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Sustainable breeding approaches for genetic improvement of Indian Buffalo populations

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Abstract

Buffaloes significantly contribute to India's livestock and economy, producing 53% of the country's milk. Buffaloes struggle with reproductive efficiency, marked by delayed maturity, prolonged postpartum recovery, poor oestrus expression, low conception rates and extended calving intervals. The primary objective of buffalo breeding is to produce more offspring, healthier young ones with reduced mortality and superior quality progeny. To achieve this, breeders require effective reproductive tools, strategies to overcome reproductive challenges and remedies to enhance fertility and efficiency. Key strategies to overcome reproductive challenges are strengthening the extension services and training, upgrading the reproductive health services, and providing accessible, high-quality germplasm and AI services. Modern animal breeding and reproduction technologies will be employed to enhance the genetic potential of buffaloes. Assisted reproductive technologies revolutionize buffalo genetics and breeding. Genomic selection is the preferred method for buffalo breeding, providing increased selection accuracy, shortened generation intervals, predictable breeding values and rapid genetic improvement.

Introduction

The domestic water buffalo, Bubalus bubalis, is a large bovid native to the Indian subcontinent and Southeast Asia. There are two main types: the swamp buffalo, common in Southeast Asia, and the river buffalo, found in India, which is prized for its milk production. With a global population of 208 million across 77 countries, India has the largest share, accounting for 109.85 million buffaloes. Buffaloes contribute significantly to India's livestock and economy, providing 53% of the country's milk production, which totals 230.58 million tonnes annually. Buffalo milk is rich in butterfat, containing 7.5-9% fat compared to cow milk's 3-5%. India is the world's largest milk producer, accounting for 24% of global production. India boasts 20 recognized buffalo breeds namely Bhadawari (Uttar Pradesh and Madhya Pradesh), Jaffarabadi (Gujarat), Marathwadi (Maharashtra), Mehsana (Gujarat), Murrah (Haryana), Nagpuri (Maharashtra), Nili Ravi (Punjab), Pandharpuri (Maharashtra), Surti (Gujarat), Toda (Tamil Nadu), Banni (Gujarat), Chilika (Orissa), Kalahandi (Odisha), Luit (Swamp, Assam, and Manipur), Bargur (Tamil Nadu), Chhattisgarhi (Chhattisgarh), Gojri (Punjab and Himachal Pradesh), Dharwadi (Karnataka), Manda (Odisha), and Purnathadi

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(Maharashtra). Buffaloes offer several advantages over crossbred cows, including adaptability, disease resistance, and efficient feed conversion. They are a vital source of milk, meat, and draught power.

Breeding Management of Buffaloes

Contrary to their reputation as seasonal breeders, buffaloes can breed year-round due to their polyoestral nature. However, environmental stress susceptibility poses significant breeding challenges, leading to anoestrus, sub-oestrus, and prolonged inter-calving periods, resulting in substantial economic losses for the dairy industry. Buffalo bulls mature sexually between 2-3 years, producing semen year-round, but quality is compromised by heat stress and poor nutrition. Spring is the peak fertility season, with optimal sperm vitality, volume, and concentration. Heat stress can reduce libido. Female buffaloes mature at 2-3 years, with puberty influenced by management factors, particularly weight (325 kg for Murrah heifers at insemination and 450-500 kg at first calving). The buffalo reproductive cycle lasts 21-29 days, depending on breed. Oestrus duration is typically 24 hours (range: 12-72 hours). Reliable signs include frequent urination, restlessness, and slight decreases in milk yield. However, oestrus signs are subtle, often only visible at night, making detection challenging. The reproductive parameters are as follows.

1. Age at puberty: 36 to 42 months
2. Length of oestrus cycle: 21 days
3. Duration of heat: 12 to 24 hours
4. Time of ovulation: 10 to 14 hours after the end of oestrus
5. Period of maximum fertility: last 8 hours of oestrus
6. Gestation period: 310 days
7. Period of involution of the uterus: 25 to 35 days

Buffalo breeding efficiency challenges

1. Unpredictable post-partum heat onset.
2. Reduced ovarian primordial cells at birth.
3. Increased follicle atresia.
4. Silent and short estrus, exacerbated by thermal stress.
5. Post-partum anestrus, a major contributor to buffalo infertility.

Factors Contributing to Low Breeding Performance in Buffaloes

1. Climate sensitivity, with optimal conception during cooler months (July-February in India).
2. Poor thermal tolerance due to inadequate thermoregulation.
3. Nutritional deficiencies, affecting fertility and reproductive health.
4. Unhygienic conditions and natural behaviours leading to uterine issues (endometritis, prolapse, retention of afterbirth).

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Enhancing Buffalo Breeding Efficiency: Strategic Approaches

To optimize breeding performance:

1. Provide suitable housing for buffaloes.
2. Offer cooling measures (showers/wallowing tanks) during heat peaks.
3. Ensure balanced nutrition with mineral supplements and quality feed.
4. Conduct regular reproductive disease testing.
5. Utilize estrus detection tools (wall charts, herd monitors, individual records).
6. Prioritize regular conception and short calving intervals (less than 410 days) for maximum lifetime milk production.

Buffalo Breeding Strategies for Enhanced Productivity

1. Selective Breeding

Selective breeding is followed for well-defined indigenous breeds Selective breeding is followed for well-defined indigenous breeds in their respective breeding tract for improvement of milk through associated herd progeny testing programme. By selective breeding it is expected that genetic improvement will be 1 to 1.5 % per annum in organised herds and 10 to 20 % per annum in farmer's herds. Selective breeding of indigenous breeds will be promoted to improve their production and reproduction potential. This will help their proliferation, conservation, and genetic upgradation.

2. Grading Up

For improving non-descript buffaloes grading-up with recognized breeds viz., Murrah, Surti is recommended. This rapid improvement approach boosts milk production 2-3 times in early generations, increases average yield from 500 kg to 1250 kg in the first generation and replaces low-producing buffaloes with high-producing ones in 5-6 generations.

Buffalo Breeding Methods

1. Natural Mating

Natural mating is the primary breeding method for most buffaloes worldwide. However, village-level breeding often lacks critical information on bull and dam quality, leading to diverse productivity and reproductive traits. Key considerations are one bull per 30 females, disease prevention measures, bull teasing for oestrus detection, breeding bull replacement after 5 years and managed service schedule: 20-25 females per bull, 2 services/week

2. Artificial Insemination

Artificial Insemination (AI) drives genetic improvement in dairy animals, boosting productivity. AI enables faster transmission of superior genes, reduced generational intervals, and enhanced reproductive efficiency. However, buffaloes face AI conception challenges, addressed through oestrus synchronization and fixed-time AI.

Conclusion

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The primary objective of buffalo breeding is to produce more offspring, healthier young ones with reduced mortality and superior quality progeny. To achieve this, breeders require effective reproductive tools, strategies to overcome reproductive challenges and remedies to enhance fertility and efficiency. Key strategies to overcome reproductive challenges are strengthening the extension services and training, upgrading the reproductive health services, and providing accessible, high-quality germplasm and AI services. Modern animal breeding and reproduction technologies will be employed to enhance the genetic potential of buffaloes. Assisted reproductive technologies revolutionize buffalo genetics and reproduction, boosting meat and milk production through estrus synchronization for timed AI, multiple ovulation and embryo transfer, *in vitro* embryo production, sexed frozen semen and advanced cryopreservation and nuclear transfer techniques. Genomic selection is the preferred method for buffalo breeding, providing increased selection accuracy, shortened generation intervals, predictable breeding values and rapid genetic improvement.

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