, chemotherapy, immunization, and husbandry improvements, tailored to local contexts. This write-up expands on common afflictions, drawing from veterinary literature to offer comprehensive strategies for sustainable goat farming.

Bacterial Diseases: Overview and Specific Pathogens

Bacterial diseases dominate goat health challenges due to the animals' susceptibility to environmental pathogens. Key groups include gram-positive rods (e.g., Corynebacterium, Clostridium), gram-negative enteric bacteria (Salmonella,

Escherichia coli), and respiratory opportunists (Pasteurella, Mannheimia). Transmission occurs via aerosols, contaminated feed/water, wounds, or colostrum/milk. Predisposing factors encompass stress from weaning, transport, pregnancy, or malnutrition, weakening mucosal barriers and immunity.

Caseous Lymphadenitis (CL)

Caused by Corynebacterium pseudotuberculosis, CL represents the most prevalent chronic bacterial disease in goats worldwide, with seroprevalence reaching 20-60% in endemic areas. The facultative intracellular bacterium enters through skin abrasions or mucous membranes, forming pyogranulomatous abscesses in lymph nodes, lungs, or viscera. External form shows firm, green-tinged pus-filled swellings at superficial nodes (e.g., submandibular, prescapular); internal dissemination causes weight loss, pneumonia, or mastitis.

Clinical signs emerge 2-6 weeks post-infection: fever (104-106°F), anorexia, and lymphadenopathy progressing to chronic debilitation. Pathology involves caseonecrotic cores surrounded by epithelioid cells, fostering persistence. Diagnosis relies on culture from aspirated pus (biotype II for goats), PCR, or ELISA serology; radiology detects pulmonary abscesses

Control mandates culling infected animals, as no cure exists for carriers. Vaccination with bacterin toxoids (e.g., Case-Bac®) reduces abscess incidence by 70-90% if administered biannually from 3 months of age. Biosecurity—footbaths, quarantine (30 days), sanitation—prevents spread; avoid sharing shearing equipment.

Pasteurellosis and Mannheimiosis

Mannheimia haemolytica (formerly Pasteurella haemolytica) and Pasteurella multocida cause acute fibrinous pneumonia and septicemia, striking kids during stress events like sudden weaning or weather shifts. Serotypes A2 (M. haemolytica) predominate in goats. Inhalation of aerosols from carriers initiates bronchopneumonia, with leukotoxin damaging respiratory epithelium.

Signs include mucopurulent nasal discharge, cough, dyspnea, rectal temperature >104°F, and rapid death in peracute cases (mortality 20-50%). Necropsy reveals consolidated lungs with frothy exudate. Confirmation uses bacterial isolation on

blood agar, showing hemolysis, and multiplex PCR.
Prevention hinges on vaccination (e.g., One Shot® polyvalent) pre-stressing events, yielding 80% protection. Treatment employs long-acting oxytetracycline (20 mg/kg IM) or florfenicol, alongside supportive oxygen and anti-inflammatories. Husbandry upgrades—ventilated barns (10-15 goats/m^2), dust control, balanced diets (16% crude protein)—curb outbreaks.

Clostridial Diseases

Anaerobic spore-formers like Clostridium perfringens (types C/D: enterotoxemia), C. tetani (tetanus), and C. chauvoei (blackleg) strike abruptly. Enterotoxemia, or pulpy kidney disease, arises from dietary shifts favoring rapid ruminal fermentation, epsilon toxin absorption causing neurological signs, diarrhea, and death. Tetanus follows wound contamination; blackleg affects fast-growing kids.
Hyperimmune serum neutralizes toxins acutely, but vaccination (CD&T toxoid, 2 mL SC at 6-8 weeks, annual boosters) prevents 95% of cases. Pasture management avoids lush legume overfeeding.

Other Bacterial Diseases

Brucellosis (Brucella melitensis): Zoonotic abortion storm; control via test-and-slaughter, Strain 19 vaccine.
Listeriosis: Circling disease from silage Listeria monocytogenes; penicillin therapy, hygienic feed.
Salmonellosis (Salmonella abortusovis): Diarrhea, abortions; electrolytes, antibiotics.
Mastitis (Staphylococcus aureus, E. coli): Udder swelling, milk drop; intramammary infusions, hygiene.
Haemoprotozoan Diseases: Overview and Specific Pathogens
Haemoprotozoans parasitize erythrocytes or endothelium, causing intravascular hemolysis, pyrexia, and icterus. Vectors include ticks (Rhipicephalus, Hyalomma), flies (Glossina for trypanosomes), and mechanical transmitters. Endemic in tropics/subtropics, prevalence surges with monsoon (up to 40%).

Anaplasmosis

Anaplasma ovis (small merozoites) and A. marginale infect RBCs, transmitted by ticks or iatrogenically. Acute phase: fever (105-107°F), anemia (PCV <20%), hemoglobinuria, emaciation; chronic carriers amplify spread.

Giemsa-stained blood smears reveal inclusions; PCR confirms. Treatment: oxytetracycline (10 mg/kg IV daily x3) or imidocarb (1 mg/kg SC). Acaricides (deltamethrin pour-on), tick-resistant breeds (e.g., Jamnapari), and zero-grazing control vectors.

Babesiosis

Babesia ovis, B. motasi (transovarial tick transmission) cause pear-shaped intraerythrocytic piroplasms. Signs: hemoglobinuria ("redwater"), jaundice, tachycardia 4-10 days post-tick bite.

Chemotherapy: diminazene aceturate (3.5 mg/kg IM) or imidocarb. Live attenuated vaccines (e.g., Bloodrick) confer immunity; flaricide dips essential.

Theileriosis

Theileria lestoquardi (malignant ovine) and T. annulata schizonts transform lymphocytes, inducing lymphoproliferation, anemia, corneal opacity ("turning sickness"). Ixodid ticks transmit piroplasms. Buparvaquone (2.5 mg/kg IM x2) treats; ball vaccine (live sporozoite) prevents. Pasture spelling (60 days) breaks tick cycles.

Trypanosomosis (Surra)

Trypanosoma evansi, T. vivax, T. congolense (extracellular, mechanical/salivarian transmission) evoke intermittent fever, cachexia, orchitis. "Mal de cadeiras" in South America. Suramin (10 mg/kg IV) or melarsomine effective early; resistance rising. Fly control (pyrethroids), resistant breeds (West African Dwarf) key.

Other Haemoprotozoans

Theileriosis minor (T. hirci): Mild anemia; rarely fatal.

Toxoplasmosis (Toxoplasma gondii): Ovine-like abortions; sulfa-drugs.

Diagnosis and Differential Approaches

Clinical diagnosis integrates history (season, movement), signs, and necropsy. Lab tools: microscopy (Giemsa for protozoa), culture (bacteria), serology (ELISA, MAT), molecular (PCR for C. pseudotuberculosis, Anaplasma), hematology

(anemia, thrombocytopenia). Differentials: viral (PPR, CA), helminths (Haemonchus), nutritional deficiencies.

Integrated Control Strategies

Biosecurity and Husbandry

Quarantine newcomers (21-30 days), all-in-all-out systems, density <10 goats/pen. Clean water/feed troughs daily; footbaths (copper sulfate 5%). Nutrition: 2.5-3% bodyweight dry matter, minerals (Cu, Se, Zn) boost immunity.

Chemotherapy and Chemotherapy Resistance

Reserve antibiotics (penicillin G 20,000 IU/kg, tetracyclines) for confirmed cases; avoid prophylaxis. Protozoal drugs: rotate classes (imidocarb, diminazene) to delay resistance.

Vaccination Programs

Core vaccines: clostridial (7-way), CL, Pasteurella. Regional: Brucella S19 (kids only), theileria. Timing: pre-weaning, pre-breeding; efficacy monitoring via serosurveys.

Vector Management

Tick: amitraz dips (q14d), ivermectin (0.2 mg/kg); rotate chemicals. Flies: traps, pour-ons. Environmental: bush clearing.

Breeding and Genetic Selection

Favor indigenous breeds (e.g., Boer for tick resistance). Marker-assisted selection for MHC genes.

Monitoring and Surveillance

Fecal cultures, blood smears quarterly; report notifiables (brucellosis).

Economic and Zoonotic Implications

Outbreaks slash productivity: 20-40% milk/meat loss. Zoonoses (brucellosis, listeria, toxoplasma) risk human health, especially pasteurization failures. Integrated programs (e.g., India's PPR eradication) yield ROI >5:1.

Emerging Challenges and Future Directions

Antimicrobial resistance, climate-driven vector shifts, climate change intensifies threats. Solutions: phage therapy for bacteria, RNAi vaccines for protozoa, One Health surveillance, AI diagnostics.

Conclusion

Proactive management of bacterial and haemoprotozoan diseases ensures goat health and profitability. Holistic strategies—vaccination, biosecurity, targeted therapy—outperform reactive measures. Farmers should consult vets for herd-specific plans, fostering resilient flocks.

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Common Viral Diseases in Goats and Control Strategies

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Goat production is an important source of meat, milk and livelihoods worldwide. Viral diseases cause substantial production losses through mortality, reduced growth, decreased milk yield, and trade restrictions. Effective control requires integrating disease-specific measures (vaccination, therapeutics, surveillance) with herd-level management, biosecurity, and public-health awareness (for zoonoses). This document summarizes the most important viral diseases of goats, their clinical features, diagnostics, and practical control strategies. Key diseases covered: Peste des petits ruminants (PPR), capripox (goat pox), contagious ecthyma (orf), caprine arthritis-encephalitis virus (CAEV), bluetongue, and foot-and-mouth disease (FMD).

1. Pestes Des Petits Ruminants (PPR)

PPR is an acute and highly contagious viral disease of goats and sheep with very high mortality in susceptible populations. The causative agent is PPR virus, a Morbillivirus belonging to the family Paramyxoviridae. The disease is widely prevalent in Asia, Middle East and Africa. Goats are more susceptible than sheep, and severe disease is commonly noticed in young animals aged 4 to 12 months. The virus is transmitted primarily through aerosol and direct contact with nasal and ocular secretions of infected animals. Fomites such as feed troughs, water utensils and bedding material also play an important role in mechanical transmission during outbreaks.

The virus initially replicates in the lymphoid tissues and subsequently targets the respiratory tract and intestinal epithelium. This induces necrotizing stomatitis, erosive enteritis and pneumonia. The incubation period ranges from 2 to 6 days. The onset of disease is marked by sudden high fever, dullness, anorexia, matting of eyelids, excessive ocular and nasal discharges, erosive lesions in the oral cavity, foul breath, diarrhoea and severe dehydration. Advanced cases show dyspnoea and

coughing due to secondary bacterial pneumonia. Mortality varies from 10% to 100% depending on immunity status and secondary infections.

Diagnosis is mainly based on clinical signs and epidemiology. Laboratory confirmation is done using antigen detection tests like CIE, AGID and ELISA, while virus isolation is performed in Vero cells. Supportive therapy is the mainstay of treatment because no specific antiviral drug is available. Broad-spectrum antibiotics, antihistamines, fluid therapy, oral rehydration solutions and intestinal astringents are used to prevent secondary infection and dehydration. Control strategies include isolation of infected animals and strict sanitation. Mass vaccination with the live attenuated PPR vaccine at 3 to 4 months of age provides long-term immunity (up to three years) and plays a key role in eradication programs.

2. Contagious Ecthyma (Orf)

Contagious Ecthyma, also called Orf, is a viral skin disease of goats and sheep characterized by proliferative dermatitis and crust formation, particularly around the mouth and nostrils. It is caused by Orf virus, a Parapoxvirus belonging to the family Poxviridae. The virus is highly resilient and can survive for years in dried scabs, contributing to its persistence on endemic farms. The disease mainly affects kids aged 3 to 6 months and is associated with high morbidity and moderate mortality. Importantly, Orf is zoonotic and may produce lesions on the hands and arms of animal handlers.

Transmission occurs by direct contact with infected animals or indirectly through contaminated feed, pasture or equipment. Minor skin abrasions facilitate viral entry. The pathogenesis involves viral replication in keratinocytes, leading to papules, vesicles, pustules and thick brown crusts around the lips and muzzle. The lesions are painful and interfere with feeding, resulting in weight loss and poor growth. In severe cases, lesions may extend to the udder, teats, ears and genitalia.

Diagnosis is based on typical skin lesions and laboratory techniques including AGPT, CFT, electron microscopy and histopathology showing intracytoplasmic inclusion bodies. There is no specific antiviral therapy; treatment is symptomatic. Local application of povidone iodine, antiseptic ointments or 5% copper sulphate helps in healing. Broad-spectrum antibiotics reduce secondary bacterial infections.

Vaccination using live scab vaccine applied on scarified skin provides immunity for up to two years and is recommended in endemic regions. Isolation of affected animals and proper disposal of scabs are essential for prevention.

3. Goat Pox

Goat Pox is a systemic viral disease of goats characterized by generalized pock lesions on the skin and mucous membranes. It is caused by Goat Pox virus, a Capripoxvirus belonging to the family Poxviridae. The disease is prevalent in many Asian and African countries and causes significant economic loss due to mortality in kids, reduced growth rate and hide value deterioration. The virus spreads through direct contact, aerosol, and contaminated fomites, while wounds and abrasions facilitate viral entry.

The incubation period ranges from 4 to 15 days. Clinical signs begin with high fever, depression and reduction in feed intake, followed by the appearance of cutaneous papules, vesicles, pustules and scabs over the body, especially head, ears, udder, perineum and limbs. Conjunctivitis, nasal discharge and respiratory distress occur in severe cases. Pregnant goats may abort during infection. Necropsy reveals pock lesions on the skin and internal organs, pneumonic changes, enlarged lymph nodes and intracytoplasmic inclusion bodies.

Diagnosis is made based on clinical signs and confirmed by serological tests such as SNT, AGPT, ELISA and virus isolation. No specific antiviral drug is available; treatment is symptomatic and includes anti-inflammatory drugs, antibiotics and wound dressing. Prevention is mainly through vaccination using live Goat Pox vaccine (Uttarkashi strain), administered once at 3 months of age with revaccination every two years. Segregation of sick animals, strict disinfection and restriction of animal movement are essential to control outbreaks.

Foot And Mouth Disease (FMD)

Foot and Mouth Disease (FMD) is a highly contagious viral disease of goats and other cloven-hoofed animals, producing painful vesicular lesions in the mouth and feet, resulting in heavy production losses due to reduced feed intake, lameness, poor growth and decline in milk yield. The disease is caused by Foot and Mouth Disease

Virus (FMDV), a small, non-enveloped, positive-sense RNA virus belonging to the genus Aphthovirus under the family Picornaviridae. Seven immunologically distinct serotypes are recognised—O, A, C, Asia-1, SAT-1, SAT-2 and SAT-3—and immunity is strictly serotype-specific. In India, serotypes O, A and Asia-1 are most frequently associated with outbreaks.FMD is widespread globally and remains endemic in many Asian and African countries. Goats and sheep often develop mild or sub-clinical infection, making them silent carriers that spread the virus to cattle and buffalo. The virus transmits rapidly through aerosol inhalation, direct contact with clinically affected or carrier animals, contaminated feed, water and fomites, as well as during transportation and livestock trading. Stress factors such as overcrowding, long travel, unhygienic environments and introduction of new animals into a flock further increase disease incidence. Kids may suffer the most severe form of disease and mortality in this age group may be high. Following entry, FMDV replicates initially in the pharyngeal epithelium and later spreads through the bloodstream producing viraemia. Vesicular lesions arise due to degeneration of stratified epithelial layers, primarily in the oral cavity, interdigital space, coronary band, udder and teats. Vesicles rupture and form raw ulcers that are extremely painful, interfering with feeding and locomotion. Secondary bacterial infections worsen the condition and animals that recover may remain pharyngeal carriers for several months. The incubation period is generally 2–14 days. The early stage is characterised by high fever, dullness, teeth grinding, excessive salivation and drooling of frothy saliva. Vesicles appear on the tongue, gums, inner lips and dental pad and rapidly rupture to create raw red ulcerated patches. Goats show difficulty in chewing and swallowing, resulting in sudden anorexia. Vesicles also form on the limbs including coronary band and interdigital space, leading to severe lameness and reluctance to walk. There is marked reduction in milk yield in lactating animals. Kids may develop myocarditis, often dying suddenly without visible oral lesions. Mortality is generally low in adults but may be high in young animals. Typical lesions and herd history are suggestive, but laboratory confirmation is essential. Diagnostic techniques include ELISA, virus neutralization test, complement fixation test, competitive ELISA, RT-PCR and virus isolation in cell culture. Suitable samples include vesicular fluid, epithelial tissue and probang samples. Differential diagnosis should consider

bluetongue, peste des petits ruminants (PPR), vesicular stomatitis and contagious ecthyma.There is no specific antiviral drug available for FMD and therapy is only supportive. Oral lesions should be cleaned with antiseptic solutions such as potassium permanganate, boroglycerine or povidone iodine to promote healing. Broad-spectrum antibiotics help prevent secondary bacterial infections. Anti-inflammatory agents and analgesics alleviate pain and encourage feed intake. Foot lesions require antiseptic dressing and animals should be kept on soft bedding. Nutritional support, electrolyte supplementation and soft diets aid recovery. The major strategy for FMD control in goats is systematic vaccination combined with strict biosecurity measures. In endemic regions, goats should be vaccinated at 4–5 months of age, revaccinated after 6 months and subsequently every 6 months using an inactivated trivalent FMD vaccine containing serotypes O, A and Asia-1. During outbreaks, immediate isolation of sick animals, disinfection of sheds using strong alkalis such as sodium hydroxide or soda ash or iodophor disinfectants, and restriction of animal movement are essential to prevent spread. Newly purchased animals must undergo at least 21 days of quarantine before herd introduction. Hygienic housing, controlled grazing, avoidance of overcrowding and prohibition of inter-farm animal exchange during disease season significantly reduce risk.

Caprine Arthritis–Encephalitis Virus (CAEV)

Caprine Arthritis–Encephalitis Virus (CAEV) is a chronic, debilitating viral disease of goats characterised primarily by progressive arthritis in adults and encephalitis in kids, leading to lifelong infection and major economic losses in dairy goat farming. CAEV is caused by a lentivirus belonging to the family Retroviridae, similar to Maedi–Visna virus of sheep. It is an enveloped RNA virus that integrates into host cell DNA, establishing lifelong persistent infection. The virus shows tropism for monocytes/macrophages and induces chronic inflammatory lesions in joints and central nervous system. CAEV occurs worldwide, particularly in dairy breeds such as Saanen, Alpine and Toggenburg, with infection rates as high as 60–80% in intensive farms if control measures are not applied. Transmission occurs mainly through ingestion of infected colostrum and milk by kids, but direct contact via body secretions, shared equipment, blood-contaminated needles, and semen from infected

bucks also plays a role. Vertical transmission in utero and through embryo transfer can occur. Latently infected animals without symptoms serve as reservoirs, contributing to silent spread within herds. Once infected, goats remain lifelong carriers. After entry, CAEV replicates in monocytes, which later differentiate into macrophages where active viral replication begins. This results in chronic inflammatory responses mediated by immune cells, cytokines and immune complexes. In adults, inflammatory lesions predominantly affect synovial membranes, cartilage and periarticular tissues, leading to arthritis. In kids, the virus invades the central nervous system, causing demyelination and perivascular mononuclear infiltration. Over time, progressive tissue damage results in irreversible clinical disease. The incubation period varies from months to years. In adult goats, the most common manifestation is chronic arthritis, especially affecting the carpal joints. Clinical signs include progressive joint swelling, lameness, pain during locomotion, stiff gait, poor body condition and eventual inability to move normally. In kids between 2 and 6 months of age, a leukoencephalomyelitis form develops, characterised by neurological signs such as hind limb ataxia, weakness, paralysis and difficulty standing or walking, while maintaining alertness. Other manifestations include hard-udder syndrome in lactating goats due to indurative mastitis, leading to reduced milk yield, and interstitial pneumonia with chronic coughing and exercise intolerance. Mortality is usually low in adults but may be high in severely affected kids. Clinical signs alone are not sufficient because many infected goats remain asymptomatic. Laboratory confirmation is done by serology using AGID (agar gel immunodiffusion) or ELISA, which are most widely used for herd screening. PCR and virus isolation from blood leukocytes, joint fluid, milk, or CNS tissue are confirmatory tests. Histopathology of affected tissues reveals chronic lymphocytic synovitis, demyelination or mononuclear encephalomyelitis. Differential diagnoses include Mycoplasma arthritis, bacterial meningitis, listeriosis and spinal injuries. There is no cure for CAEV because of lifelong viral integration in host cells. Treatment is supportive, aimed at relieving symptoms and slowing progression. NSAIDs help reduce joint pain and inflammation, and physiotherapy or controlled exercise may improve mobility. Severely debilitated animals may require humane culling. Antibiotics are ineffective because CAEV is viral but may be used to treat

secondary bacterial infections. Good nutrition and management can improve comfort but do not eliminate the virus. Since no vaccine or antiviral treatment exists, the most effective control strategy is prevention of infection in newborn kids and progressive elimination of the virus from the herd. CAEV-free herds are established by removing kids at birth and feeding them heat-treated colostrum and pasteurized milk or milk replacer from uninfected donors. Whole-herd serological testing should be performed regularly and seropositive animals should be segregated or culled depending on farm policy. Needles and surgical equipment must not be reused across animals, and natural mating or artificial insemination with semen from infected bucks must be avoided. Maintaining a closed herd system, enforcing strict biosecurity, and preventing the introduction of untested animals are critical for long-term control.

Conclusion

Viral diseases constitute a major threat to goat farming by causing high morbidity, mortality, production losses and treatment costs. PPR, Contagious Ecthyma and Goat Pox remain the most economically important viral infections of goats. Although specific antiviral drugs are not available, effective control can be achieved through strict biosecurity, early diagnosis, isolation of infected animals, supportive therapy and above all regular vaccination. Ensuring high herd immunity through systematic vaccination and educating farmers about disease management are essential for minimizing the economic loss and improving goat health and productivity.

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Physiology of Thermoregulation and Heat Stress Management in Goats

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Goats are one of the most climate-resilient livestock species due to their inherent adaptability to harsh, arid, and semi-arid environments. Yet, rising global temperatures, erratic climatic patterns, and increasing incidences of heat waves pose significant challenges to goat health, production, and reproduction. Efficient thermoregulation is crucial for maintaining homeostasis under hot environments. This chapter comprehensively discusses the physiological mechanisms governing thermoregulation in goats, including behavioral, autonomic, endocrine, cellular, and molecular responses. It further elaborates on the impacts of heat stress on productive and reproductive performance, immunity, metabolism, and overall welfare. Evidence-based strategies for heat stress mitigation - covering management, nutritional interventions, genetic selection, housing modifications, and advanced technological approaches - are explored to provide holistic solutions for sustainable goat production. The chapter also emphasizes future climate-smart strategies and research needs for enhancing thermo-tolerance in goats.

Keywords: Goats, Thermoregulation, Heat Stress, Adaptation, Physiology, Climate Change, Welfare, Productivity, Heat Mitigation

1. Introduction

Goats (*Capra hircus*) are integral to livestock production systems in tropical and subtropical regions, especially due to their remarkable adaptability to heat, water scarcity, and poor-quality forage. As climate change intensifies, goats are increasingly exposed to prolonged periods of high ambient temperatures, high humidity, and associated heat stress. Heat stress occurs when the environmental temperature exceeds the animal's thermoneutral zone, impairing its ability to dissipate heat and maintain physiological homeostasis. While goats possess unique anatomical and behavioral traits that facilitate thermoregulation, persistent exposure to extreme temperatures adversely affects physiological functions, leading to

reduced productivity, diminished reproductive efficiency, metabolic alterations, immunosuppression, and increased susceptibility to diseases. Understanding thermoregulation physiology is essential for designing effective heat mitigation strategies.

This chapter provides a detailed account of the physiology of thermoregulation in goats and discusses practical and scientific approaches to managing heat stress for maintaining optimum health and productivity.

2. Thermoregulation Physiology in Goats

Thermoregulation involves a complex interaction between the central nervous system, endocrine system, and peripheral physiological processes. Goats utilize behavioral adjustments, autonomic responses, and biochemical mechanisms to maintain body temperature within a narrow range.

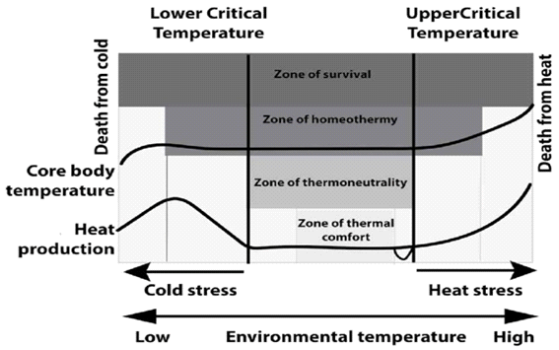
2.1 Thermoneutral Zone and Critical Temperatures: It can be better understood by learning these three fundamental terms relate to regulatory temperatures:

a) Thermoneutral Zone (TNZ): The range of ambient temperature where goats can maintain their body temperature without additional energy expenditure.

For adult goats, TNZ typically ranges between **15–27°C**, depending on breed and acclimation.

b) Lower Critical Temperature (LCT): Below TNZ, goats must generate additional metabolic heat.

c) Upper Critical Temperature (UCT): Above TNZ, goats face heat stress and activate cooling mechanisms such as sweating and panting.



2.2 Heat Production and Heat Loss Mechanisms

Goats balance heat production and heat loss through multiple pathways, like:

2.2.1 Heat Production: Heat can be generated by multiple ways :-By regulating basal metabolic activities, Producing muscle activity, Ruminal fermentation, Lactation and Hormonal influences (thyroid hormones, catecholamines)

2.2.2 Heat Loss

Heat dissipation occurs through maily four ways namely-

a. Radiation: When there is transfer of heat occur between the body and environment.

b. Conduction: When heat exchange occurs through direct contact from one object to another object..

c. Convection: When heat loss occur via air movement.

d. Evaporation: it happens when sweating and panting occur from the targeted body.

It must be noted that Goats particularly rely on **evaporative cooling** through sweating and respiratory heat dissipation.

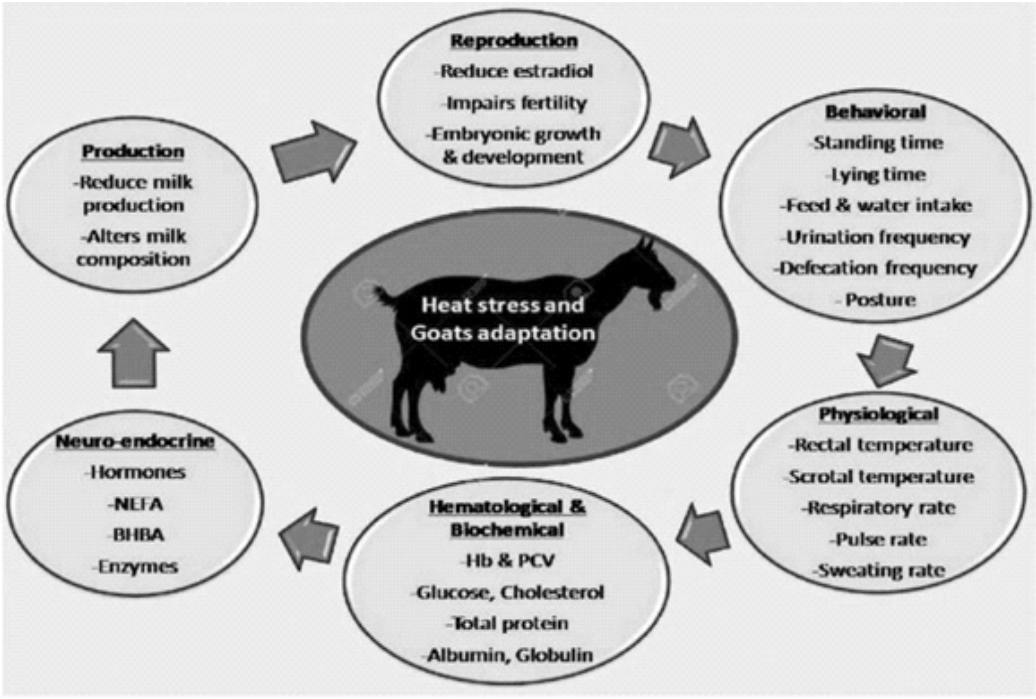
2.3 Anatomical and Behavioral Adaptations

Goats have evolved several traits that enhance heat resilience like-

2.3.1 Anatomical Adaptations: This particular type of adaptation can be adapted by thin skin with abundant sweat glands, short hair coat with lower insulation, large surface area-to-body weight ratio. Highly vascularized skin promoting heat dissipation.

2.3.2 Behavioral Adaptations: These adaptation techniques constitute of:

1) Seeking shade and reducing physical activity
2) Grazing during morning and evening hours
3) Increasing water intake
4) Spreading body limbs to promote cooling
5) Reduced feed intake during hot hours



These behavioral responses are often the first line of defense against heat stress in animals.

2.4 Neuroendocrine Regulation

Thermoregulation is centrally controlled by the hypothalamus, particularly the pre-optic area. When we focus on Hypothalamic control the thermoreceptors detect changes in core and skin temperature and Hypothalamus initiates vasodilation, sweating, and increased respiration when body temperature rises. These are the basic mechanisim produced by hypothalamus. As well as when we talk about hormonal Adjustments, heat stress alters key hormones:

i. Thyroid hormones (T3, T4): Reduced to decrease metabolic heat production.

ii. Cortisol: Elevated under chronic stress, suppressing immunity and metabolism.

iii. Aldosterone: Decreases, leading to electrolyte imbalance.

iv. Prolactin: Increases during heat stress, possibly aiding thermoregulation.

2.5 Respiratory and Sweating Responses

Sweating and Panting

Goats possess functional apocrine sweat glands. Sweat rate increases significantly with rising temperatures, especially in heat-tolerant breeds like Black Bengal, Osmanabadi, and Barbari. Pantinmg increases evaporative heat loss from respiratory tract and associated with increased respiration rate (RR) and tidal volume which increases excessive panting which lead to respiratory alkalosis.

2.6 Cardiovascular Adjustments

Heat stress induces many types of adjustments like Peripheral vasodilation to facilitate heat loss, Increased heart rate (HR) to redistribute blood to skin and reduced blood flow to internal organs, affecting digestion and immunity

2.7 Cellular and Molecular Adaptations

Heat Shock Proteins (HSPs): HSP70 and HSP90 play crucial roles in Protein stabilization, Repair of damaged proteins and Protecting cells from heat-induced apoptosis. Oxidative Stress Markers can participate in Heat stress elevation by Reactive oxygen species (ROS), Lipid peroxidation and Antioxidant enzyme activities (SOD, CAT, GPx).

3. Impacts of Heat Stress on Goats

3.1 Effects on Feed Intake and Digestion

Due to heat stress there will be reduced rumination, Lower feed intake (up to 25–40% drop), decline in rumen motility and reduced fiber digestibility.

3.2 Metabolic and Physiological Changes

Heat stress causes increased respiration and heart rate, higher rectal temperature, imbalance in electrolytes (Na^+, K^+, Cl^-), decline in blood glucose and increased NEFA utilization.

3.3 Productive Performance

Regarding milk production decreased milk yield together lower fat and protein content and reduced mammary blood flow. Growth and body condition there will be lower average daily gain (ADG) and reduced carcass quality.

3.4 Reproductive Performance

Heat stress negatively affects both males and females. In Females it lower conception rate, reduced estrus expression, embryonic mortality and do ovarian dysfunction. In Males it reduced sperm motility and concentration, increased testicular temperature and Oxidative damage to sperm DNA

3.5 Immune Suppression:

Immunity can be suprresd by decrease in lymphocyte proliferation, increased cortisol reduces immunity and higher susceptibility to parasitic and bacterial infections.

3.6 Welfare and Behavioral Disturbances

Many types of disturbance may lead by increased restlessness, shade-seeking behavior, aggression or lethargy and reduced grazing time.

4. Heat Stress Management in Goats

Heat stress mitigation requires a combination of environmental, nutritional, genetic, and technological interventions.

4.1 Environmental and Housing Modifications

4.1.1 Shade Structures: It can be done by natural shade (trees) or artificial shade (cloth, roofing) and reducing 5–10°C temperature beneath shades.

4.1.2 Ventilation: In respect to ventilation proper air circulation reduces humidity and heat load as well as open-sided sheds with east-west orientation are ideal.

4.1.3 Roofing Materials: Asbestos, thatched roofs, or insulated sheets are required

and reflective paints should be used to reduce heat absorption.

4.1.4 Cooling Systems: It can be done by fans and foggers, misting systems and sprinklers combined with fans (evaporative cooling).

4.2 Nutritional Interventions: Proper nutrition enhances stress resilience.

4.2.1 Water Management: It can be manged by unlimited access to cool, clean water and electrolyte supplementation (Na^+, K^+, Cl^-).

4.2.2 Feeding Strategies: Feeding during cooler hours and inclusion of high-energy, low-heat increment feeds.

4.2.3 Antioxidants: Vitamin E, C, Selenium, Zinc and Polyphenols and flavonoids. These reduce oxidative stress and improve immunity.

4.2.4 Buffers and Additives: Yeast cultures, Bypass fats, Betaine and Chromium These improve metabolism and reduce heat load.

4.3 Genetic and Breed Selection

Some breeds naturally show superior heat resilience, like Black Bengal, Osmanabadi, Barbari, Kanni Adu, Sirohi, Jamunapari, Desert breeds (e.g., Nubian). Genomic markers such as HSP70 polymorphisms may be used to select heat-tolerant animals.

4.4 Reproductive Management: Avoid breeding in peak summer months as well as use heat-tolerant bucks for breeding and utilize artificial insemination with high-quality semen.

4.5 Health Management During Heat Stress: It can be done by deworming to reduce parasitic load, vaccination at cooler times of the day, monitoring respiration and rectal temperature and prompt treatment of dehydration.

4.6 Technological Approaches

I. **Precision Livestock Farming (PLF):** In the we can use of sensors and IoT devices for- Continuous monitoring of body temperature, Recording heart rate and respiration and Predicting heat stress risk

II. **Remote Sensing and Climate Modelling:** Helps anticipate heat waves for early preparedness.

4.7 Behavioral Management: Allow goats to graze during early morning/late evening, Reduce crowding in pens, ensure adequate space and enrichment.

5. Climate Change, Future Challenges, and Opportunities

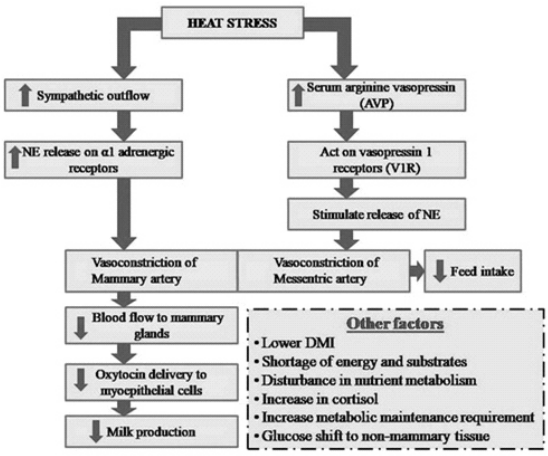
Climate change is intensifying heat stress episodes. Future strategies must include:

5.1 Climate-Smart Goat Production Systems in which improved feed resources

Water-efficient farming systems, Agroforestry and silvopasture can be done .

5.2 Genetic Engineering and Genomics: CRISPR-based gene editing targeting heat tolerance and identification of molecular markers

5.3 Policy and Farmer Awareness: It can be implemented by heat stress management training and incentives for climate-resilient housing.



6. Conclusion

Thermoregulation in goats is a complex and well-coordinated physiological process that enables them to survive in diverse and challenging environments. However, escalating global temperatures and climate variability increase the vulnerability of goats to heat stress, affecting their productivity, reproduction, metabolism, and overall welfare. A thorough understanding of thermoregulatory mechanisms is essential for formulating robust heat stress mitigation strategies.

Effective heat stress management requires an integrated approach combining proper housing design, nutritional interventions, genetic selection for thermo-tolerance, advanced technologies, and improved management practices. Climate-smart strategies will be crucial to ensure sustainable goat production. Future research should focus on molecular markers, precision livestock tools, and breeding programs aimed at enhancing heat resilience in goat populations.

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Caprine Cryptosporidiosis: A Hidden Threat to Young Kids

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Introduction

Goat farming is widely regarded as one of the most suitable livelihood options for rural farmers in developing nations. It plays an important role in improving household nutrition, strengthening the rural economy, and promoting capital generation and self-employment. Goats are easy to manage and have the remarkable ability to utilize scarce or non-conventional feed resources to produce meat and milk efficiently—features that make them especially valuable to small-scale farmers. However, a major obstacle to profitable and intensive goat production is the high mortality rate in kids due to diarrhoea, which can reach 15–40% during the first three months of life. Among the wide range of diarrhoeal pathogens like viral, bacterial, and parasitic, *Cryptosporidium* species are recognized as one of the leading causes. Cryptosporidiosis is a disease of significant zoonotic importance, as the parasite *Cryptosporidium parvum* can be transmitted from infected animals to humans. This disease is one of the most significant health concerns in newborn goat kids. Beyond causing mortality rates that may reach up to 40%, cryptosporidiosis leads to reduced productivity, poor growth, decreased feed conversion, delayed maturity, reduced fertility, and substantial economic losses due to treatment and care of affected animals. Newborns lack natural resistance to this infection, and colostrum does not provide adequate passive immunity. As a result, disease severity varies depending on factors such as the susceptibility of the herd, carrier animals, and the persistence of infection within the environment. The challenge is intensified by the absence of an effective vaccine and the complexity of current diagnostic procedures. Control is further hampered because commonly used anticoccidial drugs offer little to no effectiveness against *Cryptosporidium*. Thus, managing the disease likely requires an integrated approach combining suitable diagnostic methods with strict sanitation

and management strategies. The lack of a reliable drug or vaccine remains a major barrier to achieving effective control.

Etiology

Cryptosporidiosis in goats is caused by protozoan parasites of the genus *Cryptosporidium*, belonging to the phylum **Apicomplexa.** These parasites infect the epithelial cells lining the gastrointestinal tract. Several species of *Cryptosporidium* infect goats, but the most important are:

- ***Cryptosporidium parvum***
  - Most pathogenic and **zoonotic**
  - Primarily responsible for neonatal diarrhoea in goat kids
- ***C. xiaoi***
  - Common in small ruminants, often associated with subclinical infections
- ***C. ubiquitum***
  - Broad host range, can infect livestock and humans

Characteristics of the Parasite

- Produces **oocysts** that are immediately infective upon excretion.
- Oocysts are **highly resistant** to environmental conditions and many disinfectants.
- Parasite completes its life cycle **within the host's intestinal epithelial cells**, causing enteric damage and diarrhoea

Source and Transmission

- Primarily transmitted through the **fecal–oral route:**
  - Contaminated feed, water, bedding, or milk
  - Contact with infected animals or their feces
- **Neonatal kids** are most susceptible due to:
  - Immature immune system
  - Lack of effective passive immunity (colostrum does not provide complete protection)

Clinical signs:

Cryptosporidiosis mainly affects **neonatal goat kids (1–4 weeks old).** Clinical signs arise due to intestinal damage, malabsorption, and dehydration. **Major Clinical Signs includes:**

- **Profuse watery to yellowish diarrhoea**
  - Most characteristic sign
  - Often persistent and unresponsive to routine antidiarrhoeal drugs
- **Dehydration**
  - Sunken eyes
  - Loss of skin elasticity
  - Cold extremities in severe cases
- **Weakness and depression**
  - Kids appear dull, lethargic, less active
- **Reduced appetite (anorexia)**
  - Gradual or sudden refusal to suckle
- **Weight loss / poor growth rate**
  - Due to malabsorption and nutrient loss
- **Rough hair coat and poor body condition**
  - Seen in prolonged cases
- **Electrolyte imbalance**
  - Can lead to weakness, recumbency, or collapse

Diagnosis

There are no special techniques for diagnosis of cryptosporidiosis in goats; the diagnostic procedures for bovine or human cryptosporidiosis are applicable for the detection of *Cryptosporidium* spp in goats. Diagnostic method includes:

1. Fecal Examination: **Microscopic methods for the detection oocyst in fecec includes -**

- **Modified Ziehl–Neelsen (mZN) staining**
  - Oocysts appear **acid-fast, pink to red**
  - Common, low-cost method
- **Kinyoun acid-fast stain**

- **Negative staining techniques**
    - e.g., using malachite green, nigrosin, or carbol fuchsin
- **Sheather's sugar flotation**
    - Concentrates oocysts for better detection

*2. **Antigen Detection Test:*** **This is** more sensitive than microscopy. It includes **ELISA (Enzyme-Linked Immunosorbent Assay), Immunochromatographic rapid tests** and **Immunofluorescence assay (IFA)** and is considered one of the **most sensitive and specific** tests.

3**. **Molecular Methods: It include **PCR (Polymerase Chain Reaction)** *which is* highly sensitive *and* allows **species identification** (e.g., *C. parvum*, *C. xiaoi*)

Treatment

Supportive management mainly consists of fluid therapy to correct dehydration, nutritional supplementation and the use of anti-diarrhoeal agents. Although no definitive treatment is available for cryptosporidiosis in goats, several compounds have been evaluated for their potential anticryptosporidial effects. These include decoquinate, nitazoxanide, tilmicosin, halofuginone lactate and paromomycin sulphate.

Prevention and control:

Cryptosporidiosis can be effectively prevented through strict **biosecurity measures.** Limiting access of visitors, using footbaths, maintaining clean and dry housing, and isolating sick animals all help reduce the spread of the parasite. Providing uncontaminated feed and water, ensuring proper colostrum intake in newborn kids, and practicing good personal hygiene further minimize the risk of infection. Since the parasite is highly resistant in the environment and there is no effective vaccine, these preventive measures are essential to protect both animal and human health.

Conclusion

Cryptosporidiosis is a significant enteric disease in goats, primarily affecting neonatal kids and causing severe diarrhoea, dehydration, and high mortality. The disease not only results in economic losses due to reduced growth and productivity

but also poses a **zoonotic risk,** particularly from *Cryptosporidium parvum*. There is currently **no specific treatment or vaccine,** making supportive care, good hygiene, and proper management practices essential for control. Early detection, isolation of affected animals, and maintaining clean, dry housing are key strategies to reduce transmission. An **integrated approach combining sanitation, nutrition, and careful farm management** remains the most effective method to prevent outbreaks and ensure healthy, productive herds.

Nutritional Deficiency Diseases and Metabolic Disorders in Goats and their Management

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Nutrition plays a central role in the health, production, reproduction, and immunity of goats. Deficiencies of essential nutrients or imbalances in energy metabolism can lead to a variety of clinical disorders, affecting growth, fertility, milk yield, survivability of kids, and overall herd productivity.

Common Nutritional Deficiency Diseases

Nutrition is a critical factor influencing growth, reproduction, milk production, immunity, and general health in goats. Inadequate intake or imbalance of essential minerals and vitamins leads to several deficiency diseases that significantly impair productivity.

Copper Deficiency

Copper deficiency occurs in regions with low copper content in soil or where antagonists such as molybdenum, sulfur, and iron interfere with copper absorption. Feeding sheep mineral mixtures (low in copper) to goats also contributes deficiency.

Clinical Signs: Depigmented rough hair coat, Poor growth and Anemia.
Hindlimb weakness and incoordination in kids.

Management: Oral copper sulfate supplementation, Injectable copper and feeding of goat-specific mineral mixtures (20–40 ppm Cu). Avoid feeds high in molybdenum and sulphur.

Cobalt and Vitamin B12 Deficiency

Cobalt is necessary for rumen microbes to synthesize Vitamin B12. Deficient soils lead to inadequate intake.

Clinical Signs: Poor appetite, emaciation ,anemia and rough hair coat
Management: Vitamin B12 injections for rapid correction. Long-term prevention through feeding of cobalt-containing mineral mixtures.

Selenium and Vitamin E Deficiency (White Muscle Disease)

Common in goats grazing in selenium-deficient areas or consuming stored fodder low in Vitamin E.
Clinical Signs: Stiffness and muscle pain. Lameness and difficulty in standing. Weakness in newborn kids and sudden death due to cardiac muscle degeneration.
Management: Inj. of Selenium + Vitamin E preparations (e.g. Repronol). Supplement mineral mixtures containing 0.2–0.3 ppm selenium and provide Vitamin E-rich feeds (green fodder) to pregnant does.

Iodine Deficiency (Goiter)

Occurs in areas with iodine-deficient soils or when diets lack iodized salt.
Clinical Signs: Goiter (thyroid enlargement), especially in newborn kids. Weak or stillborn kids.
Management: Supplement iodized salt or iodine-containing mineral blocks to correct dietary deficiencies in pregnant does.

Calcium and Phosphorus Deficiency

Imbalanced rations, poor-quality roughage, and high cereal feeding leads to inadequate Ca:P ratios.
Clinical Signs: Rickets in kids (bent legs or swollen joints). Osteomalacia (soft bones) in adults. Reduced milk production, poor growth and reproductive inefficiency.
Management: Maintain dietary Ca:P ratio at approximately 2:1, supplement legume fodder (rich in calcium), provide mineral mixtures regularly and Limit excessive grain feeding.

Vitamin A Deficiency

Occurs when goats consume dry, poor-quality fodder lacking carotene.

Clinical Signs: Night blindness, dry skin, rough coat, keratinization of mucous membranes and reproductive failure.

Management: Provide green fodder rich in carotene. Vitamin A injections in deficient herds.

Vitamin D Deficiency

Caused due to limited sunlight exposure or diets low in Vitamin D.

Clinical Signs: Rickets in kids. Bone deformities, lameness and reduced growth rate.

Management: Allow adequate sunlight exposure, vitamin D supplementation and balanced Ca and P supplementation.

Magnesium Deficiency (Grass Tetany)

Mostly occurs in goats grazing on lush, fast-growing pastures (low in magnesium).

Clinical Signs: Nervousness, hyperexcitability, muscle tremors, convulsions and sudden death

Management: Immediate IV magnesium sulfate in emergencies. Avoid lush pastures.

Common Metabolic Disorders

Metabolic disorders in goats arise when there is an imbalance between nutrient intake, energy demand, and physiological requirements. These disorders commonly occur during critical stages such as late pregnancy, early lactation, rapid dietary changes, or when feeding practices do not match the animal's metabolic needs.

Pregnancy Toxemia (Ketosis)

Pregnancy toxemia occurs in the last 4–6 weeks of gestation, especially in

does carrying twins or triplets. It results from negative energy balance when dietary energy fails to meet the high fetal demand.

Clinical Signs: Loss of appetite, depression, dullness, sweet acetone odor on breath, weakness, incoordination ,recumbency and coma in severe cases.

Management: Oral propylene glycol (30–60 mL twice daily). IV 5–10% glucose infusion. Electrolyte therapy and preventive management by supplying energy-dense feed to pregnant does.

Milk Fever (Hypocalcemia)

Common around kidding due to sudden calcium demand for colostrum and milk production. Imbalanced Ca:P ratio and low dietary calcium predispose goats to milk fever.

Clinical Signs: Muscle tremors, stiff gait, weakness,cold extremities, recumbency and inability to rise. Rapid progression to coma if untreated.

Management: Slow IV administration of calcium borogluconate. Oral calcium gels after stabilization. Prevention includes adequate mineral supplementation and avoiding high-calcium diets prepartum.

Ruminal Acidosis

Occurs due to sudden ingestion of large quantities of grain or high-carbohydrate feed, leading to rapid fermentation and lactic acid buildup in the rumen.

Clinical Signs: Diarrhea, dehydration, bloat , ataxia and reduced rumen motility.

Management: Immediate withdrawal of grain and give oral antacids (Magnesium oxide). Intravenous fluids with bicarbonate and rumen transfaunation to restore rumen flora.

Urolithiasis (Urinary Calculi)

Formation of urinary stones due to mineral imbalance, especially Ca:P ratio, low water intake, and heavy concentrate feeding. Most common in male goats.

Clinical Signs: Straining to urinate, dribbling or absence of urine, restlessness and discomfort. Bladder rupture in severe cases, leading to fatal uroperitoneum.
Management: Surgical intervention (tube cystotomy) for obstructed cases Ammonium chloride to acidify urine and dissolve small stones. Prevention includes maintaining Ca:P ratio at 2:1, adding ammonium chloride (0.5–1%) to feed, and encouraging water intake.

Fatty Liver Syndrome

Occurs in obese pregnant or early lactating does due to excessive mobilization of body fat when dietary energy is insufficient.
Clinical Signs: Poor appetite, depression, weakness, ketosis-like symptoms and low milk production
Management: IV glucose administration, propylene glycol orally and improving nutritional plane with high-quality feed. Prevent obesity in breeding animals.

Bloat

Accumulation of gas in the rumen due to rapid fermentation, especially when goats graze legume-rich pastures or consume finely ground feed.
Clinical Signs: Left abdominal distension, dyspnoea, restlessness and sudden death in acute cases.
Management: Anti-foaming agents (mineral oil etc.), passing a stomach tube and trocarization in life-threatening cases. Prevention through controlled grazing and avoiding sudden dietary changes.

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पटना–800014, बिहार

नामांकन नोटिस

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:–

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बी.एस.सी. (पोल्ट्री प्रोडक्शन)	3 वर्ष (6 सेमेस्टर)

पैरा वेटरनरी साइंसेज

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

पोस्ट ग्रेजुएट डिप्लोमा

ऑनलाईन – वेटरनरी होम्योपैथी, एथ्नोवेटरनरी मेडिसिन, वन हेल्थ, ऑफलाईन – बोवाइन क्लिनिकल प्रैक्टिस, कैनाइन एंड फेलाइन क्लिनिकल प्रैक्टिस ।
एडवांस ट्रेनिंग कोर्स ऑन इम्पोर्टेंट वेटरनरी क्लिनिकल प्रोसीजर अवधि: 3 सप्ताह, प्रवेश क्षमता: 6

सर्टिफिकेट कोर्स

वेटरनरी फॉरेंसिक साइंस, सीमन हैंडलिंग एवं आर्टिफिशियल इन्सेमिनेशन, मॉलिक्यूलर डायग्नोसिस ऑफ इन्फेक्शस डिजीजेस, वेटरनरी 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)

प्रवेश क्षमता, अवधि एवं सभी कोर्स की विस्तृत जानकारी हेतु विश्वविद्यालय की वेबसाइट **www. basu.org.in** पर अपलोड किए गए विवरण पुस्तिका को देखें।

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