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**Review Article**

# ASSOCIATION OF NUTRITIONAL STATUS TO REPRODUCTIVE PERFORMANCE IN BUFFALOES

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## ABSTRACT

Buffalo rearing is an integral part of livelihood for rural people in many countries. The buffalo production system, however, in many cases is a subsistence type in nature where nutrition is based on only roughage feed with an occasional concentrate supplement that exacerbates nutritional stress. Nutrition plays a vital role in reproductive performance of animals. In dairy cows, plenty of information is available regarding nutrition-reproduction interactions even though the exact role of nutrition on reproduction is not much clear. In buffaloes, there are increasing reports on the role of several nutritional factors that affect the reproductive efficiency. The feeding of rural buffaloes depends largely upon the seasonal availability of grasses and fodder. This causes fluctuation in their nutritional status which is one of the reasons for having seasonal reproductive pattern in Asian buffaloes. The phenomenon of higher incidence of ovarian inactivity in buffaloes during pre-monsoon fodder-scarce season is associated to poor body condition score, indicating nutritional cause with poor accessibility to the major nutrients. Monitoring nutritional status is much important, and nutritional under-status is related to several reproductive problems including anestrus, and success of its treatment. Moreover, the outcome of the novel hormonal regimens for inducing ovulation in anestrus buffaloes is also affected by their nutritional status. This review paper highlights the associations of nutritional status of buffaloes to their reproductive performance and success of hormonal interventions. Thus, it enhances the understanding of nutrition-reproduction interactions in buffaloes.

**Key words**: Anestrus, buffalo, nutrition, reproduction, season

## INTRODUCTION

Nutrition-reproduction interactions have been extensively studied in the past, and it has been confirmed that nutrition plays a vital role in reproductive performance of animals. Nutrition influences fertility of dairy animals by altering several physiological and regulatory mechanisms (Pradhan and Nakagoshi, 2008). Several nutritional factors such as energy, protein, minerals and vitamins are associated to reproduction in the dairy animals (Butler, 2000). Deficiencies of various trace minerals, inadequate vitamin intakes, energy-protein imbalances and excessive protein intakes are mentioned as contributors to infertility and poor reproductive performance in dairy animals. Protein and energy are the nutrient components needed in the largest quantities, and directly affect body condition scores (BCS) and normal reproductive performance (Pryce et al., 2001). There is a strong link between nutrition and fertility, where nutrient partitioning to the mammary gland in early lactation, when dry matter intake (DMI) is reduced, resulting in negative energy balance (NEB) and many associated disorders (Butler and Smith, 1989; Butler, 2000; Pradhan and Nakagoshi, 2008). In high yielding dairy cows, reduced DMI during early lactation and associated NEB due to very high metabolic load delays postpartum restoration of LH pulsatility, resulting into prolonged postpartum anestrus (Connor et al., 1990; Hegazi et al., 1994). Such information is scarce in case of buffaloes.

Buffaloes are the major source of rural economy in many developing countries across the world. In many Asian countries, buffaloes have major contribution on milk and meat production. However, one of the major problems of buffalo production worldwide is that- they are sluggish breeder, besetting with various constraints which adversely influence its fertility; such as, problems of silent heat coupled with poor expression of estrus, irregular estrus cycles, prolonged days open and low conception rates (Barile, 2005; Madan and Prakash, 2006; El-Wishy, 2007; Sah and Nakao, 2010). Although buffaloes are considered similar to cattle regarding several anatomical and physiological features, buffaloes receive a par below quality nutrition in terms of energy, protein, minerals and vitamins than other dairy and beef animals. One of its possible reasons is that buffalo production system is a subsistence type in most of the countries where they are generally kept only under roughage feed with an occasional concentrate supplement that put them under nutritional

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stress. It is also possible that such under nutrition is associated to the traditionally observed poor fertility in buffaloes. In South Asian region, annual changes in rainfall appear to influence estrus cyclicity of buffaloes, with availability and quality of herbage related to cyclical reproductive pattern (Perera, 2011). However, the information regarding the possible effects of long term marginal deficiencies and the interaction of many nutrients, especially trace minerals, to reproduction needs to be broadened. Similarly, the interactions of nutritional factors to impaired reproductive performance in field situations need concrete understanding. This review paper highlights the associations of nutritional status of buffaloes to their reproductive performance and success of hormonal interventions. Thus, it enhances the understanding of nutrition-reproduction interactions in buffaloes.

## NUTRITION AND ANESTRUS

In dairy animals, nutrition is one of the major causes of anestrus (Kumar et al., 2014) and other reproductive disorders (Pradhan and Nakagoshi, 2008). The process of follicular growth, maturation and ovulation is affected by nutritional status of animals (Diskin et al., 2003). The nutritional status of animals can be subjectively accessed in terms of their BCS. Thus, BCS is the measures of overall nutritional status, and in particular, it indicates the energy dynamics of animals. It is an important factor influencing the reproductive performance (Baruselli et al., 2001). It is well established that reproductive efficiency in dairy cattle is related to BCS. In buffaloes, the phenomenon of higher incidence of ovarian inactivity during summer is associated to poor BCS indicating nutritional cause with poor accessible nutrition in summer (Ali et al., 2009; Devkota et al., 2012).

Nutritional availability and balanced nutrition positively affects the BCS of dairy cows (Maina et al., 2008), whereas the incidence of true anestrus and abnormal ovarian cyclicity in buffaloes is correlated negatively with the BCS (Devkota et al., 2012). In dairy cows, BCS at the calving time indicates the future resumption of postpartum cyclicity (Lalman et al., 1997), and low BCS during early lactation leads to prolonged postpartum anestrus (Dziuk and Bellows, 1983; Robinson, 1990). Therefore, monitoring of BCS that directly reflects the nutritional status is highly important to understand the ovarian activity in animals.

Research carried out in rural buffaloes in Southern part of Nepal using nutritional indices of BCS and some blood metabolic parameters has indicated that buffaloes are under severe nutritional stress during the pre-monsoon fodder-scarce dry season of February to June. Here, monsoon rain starts in the middle of June, and generally February to June has less vegetation causing grass and fodder scarcity. Thus, feed limitation to animals is common and animals suffer with required dry matter intake, major nutrients and balanced diet. During this season, we measured the blood metabolic parameters of calcium (Ca), inorganic phosphorus (iP), total protein (TP), urea, cholesterol and glucose in anestrus buffaloes (Bohara and Devkota, 2009). The blood levels of Ca, iP and TP was lower than the normal levels for these parameters for Nepalese buffaloes (Kobayashi et al., 2003). Among the anestrus cases, the average blood Ca level in true anestrus buffaloes with inactive ovaries was lower than that of the CL bearing anestrus buffaloes or the silently cycling buffaloes (Table 1). Moreover, the BCS in true anestrus buffaloes was lower than that in the silent anestrus buffaloes (Fig. 1, Bohara and Devkota, 2009). When these parameters were examined in the similar cases of anestrus buffaloes during fodder-rich post-monsoon season, a considerable proportion of buffaloes had subnormal blood Ca, iP and TP levels (Devkota et al., 2013). Therefore, under-status of nutrition is likely to be associated to anestrus in buffaloes.

**Table 1. Some blood metabolic parameters of silently cyclic anestrus vs non-cyclic true anestrus buffaloes in Southern Nepal (Bohara and Devkota, 2009)**

| Parameters (mg/dl) | Silently cyclic anestrus (n=5) | Non-cyclic true anestrus (n=8) | P value |
|---|---|---|---|
| Ca | 7.36± 0.61 | 5.7±0.41 | 0.05 |
| iP | 4.21±0.38 | 3.43±0.23 | 0.13 |
| TP | 5.77±0.57 | 4.69±0.33 | 0.15 |
| Urea | 22.13±2.92 | 24.15±1.84 | 0.58 |
| Cholesterol | 162.59±20.84 | 142.69±6.49 | 0.41 |
| Glucose | 73.88±7.14 | 66.44±7.01 | 0.47 |

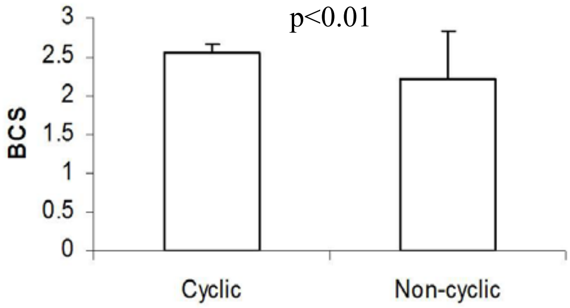


Figure 1. Body condition score (BCS) of silently cyclic vs non cyclic or true anestrus buffaloes. Bohara and Devkota, 2009.

It is well established that minerals play an intermediate role in the action of hormones and enzymes at cellular level and its deficiency ultimately affect the reproductive performance of females (Bearden et al., 2004). In addition to NEB, the deficiency of minerals like calcium Ca, P, copper, zinc and manganese are also associated with anestrus in dairy cows (Pradhan and Nakagoshi, 2008; Kumar et al., 2014). The major mineral deficiencies having impact in animal health and reproduction in Indian subcontinent are the Ca, P, sodium, copper, cobalt, iodine, zinc, iron, manganese and selenium (Dua 2009). It is common to have a lower level of serum Ca in anestrus buffaloes as compared to estrus buffaloes (Newar et al., 1999). The Ca-dependent mechanisms are involved in steroid biosynthesis in the gonads. A Ca-dependent mechanism, rather than a cAMP-dependent mechanism, may be responsible for the major steroidogenic pathways, and Ca may also have a role in steroidogenesis by influencing delivery or utilization of cholesterol by mitochondria or by stimulating the conversion of pregnenolone to progesterone (Hurley and Dowane, 1989). Furthermore, GnRH stimulation of LH release from pituitary cells involve a Ca-dependent mechanism. No cAMP is involved and LH is not released in the absence of Ca (Hurley and Dowane, 1989). Thus ovarian inactivity leading to acyclicity is a possible fate.

**Nutritional state and its association to treatment response in anestrus buffaloes**

Several factors including nutrition affect the response of buffaloes with anestrus to treatment (Das and Khan, 2010). It is known that BCS affects the response of anestrus dairy cows to treatment (Rhodes et al., 2003) and the success of timed AI after ovulation synchronization in beef cattle (Stevenson et al., 2000). In silently ovulated buffaloes bearing a CL in the ovary, treatment with PGF2α produces a considerable response with a consequent estrus and fertile ovulation (Chohan, 1998; Dhaliwal et al., 1987; Dhaliwal et al., 1988; Rao and Venkatramiah, 1991; De Rensis et al., 2005; Devkota and Bohara, 2009; Sah and Nakao, 2010; Devkota et al., 2013). However, low BCS before treatment affects negatively on pregnancy rate, and deficiency of Ca and protein and gastrointestinal parasitic infection, all compromising on nutritional status, reduces the pregnancy rate after treatment of anestrus buffaloes (Devkota et al., 2013). Ca is involved in steroid genesis and ovulation [Hurley and Dowane, 1989], so its deficiency may cause hormonal incompetence or ovulation failure resulting in pregnancy failure or its loss. Protein deficiency may adversely affect reproductive function via a decrease in IGF-1 release in response to exogenous hormone (Lucy et al., 2001). True anestrus buffaloes show lower levels of serum protein as compared to normal cyclic buffaloes [Kumar et al., 2010]. Therefore, Ca and protein deficiency needs to be paid more attention as major causes of subfertility in buffaloes. Producers should be informed that buffaloes with low BCS may not respond to the treatment and be encouraged to improve nutritional state of the animals.

**Nutritional state and its association to outcome of the novel ovulation induction protocols in anestrus buffaloes**

It is important to link the seasonal pattern of buffalo reproduction to nutrition and fodder availability that largely varies upon the rain fall pattern in most of the buffalo raising countries. Seasonal influence in buffalo reproduction has been reported from India, Pakistan, Nepal and many other countries (Barile, 2005; De Rensis and Lopez-Gatius2007; Devkota and Bohara, 2009; Perera, 2011; Chaudhary et al., 2012).

Several novel protocols of ovulation induction and estrus synchronization have been applied in buffaloes especially to overcome the problems of anestrus and other seasonal reproductive disorders. The presence of a dominant follicle and an active corpus luteum directly indicate the success of synchronization

(Brito et al., 2002; Warriach et al., 2015). However, the success indirectly depends upon the nutritional status of the animals, which correlates with the ovarian activity (Devkota et al., 2013; Warriach et al., 2015). Progesterone based treatment regimes (PRID, CIDR, CRESTAR, Progesterone injections) either alone (Singh et al. 1983) or in combination with gonadotrophins (Neglia et al. 2003) prove to be very effective in inducing ovarian activity in anestrus buffaloes during summer season. Naseer et al (2011) used CIDR based synchronization regimens in anestrous Nili-Ravi buffaloes and obtained 37% pregnancy rate. The author used a 7 days CIDR co-synch protocol (D0: GnRH I. and CIDR in, D7: CIDR out and PGF2$\alpha$ inj., D10: fixed time insemination and GnRH II.) during pre-monsoon month of May for 2 consecutive years (2013 May, pre-monsoon I and 2014 May, pre-monsoon II) in seven anestrus buffaloes each year, but with different BCS of <2.5 (poor) and ≥2.5 (good) during the pre-monsoon I and II, respectively (BCS of 1 to 5 scale, 1: very thin, 5 very fat). Six buffaloes with the good BCS of ≥2.5 were also applied with the similar protocol during post-monsoon month of November in 2013. Interestingly, none of the buffaloes with the BCS of <2.5 during pre-monsoon I conceived, however, 3 out of 7 (42.9%) buffaloes in the pre-monsoon II with good BCS conceived, even though it was lower than the conception rate of the post-monsoon month in a

**Table 2. Association of nutritional status on the outcome of assisted reproduction using a 7-days CIDR co-synch protocol in anestrus buffaloes**

| Seasons | Environmental parameters | | | BCS groups | No. of animals treated | No. of animals pregnant | Pregnancy rate (%) | P value |
|---|---|---|---|---|---|---|---|---|
| | T max ($^o$C) | T min ($^o$C) | RH (%) | | | | | |
| Pre-monsoon I | 39.0±0.6 | 29.7±0.6 | 51.0±7.9 | <2.5 | 7 | 0 | 0.0 | |
| Pre-monsoon II | 37.0±1.0 | 28.3±0.6 | 50.0±5.0 | ≥2.5 | 7 | 3 | 42.9 | 0.01 |
| Post-monsoon | 28.3±0.6 | 17.3±0.6 | 66.7±4.2 | ≥2.5 | 6 | 4 | 66.7 | |

similar BCS buffaloes (Table 2). Because temperature and humidity during Pre-monsoon I and II were almost similar, and the difference was with the BCS of the animals, it strongly indicates that nutritional status significantly affects the outcome of hormonal protocols in anestrus buffaloes. The result also indicates a significant association of the BCS to the first AI pregnancy rate after CIDR-cosynch treatment to anestrus buffaloes during the fodder-scarce pre-monsoon dry season (Table 3). Therefore, monitoring of BCS is highly important in the field condition that indicates the outcome of the novel treatment to anestrus buffaloes. In general, a strategy of improvement in nutrition and management is prerequisite for hormonal manipulation in order to improve productivity in anestrus buffaloes.

**Table 3. Association of BCS to the first AI pregnancy rate after CIDR-cosynch treatment to anestrus buffaloes during fodder-scarce dry pre-monsoon season**

| BCS | Number of animals treated | Number of animals pregnant after first AI | First AI pregnancy rate (%) | P value |
|---|---|---|---|---|
| ≥2.5 | 7 | 3 | 42.9 | 0.03 |
| <2.5 | 7 | 0 | 0.0 | |

## CONCLUSION

Buffalo rearing is very important in supporting rural livelihood in terms of family nutrition as well as added household income in many countries where they are mostly kept under the small holder farming system with compromised nutritional management. This has largely caused under-performance in terms of reproductive efficiency. Monitoring nutritional status is critical whereas nutritional under-status is related to the several reproductive problems including anestrus and success to its treatment. The outcome of the novel hormonal regimens is also affected by the nutritional status in buffaloes. It is clear that nutrition is closely related to reproduction in buffaloes. Therefore, understanding of nutrition – reproduction interaction is important while implementing modern techniques to improve reproductive efficiency of the buffalo. Future research should be directed to understand the association of environment-nutrition-reproduction interaction under the field condition.

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