



Precision Feeding Strategies for Sheep and Goats under Climate Change Conditions

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INTRODUCTION

Sheep and goats are vital to the livelihoods of millions of people worldwide, particularly in arid, semi-arid, and mountainous regions. They provide meat, milk, fiber, skin, and manure while serving as a financial safety net for smallholder farmers. Despite their adaptability to harsh environments, small ruminants face increasing threats from climate change. Rising global temperatures, irregular precipitation, and frequent droughts are altering forage availability and quality, exacerbating the nutritional challenges faced by these animals. Traditional feeding practices—often based on extensive grazing without consideration of individual nutritional needs—are becoming inadequate under changing climatic conditions. Feed scarcity, reduced nutrient density of forages, and heightened heat stress demand innovative solutions. Precision feeding has emerged as a promising approach to optimize nutrient utilization, reduce environmental impact, and enhance resilience of sheep and goat production systems. This article provides a comprehensive review of precision feeding strategies for sheep and goats under climate change conditions. It emphasizes how targeted nutrition, supported by technology and sustainable feed resources, can ensure productivity, animal welfare, and ecological sustainability.

2. Climate Change and Its Implications for Small Ruminant Nutrition

2.1 Temperature Rise and Heat Stress

Rising global temperatures increase heat stress in sheep and goats, reducing voluntary feed intake and altering metabolic functions. Heat-stressed animals require more energy for thermoregulation, which lowers nutrient availability for growth, lactation, and reproduction.

2.2 Altered Forage Quantity and Quality

Changes in rainfall and drought cycles reduce pasture growth, leading to seasonal scarcity. Elevated atmospheric CO₂ can increase plant biomass but lower crude protein and mineral content, thereby decreasing nutritive value.

2.3 Water Scarcity

Climate variability affects water availability, which is critical for feed digestion, nutrient absorption, and thermoregulation in small ruminants.

2.4 Greenhouse Gas (GHG) Emissions

Enteric methane emissions from small ruminants contribute to climate change. Inefficient feeding systems amplify these emissions due to incomplete digestion of low-quality forages.



Fig:1 Climate Change and Its Implications for Small Ruminant Nutrition

3. Precision Feeding: Concept and Relevance

Precision feeding is defined as supplying nutrients in amounts that closely match the requirements of individual animals or homogenous groups, minimizing both deficiencies and excesses. Unlike conventional methods, precision feeding accounts for:

- **Individual animal variation** (age, breed, weight, physiological stage).
- **Seasonal changes** in forage availability.
- **Real-time monitoring** of nutrient intake and animal performance.

In the context of climate change, precision feeding enhances resilience by:

- Optimizing feed efficiency under limited resources.
- Reducing methane and nitrogen excretion.
- Improving productivity and animal health despite climatic stressors.

4. Precision Feeding Strategies for Sheep and Goats

4.1 Nutrient Requirement-Based Feeding

- Adoption of updated feeding standards (NRC, ICAR, AFRC).

- Individualized rations using body weight, growth stage, lactation status, and reproductive needs.
- Group feeding based on production stage to minimize over- or underfeeding.

4.2 Alternative and Climate-Resilient Feed Resources

- **Drought-tolerant forages** (e.g., *Cenchrus ciliaris*, Napier hybrids).
- **Tree fodders and browse species** (*Leucaena*, *Prosopis*, *Acacia*).
- **Agro-industrial by-products** (molasses, oilseed cakes, fruit pomace).
- **Insect protein and algae** as novel feed ingredients.

4.3 Feed Additives and Supplements

- **Probiotics and prebiotics** to enhance rumen microbial activity.
- **Enzymes** (cellulase, xylanase) to improve fiber digestibility.
- **Tannins and saponins** from plants to mitigate methane emissions.
- **Electrolyte supplements** to reduce heat stress effects.

4.4 Phase Feeding and Dynamic Ration Adjustment

- Adjusting rations across life stages: pre-weaning, post-weaning, growth, reproduction, and lactation.
- Seasonal ration adjustments based on forage quality and availability.

4.5 Precision Grazing and Pasture Management

- Rotational grazing with controlled stocking rates.
- Use of satellite and drone-based monitoring for pasture biomass estimation.

- Integration of legumes into grazing systems for improved forage protein.

4.6 Technological Innovations in Precision Feeding

- **RFID-based automatic feeders** to monitor individual feed intake.
- **Wearable sensors** to track rumination, activity, and body temperature.
- **IoT-enabled systems** for real-time ration balancing.
- **Machine learning models** predicting nutrient requirements under varying climatic conditions.



Fig:2-Modern farm setting with automated feeders, feed bins or RFID-tag systems that measure intake.

5. Case Studies and Research Highlights

- **India:** Incorporation of tree leaves and crop residues in goat diets improved growth by 12% under semi-arid conditions.
- **Australia:** Use of RFID-enabled feeders in sheep flocks enhanced feed efficiency by 8% and reduced methane emissions by 10%.
- **Africa:** Drought-tolerant browse plants integrated into goat feeding systems ensured year-round nutrient supply.
- **Europe:** Precision grazing systems using satellite monitoring optimized forage use and reduced feed costs.

6. Benefits of Precision Feeding under Climate Change

6.1 Productivity Benefits

- Improved weight gain, milk yield, and reproductive efficiency.
- Better immune competence and reduced disease susceptibility.

6.2 Economic Benefits

- Reduced feed costs by minimizing wastage.
- Enhanced profitability through efficient resource use.

6.3 Environmental Benefits

- Lower methane and nitrogen emissions.
- Reduced ecological footprint of sheep and goat production.

6.4 Welfare Benefits

- Reduced heat stress effects through tailored rations.
- Enhanced overall well-being of animals.



Fig:3-Modern uplift Housing system

7. Challenges and Limitations

- Limited availability of precision technologies in smallholder systems.
- High initial investment for automated feeders and IoT devices.
- Lack of farmer training and awareness.
- Need for region-specific feeding standards under climate variability.

8. Future Perspectives

The integration of big data, artificial intelligence, and precision livestock farming tools will revolutionize sheep and goat nutrition. Predictive models using climate data will allow dynamic ration formulation to match future forage scenarios. Public-private

partnerships and policy support are essential to make precision feeding technologies affordable and accessible to smallholders.

CONCLUSION

Precision feeding offers a climate-resilient strategy for sustainable sheep and goat production. By tailoring nutrient supply to individual needs, utilizing alternative feed resources, and leveraging technology, precision feeding improves productivity, reduces environmental impact, and enhances animal welfare. In the face of climate change, widespread adoption of these practices is crucial to ensuring the sustainability of small ruminant farming.