Int.J.Curr.Microbiol.App.Sci (2025) *14*(08): 161-175

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 14 Number 8 (2025)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2025.1408.015

Impact of Farm Management and Trace Mineral Status on Infertility in Dairy Cattle in Khartoum State, Sudan

Badwi A. Montasir[1], Shadia A. Mohamed[2], Abdalla A. O. Abdelrahim[3*], Nabaa kamal Alshafei[4], S. O. Nawal[4], I. A. Abdelrhman[5], Adil M. A. Salman[6] and M. I. M. Fangama[7]

[1]Department of Internal Veterinary Medicine, Faculty of Veterinary Medicine, West Kordufan University, Sudan
[2]Department of Internal Veterinary Medicine, University of Bahri
[3]Department of veterinary preventive medicine, Faculty of Veterinary Medicine, West Kordufan University, Sudan
[4]University of Bahri, College of Veterinary Medicine
[5]Department of Physiology, Faculty of Veterinary Medicine, West Kordufan University, Sudan
[6]University of Bahri, College of Veterinary Medicine, Department of Food Safety and Veterinary Public Health, Khartoum, Sudan
[7]Management of public health, Ministry of Health, Qatar
**Corresponding author*

Keywords

Dairy cattle, Infertility, Farm management, Trace minerals, Copper, Cobalt, Khartoum, Bahri, Omdurman

Article Info

Received:
19 June 2025
Accepted:
30 July 2025
Available Online:
10 August 2025

A B S T R A C T

Infertility in dairy cattle is a critical issue that undermines productivity and profitability, often resulting from poor management practices, inadequate nutrition, insufficient veterinary care, and trace mineral deficiencies. In Sudan, particularly in urban dairy farming areas such as Khartoum, Bahri, and Omdurman, milk production represents a key livelihood source, yet limited studies have examined the contribution of management practices and mineral imbalances to infertility. This study investigated the relationship between farm management, trace mineral levels, and infertility in dairy cows across these regions, focusing on 800 animals from different farms. Data were gathered through farm visits, farmer interviews, and direct observations of herd management, including herd size, cow age, number of calvings, feeding and hygiene routines, vaccination coverage, and veterinary supervision. Blood samples were collected from infertile cows for biochemical analysis of trace minerals including copper, cobalt, zinc, phosphorus, and iodine. Statistical analysis was conducted to compare differences among the three localities. Results indicated no significant differences in herd size, cow age, farm area, or calving numbers per cow, though vaccination rates varied significantly, with the highest coverage in Khartoum and the lowest in Bahri ($p = 0.01$). Hygiene practices, tick control, and veterinary supervision differed slightly but without statistical significance, while Bahri exhibited more dietary diversity without a significant effect. Reproductive health assessment showed higher early and late abortion rates in Bahri, though not statistically significant. Mineral analysis revealed significant differences in copper and cobalt, with copper levels highest and cobalt lowest in Bahri ($p < 0.001$ and $p = 0.003$, respectively), while zinc, phosphorus, and iodine showed no significant variation. The findings suggest that infertility in dairy cows is associated with both management practices and mineral imbalances, particularly the elevated copper and reduced cobalt levels observed in Bahri. Strengthening nutrition, ensuring adequate mineral supplementation, and improving vaccination and veterinary care are recommended to mitigate infertility and enhance dairy farm productivity in urban Sudan.

Introduction

Infertility in dairy cattle is a significant problem in many countries, especially in developing regions where management practices and veterinary services may be inadequate. It causes considerable economic losses through extended calving intervals, decreased milk production, increased treatment costs, and early culling of animals (Kennedy and Miller, 2007). In Sudan, particularly in Khartoum State, infertility is increasingly reported by dairy farmers as a major constraint to productivity and farm profitability (Tamador and Moamer, 2014).

Several factors are known to contribute to reproductive failure in dairy herds. These include poor hygiene, irregular veterinary supervision, low vaccination coverage, and improper nutrition (Adam and Ibtisam, 2015; Mansour *et al.,* 2014). Among these, trace mineral deficiencies have been widely studied and linked to reproductive disorders such as delayed estrus, an ovulation, repeat breeding, and early embryonic loss (Mohamed *et al.,* 2017; Akhtar *et al.,* 2014). Minerals like copper (Cu), zinc (Zn), cobalt (Co), phosphorus (P), and iodine (I) are crucial for normal reproductive function, and their deficiency has been associated with reduced conception rates and infertility in cows (Ahmed *et al.,* 2010; Abhijit *et al.,* 2015).

In addition to nutritional factors, disease prevention through proper vaccination plays a vital role in maintaining reproductive health. Inadequate vaccination coverage against diseases such as Foot and Mouth Disease (FMD), Anthrax, Hemorrhagic Septicemia (HS), and Contagious Bovine Pleuropneumonia (CBPP) increases the risk of reproductive losses and infertility (Cashman *et al.,* 2008; Mohamed, 2011).

The same author stated that signs of iodine deficiency include delay in puberty, suppressed or irregular estrus, failure of fertilization, early embryonic death, still birth with weak calves, abortion and increased frequency of retained placenta in female.

Sign of cobalt deficiency include delayed uterine involution, irregular estrous cycle and decreased conception rate (Satish Kumar, 2003). Deficiency of zinc decreased fertility and abnormal reproductive events in females (Satish Kumar, 2003). Apart from this zinc has a critical role in repair and maintenance of uterine lining following parturition and early return to normal reproductive function and estrus (Beigh *et al.,* 2016). Phosphorus is one of the important elements for normal sexual behavior (Satish Kumar, 2003). Delayed onset of puberty and silent or irregular estrus in heifers, failure of estrus and long inter calving period in cows and still born or weakly expelled calves or even embryonic death due to lack of uterine muscle tone are reported to be some of important clinical manifestations exhibited by the animals from phosphorus deficient areas (Chaudhary and Singh, 2004).

In connection with above little research information is available about the effect of the mineral deficiency on infertility in the dairy cattle, in Khartoum State. Therefore, the present study was conducted to investigate the risk factors and management in the reproductiveity of dairy cattle and analysis of minerals deficiency.

Justification

Infertility in dairy cattle is a major reproductive challenge that leads to significant economic losses due to decreased milk production, increased calving intervals, and higher culling rates. In Khartoum State, where the dairy industry largely depends on small-scale and traditional systems, infertility issues are often overlooked and poorly managed. Previous studies have suggested that trace mineral deficiencies—particularly in copper and cobalt—can severely affect reproductive performance. However, limited research has been conducted in Sudan to quantify the extent of these deficiencies and their specific impact on infertility under local farming conditions.

Additionally, inadequate farm management practices, including poor hygiene, insufficient veterinary care, and lack of proper nutrition, may further exacerbate reproductive problems. Therefore, this study is essential to identify the key mineral and management-related risk factors contributing to infertility in dairy cattle, and to provide evidence-based recommendations aimed at improving reproductive health and productivity in the region.

General Objectives

To evaluate the effect of trace mineral deficiencies and farm management practices on infertility in dairy cattle in Khartoum State, Sudan.

Specific Objectives

This study aims to determine the serum levels of selected trace minerals—copper, cobalt, zinc, iodine, and phosphorus—in infertile dairy cows across different localities in Khartoum State, while also assessing variations in mineral concentrations among Khartoum, Bahri, and Omdurman and their possible association with infertility. In addition, the research evaluates farm management factors, including hygiene, nutrition, veterinary supervision, and vaccination practices, to investigate their potential contribution to reproductive failure in dairy herds.

Materials and Methods

Area of Study

This study was conducted from February to October 2018 in Khartoum State. Khartoum state is located in North eastern part of the center of Sudan. The state is located between longitudes 31.5° to 34° E, as well as latitudes 15° to 16° N (Ministry of Animal Recourses Fisheries Informational Center (MARFIC, 2015). Khartoum State is bounded by North Kordofan state in the west, River Nile in the north. In addition, in the Northwest is bordered by the Northern State, in south by White Nile State, and Gazeera State in the east (Fig. 1) (MARFIC, 2015). Samples were collected from the following area: Khartoum North includes Tibna and Shambat districts, Sofoula districts which located in Khartoum, as well as Omdorman include Almoielih and Jabal Tooria.

Study Design

This was a cross-sectional study conducted on 800 dairy cows from selected farms in Khartoum, Bahri, and Omdurman. Data were collected through farmer interviews and farm observations to assess management practices. Blood samples were taken from infertile cows to measure trace mineral levels. The information was analyzed to identify patterns and differences between the three localities related to infertility.

Animals studied

A total of 75 dairy cow with a history of infertility were used in this study. Samples were collected from the three localities of Khartoum State namely Khartoum, Bahri, and Omdurman (n = 25 each).

Structured questionnaires

There were designed to collect the required data concerning a wide range of causes of infertility in dairy farms. Two types of questionnaires had been used one of them concerning farm (area, shelter, tick spray and hygiene measure) and the other one was related to the animal (infertility number, age, calving number and nutrition).

Sample collection

A total of 75 blood samples (5ml each) had been taken from the jugular vein in plain vacutainers left to separate at room temperature for 24 hour and the clear serum was harvested in Eppendorf tubes and kept at -20 ºC for the analysis.

Blood sample

Blood samples (5 ml) were collected from the jugular vein of each cow using sterile vacutainer tubes. The samples were allowed to clot and then centrifuged to separate the serum, which was stored at -20°C until analysis. Serum concentrations of copper, cobalt, and zinc were measured using an atomic absorption spectrophotometer, while phosphorus and iodine were determined using spectrophotometric methods. Additionally, structured questionnaires were used to collect data on farm management practices, including housing, hygiene, nutrition, vaccination, and veterinary supervision.

Sample analysis

The spectrophotometric method was adopted for the determination of Phosphorus and Iodine (Afkhami and Zare, 2001). The micro minerals (Cu, Co and Zn) were measured with the help of atomic absorption spectrophotometer (Butrimovitz and Purdy, 1977). Made in England uncan929 A.A UV spectrometer.

Analysis of Copper, Cobalt and Zinc from serum

Sample preparation

Serum was diluted for analysis of Copper and Cobalt in 1:1, and Zinc 1: 5 with deionized water according to method by Butrimovitz and Purdy (1977).

Calculation according to (Young, 1991).

Analysis

Determination of the concentration of Copper, Cobalt and Zinc were listed in the Standard condition section. Copper and cobalt standards prepared by diluting Copper and Cobalt stock standard solution, described in the "Standard condition" for Copper and Cobalt with 10% (v/v) glycerol. A 10% (v/v) glycerol solution should also be used as blank solution when determining Copper and Cobalt.

Zinc standards were prepared by diluting the stock Standard solution, described in the Standard condition for Zinc with 5% (v/v) glycerol. A 5% (v/v) glycerol solution should be used as blank solution when determining zinc (Butrimovitz and Purdy, 1977)**.**

Data analysis

The data were analyzed using SPSS software (version 11.5). One-way ANOVA and Chi-square tests were used to assess statistical differences, and significance was considered at $P < 0.05$**.**

Results and Discussion

A total of 800 dairy cattle were examined across farms located in Khartoum, Bahri, and Omdurman. The average number of cows per farm was as follows: Khartoum (74.52 ± 14.575), Bahri (52.68 ± 15.290), and Omdurman (71.44 ± 19.509).

The mean number of infertile cows recorded was 2.92 ± 0.770 in Khartoum, 3.60 ± 0.624 in Bahri, and 2.12 ± 0.267 in Omdurman. The average ages of the dairy cows were 7.28 ± 0.478 years in Khartoum, 8 ± 0.361 in Bahri, and 8.4 ± 0.402 in Omdurman.

The average farm areas were reported as 5897.71 ± 2838.24 m² in Khartoum, 690.80 ± 159.512 m² in Bahri, and 723.20 ± 432.432 m² in Omdurman. The mean number of calving per cow was 2.79 ± 0.276 in Khartoum, 2.92 ± 0.251 in Bahri, and 2.76 ± 0.260 in Omdurman.

Statistical analysis showed no significant differences among the three localities in terms of these management factors (Table 2).

Vaccination Practices

The proportion of vaccinated dairy cattle varied significantly across localities: Khartoum (51%), Bahri (14.3%), and Omdurman (34.3%) ($p = 0.01$). Vaccination rates against Foot and Mouth Disease (FMD) were 40% in Khartoum, 10% in Bahri, and 50% in Omdurman. For FMD combined with Anthrax, the rates were 64.3% (Khartoum), 14.3% (Bahri), and 21.4% (Omdurman). No significant differences were observed in the vaccination against other disease combinations (Table 3).

Hygiene, Tick Control, and Veterinary Supervision

Hygiene routines varied: daily cleaning was practiced by 33.3% of farms in Khartoum, 8.3% in Bahri, and 58.3% in Omdurman. Weekly and monthly cleaning frequencies also varied, with no significant differences found among the localities ($p = 0.200$). Tick control practices showed that regular spraying was done by 39.3% of farms in Khartoum, 46.4% in Bahri, and 14.3% in Omdurman ($p = 0.153$). Veterinary supervision was present in 50% of Khartoum farms, 15.4% in Bahri, and 34.6% in Omdurman, with no significant difference observed ($p = 0.123$) (Table 4).

Feeding Practices and Shelter

Nutritional inputs varied across regions. The combination of cane, concentrate, and limestone was used in 47.5% of Khartoum farms, 30.4% in Bahri, and 21.0% in Omdurman.

Additionally, a more diverse diet (clover, cane, concentrate, local feed, and limestone) was more common in Bahri (75%) compared to Khartoum (25%) and Omdurman. Shelter availability and nutrition patterns did not show statistically significant differences between the three localities (Table 5).

Reproductive Health

Early abortion rates were 37.5% in Khartoum, 50% in Bahri, and 12.5% in Omdurman. Late abortion rates were 0% in Khartoum, 50% in both Bahri and Omdurman. No significant differences were observed in abortion rates or in other reproductive factors such as the presence of calving areas or animal types (cattle only vs. mixed herds) (Table 6).

Serum Mineral Analysis

Significant differences were observed in certain trace mineral concentrations in the serum of infertile dairy cows. Copper (Cu) levels were significantly higher in Bahri (0.147 ± 0.006 mg/L) compared to Khartoum (0.114 ± 0.005 mg/L) and Omdurman (0.100 ± 0.002 mg/L) ($p < 0.001$). Cobalt (Co) levels were significantly lower in Bahri (0.048 ± 0.001 mg/L) compared to Khartoum (0.055 ± 0.001 mg/L) and Omdurman (0.058 ± 0.002 mg/L) ($p = 0.003$).

No significant differences were found in serum levels of Zinc (Zn), Phosphorus (Po), or Iodine (I) among the localities. The mean concentrations of these minerals were within the following ranges: Zn (0.181–0.197 mg/L), Po (3.69–3.81 mg/L), and I (2.88–3.13 mg/L) (Table 7).

In the present study, the overall prevalence of infertility among dairy cattle in Khartoum State was 9.4%. This rate is relatively low compared to previous findings, such as those by Tamador and Moamer (2014), who reported a prevalence of 17.31% in the Eastern Nile region. Furthermore, the infertility rate observed in this study is markedly lower than the 32.6% reported by Maryam *et al.,* (2012) in southern Iran, indicating potential regional, environmental, or management-related differences.

The vaccination rate against major infectious diseases such as Foot and Mouth Disease (FMD), Anthrax, Contagious Bovine Pleuropneumonia (CBPP), and Hemorrhagic Septicemia (HS) was found to be 33.3%. This is significantly lower than the 65.2% reported by Adam and Ibtisam (2015).

The discrepancy could be attributed to various factors including vaccine failure, improper storage and handling, incorrect timing or route of administration, limited availability of vaccines, and lack of awareness among farm owners (Cashman *et al.,* 2008; Mohamed *et al.,* 2017).

Only 33.3% of the farms surveyed were under regular veterinary supervision. This finding is in contrast to the results of Adam and Ibtisam (2015) and Mohamed (2011), who reported supervision rates of up to 98.9%.

The lack of veterinary follow-up in the current study may be explained by low awareness among farmers regarding the role of veterinarians in improving reproductive and general herd health.

With respect to hygiene, only 30.6% of farms practiced regular dung removal. This is significantly lower than the 61.1% reported by Mansour *et al.,* (2014) and the 56% documented by Cashman *et al.,* (2008). These variations may be linked to seasonal changes, labor availability, or farm design, as some farmers reported removing dung every 1–3 days or weekly based on circumstances.

In terms of nutrition, 33.3% of the farms used a ration composed of cane, concentrate, and limestone. This agrees with the findings of Abdalla *et al.,* (2015), who reported a similar practice (30%) in Mossay. However, this feeding strategy may be nutritionally insufficient and reflects poor dietary management practices, which are known to negatively impact reproductive performance.

Mineral deficiencies are a well-known cause of reproductive inefficiency in dairy cattle (Mohamed *et al.,* 2017). Trace elements such as copper, cobalt, phosphorus, zinc, and iodine play essential roles in maintaining reproductive function, hormone production, and normal estrous cycles (Kennedy and Miller, 2007).

In this study, serum zinc concentrations did not vary significantly between localities ($p > 0.05$), which contradicts findings by Akhtar *et al.,* (2014) and Mohamed *et al.,* (2017), who reported significant associations between zinc levels and infertility ($p = 0.04$).

Conversely, serum copper concentrations differed significantly ($p < 0.05$), being highest in Bahri, which agrees with findings reported by Ahmed *et al.,* (2010), but contradicts Ceylan *et al.,* (2008) and Mohamed *et al.,* (2017), who found no significant relationship ($p = 0.3$).

Phosphorus levels did not show significant variation across study areas ($p > 0.05$), in contrast to Burle *et al.,* (1995) and Mukund *et al.,* (2014), who reported statistically significant differences ($p = 0.00$).

Cobalt levels, on the other hand, showed significant variation among the localities ($p < 0.05$), with lower values in Bahri, disagreeing with Abhijit *et al.,* (2015), who found no significant differences ($p = 0.4$). Lastly, iodine levels also exhibited significant differences, suggesting that trace mineral imbalances could be contributing factors to infertility in the studied herds.

Table.1 Mean number and standard errors (S.E) of data collected (number of cows, number of the infertile, age, area and calving number) from Dairy Farm in Khartoum State

Traits	Localities			Significant
Number of cows	**Khartoum**	**Bahri**	**Omdurman**	
74.52 ± 14.575	52.68 ± 15.290	71.44 ± 19.509	0.604	
Number of the infertile	2.92 ± 0.770	3.60 ± .624	2.12 ± 0.267	0.217
Age	7.28 ± 0.478	8 ± 0.361	8.4 ± 0.402	0.353
Area	5897.71 ±2.838.24	690.80 ±159.512	723.20 ± 432.432	0.41
Calving number	2.79 ± 0.276	2.92 ± 0.251	2.76 ± 0.260	0.90

Table.2 Results of data analysis of vaccination and vaccination against disease in dairy farms in Khartoum State

Factors	Localities			Chi Square	Significant
	Khartoum	**Bahri**	**Omdurman**		
Vaccination					
Yes	51%	14.3%	34.3%	13.607	0.01
No	17.5%	50%	32.5%		
Vaccination against disease					
FMD	40%	10%		10.007	0.615
Anthrax	0%	0%			
FMD+Anthrax	64.3%	14.3%			
FMD+Anthrax+HS	50%	50%			
FMD+Anthrax+HS+CBPP	100%	0%			

Table.3 Results of data analysis (hygiene measure, tick spray and veterinary supervision) of Dairy Farms in Khartoum state

Factors	Localities			Chi Square	Significant
	Khartoum	**Bahri**	**Omdurman**		
Hygiene measure				8.551	0.200
Daily					
Weekly	33.3%	8.3%	58.3%		
Monthly	28.6%	34.8%	28.3%		
Others	37%	60%	20%		
	28.6%	28.6%	42.9%		
Ticks spray				9.393	0.153
Regular	39.3%	46.4%	14.3%		
Irregular	36.1%	27.8%	36.1%		
Veterinary				13.607	0.1
supervision	50%	15.4%	34.6%		
Yes	24.5%	42.9%	32.7%		
No					

Table.4 Results of the data analysis (shelter and nutrition) of dairy farms in Khartoum state

Factors	Localities			Chi Square	Significant
	Khartoum	Bahri	Omdurman		
Shelter					
Yes	32.3%	30.6%	37.1%	0,758	0.685
No	38.5%	46.2%	15.5%		
Nutrition					
Cane					
Concentrate	50%	50%	0%		
Lime stone	50%	0%	50%	40.295	0.369
Cane+ concentrate + limestone	0%	0%	100%		
	47.5%	30.4%	21.0%		
Clover + cane + concentrate +local + lime stone	25%	75%	0%		

Table.5 Results of data analysis of dairy cattle farms in Khartoum State

Factors	Localities			Chai square	significant
	Khartoum	Bahri	Omdurman		
Abortion					
Early	37.5%	50%	12.5%	3.938	0.140
Late	0%	50%	50%		
Calving area					
Yes	33.3%	44.4%	22.2%	0.758	0.685
No	33.3%	31.8%	34.8%		
Animal type					
Cattle	40%	29.8%	29.8%	6.063	0.194
Cattle+ sheep	6.7%	46.7%	9.3%		
Cattl+sheep+goat	33.3%	33.3%	33.3%		

Table.6 Mean± standard errors values for different minerals in the serum of dairy cattle with infertility in Khartoum State

Elements	Localities			P Value
	Khartoum	Bahri	Omdurman	
Cu mg/L	0.114±0.005b	0.147±0.006a	0.100±0.002b	0.000
Zn mg/L	0.197±0.016a	0.181±0.005a	0.193±0.006a	0.585
Co mg/L	0.055±0.001a	0.048±0.001b	0.058±0.002a	0.003
Po mg/L	3.733±0.053a	3.808±0.043a	3.690±0.107a	0.399
I mg/L	3.127±0.073a	2.884±0.151a	2.950±0.091a	0.312

Note: In tables, values marked with different letters (a, b) indicate statistically significant differences between means, ($p < 0.05$). ± SE while identical letters denote no significant differences.

These findings highlight the importance of comprehensive reproductive health programs that include proper vaccination, hygiene management, nutritional adequacy, and mineral supplementation to mitigate infertility in dairy cattle.

This study highlights the significant role of copper and cobalt deficiencies, along with poor farm management practices, in contributing to infertility among dairy cattle in Khartoum State. The low levels of veterinary supervision and vaccination further worsen the problem.

To improve reproductive performance and reduce infertility rates, it is essential to enhance mineral supplementation, strengthen veterinary services, and promote better hygiene and feeding practices in dairy farms.

Author Contributions

Badwi A. montasir: Investigation, formal analysis, writing—original draft. Shadia A. Mohamed: Validation, methodology, writing—reviewing. Abdalla A. O. Abdelrahim:—Formal analysis, writing—review and editing. Nabaa kamal Alshafei: Investigation, writing—reviewing. S. O. Nawal: Resources, investigation writing—reviewing. I. A. Abdelrhman: Validation, formal analysis, writing—reviewing. Adil M. A. Salman: Conceptualization, methodology, data curation, supervision, writing—reviewing the final version of the manuscript. M. I. M. Fangama: Investigation, formal analysis, writing—original draft

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

References

Abdalla, A. A., Mohamed, E. M., and Elhassan, A. M. (2015). Nutrition practices and their effect on reproductive performance of dairy cattle in Mossay region, Sudan. *Sudan Journal of Animal Production*, *9*(1), 55–61.

Abhijit, D., Sharma, S. K., and Kumar, R. (2015). Role of cobalt in animal reproduction: A review. *Veterinary World*, *8*(1), 19–22.

Adam, A., and Ibtisam, M. (2015). Evaluation of dairy farm management practices and vaccination programs in Khartoum State, Sudan. *Sudan Veterinary Journal*, *20*(2), 101–107.

Afkhami, A. and Zarei, A. R. (2001). Spectrophotometric Determination Of Period ate And Iodated *By A* Differential Kinetic Method. Talanta Vol.53, pp 815– 821, ISSN *0039- 9140*. https://doi.org/10.1016/s0039-9140(00)00577-4

Ahmed, A. M., El-Wakeel, M. A., and Nour, M. S. (2010). Serum copper concentration and fertility status in crossbred dairy cows. *Journal of Animal and Veterinary Advances*, *9*(2), 337–341.

Akhtar, M., Ali, M., and Ashraf, M. (2014). Zinc supplementation and its effect on reproductive performance in repeat breeder dairy cows. *Pakistan Veterinary Journal*, *34*(2), 208–211.

Beigh, Y. A., Rouf, R. D., and Javeed, A. M. (2016). Role of micronutrients in bovine reproduction. *Theriogenology Insight*, *6*(1), 57–65. https://doi.org/10.5958/2277-3371.2016.00008.4

Burle, P. S., Patil, N. A., and Deshpande, S. B. (1995). Phosphorus deficiency and infertility in crossbred cows. *Indian Journal of Animal Reproduction*, *16*(1), 47–49.

Butrimovitz, G. P and Purdy W. C. (1977) The Determination of Zinc in Blood Plasma By Atomic Absorption Spectrometry, *Anal.Chim.Acta*94,63 -73. https://doi.org/10.1016/S0003-2670(01)83632-1.

Cashman, K., Walshe, M., and Doran, L. (2008). Evaluation of hygienic practices and biosecurity measures in dairy farms. *Livestock Research for Rural Development*, *20*(7), Article #105.

Ceylan, A., Aksakal, V., and Aksu, D. S. (2008). Effects of copper and zinc levels on reproduction in dairy cows. *Journal of Animal and Veterinary Advances*, *7*(4), 512–516.

Chaudhary, S., and Singh, A. (2004). Role of nutrition in reproduction: A review. *Intas Polivet*, *5*, 229–234.

Kennedy, D., and Miller, J. K. (2007). Mineral imbalances and reproductive failure in cattle. *Veterinary Clinics of North America: Food Animal Practice*, *23*(2), 345–362.

Mansour, S. A., Khalifa, H. A., and Yousif, A. O. (2014). Assessment of cleaning practices in dairy cattle farms in Sudan. *Sudan Journal of Veterinary Science and Animal Husbandry*, *53*(3), 102–110.

MARFIC, 2015. Ministry of Animal Recourses Fisheries Informational Center.

Maryam, F., Rahimi, S., and Gharagozlou, F. (2012). A survey on infertility prevalence and risk factors

in dairy cows in southern Iran. *Iranian Journal of Veterinary Research*, *13*(4), 287–292.

Mohamed, E. M., Rahama, M. Y. A., and Salman, A. M. A. (2017). The effect of mineral supplementation on reproductive efficiency of repeat breeder cows in Sudan. *Global Journal of Animal Scientific Research*, *5*(1), 13–21.

Mohamed, S. A. (2011). Coverage of veterinary services in dairy farms of Khartoum State. *Sudan Veterinary Journal*, *18*(2), 45–51.

Mukund, D. G., Bhosale, S. V., and Patil, P. K. (2014). Role of phosphorus in reproductive health and productivity in dairy cows. *Indian Journal of Animal Reproduction*, *35*(1), 58–61.

Satish Kumar. (2003). Management of infertility due to mineral deficiency in dairy animals. In *Proceedings of ICAR Summer School on Advance Diagnostic Techniques and Therapeutic Approaches to Metabolic and Deficiency Diseases*.

Tamador, A. A., and Moamer, A. H. (2014). Study on the incidence and causes of infertility in dairy cows in Eastern Nile locality, Khartoum State. *Sudan Journal of Veterinary Research*, *29*, 70–75.

Young, D. S. (1991). Effect of drugs on clinical laboratory tests.3e ed; AACCpressWashinton (DC), 1991; Supplement No.1,1991.

How to cite this article:

Badwi A. montasir, Shadia A. Mohamed, Abdalla A. O. Abdelrahim, Nabaa kamal Alshafei, S. O. Nawal, I. A. Abdelrhman, Adil M. A. Salman and Fangama, M. I. M. 2025. Impact of Farm Management and Trace Mineral Status on Infertility in Dairy Cattle in Khartoum State, Sudan. *Int.J.Curr.Microbiol.App.Sci.* 14(08): 161-175.
doi: https://doi.org/10.20546/ijcmas.2025.1408.015