International Journal of Livestock Research, Vol. 11 (12) Dec' 2021
http://www.ijlr.org
eISSN: 2277-1964

Review Article

# Factors Affecting Age at First Conception and Calving in Buffalo

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**How to cite this paper:** Bashyal, S., Bhattarai, N., & Poudel, D. (2021). Factors Affecting Age at First Conception and Calving in Buffaloes. *International Journal of Livestock Research,* 11(12), 8-17. https://dx.doi.org/10.5455/ijlr.20201020030555

**Received** : Oct 20, 2020
**Accepted** : Dec 27, 2020
**Published** : Dec 31, 2021



## Abstract

*It is necessary to understand the reproductive physiology of buffalo, its relationship with productive performance and factors affecting its behavior. Age at first conception and calving has been found to differ among several breeds with different morphological and reproductive performance. These parameters differ with regards to various physiological factors like age and weight at maturity; fertility issues like delayed attainment of puberty and silent heats; and nutritional factors like short term and long-term dietary supplement. Environmental conditions and management practices have shown variability in reproductive performance of indigenous as well as crossbred buffaloes. It is important to define the normal fertility indices specific to environmental and management status of our country and identify the major factors affecting reproductive and productive performance of livestock including buffaloes.*

**Keywords:** Age at First Calving, Breed, Breeding Season, Conception, Estrus, Heifer, Puberty

## Introduction

Buffalo is one of the major livestock species reared in Nepal for multiple purposes such as meat, milk and draft. There are 5,308,664 heads of buffaloes in Nepal contributing about 65 percent to the total milk and about 50 percent to the total meat production in the country (MOALD, 2019). Indigenous breeds of Nepal are riverine type with 25 pairs of chromosomes, which include Lime, Parkote, Gaddi, Terai local (not included in breeds list of FAO) while 2 pure Murrah breeds are domesticated and crossed with local breeds (FAO). Major problems in terms of buffalo husbandry and production are lack of policies and their implementation, insufficient extension activities, unplanned breeding and subsequent decline in the availability of pure native breeds with unique characteristics.

It is necessary to understand the reproductive physiology of buffalo, its relationship with productive performance and the factors affecting its behavior. Among the different steps of puberty phenomenon viz. sexual desire, ovulation, estrus, conception, pregnancy and lactation, conception is the first pre-requisite of an animal entering into the productive life. Calving is followed by pregnancy, after certain gestation period. Average age at first estrus for river type buffaloes and swamp type buffaloes were recorded to be 15 to 18 months and 21 to 24 months respectively while first conception usually occurs at the age of 24 to 36 months depending upon various factors (Jainudeen & Hafez, 1993). Maturity in buffaloes is affected by different environmental factors and seasonal breeding patterns. Reproductive efficiency in buffaloes is affected by various factors like delayed attainment of puberty, seasonal variation, poor estrus expression and long post-partum anestrus. Production in domestic animals increases either with the improvement in management techniques or with genetic selection of production-based morphological and reproductive traits.

## Materials and Methods

The methodology used in preparing this article were the collection of information from different searching sites like google, google scholar, academia, springer etc., research articles published in various national journals published by Nepal Agricultural Research Council (NARC), Agriculture and Forestry University (AFU), Himalayan College of Agricultural Sciences and Technology (HICAST); international journals, and proceedings of International Buffalo Symposium 2017 and different international congress and conferences. Major focus has been given to Nepalese articles and information on Nepalese indigenous breeds.

## Results and Discussion

### Genetic Factors

#### *Breed*

According to FAO, different research scientists have found differences in age of puberty and age at first conception in breeds like Egyptian, Italian, Murrah, Surti, Nili-ravi from across the world (Barile, 2007). Age at first service and age at first calving of two indigenous breeds of Nepal, Lime and parkote, were observed to be 2.9±0.63 years and 3.88±0.64 years respectively (Shrestha, Shah, Acharya, & Dhungana, 2012). Similar results were obtained in different indigenous breeds of Nepal, Terail Local, Mid-hill Local, Parkote, Lime and Arna, noted to be 45, 46, 46, 47 and 50 months respectively (Mandal, Jha, & Pariyar, 2009). Age at first calving of 20 adult buffaloes in Eastern regions of Nepal was recorded as 3.75±0.14 years according to a field study conducted at Kosaha-2, Shreepur-7 and laukahi-5 of Sunsari district (Sapkota, *et al.*, 2017). In an average, age at first calving of indigenous breeds was found to be 50.5 months with low milk yield, yet fairly comparable with Murrah blood levels (Rasali, 1998). Native Parkote breeds of buffalo in Dolakha district were of similar size with Lime and Terai buffalo, with age at first calving of 61 months (Shrestha & Neupane, 2000). Gaddi buffaloes are considered better in terms of morphological growth and production performance in comparison to other indigenous breeds of buffaloes (Shrestha N. P., Neupane, Kunwar, & Pokhrel, 1998).

Age at first calving of Gaddi buffaloes in Far-Western regions of Nepal was 55.5±1.3 months while the average body length, height at wither, height at hip bone, height at barrel and heart girth were recorded as 118.9±1.61, 129.4±2.08, 119.6±0.933, 48.9±0.604 and 194.9±1.64 cm respectively; which are greater in comparison to other indigenous breeds (Mishra, Neupane, & Kadel, 2002). Age at first calving of local breeds of Bajura district in Nepal was significantly higher than crossbred Murrah buffaloes. Local breeds were also found to have significant

differences in calving interval, lactation yield and milk yield at different parity compared to crossbred Murrah buffaloes (table 1) which were heavier, longer and with greater heart girth, loin girth, barrel height from ground, fore-feet above and below knee and rear feet above and below hock (Shrestha & Shrestha, 1997).

**Table 1:** Age at first calving and morphological characteristics of different breeds of buffaloes

| S. No. | Breed | Age at First Calving (Months) | References |
|---|---|---|---|
| 1 | Lime | 46 | (Shrestha *et al.*, 2003) |
| 2 | Parkote | 61 | (Shrestha *et al.*, 2003) |
| 3 | Gaddi | 55.5 | (Mishra, Neupane, & Kadel, 2002) |
| 4 | Murrah crossbred | 50 | (Shrestha & Neupane, 2000) |

Indigenous breeds of Nepal have poor fertility status compared to exotic cosss buffaloes which is depicted in Table 2. Based on the research conducted by National Buffalo Research Program, Nepal, the average performance of Murrah buffaloes recorded in 2015 were: lactation yields (1229.7±380.7 kg), calving interval (387.6 ± 31.5 days), calving to conception (49.4±14.0 days) and dry days (65.3±12.7 days) (Ali, Shah, & Kushwaha, 2017). However, Adhikari, Gautam, Barshila, & Devkota (2017) did not find any significant differences in age at first conception, calving to first estrus interval, lactation length and number of breedings per conception among local and crossbred Murrah buffaloes in Chitwan and Kaski district of Nepal (Table 3).

**Table 2:** Comparison of reproductive performance of indigenous and exotic cross breeds in western hills of Nepal.

| S. No. | Reproductive Performance (Months) | Indigenous Breeds | Exotic Cross Breeds |
|---|---|---|---|
| 1 | Age at first mating | 46 | 44.6 |
| 2 | Age at first calving | 55 | 56.4 |
| 3 | Calving interval | 17 | 17.7 |
| 4 | Calving to conception period | 6.4 | 6.5 |

*Source: (Joshi, Joshi, & Shrestha, 2001)*

**Table 3:** Comparison of reproductive performance of indigenous and exotic cross breeds in Chitwan and Kaski district of Nepal.

| S. No. | Reproductive Performance (Months) | Indigenous Breeds | Exotic Cross Breeds |
|---|---|---|---|
| 1 | Age at first conception (years) | 2.83±0.58 | 2.93±0.71 |
| 2 | Calving to first estrous interval (month) | 3.15±2.33 | 3.48±3.60 |
| 3 | Calving interval (month) | 14.75±3.57 | 14±3.44 |
| 4 | Number of breeding per conception | 1.41±0.66 | 1.24±0.51 |

*Source: (Adhikari, Gautam, Barshila, & Devkota, 2017)*

***Heredity***

The average age at first calving of crossbred buffaloes from Brazil was 36.7 months with high heritability coefficient (0.42); selection in this trait can be very helpful in improving reproductive performance of buffaloes (Malhado, Ramos, Carneiro, & Carrillo, 2013). Contrasting results as low estimates of heritability of age at first calving and calving interval obtained by (Seno, *et al.*, 2010) indicate that these traits should not have a good response for selection. Moderate heritability and positive correlation of age at first service and first calving suggest that one trait can be improved by selecting the other trait (Shah, Bhattarai, Yadav, & Sharma, 2017).

**Physiological Factors**

### *Age at Maturity*

On an analysis of genetic and phenotypic correlation for some sexual maturity traits of Nili-ravi buffalo, it was found that age and weight at maturity has positive and significant relationship with age and weight at first conception (Naaz & Ahmad, 2006). Similar results were obtained in a 9-year analysis on Murrah buffaloes in Haryana, India (V, Prasad, Kumaresan, & Manimaran, 2017) showing that age at maturity is a good indicator for age at first conception and calving.

### *Fertility Issues*

Age at first calving can be used as an indicator of fertility and productivity in buffaloes. Delayed attainment of puberty and poor estrus detection mainly affect the reproductive efficiency of buffaloes. Among the anestrus buffaloes in hills and terai regions of mid Nepal, 45.2% were in silent estrus which can be treated with GnRH analogue or cloprostenol based on the major structure (Gautam, Gyawali, Nath, & Pant, 2017). Single injection of L. Tyrosine (100 mg/kg body weight) in buffalo heifers aged 30-36 months induced heat within 3-4 days (E. EL. Amrawi, Hussein, El. Bawab, & Zakaria, 1997). With the application of Ovulation Synchronization (Ovsynch) protocol, conception rate of buffalo heifers was found higher compared to buffalo cows which might be due to parity effects like earlier ovulation and less functional corpus luteum (Derar, Hussein, Fahmy, El-Sherry, & Megahed, 2012) .

Presence of bulls in the vicinity of buffalo herds or regular exposure to teaser bulls (bull prading) may help in estrus detection. Estrus expression and conception rate were not significantly different in good, transition and poor breeding season after the application of Progestin based hormone protocol (Shah, *et al.*, 2017). PRID (progesterone-releasing intravaginal device) plus PMSG (Pregnant Mare Serum Gonadotrophin) were found effective to induce estrus in non-cycling buffalo heifers by stimulating hormonal changes (Saini, Galhotra, Sangwan, & Razdan, 1988). Progesterone intravaginal pessary (CIDR) with prostaglandin F2α and PMSG was also reported to induce estrus in non-cycling buffalo heifers (Andurkar & Kadu, 1995).

### *Anticipation of Puberty*

Pubertal mating is less certain while there are differences in recurrence pattern of estrus, silent heats, association with the male and the subsequent time elapse and weight gain from first estrus to first conception (Hafez, 1995). Silent heats in buffalo heifers can be detected by the vulval discharge of clear mucus (Singh, Singh, & Sharma, 1984). The success of conception relies partly on the detection of estrus indicators like Leutinizing Hormone and estrus specific chemical compounds like 4-methyl phenol para cresol and 9-octadecenoic acid (Archunan, 2020). Anticipation of puberty can be much helpful to reduce the age at first conception and calving. Identification of puberty according to progesterone value can help in obtaining lower age at puberty (Salama, Mokhless, & Barkawi, 1994). Similarly, it is important to increase the effectiveness of Artificial Insemination by overcoming estrus detection problems. Artificial insemination is limited in buffaloes with difficult estrus detection due to weak estrus symptoms and variable estrus length.

## Environmental Factors

### *Time of Birth*

Winter season born calves reached up to maximum age at maturity, first conception and calving followed by spring and dry summer, and humid summer and autumn born ones while significant difference was found based on year of birth too, which might be attributed to seasonal conditions in different years (Hammad-ur-rahman, *et al.*, 2020). Similar results were obtained on a study on Bulgarian Murrah buffaloes where summer born heifers had most pronounced seasonality of calving, with no effects on age at first calving. Likewise, monsoon calving buffalo reached to estrus and conceived earlier than summer and winter calving Murrah buffaloes in Punjab, India (Abayawansa, Prabhakar, Singh, & Brar, 2011). Earliest age at first calving was found on calves borne on autumn, while highest age at first calving was obtained when spring borne heifers calved in summer (P. PENCHEV, 2014). First born calves suffer more from stress due to growing, producing and insufficient energy available to them so they may take longer period for first conception (Ali, Javed, Ahmad, & U, 2011).

***Season of Breeding***

Though buffaloes are capable of breeding throughout the year, expression of heat is generally more pronounced during winter season. Feed and fodder shortage during dry weather was found to cause seasonal anestrus in buffaloes associated with poor Body Condition Score. Higher incidence of silent heats were observed during low breeding months in Southern Nepal with >70% anestrus from March to June and <50% anestrus in August-December (Devkota, Bohara, & Yamagishi, 2012). Nepalese buffaloes show good, intermittent and poor breeding efficiency in autumn, winter and summer season respectively which are categorized as good breeding season, transition season and low breeding season by (Devkota, 2017). Shah *et al*. (2017) reported high cholesterol level, low cortisol and similar levels of glucose and serum in good breeding season compared to transition and low breeding season.

Mid-hill and lower mountainous regions of Nepal receive environmental fluctuations from cold-dry winter, moderate autumn and hot-dry spring to hot-rainy summer. Reduced feed intake due to stress during extreme hot or cold season reduces the reproductive efficiency by depressing the sexual activity in buffalo heifers. Some factors like elevated prolactin secretion due to temperature stress and reduced feed availability due to changes in rainfall pattern in the tropical region and changes in photoperiod and melatonin secretion in temperate regions may be attributed to seasonal effects on reproductive efficiency (Perera, 2011) which in turn, can increase the age at first conception and calving in buffaloes.

***Location***

Seasonal patterns of reproductive performance in buffaloes depend on favorable environmental conditions that differ also based on the environmental features of their place of origin (Zicarelli, 1997). On a study conducted on Lime and Parkote breeds of buffaloes during October to November 2016, reproductive traits like age at first service, age at first calving, post-partum estrus and calving interval were found significantly different in Faliyagaun of Myagdi and Ramjhathati of Parbat district of Nepal which might be due to altitude as well as the feed and management practices (Bhandari, Bhattarai, Sharma, Kolachhapati, & Sapkota, 2017). Effect of altitude was found to be significant on age at first calving and lactation yield, indicating that reproductive performance of low hills buffaloes is more efficient than high hills (Rasali, 1996). A case study revealed that the age of puberty and first calving were 4.4 and 5.2 years, 4.3 and 5.1 years, 4.2 and 5.4 years and 4.9 and 58 years for Lamjung, Syangja, Bara and Sankhuwasabha districts respectively (Sharma, Kolachhapati, & Kharel, 2001)

***Photoperiod***

Photoperiod, accompanied with melatonin secretion, is more attributable to reproductive seasonality in buffalo, rather than diet, food availability or metabolic status. Melatonin, a hormone secreted by the pineal gland in most ruminant animals during the night, was found in a higher concentration in buffalo heifers compared to cow buffaloes in a study carried out by (Borghese, Baarile, Terzano, Pilla, & Parmeggiani, 1995). Decreasing day length resumes ovarian activity and higher persistence level of melatonin is found at night (Parmeggiani, *et al.,* 1993). The problem of seasonal reproduction, related to photoperiod in buffalo can be overcome by treatment with melatonin implants that improves luteal profile by increasing ovarian activity in heifers (Kavita, *et al.,* 2018) and favors pregnancy during summer (Pandey, *et al.,* 2019).

**Health and Nutritional Factors**

***Nutrition***

Physiological and regulatory mechanisms are affected by nutritional parameters. Reduction in dry matter intake results in negative energy balance and causes many disorders. Shah *et al.* (2017) have found that the conception rate varies significantly in different Body Condition Score groups of buffaloes. High dietary energy level accompanies an increase in daily weight gain and early attainment of puberty compared to those heifers fed with low diet level (Borghese A. , *et al.,* 1994a). Taha (1976) reported that complete suckled heifers reached puberty and conceived earlier compared to half and quarter suckled ones. Vegetable oils like mustard oil, soybean oil, rice bran oil of 3.5% concentrate supplementation reduced the age of puberty and improved ovarian follicular characteristics with positive impacts on conception (Vishnu, Kumar, Tran, Malla, & Tyagi, 2017). On feeding 35% DM from concentrate followed by ad-libitum colostrum feeding for four days, milk feeding for 2 months and 2.5% DM feeding for 3

years, Murrah buffaloes showed increase in body weight and reduced age at first conception and calving (Karki, Mandal, & Prasai, 2017). On a study conducted in Nili-Ravi buffaloes, it was found that concentrate supplementation in nutrient supply only during pre-pubertal stage caused no significant differences in age, weight and condition at puberty, weight at calving, lactation length and yield but better reproductive performance was achieved on feeding concentrate (CP = 17.9%, ME = 2.66 Mcal/kg) at the rate of 0.5% of body weight (Saadullah, et al., 2020). Italian buffalo heifers with high diet levels, according to standard requirement, showed puberty earlier than low diet fed buffaloes (Borghese A. , Terzano, Barile, & Parneaggiani, 1994)

***Disease Incidence***

Kandel, Poudel, & Bhattarai (2017) revealed that problems like repeat breeding, mastitis, internal parasite, ectoparasite, milk fever, metritis, foot and mouth disease etc. have been faced by Nepalese farmers. Serological test of blood samples showed the presence of antibodies against infectious bovine *Rhinotracheitis*, *Neospora* and *Leptospria hardjo* while biochemical test revealed deficiency of copper, selenium, manganese and low blood urea in cattle and buffalo with reproductive problems (Dyson, Sharma, & Pant, 2000). Diseases and clinical problems like dystocia, merititis, brucellosis and Leptospirosis were not found to be significant in infertile animals (Joshi, Joshi, & Shrestha, 2001).

**Management Factors**

***Feeding Practices***

Kaur & Arora (1989) reported that feeding level and energy level of diet has direct effects on growth, sexual development and onset of puberty in Murrah buffaloes. Farm management and good feeding practices improve sexual maturity, promote ovarian cyclic activity at about 20.7 months and increase progesterone level showed to be highest at about 19.1 months and 359 kg of body weight in Italian buffalo heifers (Borghese A. , *et al.*, 1994a). Bhatti *et al.* (2007) have reviewed that the age at maturity can be reduced in buffaloes and cows with better feeding and management for accelerated growth rate. Short term dietary supplementation at different rates of CP/NSC ratio had no effects on age at conception, daily weight gain and live weight at conception but the Mediterranean buffalo heifers with good management from the time of weaning conceived at younger age and low live weight compared to those with good management only during pre-pubertal period (Campanile, Di Palo, Gasparrini, D'Occhio, & Zicarelli, 2001). Special attention in heifer management should be provided starting from the birth considering the importance in promoting growth and achieving puberty. Supplying good feed, improving management system and spraying water during hot period can decrease the age at first estrus helping to attain puberty earlier (Mohamed, El-Ashry, & El-Searfy, 1980), (Saini, Dhanda, Singh, & Georgie, 1998).

***Management System***

Murrah buffaloes raised in good feeding and management practices in Lahachowk Krishi farm, Kaski of Nepal showed good production performance with average age at first calving of 41 months (Paneru, Awasthi, Subedi, Shah, & Dhungana, 2017). Infertility problems in buffaloes of western hills of Nepal were primarily accounted to repeat breeding, anestrus and silent heats which were found higher in stall fed buffaloes and buffaloes in low hills compared to those in semi-stall-fed management system and in mid hills respectively (Rasali, Joshi, Shrestha, & Gautam, 1998). Reproductive traits of monsoon calver buffaloes in western hills of Nepal like age at first calving, calving to first service period were not found to differ across stall feeding and semi-stall-feeding management system (Rasali, Gurung, & Yadav, 1997). Murrah buffaloes raised under intensive farm management showed low reproductive performance compared to those in Brazil, suggesting need of improvement in age at first calving and calving interval (Chaikun, Hengtrakunsin, & Mitchaothai, 2013). Parent stock of Mehsana Riverine Buffalo, imported from India, raised in an open place with free access to pasture, hay, silage and clean water under tropical conditions of Thailand showed the fertility performance as age at first calving to be 39.57 months *(*Muangproma, *et al.*, 2013).

## Conclusion

From the above findings, it can be concluded that the reproductive performance of buffaloes is influenced by different genetic, seasonal, physiological, nutritional and management factors. Yet, precise information on major

determining factors to affect age at first conception and calving has not been obtained. It is important to define the normal fertility indices specific to environmental and management status of our country and identify the major factors affecting reproductive and productive performance of livestock including buffaloes. This article reviews the effects of different genetic and non-genetic parameters on age at first conception and calving studied by different research scientists. A necessity of better understanding on direct and indirect effects of each factor has been raised as the future prospect.

## Acknowledgement

We express our due acknowledgement towards faculty members of Department of Animal Breeding and Biotechnology, Agriculture and Forestry University for encouragement to prepare the manuscript.

## Conflict of Interests

There is no conflict of interest.

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IJLR remains neutral concerning jurisdictional claims in published institutional affiliation.

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