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Original Research Article

Incidence of Reproductive Problems and Blood Mineral Status of Crossbred Cattle in Kakatpur Block of Odisha, India

Debasish Satapathy[1*], S. K. Mishra[2], R. K. Swain[2], K. Sethy[2], S. Barik[1], J. K. Sahoo[3] and S. S. Boitai[4]

[1]Animal Nutrition Division, ICAR- National Dairy Research Institute, Karnal, Haryana, India
[2]Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, OUAT, Bhubaneswar, Odisha, India
[3]Department of Animal Nutrition, IVRI- Izzat Nagar, Bareily, Uttar Pradesh, India
[4]Department of animal reproduction and obstetrics, College of Veterinary Science and Animal Husbandry, OUAT, Bhubaneswar, Odisha, India

**Corresponding author*

A B S T R A C T

A survey was conducted in the villages of the Kakatpur block of Odisha to know the feeding habits of crossbred cattle, reproductive problem incidence and their blood mineral status. Survey was conducted among 306 CB cattle by a questionnaire, feeding practice were recorded; blood was collected for blood mineral status; different feeds and fodder were collected which were available to the animals. Out of 118 CB cows, 36.44% were found to be have reproductive problems while out of 188 CB heifers, 48.93% were had reproductive problems. As a whole 44.11 % were having reproductive problems. More number of anestrous cases were recorded among heifers. Proximate analysis and mineral analysis of feeds and fodder were conducted. From feeding practice, it was revealed that cattle were receiving less DCP and TDN because of less supplementation of concentrate feed, apart from that animals were not receiving any mineral mixture. Blood mineral analysis reflected that animals were deficient in macro mineral. Therefore, it can be concluded that low supplementation energy, protein macro and micro minerals deficiency were major reasons behind higher incidence of reproductive problems in Kakatpur block of Odisha. Therefore, concentrate feeding and mineral mixture supplementation was advised to the farmers.

Keywords

Crossbred cattle, mineral, Nutrient availability, Reproductive problem

Introduction

Livestock sector is the best and most effective tool for livelihood security and poverty alleviation. Nutrition and Reproduction are two important factors that affect the production performance of the animal. Proper reproductive health and good plane of nutrition helps in increasing the milk production of an animal, which is the prime intention of the farmer. Reproductive efficiency of the lactating herd is a major component of profitability in dairy farms. It is well described that poor nutritional status and metabolic health negatively influence reproduction in dairy cows. During the last

decades, genetic selection and improved management of herds have dramatically increased milk production, but fertility has decreased in dairy cows (Butler, 2000). Several factors like biological type, physical environment and nutrition affect the reproductive efficiency of animals. Reproduction problems of crossbred animals are generally delayed maturity, anestrous, repeat breeding, post-partum anestrous *etc*. Crossbred animals generally produce more milk, so require more energy in their diet. In field practices crossbred animals are fed less feed or low nutritive feed leading to negative energy balance condition. Insufficient intake of energy, protein, vitamins, and macro- and/or micro-minerals are associated with suboptimal reproductive performance such as delayed puberty, reduced ovulation, lower conception rate, lengthened post-partum anestrus and reduced perinatal survival as well as performance (Robinson, 1990).

Deficiency of energy for an extended period leads to anovulation, postpartum anestrus, as well as infertility (Staples *et al.,* 1990). Deficiency of Cu, Fe, Mn and Zn have been associated with repeat breeding, decreased conception, abortion, foetal mummification, prolonged labour and lower birth weight (Kumar *et al.,* 2011). Trace elements like Cu, Co, Zn, Fe, Se, I, Mo, Mn and certain macro elements like K, Ca, Na, Cl, P are found to be very essential for normal livestock growth and performance (Underwood, 1981). Usually roughages and green fodder are deficient in micro and macro minerals. Along with that previous reports were there regarding deficiency of some minerals in soil, feeds and fodder in some regions of Odisha (Mohapatra *et al.*, 2012). Therefore, a survey was carried out to assess the reproductive disorder incidence with relation to their feeding schedule in Kakatpur block of Odisha.

Materials and Methods

The investigation was undertaken in the Department of Animal Nutrition, Faculty of Veterinary Science and Animal Husbandry, O.U.A.T., Bhubaneswar. An on-farm trial was carried out in the villages namely Othaka, Sarangadharapur, Anantapur, Panichatra, Jagannathpur, Tentulia, Bangurigaon, Nasikeshara, Kalakantapur of Kakatpur block of Puri district of Odisha which is under East and South Eastern Coastal Plain Zone. The Kakatpur block is located between 20° 1' 0" N latitude and 86° 12' 0" E longitudes at an altitude of 19.3 meters. The average rainfall of the zone is about 1488.43 mm. The important soil groups of East and South Eastern Coastal Plain zone are alluvial, laterite, saline soil and are acidic in nature. The survey work was conducted through a structured schedule survey format for obtaining general information from the dairy farmers *viz.*, breed, age of animals, details of estrus, follow of action after estrus, age at first calving, calving number, services per conception, date of last calving and other breeding history viz., anestrus, post-partum anestrus, repeat breeding and feeding practices of dairy cows. Further, the reproductive statuses of the dairy cows were assessed by per-rectal examination of individual cows. Each animal was examined per rectally to know the status of reproductive organs like cervix, uterus and ovary *etc.* Feeding schedule of the animals such as amount of concentrate, green fodder and roughage provided to the animals were recorded. Milk production performance of the animals were recorded. Proximate composition of feeds and fodder, which were fed to the animals in that area were estimated as per the process provided by AOAC (2005). Concentration of minerals such as Ca, P, Mn, Zn, Cu were estimated by AAS. From all animals having

reproductive disorders 100 animals were selected randomly and their body weight was calculated by the formula $LG^2/660$ where, where L was the length from point of shoulder to pin bone in inches and G was the heart girth in inches. Average digestible crude protein (DCP) and total digestible nutrient (TDN) requirement and supplied to the animals were calculated as per the body weight and milk production status of the animals. Blood was collected from those selected animals for estimation of serum mineral status. Serum macro (Ca and P) and micro (Zn, Mn, Cu) mineral status were estimated by AAS.

Incidence of reproductive disorders in Kakatpur block

Distribution of reproductive disorder of CB cows in Kakatpur block is presented in Table 1. This study documented the common reproductive disorders encountered under smallholder's dairy production system in Kakatpur block. Animals derive most of their feed-fodder requirement from agricultural residues and by-products, and in turn provide draught power and dung manure for cropping activities. The survey on reproductive disorder distribution revealed that, of those 118 cows surveyed, 43 (36.44%) were found to have reproductive problems and of 188 heifers, 92 (48.93%) were found to have reproductive disorders. As a whole 44.11% CB female cows were found to have reproductive problems i.e. 135 numbers, which is in close approximation with earlier findings of Hadush *et al.,* (2013) in Ethiopia. Incindence of anoestrus and repeat breeding condition in CB cows and heifers of Kakatpur block is presented in Table 2. It was observed that out of 92 CB heifers 48 were having anoestrus problem while 44 were having repeat breeding problem. Among 23 CB cows, number of animals having post-partum anestrus and repeat breeding condition were 2 and 41, respectively. In total out of 135 animals which had reproductive problems, 50 were suffering from anoestrus condition and 85 were having repeat breeding condtion. From those 135 animals, 100 CB females were selected. Out of 100 animals, number of cows and heifers were 35 and 65 respectively. Among the experimental cows, 34 numbers were repeat breeders and one cow in post-partum anestrous state. Among the heifers, number of anestrus heifers and repeat breeding heifers cases were 34 and 31 respectively. Proportionately CB heifers were found to have higher percentage of anoestrus condition while CB cows with higher repeat breeding condition. Mohanty *et al.,* (1997) and Khan *et al.,* (2016) also reported high incidence of anoestrus cases in Odisha and Nosrt-Eastern India, respectively. In a recent study by Das *et al.,* (2016), 54.76% and 36.90 % of reproductive disordered animals were having repeat breeding and anestrous problems making these two as most prevalent reproductive problems in Cuttack district of Odisha. However, a decade ago, Das *et al.,* (2004) reported occurrence of 15.97% anoestrus cases in Cuttack and Bhubaneswar. The comparatively low incidence reported by them could be due to the fact that this is an urban area. Rao and Sreemanarayan (1982), Singh *et al.,* (2003) and Pandit (2004) in Andhra Pradesh, Punjab and Madhya Pradesh, respectively also reported higher incidence of anoestrus in cows.

Chemical composition of feeds and fodder of Kakatpur block

Proximate composition of feed and fodder fed to the animals in Kakatpur block is presented in Table 3. The normal feeding practices of the dairy animals were found to contain paddy straw, wheat bran, and mixed

grass with occasional feeding of maize fodder, mung chunni, and compound feed. The CP, EE, CF, NFE and total as content of feeds and fodder were found to be in the range of 2.56 to 15.53 percent, 1.98 to 4.04 percent, 8.58 to 37.18 percent, 45.64 to 67.54 percent and 6.31 to 14.01 percent (on DM basis) respectively. Mixed grass contained 5% protein and the mixed grass normally found to contain locally available grasses including dub grass, which is very low as compared to value reported by Naik and Sengar (1997). The variation in proximate composition as observed might be due to the types of grasses grown the survey area. Other parameters were well within the range reported by NDDB (2012). Macro and micro mineral status of those feeds and fodder are presented in Table 4.

The calcium content (%) of the feed and fodders commonly used by the farmers of the Kakatpur block like paddy straw, maize. wheat bran, mung chuni, mixed grass ranged from 0.19 to 0.45, phosphorus content (%) varied between 0.23 to 0.38, zinc content (ppm) varied between 30.06 to 44.46, copper content (ppm) ranged from 6.85 to 12.24, manganese content (ppm) varied between 22.26 to 42.52. The calcium content of the paddy straw of the analyzed samples was observed to be low in calcium than that of critical level (0.3%). The straws and stovers were deficient in calcium as they contain excess of silica, oxalates and tannins, which might have interfered in the utilization of calcium and also due to accumulation of minerals in seed due to translocation. These results were in accordance with Singh *et al.,* (2011) and Panda *et al.,* (2016) in Odisha. The phosphorus content of the paddy straw in the present study was observed to be lower than that of critical level (0.25%). Wheat bran and maize were found to be contained marginally higher phosphorus than that of critical level. Singh *et al.,* (2011) reported similar range of phosphorus in maize and wheat bran as observed in the present study.

Nutrient availability to the CB cattle of Kakatpur block

The availability of nutrient to the CB cows of Kakatpur block is presented in the Table 5. Average daily intake (kg/ head/day) of straw, green fodder and concentrate/ compound feed of surveyed animals are found to be 3.54 ± 1.13, 3.04 ± 0.97 and 0.67 ± 0.08. Average body weight of selected 100 animals was 255.39 ± 11.79 kg. DCP supplied (kg/head/day) and requirement (kg/head/day) of the animals were 0.26 ± 0.04 and 0.37 ± 0.07, respectively. Therefore, a deficiency of 0.11 ± 0.03 kg of DCP per animal per day was observed. Similarly, TDN supplied and requirement of the animals were 2.94 ± 0.34 and 3.49 vs 0.25 kg/head/day. Here 0.55 ± 0.16 kg of TDN was less supplied to the animals. Therefore, animals were in negative energy balance. The supply of nutrients is dependent on the type of animal, productivity of animals, land holding and socio economic status of the farmer, season and availability of resources (Ganai *et al.,* 2004). Moreover, the availability of nutrients to different categories of animals was governed by the immediate economic value of the animals (Mudgal *et al.,* 2003).

The low productivity of the animal as observed in the present study might be due to nutrient deficiency in animals and poor quality nutrient supply to the animals. Because energy and protein play vital role in expression of reproductive status of the animals. It has been observed that, negative energy balance results in diminished post-partum reproductive ability of high-yielding dairy cows and CB cows (Fan *et al.,* 2017; Theodore *et al.,* 2017).

Table.1 Incidence of reproductive disorder animals in Kakatpur block of Odisha

Sl No.	Species	No. of Animals
1	Total number of CB animals surveyed	306
2	Number of CB cows surveyed	118
3	Number of CB cows with reproductive disorder	43
4	Percentage of CB cows with reproductive disorder	36.44
5	Number of CB heifers surveyed	188
6	No of CB heifers with reproductive disorder	92
7	Percentage of CB heifers with reproductive disorder	48.93
8	Total number of CB animals with reproductive disorder	135
8	Total CB animal with reproductive disorder (%)	44.11

Table.2 Incidence of anoestrus and repeat breeding condition in CB cattle of Kakatpur block

Disorders	CB Heifers (number)	CB cows (Numbers)	Total
Anoestrus	48	2	50
Repeat breeding	44	41	85
Total	92	43	135

Table.3 Proximate composition (% DM basis) of feeds and fodder fed to the animals of Kakatpur block, Odisha

	Wheat bran	Maize fodder	Mixed grass	Mung chunni	Compound feed	Paddy straw
DM %	87.32	23.68	20.39	88.67	88.52	90.12
CP %	15.53	5.89	5.0	8.43	10.86	2.76
EE %	3.14	1.98	3.15	2.41	4.04	2.78
CF %	13.21	37.18	32.34	26.71	8.58	36.80
NFE %	61.81	47.11	45.64	48.44	67.54	48.74
Total ash %	6.31	7.84	13.87	14.01	8.98	8.92

Table.4 Mineral composition of feeds and fodder fed to the animals of Kakatpur block, Odisha

	Wheat bran	Maize fodder	Mixed grass	Mung chunni	Compound feed	Paddy straw
Ca (%)	0.19	0.25	0.45	0.34	0.21	0.20
P (%)	0.23	0.38	0.31	0.29	0.22	0.04
Zn (ppm)	43.24	44.46	31.13	42.97	38.79	30.06
Mn (ppm)	42.52	23.68	29.17	38.83	36.64	22.26
Cu (ppm)	6.85	7.98	9.46	12.24	7.51	8.47

Table.5 Availability of nutrients (kg/head/day) to crossbred cattle in Kakatpur block (Farmers's practice)

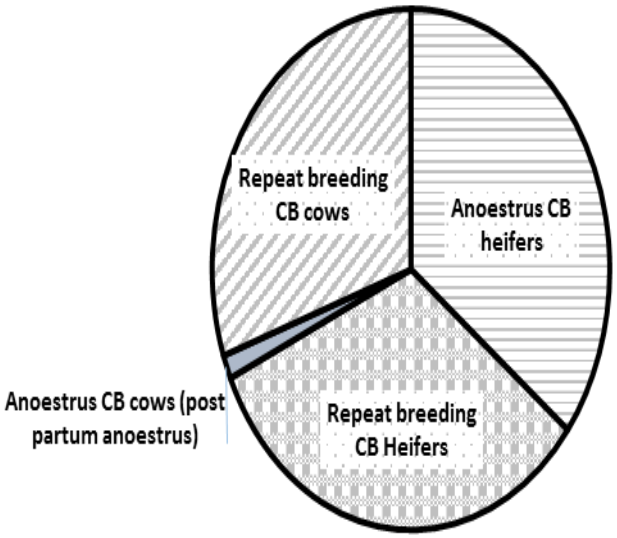
Sl No.	Attributes	Values
1	Average Straw Intake (kg)	3.54 ± 1.13
2	Average Green Fodder intake (Kg)	3.04 ± 0.97
3	Average Compound Feed Intake (Kg)	0.67 ± 0.08
4	Average DM intake (kg)	4.48 ± 1.15
5	Average body weight of animals (100 randomly selected animals)	255.39 ± 11.79
6	Average DCP supply (kg)	0.26 ± 0.04
7	Average DCP Requirement (kg)	0.37 ± 0.07
8	Average DCP Balance (kg)	0.11 ± 0.03
9	Average TDN Supply (kg)	2.94 ± 0.34
10	Average TDN Requirement (kg)	3.49 ± 0.25
11	Average TDN Balance (kg)	0.55 ± 0.16

Table.6 Average blood mineral status of reproductive disordered cattle (100 number) of Kakatpur block of Odisha on the day of survey

Sl No.	Minerals	Concentration	Critical Level*
1	Calcium (mg/dl)	7.26 ± 0.34	8.00
2	Phosphorus (mg/dl)	3.54 ± 0.16	4.5
3	Zinc (ppm)	0.83 ± 0.03	0.8
4	Manganese (ppm)	0.32 ± 0.04	0.2
5	Copper (ppm)	0.72 ± 0.01	0.65

*McDowell *et al.,* (1993)

Fig.1 Incidence of anoestrus and repeat breeding condition in CB cattle of Kakatpur block



The harmful effect of negative energy balance might be reduced embryo development during the first week after AI, suggesting a lingering effect of the transition problems on oocyte competence (Wiltbank *et al.,* 2015). In another study, Kendrick *et al.,* (1999) randomly assigned 20 dairy cows to 1 of 2 treatments formulated so that cows consumed either 3.6 % (high energy) or 3.2 % (low energy) of their body weight. Follicles were transvaginally aspirated twice weekly and oocytes were graded based upon cumulus density and ooplasm homogeneity. Cows in better energy balance (high energy) had greater intrafollicular IGF-I and plasma progesterone levels and tended to produce more oocytes graded as good. Therefore, NEB not only delays resumption of ovulatory cycles, but it might also influence the quality of occytes once cows are inseminated. Diets with limited crude protein can compromise microbial growth and rumen fermentation, which often reflects in declines in feed intake and milk production. Prolonged inadequate protein intake has been reported to reduce reproductive performance.

Protein deficiencies in lactating cows may increase the incidence of silent heats (cow releases the egg but she is not seen in heat) and lower conception rates. Heifers that are raised on a protein-deficient diet lack the skeletal growth in relation to their size, especially in the pelvic area. These heifers are older when they start cycling, have more difficulty calving, and may not milk as well once they enter the milking herd (Amaral-Phillips and Heersche, 1997). Apart from that mineral mixture feeding practice was not adopted at all or very rarely adopted by the farmers in field condition because of lack of knowledge about importance of mineral mixture and low economic condition of farmers. Therefore, deficiency of mineral in animals were expected.

Blood mineral status of the animals of Kakatpur block

Average blood mineral status of reproductive selected disordered cattle (100 number) of Kakatpur block of Odisha on the day of survey is presented in Table 6. Blood mineral concentration (mg/dl) of macro minerals such as Ca and P were found to be 7.26 ± 0.34 and 3.54 ± 0.16,respectively, which are below the critical limit of blood calcium and phosphorus concentration (8.00 and 4.5 mg/dl, respectively). This result is supported by findings of Panda *et al.,* (2016) who also observed low plasma Ca and P level in western Odisha. However, they contradicts present finding as they observed low level of some micro minerals like Cu and Zn. The lower level of Ca observed in anoestrous cow, heifers and repeat breeding cows might be due to failure of endocrine system to mobilize body Ca that might have resulted in reproductive failure. The results of Ghanwat *et al.,* (2007) also suggested that mean serum Ca level was significantly low in repeat breeders. The deficiency might be due to low content of Ca in forages and presence of substantial amounts of oxalates in paddy straw, which is a major source of roughage in the animals' diet. The lower level of plasma phosphorus in repeat breeder cows and anoestrous, cows observed in present study is in close conformity with the findings of Tiwary *et al.,* (2007), who reported marginal deficiency of P in blood serum was sufficient to cause disturbance its pituitary ovarian axis without manifestation of specific deficiency symptoms. Several reproductive problems have been encountered in the areas deficient with phosphorus such as delayed onset of puberty, silent or irregular estrus, long intercalving period, stillborn or weakly expelled calves or even embryonic death due to lack of uterine muscle tone (Chaudhury and Singh, 2004). Average concentration of

micro minerals such as Zn, Mn and Cu were not below the critical limit. However, they were on the border line of deficiency. Concentration (ppm) of micro minerals such as Zn, Mn and Cu were found to be 0.83 ± 0.03, 0.32 ± 0.04 and 0.72 ± 0.01, respectively. Micro minerals were not below the critical level. However, they were very close to the bottom line of the critical limit. Lower levels of copper, zinc and manganese in animals having reproductive problems might be due to the deficiency of these trace minerals in fodders (Yatoo *et al.,* 2013). Trace minerals play a vital role in estrogen and progesterone synthesis and production. Copper and zinc are involved in regulating progesterone production by luteal cells via involvement of superoxide dismutase (Sugino *et al.,* 1999). Zinc is a component of insulin like growth factors involved in regulation of granulosa cell estradiol production during follicular waves in cattle (Kobayashi *et al.,* 2006). Manganese acts as a cofactor in the synthesis of cholesterol which is precursor of steroids like estrogen and progesterone (Nocek *et al.,* 2006).

Trace minerals and steroid hormone have important interrelation. Deficiency of former can affect latter and consequently reproductive performance of animals especially in heifers (Yatto *et al.,* 2016).

Copper complexes with GnRH and interact with GnRH receptors and modulate intracellular signaling in the gonadotrope cells of the anterior pituitary (Michaluk and Kochman, 2007). Common copper deficiency symptoms in cattle include delayed or suppressed estrus, decreased conception, infertility and embryo death (Corah and Ives, 1991). Therefore, it can be said that along with energy and protein, micro and macro minerals play vital role in improving reproductive status of crossbred animals (Devasena *et al.,* 2015).

From the present study, it can be concluded that macro and micro minerals are closely related with the reproductive performance of the animals. Therefore, mineral mixture feeding to the cattle should be encouraged. Animals in Kakatpur block of Odisha were receiving less DCP and TDN as compared to their requirement, which was adding the burden to their reproductive performance. Therefore, the farmers should adopt supplementation of good quality nutrient i.e. good quality green fodder and concentrate.

References

Amaral-Phillips, D. M. and Heersche, G. J. 1997. Role of nutrition on reproductive performance. Cooperative Extension Service, College of Agriculture, University of Kentucky. ASC p. 138.

AOAC. 2005. Official Methods of Analysis, 18th edn. Association of Official Analytical Chemists International, Gaithersburg, MD, USA.

Butler, W. R. 2000. Nutritional interactions with reproductive performance in dairy cattle. *Animal Reproduction Science*. 60 : 449-457.

Choudhary, S. and Singh, A. 2004. Role of nutrition in reproduction: a review. *Intas Polivet*. 5(2): 229-234.

Corah, L. R. and Ives, S. 1991. The effects of essential trace minerals on reproduction in beef cattle. *Veterinary Clinics of North America: Food Animal Practice*. 7(1): 41-57

Das, R.K., Ray, S.K.H., Mohanty, D.N., Das, S. and Jena, J.C. 2004. Preliminary studies on the incidence of gynaceo-clinical disorders of bovine. *Livestock International*. 8: 6-9.

Das, S., Pradhan, C. R., Mishra, S. K., Swain, R. K., Mishra, P. C., Sahoo, G., Sethy, K. and Chichilichi, B. 2016. Incidence of infertility and biochemical profile of crossbred cows in Cuttack district of Odisha, India. *Exploratory Animal and Medical Research*. 6(2): 224-230.

Devasena, B., Ramana, J.V., Prasad, P.E.,

Sudheer, S. and Prasad, J.R. 2015. Plasma mineral profile and its correlation with reproductive status in crossbred cows. *Intas Polivet*. 16(1):49-53.

Fan, Z., Shi S., Chuchu, X., Changsheng, L., Xinhuan, X., Cheng, X., Gang, W., Hongyou Z., Chuang, X. and Wei, Y. 2017. Investigation of negative energy balance and postpartum anoestrus in an intensive dairy farm from the Chinese province of Heilongjiang. *ActaVeterinaria Brno*. 86(1): 59-65.

Ganai, A.M., Matto, F.A., Singh, P.K. and Parray, B.A. 2004. A survey of feeds and feeding practices in Kashmir valley. *Indian Journal of Animal Nutr*ition. 21(1): 69-72.

Ghanwat, D.V., Sarode, D.B., Mainde, U. P. and Dhoot, V. M. 2007. The mineral profile of soil, fodder of Nagpur District with reference to soil plant animal relationship. *Intas Polivet.* 2: 320-23.

Hadush, A., Abdella, A., Regassa, F. 2013. Major pre-partum and postpartum reproductive problems of dairy cattle in Central Ethiopia. *Journal of Veterinary Medicine and Animal Health.* 5(4):118–123.

Kendrick, K.W., Bailey, T.L., Garst, A.S., Pryor, A.W., Ahmadzadeh, A., Akers, R.M., Eyestone, W.E., Pearson, R.E. and Gwazdauskas, F.C. 1999. Effects of energy balance on hormones, ovarian activity, and recovered oocytes in lactating Holstein cows using transvaginal follicular aspiration. *Journal of Dairy Science*. 82:1731-1740.

Khan, M. H., Manoj, K. and Pramod, S. 2016. Reproductive disorders in dairy cattle under semi-intensive system of rearing in North-Eastern India. *Veterinary World*. 9(5): 512.

Kobayashi, Y., Jimenez-Krassel, F., Ireland, J.J. and Smith, G.W. 2006. Evidence of a local negative role for cocaine and amphetamine regulated transcript (CART), inhibins and low molecular weight insulin like growth factor binding proteins in regulation of granulosa cell estradiol production during follicular waves in cattle. *Reproductive Biology and Endocrinology*. 4: 22

Kumar, S., Pandey, A.K., Razzaque, W.A.A. and Dwivedi, D. K. 2011. Importance of micro minerals in reproductive performance of livestock. *Veterinary World*. 4(5): 230-233.

McDowell, L.R, Conrad, J.H. and Glen-Hembry, F. 1993. Minerals for Grazing Ruminants in Tropical Regions. 2ndedn. Animal Science Department. Center for Tropical Agriculture, University of Florida: 61-67.

Michaluk, A. and Kochman, K. 2007. Involvement of copper in female reproduction. *Reproductive Biology*. 7(3): 193-205.

Mohanty, L.D., Mishra, P.C., Pradhan, R.K., Mishra, M.M., Mitra, S.K., Mishra, S.K. and Nanda, J. 1997. Some field observations at infertility clinic in intensive cattle development zone, Cuttack, Orissa. XIV Annual Convention of National Symposium of ISSAR. Bidar, 14-16 November, p.104.

Mohapatra, P., Swain, R.K., Mishra, S.K., Sahoo, G. and Rout, K.K. 2012. Effect of supplementation of area specific mineral mixture on reproductive performance of the cows. *Indian Journal of Animal Science*. 82(12): 1558-1563.

Mudgal, V., Mehta, M.K., Rane, A.S. and Nanavati, S., 2003. A survey on feeding practices and nutritional status of dairy animals in Madhya Pradesh. *Indian Journal of Animal Nutrition*. 20(2): 217-220.

Naik, P.K. and Sengar, S.S. 1998. Chemical Composition and In Sacco DM Degradability of some Common Weeds. *Indian Journal of Animal Nutrition*. 15(2): 138-140.

Nocek, J.E., Socha, M.T. and TomLinson, D.J. 2006. The effect of trace mineral fortification level and source on performance of dairy cattle. *Journal of Dairy Science*. 89: 2679–2693

Nutritive value of commonly used feeds and fodders of India. 2012. Animal Nutrition Group, National Dairy Development Board. Anand-38001.

Panda, M., Panda, N., Panigrahi, B., Swain, R. K. and Mishra, A. 2016. Mineral Profile

and Metabolic Status of Cattle in Western Undulating Zone of Odisha. *Indian Journal of Animal Nutrition*. 33(3): 290-295.

Pandit, R.K. 2004. Incidence of different kinds of reproductive disorders in livestock. *Indian Journal of Animal Reproduction*. 25: 35-36.

Rao, A.V. N. and Sreemannarayana. O. 1982. Clinical analysis of reproductive failure among female buffaloes (Bubalusbubalis) under village management in Andhra Pradesh. *Theriogenology*. 18(4): 403-411.

Robinson, J.J. 1990. Nutrition in the reproduction of farm animals. *Nutrition ResearchReview*. 3: 253-276.

Singh, G., Sidhu, S.S. and Verma, H.K. 2003. Incidence of reproductive disorders of buffaloes in different zones of Punjab state. *Journal of research Punjab Agriculture University*. 40: 79-81.

Singh, R.K., Mishra, S.K., Swain, R.K., Dehuri, P.K. and Sahoo, G.R. 2011. Mineral profiles of feeds, fodders and animals in mid-central table land zone of Orissa. *Animal Nutrition and Feed Technology*. 11:177 – 184.

Staples, C.R., Thatcher, W.W. and Clark, J.H. 1990. Relationship between ovarian activity and energy status during the early postpartum period of high producing dairy cows. *Journal of Dairy Science*. 73: 938-947.

Sugino, N., Takiguchi, S., Kashida, S., Takayama, H.Y., Nakamura, Y. and Kato, H. 1999. Suppression of intracellular sod activity by antisense oligonucleotide causes inhibition of progesterone production by rat luteal cells. *Biology of Reproduction*. 61: 1133-1138.

Theodore, V. K., Panchal, M. T., Dhami, A. J., Parmar, S. C., Bhanderi, B. B. and Chaudhary, S. 2017. Effect of Bypass Fat and Minerals Supplementation during Transitional Period on Plasma Levels of Thyroid Hormones, Metabolites and Postpartum Fertility in Crossbred Cows. *The Indian Journal of Veterinary Sciences and Biotechnology*. 13(1):1-8.

Tiwary, M. K I, Tiwari, D. P., Kumar, A. and Mondal, B. C. 2007. Existing Feeding practices, Nutrient Availability and Reproductive status of Dairy Cattle and Buffaloes in Haridwar District of Uttarakhand. *Animal Nutrition of Feed Technology*. 7: 177-85.

Underwood, E.J. 1981. The mineral Nutrition of Livestock. Common wealth Agricultural Bureau, Slough, U.K.

Wiltbank, M. C., Grummer, R.R., Shaver, R.D., Santos, J.E.P., Sartori, R., Carvalho, P.D., Souza, A.H. and Toledoa, M.Z. 2015. Nutrition and reproductive efficiency: transition period management, energy status, and amino acid supplementation alter reproduction in lactating dairy cows. In 2015 Florida Ruminant Nutrition Symposium; Feb: 2-4.

Yatoo, M. I., Dimri, U. and Sharma, M.C. 2013. Status of Micro Mineral Deficiency in Cattle in Kashmir Valley. *Journal of Animal Health and Production*. 1(3): 24-28.

Yatoo, M. I., Saxena, A., Gopalkrishnan, A., Kumar, S. S., Sujatha, V., Murugan, M. S. and Sharma, M. C. 2016. Status and interrelation of trace minerals and steroid hormones in heifers. *Advance in Animal and Veterinary Science*. 4(2): 1-4.