



## Research Article



# Risk Factors Associated with Production and Reproduction in Dairy Camps (Kuku and Saig) at Khartoum State, Sudan

Sundos G. A. Yousif<sup>1</sup>, and Ibtisam E. M. El Zubeir<sup>2,3,\*</sup> <sup>1</sup>Ministry of Agriculture and Animal Resources and Irrigation, Khartoum State, Sudan<sup>2</sup>Institute for Studies and Promotion of Animal Exports, University of Khartoum, Khartoum, P.O. Box 321 Postal code 13314, Sudan<sup>3</sup>Department of Dairy Production, Faculty of Animal Production, University of Khartoum, Khartoum, P.O. Box 321 Postal code 13314, Sudan

\* **Corresponding author:** Ibtisam E. M. El Zubeir, Department of Dairy Production, Faculty of Animal Production, University of Khartoum, Khartoum, P.O. Box 321 Postal code 13314, Sudan. Email: [Ibtisamelzubeir17@gmail.com](mailto:Ibtisamelzubeir17@gmail.com); [Ibtisam.elzubeir@uofk.edu](mailto:Ibtisam.elzubeir@uofk.edu)

## ARTICLE INFO

**Article History:**

Received: 22/01/2024

Revised: 20/02/2024

Accepted: 01/03/2024

Published: 25/03/2024

**Keywords:**

Dairy camp

Reproductive disorder

Risk factor

## ABSTRACT

**Introduction:** Lack of awareness about reproductive disorders and their importance in the economic viability of farms in Sudan causes challenges among the majority of small farmholders. The present study was conducted to investigate the risk factors of production and reproduction in Kuku and Saig dairy camps in Khartoum State, Sudan.

**Materials and methods:** In December 2017, a random selection of 100 farms was carried out. The current cross-sectional study was based on a structural questionnaire and direct interviews with the farm owners.

**Results:** Vaccination against contagious diseases was practiced in 80% of the farms in the Kuku and Saig dairy camps in Khartoum State, Sudan. Quarantine of sick animals and newly introduced cows to the herd was practiced only in 23% of the farms. The study found a high prevalence of mastitis (95 farms), the spread of tick infestation (86 farms), and theileriosis (53 farms). There have been 58 farms, where animals showed signs of lameness and 67 farms showed signs of jaundice disease. In the case of selected dairy camps, natural mating was predominant at 98% and bulls from outside the herd accounted for 89% of farms. Besides, 75% of the selected farms suffered from repeat breeders' syndrome. The culling strategy was used in 86% of the dairy farms. There was a low risk of association between the treatment of diseases by the veterinarian, washing labor's hands and udders of cows before and after the milking process, and between the type of mating and repeat breeders. In addition, there was a moderate risk of a correlation between the treatment of the disease by the veterinarian and the contact of other species of animals with the cows in the pen, monitoring of estrus and repeat breeders, abortions, and calving intervals as well. Moreover, a high risk of correlation was obtained between the isolation of animals and the use of vaccination.

**Conclusion:** Control of the disease was unsatisfactory, especially in the Saig camp, with traditional basis management. Hence it is highly recommended to train the farm workers, improve their management, and enhance the animals' health level.

## 1. Introduction

About 80% of the consumed milk in Khartoum State is produced through traditional systems. Other milk production sectors include dairy cooperative societies, private sector farms, and modern dairy farms<sup>1</sup>. Cows are known as the main milk producing animals in Khartoum State, specifically, cross dairy cows as predominant herds<sup>2</sup>.

Traditionally, milk production in small quantities for family needs is the beginning of dairy development, as the surplus of milk is usually sold in the nearby areas<sup>2</sup>. The main challenge to dairy herd farmers is to maintain a dairy herd profit and prevent economic loss, especially when dairy cattle is reared under stressful conditions. To achieve

► Cite this paper as: Yousif SGA, El Zubeir IEM. Risk Factors Associated with Production and Reproduction in Dairy Camps (Kuku and Saig) at Khartoum State, Sudan. Farm Animal Health and Nutrition. 2024; 3(1): 1-13. DOI: 10.58803/fahn.v3i1.34



The Author(s). Published by Rovedar. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

this goal, farmers have to manage the herd and improve the overall health indices, increase milk yield, and reproductive performance<sup>3</sup>.

Due to the tropical conditions, the most insufficient reproductive performance was observed in Sudan<sup>4</sup>. Moreover, lack of awareness about reproductive disorders and their importance in the economic viability of these farms causes challenges among the majority of small farm holders<sup>5</sup>.

Although some factors are out of control, farmers have to manage their businesses and prevent financial risks<sup>6</sup>. The infectious diseases may directly affect livestock productivity, improve mortality, and reduce rates of reproduction, milk production, and weight gain<sup>7,8</sup>. Stakeholders in the dairy industry reported many barriers to the implementation of biosecurity practices by farmers. Barriers include limited money and time in sub-optimization of farm infrastructure and management systems to support biosecurity<sup>9</sup>. However, the knowledge of risk factors that enhance the spreading of infectious diseases is a vital prerequisite for effective control, management, and eradication of these diseases<sup>10</sup>. In addition, there are constraints on livestock production that can be addressed by improving the genetic potential of the animal, such as feed conversion efficiency, female productivity and fertility, influencing sex ratios, and resistance to parasites and pathogens. Further, quality attributes, including nutritional content and meat texture are effective<sup>11</sup>.

Besides the lack of records and the channels of milk marketing in Khartoum State, trained laborers, availability of feeds, and herd health are the other herd owner's problems<sup>2</sup>. Traditional farm management in most parts of Khartoum North, runs dairy producers into many restrictions, including labor problems, spread of epidemic diseases, high ration price, and difficulties in marketing the milk<sup>12</sup>. Additionally, the major problems, that affect the dairy sector, include the prices of drugs, lack of new technologies and extension services, high cost of nutrition, poor veterinary services, and water security<sup>13</sup>.

The present study was conducted to investigate the possible risk factors of production and reproduction in dairy camps (Kuku and Saig dairy camps), Khartoum State, Sudan. It is aimed to help and draw the attention of the policy departments of Kuku and Saig projects as well as making decisions and improving the production and reproduction status of the dairy cows in Khartoum State.

## 2. Materials and Methods

### 2.1. Ethical approval

The current study was conducted according to the Institutional Animal Care and Use stated by Committee guidelines of Khartoum University, Sudan.

### 2.2. Study area

The present study was carried out during December

2017, targeting dairy farms located at Soba West Agriculture Project (Saig dairy project) and Kuku dairy project (Mahlab 2 and Mahlab 3 camps) in Khartoum State, Sudan.

#### 2.2.1. Kuku dairy project

The Kuku dairy project, as the largest milk-producing and marketing area in Khartoum State was started in 1960 in Khartoum North, Sudan. It is regarded as a semi-intensive system of milk production. The Kuku dairy project farms consisted of 3 camps that were distributed in the area, each camp contained small units and a few numbers of cows to large dairy herds.

#### 2.2.2. Soba west agriculture project (Saig project)

Saig dairy project was established in 2006 in Khartoum south, Sudan. The Ministry of Agriculture and Animal Resources and Irrigation, Khartoum State rented out an area. The project was a compound of 3 dairy camps, including Alsabeel, Alazhari, and Jabra. The capacity of Saig project was 20000-25000 head/cow, with 454 barns, and variable housing systems.

### 2.3. Questionnaire and data collection

The study was a cross-sectional survey with open-ended questionnaire. Risk factors of production and reproduction were investigated in 100 farms in the selected camps according to the participant's ability (52 participants in Saig and 48 participants in Kuku). Data was collected through recording and taking notes.

### 2.4. Statistical analysis

The data were analyzed via the Statistical Package of Social Science (SPSS) software program version 16. Descriptive statistic, such as count and percentage using frequency and cross-tabulation was performed, while analytical statistic was used to compare the means of the location. The chi-square test and correlation ( $p < 0.05$ ) were used to get significant levels between variables to estimate the risk of some variables.

## 3. Results and Discussion

### 3.1. General information about farmers and dairy farms

The obtained result indicated highly significant variation regarding the ownership of the farms ( $p < 0.05$ ). In the Saig project, 48% were governmental lessor, whereas in the Kuku project, only 9% of dairy farms were rented, and the rest (43%) were owned by the producers (Table 1). The low percentage of Kuku dairy project is due to the establishment in 1960.

The illiteracy among represented dairy owners in Khartoum State reported 13% in the present study in Kuku project and 9% in Saig project as shown in Table 1.

**Table 1.** General information about the dairy farm's owners in Kuku and Saig projects in Sudan

Location	Ownership of farm				Education level					
	Own	Lessor	Governmental	Total	Illiterate	Basic	Primary	Secondary	University	Total
Kuku	43 (43%)	9 (9%)	0	52 (52%)	13 (13%)	1 (1%)	34 (34%)	1 (1%)	3 (3%)	52 (52%)
Saig	0	0	48 (48%)	48 (48%)	9 (9%)	2 (2%)	32 (32%)	0	5 (5%)	48 (48%)
Total	43 (43%)	9 (9%)	48 (48%)	100 (100%)	22 (22%)	3 (3%)	66 (66%)	1 (1%)	8 (8%)	100 (100%)

Significant difference ( $p < 0.05$ )

Ns: Non-significant difference

It was less than that reported (26.8%) among Kuku dairy cooperative's members<sup>14</sup>. However, the highest illiteracy level (36%) was reported among dairy farm owners in Khartoum State, while 22% of dairy farmers had informal education<sup>2</sup>. Some of the educated people involved in dairy farming, especially at Saig, Soba West project, the newly established project (Table 1). Based on the present study, most dairy workers had primary education (66%) and a few of them had basic (3%), and secondary (1%) levels of education. In addition to the illiteracy, ignorance of the continual routine and regular training resulted in the lack of awareness of good hygienic practices<sup>12</sup>.

### 3.2. Farming experiences and record keeping

As can be seen in Table 2, more than 73% of the farmers had more than 10 years of experience in dairy farming (41% in Kuku project and 32% in Saig project). Furthermore, farm owners with 10 years of experience were reported as 17% (6% in Kuku and 11% in Saig project). However, there were producers with about five

years of experience (5% in Kuku and 4% in Saig project, Table 2). The obtained results supported the previous study, which found that about 17% of the farm owners have 10 years of experience<sup>15</sup>.

Table 2 indicates that keeping records was found in only 25% of the studied farms (18% and 7% of the farms in Kuku and Saig projects, respectively). The recording was rarely found in dairy farms in Khartoum State<sup>15</sup>. However, half of the dairy owners (50%) in Nyala, South Darfur State used the records<sup>16</sup>. Most of the records in Khartoum State dairy farms were poor<sup>2,17</sup>. Although recording was vital, farm owners did not pay attention to the importance of the recording system. Health records can be used to control diseases, treatment the cows, and avoid many health hazards<sup>1</sup>.

### 3.3. Breeds and pens and types of production

Table 3 shows that all studied farms in Khartoum State were specialized for dairy production. Similar findings were reported previously<sup>12</sup>.

**Table 2.** Farming experiences and record keeping in Kuku and Saig dairy projects in Sudan

Location of farm	Farming experiences				Record keeping		
	5 years	10 years	>10 years	Total	Yes	No	Total
Kuku	5 (5%)	6 (6%)	41 (41%)	52 (52%)	18 (18%)	34 (34%)	52 (52%)
Saig	4 (4%)	11 (11%)	32 (32%)	48 (48%)	7 (7%)	41 (41%)	48 (48%)
Total	9 (9%)	17 (17%)	73 (73%)	100 (100%)	25 (25%)	75 (75%)	100 (100%)

Ns: Non-significant difference

**Table 3.** Information about the breed and construction of pens in Kuku and Saig projects in Sudan

Location of farm	Breeds			Pens							
	Cross	Cross+ Local	Total	Building				Shad			
				Iron	Wood	Iron + Wood	Other	Total	Yes	No	Total
Kuku	48 (48%)	4 (4%)	52 (52%)	11 (11%)	4 (4%)	4 (4%)	33 (33%)	52 (52%)	42 (42%)	10 (10%)	52 (52%)
Saig	34 (34%)	14 (14%)	48 (48%)	3 (3%)	7 (7%)	1 (1%)	37 (37%)	48 (48%)	38 (38%)	10 (10%)	48 (48%)
Total	82 (82%)	18 (18%)	100 (100%)	14 (14%)	11 (11%)	5 (5%)	70 (70%)	100 (100%)	80 (80%)	20 (20%)	100 (100%)

Significant difference ( $p < 0.05$ )

Ns: Non-significant difference

**Table 4.** Types of feed trough and water trough in Kuku and Saig projects in Sudan

Location of farm	Feed trough structure					Water trough structure				
	Iron	Building	Other	Iron and Building	Total	Iron	Building	Tube	Other	Total
Kuku	19 (19%)	31 (31%)	1 (1%)	1 (1%)	52 (52%)	9 (9%)	41 (41%)	1 (1%)	1 (1%)	52 (52%)
Saig	39 (39%)	2 (2%)	7 (7%)	0	48 (48%)	33 (33%)	6 (6%)	5 (5%)	4 (4%)	48 (48%)
Total	58 (58%)	33 (33%)	8 (8%)	1 (1%)	100 (100%)	42 (42%)	47 (47%)	6 (6%)	5 (5%)	100 (100%)

Significant difference ( $p < 0.05$ )

Building designs with local materials were observed in more than 70% of the investigated farms, 33% in Kuku Project, and 37% in Saig Project (Table 3). The findings agreed with the previous reported results by Mohammed and El Zubeir<sup>15</sup> and Yousif and Fadl Elmoula<sup>17</sup>. In addition, 30% of the dairy farms used metals and wood in the farm buildings, the farm buildings using metal and wood revealed 19% in Kuku Project and 11% in the Saig Project (Table 3). The farm constructed materials in Khartoum State included available materials and some of dairy units were divided into fences for different age groups of the cows<sup>2</sup>. The present result also agreed with those reported that metal, wood, and hay were common in constructing dairy farm buildings in Khartoum<sup>12</sup>. However, about 55% of dairy farms in Mossay district at Nyala, South Darfur State, were constructed from constant materials (bricks, iron, and cement), while 20% were made of local materials and the remaining (5%) were prepared from both constant and local materials<sup>16</sup>. In the present study, 80% of the pens were found to have shaded areas (42% of dairy farms in the Kuku project and 38% in Saig project) as shown in Table 3, data supported the previous findings<sup>16</sup>. The provision of adequate shading is the easiest and most effective way to control cows' heat stress<sup>13</sup>. Additionally, A key survey showed that the dairy farms had this issue engaged in several malpractices in Eastern Nile, Khartoum State. In view of the poor construction of the majority of farms and the lack of management skills in the areas of nutrition strategy, general hygiene, herd health programs, herd growth and replacement, and milk marketing, the majority of farms have been poorly constructed and have limited management skills<sup>12</sup>.

The cows found were cross breed, Freisian  $\times$  local breed; they were 48% in Kuku project and 34% in Saig project. However, the presence of both local and cross-breeders on the same farm was reported as 4% in Kuku project and 14% in Saig project (Table 3). It was due to the average milk yield/cow/year for the foreign breed, which was 4.3 tons/year, for the crossbreed is 2.6 tons/year, and for the local breeds is 1.6 tons/year<sup>1</sup>. The present data revealed highly significant variation ( $p < 0.05$ ). It is clear that all farmers had cross-breed dairy cattle and local breeds with unknown foreign blood levels. Lack of records could be the main reason. The finding was in line with the previous reports, which stated that the herd consisted of cross breeds (local  $\times$  Freisian) in Kuku Project<sup>2,12,14</sup>. The dairy farmers mentioned that the milk yield of the

crossbreed was reported between (20-25 L/day), while the Friesian cows yielded about (35 L/day). Moreover, in these projects, the owners have been shifted to cross cows since the local cows produce lower milk<sup>2</sup>.

### 3.4. Feeding, watering, and nutrition in dairy farms

Highly significant variations were found between the studied dairy farms in two areas concerning the feeding and watering materials ( $p < 0.05$ , Table 4). In addition, significant differences were found for the used ratio of roughages to concentrate, the accurate level was only observed in 5% and 17% of the dairy farms in Kuku and Saig projects ( $p < 0.05$ , Table 5). In spite of the animal's physiological status, the concentrate was distributed to the dairy herds<sup>18</sup>.

The obtained results from farm visits indicated that 82% of dairy farms 45% in Kuku project and 37% in Saig project concentrated in feeding their herds with hay (Table 5). Moreover, one farm in Kuku project and two farms in Saig project used only roughage to feed their cows, while the total mixed ration was used in 2% and 5% of the farms in the Kuku and Saig projects, respectively. It was also found that 4% of the farms in each of Kuku and Saig projects besides the concentrates use some industrial by-products.

In Kuku, 21% and in Saig projects 22% of farms are considered for animal fodder requirements in the production process (Table 5). Similarly, farmers in the Kuku and Alrudwan projects have been found to provide a suitable adequate feed ration for their dairy herds, which has taken into account health and production<sup>2</sup>. About 96.67% of farm owners fed their herds' green fodder by adding concentrates and 55% of them fed concentrates not according to the productivity of the cow<sup>12</sup>. The present result goes in line with Mustafa et al.<sup>8</sup>, which reported that farms were mixed with fodder by 24% of smallholders and 8.9% mixed farms with fodder and crops. Due to its scarcity and significant price, forage is one of the main problems for dairy cow owners<sup>16</sup>. However, forced slaughter related to these welfare reasons will be reduced by improvements in health care, housing, and nutrition<sup>19</sup>.

The sources of concentrate in the dairy farms are the sale points, directly from the producing companies or both. The purchased concentrates from companies indicated 19% of farms located at Kuku and 5% in Saig projects, while 30% of farms in Kuku project and 19% in Saig



project purchased the concentrates from the market. The data revealed significant differences as shown in Table 5 ( $p < 0.05$ ). However, 8% and 9% of the studied farms in Kuku and Saig projects, respectively, changed their concentrate mixture frequently (Table 5). The feeding system depends on many factors, including the experience of the farm's owners and their labors, the feed mainly roughages (sorghum, stover, and alfa 70), and concentrates (groundnut cake, wheat bran, and a total mixed ration for dairy cattle) is purchased from the local markets<sup>1</sup>.

### 3.5. Biosecurity in dairy farms

It was noted that 60% of the dairy owners in Khartoum State reared only cows in their dairy farms. However, 40% of dairy farms, 30% of the farms located at the Kuku project, and 10% in the Saig project reared sheep, goats, horses, and donkeys beside the cows (Table 6). A highly significant difference was shown (Table 6), which agreed with the similar previous study ( $p < 0.05$ )<sup>15</sup>. In Kuku, dairy cow keepers rear cows, sheep, goats, and chickens. The main milk-producing animal is cow (60%) on their farm<sup>2</sup>.

In Khartoum State, 77% of dairy farms were reported without quarantine measurement of the newly coming animals. This is consistent with the report, which stated that most of the farms under investigation had not implemented quarantines for newly introduced cows and 75% did not apply proper disposal of dead calves as this could pose risks to dairy farming or public health<sup>20</sup>. Since 64.4% of the owners of the farms keep their dairy cows in the farms, the quarantine of newly introduced cows in Khartoum State was carried out in 34.4% of the total farms<sup>15</sup>. In addition, practices considered to be the most efficient in measures of biosecurity were part of keeping a quarantined herd and having new animals tested for disease status on farms when they are purchased<sup>21</sup>. Moreover, animals should be prevented from direct contact with each and before handling cattle, wearing protective clothes should be instructed to professional visitors<sup>22</sup>. The majority of respondents believed that the purpose of on-farm biosecurity was to prevent the introduction of a new pathogen and the spread of an existing pathogen and considered general biosecurity to be effective and important<sup>23</sup>.

Table 6 shows the weekly pen cleaning practice basis in 47% of the farms in Kuku and 41% in the Saig project. However, 5% of the farms in the Kuku project and 3% of the farms in the Saig project were cleaned every two weeks. In addition, 4% of the farms in the Saig project were cleaned for more than two weeks. In Khartoum State, most of the pens appeared to be heavily contaminated with dung, and the cows in the pens appeared to have teats heavily soiled with dung. Although the cows were heavily visibly soiled, most of the farm's owners stated that they removed dung between 3-7 days, which might be due to the small size of the pens and the large number of herds enclosed<sup>24</sup>. Moreover, the daily manure disposal by selling was practiced by the majority of farm householders (87.8%) in Khartoum North<sup>8</sup>.

According to Table 6, 18% of the pens in the Kuku project and 5% in the Saig project were used to isolate the cows. The sanitation system was implemented in 35% and 13% of the farms located at Kuku and Saig projects, respectively. Similarly, the ventilation and general hygiene at both maternity and pens and milking parlors are poor among the cow herds in Alrudwan Dairy Camp, Khartoum State<sup>1</sup>. Moreover, testing, isolation, and culling were practiced by a few of the dairy farms in Khartoum State<sup>24</sup>.

Laborers washed their hands before milking in (37%) of the farms in the Kuku project and (42%) in the Saig Project (Table 6). Cleaning hands before milking was rarely practiced in Khartoum State<sup>15</sup>. Washing and udder sanitation before and after milking were done in 6% of the Kuku project farms and 2% of the farms at Saig project (Table 6). Cleaning udder was rare in Khartoum State<sup>15</sup>. Poor hygiene in milking places may maximize the faecal contamination risk of the teats during milking and it is strongly recommended that teats must be cleaned and dried<sup>1</sup>. The highest prevalence of *Listeria* spp. in teats sampled from the dairy farms at Khartoum indicated the lack of cleaning udder and/or lubricating the teats with unclean animals that might lead to contamination of teats<sup>25</sup>. Moreover, the abnormal milk was disposed off directly in the pens in most of the dairy farms in Khartoum State<sup>24</sup>. It could lead to cross-contamination and the spread of bacteria from the milk to other sources<sup>25</sup>. Therefore, in order to improve their management and hygienic practices along with the health of animals, it was recommended that cooperation be established between dairy farmers<sup>24</sup>.

### 3.6. Health and veterinary supervision in dairy farms

In Kuku project (51%) and in Saig project farms (46%) of the laborers were treated for diseases (Table 7). The veterinarian treated 38% and 47% of sick cows in Kuku and Saig projects, respectively. This finding showed a highly significant difference ( $P < 0.05$ ) in Table 7.

In all studied farms diseases were treated in pens. According to Table 7, 54% of the dairy farms are under veterinary supervision (26% of the farms in Kuku project and 28% of the farms in Saig project). A slightly higher value (60.8%) was reported previously for the supervision of the dairy farms in Khartoum State. There was a highly significant difference in that treatment mostly was done by the owners and herd keepers<sup>15</sup>. Hence, many health problems that might arise in those farms are due to the complete absence of veterinary supervision<sup>24</sup>.

Concerning the treatment of sick animals, the notes show that pharmaceutical was ordinarily done by veterinarians with the assistance of rancher proprietors and laborers as a common practice (97%) compared to drugs practiced by the veterinarian alone (85%). Similarly, 98.9% of the dairy farms were monitored by veterinarians<sup>12</sup>. In addition, it was specified that medicine was ordinarily done by the veterinarians with the assistance of the laborers (43.33%), compared to those veterinarians who did it alone (18.9%)<sup>15</sup>. Furthermore, it was

**Table 5.** Compounds of nutritional strategy in dairy farms in Kuku and Saig projects in Sudan

Location of farm	Nutrition																	
	Consecrate: roughages				Consecrate				Amount				Source				Change	
	Yes	No	other	Total	roughage s	Consecrat e	Consecrate + roughages	other	Total	Yes	Total	Compan y	Marke t	both	Total	Yes	No	Total
Kuku	5 (5%)	46 (46%)	1 (1%)	52 (52%)	1 (1%)	2 (2%)	45 (45%)	4 (4%)	52 (52%)	22 (22%)	52 (52%)	19 (19%)	30 (30%)	3 (3%)	52 (52%)	8 (8%)	44 (44%)	52 (52%)
Siag	17 (17%)	26 (26%)	5 (5%)	48 (48%)	2 (2%)	5 (5%)	37 (37%)	4 (4%)	48 (48%)	21 (21%)	48 (48%)	5 (5%)	19 (19%)	24 (24%)	48 (48%)	9 (9%)	39 (39%)	48 (48%)
Total	22 (22%)	72 (72%)	6 (6%)	100 (100%)	3 (3%)	7 (7%)	82 (82%)	8 (8%)	100 (100%)	43 (43%)	100 (100%)	24 (24%)	49 (49%)	27 (27%)	100 (100%)	17 (17%)	83 (83%)	100 (100%)

Significant difference (p &lt; 0.05)

**Table 6.** Biosecurity measurements in dairy farms at Kuku and Saig projects in Sudan

Location of farm	Biosecurity														
	Presence of other animals		Number of dung removal			Isolations pen		Sanitation			Washing hand			Washing udder and Sanitation	
	Yes	No	Weekly	2 week	More than week	Yes 6 (6%)	No	Yes	No	Total	Yes	No	Total	Yes	No
Kuku	30 (30%)	22 (22%)	47 (47%)	5 (5%)	0 52 (52%)	2 (2%)	34 (34%)	35 (35%)	17 (17%)	52 (52%)	37 (37%)	14 (14%)	51 (51%)	6 (6%)	45 (45%)
Saig	10 (10%)	38 (38%)	41 (41%)	3 (3%)	4 (4%)	8 (8%)	43 (43%)	13 (13%)	35 (35%)	48 (48%)	42 (42%)	6 (6%)	48 (48%)	2 (2%)	46 (46%)
Total	40 (40%)	60 (60%)	88 (88%)	8 (8%)	4 (4%)	23 (23%)	77 (77%)	48 (48%)	52 (52%)	100 (100%)	79 (79%)	20 (20%)	99 (99%)	8 (8%)	91 (91%)

Significant difference (p &lt; 0.05)

Ns: Non-Significant difference

**Table 7.** Health management in dairy farms at Kuku and Saig projects in Sudan

Location of farm	Treatment of diseases														
	By labors			By veterinarian			In pen			Vaccination			Veterinary		
	Yes	No	Total	Yes	No	Total	Yes	No	Total	Yes	No	Total	Yes	No	Total
Kuku	51 (51%)	1 (1%)	52 (52%)	38 (38%)	14 (14%)	52 (52%)	52 (52%)	0	52 (52%)	44 (44%)	8 (8%)	52 (52%)	26 (26%)	26 (26%)	52 (52%)
Saig	46 (46%)	2 (2%)	48 (48%)	47 (47%)	1 (1%)	48 (48%)	48 (48%)	0	48 (48%)	36 (36%)	12 (12%)	48 (48%)	28 (28%)	20 (20%)	48 (48%)
Total	97 (97%)	3 (3%)	100 (100%)	85 (85%)	15 (15%)	100 (100%)	100 (100%)	0	100 (100%)	80 (80%)	20 (20%)	100 (100%)	54 (54%)	46 (46%)	100 (100%)

Significant difference (p &lt; 0.05)

found that the disease was not controlled properly in Khartoum State, as most of the laborers give the treatment without consultation with the veterinarians<sup>2</sup>. Around 70% of the dairy farm owners in Pennsylvania (USA) treat their animals with medicine<sup>26</sup>. In Tanzania and Sudan, farm owners give their livestock antibiotics without prescription<sup>27,28</sup>.

The majority of farm owners (80%) vaccinate the animals against contagious diseases, such as contagious bovine pleura-pneumonia, hemorrhagic septicemia, black quarter, and anthrax. In 44% of the farms in Kuku project and 36% of the Saig project farms, vaccination against contagious diseases was noticed (Table 7)<sup>15</sup>. Since the government has continuous programs to control contagious diseases, vaccination was practiced in 65.2% of the investigated farms. However, some farmers had not responded to the vaccination program because they believed that vaccinating their cows would lead to disease. Moreover, vaccination against contagious diseases was administrated irregularly and preventive measures practices were not optimum<sup>15,24</sup>. Although vaccination reduced the infection and clinical signs of the diseases, it did not prevent losses in milk production<sup>29</sup>.

### 3.7. Occurrence of diseases in dairy farms

Table 8 shows the occurrence of diseases, including mastitis, brucellosis, theileriosis, tick infestation, lameness, jaundice, infectious diseases, diarrhea, metritis, and arthritis. Ignorance and unawareness of health aspects and hygienic practices might lead to contamination of milk and other sources<sup>25</sup>.

Mastitis was reported in a high percentage, it was reported in 46% of the farms in the Kuku project and 44% of farms in the Saig project (Table 8). More than 90% of cows suffered from mastitis, due to poor hygienic practices during milking and absence of drying programs<sup>15</sup>. In Alrudwan dairy camp, Khartoum State, a high incidence of mastitis was observed 64% compared to 35.4% during the dry season<sup>1</sup>. Some farmers could not recognize the dangers of consuming infected milk that contains pathogenic bacteria or their toxins<sup>30</sup>. Mastitis was prevalent in 70% of the studied farms in Khartoum State and it was recommended that dairy farmers should receive the essential training and extension<sup>24</sup>.

In the present study, the prevalence of brucellosis is low (13%). The prevalence of brucellosis was found as 4% and

9% in the Kuku and Saig projects, respectively (Table 8). The highest numbers of aborted cows at late pregnancy were shown in the dairy farms in Khartoum, while those at Khartoum North and Omdurman were relatively lower<sup>24</sup>. In addition, the brucella antibodies were detected in 86.67% of the milk samples, which might create health risk<sup>24</sup>. However, the prevalence of anti-brucella antibodies in Khartoum State was relatively higher. Therefore, brucellosis in cattle is, perhaps a significant public health problem. It is recommended to make the cattle owners and/or herders more aware of brucellosis transmission<sup>10</sup>.

The tick infestation was reported in 46% of the farms in Kuku project and 40% of the farms in the Saig project. In the same way, drier summer conditions and wet summers were reported 62.5% and 38.15%, respectively in terms of overall number diagnosed as ticks with an infection and the prevalence of tick infestation<sup>1</sup>. Moreover, the major cause for the widespread tick infestation in Alrudwan dairy campus is the muddy and baked-brick buildings that ticks can stay in their wall for years<sup>1</sup>. Suffering from theileriosis was 32% in the farms in Kuku project and 21% in Saig project farms (Table 8). The high level of ticks and theileriosis indicated the prevalence of cows' theileriosis (Table 8), which agreed with Mohammed et al.<sup>15</sup>, which reported 66.7% of theileriosis and 88.9% of ticks spread in the total farms. The prevalence of *Theileria* spp. was higher in females and in cross-bred Friesian × Zebu compared to Zebu breeds and highest among heifers and steers aged 1-4 years old<sup>31</sup>.

Jaundice was reported in 67% of the dairy farms, it was reported in 32% of Kuku farms, and in 35% of farms in Saig projects (Table 8). It is higher than those estimated for Jaundice disease in dairy operations (22%) and beef operations (8%)<sup>32</sup>. Diarrhea and Jaundice were found as the major causes of mortality in suckling calves in Khartoum State<sup>13</sup>.

The obtained data indicated the presence of lameness (58%, Table 8). Lameness was found in 22% and 36% of the farms in Kuku project and Saig project, respectively. Foot injuries were one of the common reasons 2.0% for involuntary culling in Khartoum State<sup>3</sup>. Due to the impact on animal welfare, economics, and consumer perceptions, lameness in dairy cattle is a serious problem for the industry<sup>33</sup>. Since lame cows in the previous lactation will be at a higher risk of becoming lame again<sup>34</sup>. In order to reduce the level of lameness in herds, though, awareness of risk factors may enable producers to make decisions on

**Table 8.** Occurrence of diseases in dairy farms at Kuku and Saig projects in Sudan

Location of farm	Types of diseases								
	Mastitis	Brucellosis	Theileriosis	Tick	Lameness	Jaundice	Infectious diseases	Other	Total
Kuku	46 (46%)	4 (4%)	32 (32%)	46 (46%)	22 (22%)	32 (32%)	23 (23%)	20 (20%)	49.2%
Saig	44 (44%)	9 (9%)	21 (21%)	40 (40%)	36 (36%)	35 (35%)	51 (51%)	39 (39%)	50.8%
Total	90 (90%)	13 (13%)	53 (53%)	86 (86%)	58 (58%)	67 (67%)	74 (74%)	59 (59%)	100%

where changes should be made<sup>33</sup>.

Other infectious diseases were reported as 23% and 51% in the dairy farms in Kuku project and Saig project, respectively. In addition, some other diseases were found in the farms reported as (20%) in the Kuku Project and (39%) in Saig Project (Table 8). In dairy units at Khartoum State, diseases in dairy cattle caused an annual loss of million Sudanese Dinars (SD), a large portion of which is attributable to deaths, treatment costs, reduced feed efficiency, and drop in milk yield<sup>1</sup>.

### 3.8. Occurrence of reproductive diseases in dairy farms

Table 9 indicates that occurrence of reproductive diseases, such as the retained placenta was found in 24% of the farms in Kuku project and 39% of the farms in Saig project. The data indicated significant difference ( $p < 0.05$ ). The major reproductive problems in Sudan were abortion, infertility stillbirth, metritis, and retained placenta<sup>5</sup>. The percentage of retained placenta present in the current study was in line with Mayne et al.<sup>35</sup>, who concluded poor body condition associated with a risk of retained placenta after calving. The incidence of retained placenta (63.5%) was high during the wet summer conditions compared to those that occurred during dry summer (36.5%) in Alrudwan dairy camp, Khartoum State<sup>1</sup>. It was reported by most farmers that there are cases of retained fetal membranes (RFM, 63%) of cows had once retained placenta, 28% had retained placenta twice, and 8% had it three times<sup>36</sup>. Moreover, in Sudan, RFM is one of the common conditions for cattle with infertility problems, hence maintaining an adequate dietary source of the minerals at the end of the pregnancy period is recommended<sup>36</sup>.

In 22% of the farms located in Kuku project, and 28% of the farms in the Saig project abortion was found (Table 9). The incidence of abortion at late pregnancy was higher at the farms in Khartoum town, while it was relatively lower in Khartoum North and Omdurman towns. The highest number of aborted cows at late pregnancy showed 16 cases in dairy farms in Khartoum town<sup>24</sup>. It is difficult to determine the causes of bovine abortion because numerous infectious and noninfectious factors cause abortion<sup>37</sup>. According to the dairy owners in central Sudan, the occurrence of abortion and infertility are economic losses due to the death of newborn calves and the drop in milk yield<sup>5</sup>.

Milk fever was present in 38% of the farms, including, 16% and 22% of the farms in the Kuku and Saig projects, respectively (Table 9). It might be due to the decrease in calcium intake during the dry period<sup>38</sup>. Milk fever disorder during the dry season was high 59.3% compared to that occurred during the wet summer season 40.7% in Khartoum State<sup>1</sup>. The prevalence and incidence rate of milk fever in Khartoum State was in the range of 2.2 and 8.0% among the examined herds. Moreover, milk yield, age, and previous history represented high-risk factors for the occurrence of milk fever<sup>39</sup>.

### 3.9. Reproduction management in dairy farms

The obtained results from farm visits showed that 98% of the dairy farms practiced natural mating, the natural mating was practiced in 52% and 46% of the farms in Kuku and Saig projects, respectively (Table 10). In addition, in 49% and 40% of the farms located within the Kuku project as well as Saig project, there was a source of bull from that farm. Similarly, most of the farmers in Khartoum North Province (91.1%) use natural mating and the remaining proportion were reported to use artificial insemination<sup>18</sup>. Additionally, natural mating was adopted by all herders in extensive and semi-extensive systems in Kordofan, Sudan<sup>40</sup>. The artificial insemination was found to be used in combination with natural mating in 42.67% of farms. Only 10% of dairy farms were found to use artificial insemination as a method for insemination<sup>12</sup>.

The present result found high significant ( $P < 0.05$ ) variation in monitoring the estrous (Table 10). Monitoring of estrous in dairy farms was relatively high (36%) in dairy farms located in the Kuku project compared to those in dairy farms located in Saig project (15%). It also indicated the farmer's experience and management skills in Kuku project. The improvement of fertility traits in heifers and cows could be achieved by improving reproductive management such as successful detection of heat and timely insemination<sup>41</sup>.

The estrous signs are clearly shown in 48% and 27% of the cows in dairy farms in the Kuku and Saig projects respectively, while the rest of the farms use hormonal protocol for estrous detection. The data showed significant ( $p < 0.05$ ) variations as shown in Table 10. Moreover, 8% of the farms in the Kuku Project use estrous synchronization ( $p < 0.05$ ). Detection of estrus was carried out early in the morning and late in the afternoon<sup>42</sup>.

### 3.10. Control of reproductive disorders in dairy farms

As can be seen in Table 11, only 3% of the farms in the Kuku project were found to estimate fertility percent. The possible factors involved in the failure are inadequate estrous detection, inadequate animal identification, and/or inadequate records. Lack of ovarian activity caused due to anemia, energy deficiency, low hormone levels associated with prolonged feeding, pyometra, quiet or silent estrus/estrus normal ovarian activity with little or no sign of estrus<sup>43</sup>. Moreover, involuntary culling due to infertility represents 17.7% of dairy farms in Khartoum State<sup>3</sup>. Reproductive performance is considered based on age at first service, age at first calving, days open, calving interval, number of services per conception, and breeding efficiency<sup>44</sup>.

The dairy farms controlling the calf interval were found as 6% in dairy camps (5% in the farms in Kuku and 1% in Saig projects) as shown in Table 11. Thus, factors, such as male fertility, heat detection specificity, and timing of breeding should be monitored<sup>6</sup>. In order to breed regularly, it is vital to have functional ovaries, display estrous behavior, mate, conceive, sustain the embryo through



**Table 9.** Occurrence of reproductive diseases in dairy farms at Kuku and Saig projects in Sudan

Location of farm	Reproductive disease											
	Retained Placenta			No of cases (1-10)	Abortion			No case 1-10	Milk fever			No case 1-10
	Yes	No	Total		Yes	1-10	total		Yes	No	total	
Kuku	24 (24%)	28 (28%)	52 (52%)	34 (34%)	22 (22%)	30 (30%)	52 (52%)	22 (22%)	16 (16%)	35 (35%)	51 (51%)	16 (16%)
Saig	39 (39%)	9 (9%)	48 (48%)	38 (38%)	28 (28%)	20 (20%)	48 (48%)	27 (27%)	22 (22%)	25 (25%)	47 (47%)	22 (22%)
Total	63 (63%)	27 (27%)	100 (100%)	72 (72%)	50 (50%)	50 (50%)	100 (100%)	49 (49%)	38 (38%)	60 (60 %)	98 (98%)	38 (38%)

Significant difference (p &lt; 0.05)

Ns: Non-Significant difference

**Table 10.** Reproductive management in dairy farms at Kuku and Saig projects in Sudan

Location of Farms]	Type of mating			Source of bull			Monitoring of estrous			Heat detection				Estrous synchronization		
	Natural	Artificial	Total	In	out	Total	Yes	No	Total	Natural	Hormonal	both	Total	Yes	No	Total
Kuku	52		52	49	3	52	36	16	52	48	3	1	52	8	44	52
	(52%)	0	(52%)	(49%)	(3%)	(52%)	(36%)	(16%)	(52%)	(48%)	(3%)	(1%)	(52%)	(8%)	(44%)	(52%)
Saig	46	2	48	40	8	48	15	33	48	27	7	14	48	0	48	48
	(46%)	(2%)	(48%)	(40%)	(8%)	(48%)	(15%)	(33%)	(48%)	(27%)	(7%)	(14%)	(48%)		(48%)	(48%)
Total	98	2	100	89	11	100	51	49	100	75	10	15	100	8	92	100
	(98%)	(2%)	(100%)	(89%)	(11%)	(100%)	(51%)	(49%)	(100%)	(75%)	(10%)	(15%)	(100%)	(8%)	(92%)	(100%)

Significant difference (p &lt; 0.05)

**Table 11.** Control of reproductive disorders in dairy farms at Kuku and Saig projects in Sudan

Location of Farm	Fertility estimation			Calving interval			Uterine prolapse			Repeat breeder			No case		
	Yes	No	Total	Yes	No	Total	Yes	No	Total	Natural	Hormonal	Total	1-10	More than 15	Total
Kuku	3 (3%)	49 (49%)	52 (52%)	5 (5%)	47 (47%)	52 (52%)	8 (8%)	44 (44%)	52 (52%)	40 (40%)	12 (12%)	52 (52%)	48 (48%)	0	48 (50%)
Saig	0 (48%)	48 (48%)	48 (48%)	1 (1%)	47 (47%)	48 (48%)	8 (8%)	40 (40%)	48 (48%)	35 (35%)	13 (13%)	48 (48%)	47 (47%)	1	48 (50%)
Total	3 (3%)	97 (97%)	100 (100%)	6 (6%)	94 (94%)	100 (100%)	16 (16%)	84 (88%)	100 (100%)	75 (75%)	25 (25%)	100 (100%)	95 (95%)	1 (1%)	100 (100%)

Ns: Non-Significant difference

**Table 12.** Reproductive monitoring in dairy farms at Kuku and Saig projects in Sudan

Location of Farm	Calving pens			Check of conception			Ultrasound			Replacement			Culling		
	Yes	No	Total	Yes	No	Total	Yes	No	Total	Yes	No	Total	Yes	No	Total
Kuku	6 (6%)	46 (46%)	52 (52%)	27 (27%)	25 (25%)	52 (52%)	2 (2%)	50 (50%)	52 (52%)	49 (49%)	3 (3%)	52 (52%)	47 (47%)	5 (5%)	48 (50%)
Saig	4 (4%)	44 (44%)	48 (48%)	14 (14%)	34 (34%)	48 (48%)	1 (1%)	47 (47%)	48 (48%)	39 (39%)	9 (9%)	48 (48%)	39 (39%)	9 (9%)	48 (50%)
Total	10 (10%)	90 (90%)	100 (100%)	41 (41%)	59 (59%)	100 (100%)	3 (3%)	97 (97%)	100 (100%)	88 (88%)	12 (12%)	100 (100%)	86 (86%)	14 (14%)	100 (100%)

Ns: Non-significant difference

gestation, calve, resume estrous cyclist, and restore uterine function after calving<sup>43</sup>. On the other hand, intervention by farmers, that includes prevention and control of endometritis disease in the dairy herd should be facilitated for prioritization in extension services<sup>45</sup>.

In the selected dairy farms of the Kuku project and Saig project, 8% of cases were reported by uterine prolapse (Table 11). Furthermore, in the Alrudwan dairy campus, 7 cows were suffering from uterine prolapse<sup>1</sup>. As it was observed during the current study, pre-calve dystocia, environment, and nutrition might cause the problem. In addition, reproductive problems in dairy cow's result from uterine infections<sup>46</sup>. However, the incidence of reproductive disorders was more frequent in intensively managed farms compared to semi-intensively managed one<sup>5</sup>.

The repeat breeder cases (1-15) were found in 40% of the farms located in the Kuku project and 35% in Saig project. Using of the hormones to control repeat breeder was practiced in 12% and 13% of the dairy farms in Kuku project and Saig project, respectively (Table 11). However, correcting the plasma glucose, Zn, Mn, and Fe as well as lowering the urea nitrogen could be an effective strategy to treat the repeat breeding syndrome in Sudanese crossbred cows<sup>47</sup>. Herds with repeated estrus were supplemented with copper and magnesium to minimize fertility problems. As the deficiencies of phosphorus and zinc are linked to low levels of progesterone, it could cause failure in fertilization or early embryonic death<sup>43</sup>. Unsaturated fatty acid diets improve the milk yield and embryo development rates when administered at dry and postpartum periods, thus it is beneficial in repeated breeding in dairy cow<sup>43</sup>.

### 3.11. Pregnancy testing and replacement strategy in dairy farms

There were calving pens in 6% of the dairy farms in the Kuku project and 4% in the Saig project farms (Table 12). During the last trimester, the pregnant cows should be looked after separately and in well-constructed calving pens<sup>42</sup>.

Pregnancy testing was practiced in 27% and 14% of farms in the Kuku and Saig projects, respectively, and the number of farms using ultrasound were 2% in the Kuku project and 1% in the Saig project (Table 12). The herd replacement was practiced in (49%) of the farms in the Kuku project and (39%) in the Saig project (Table 12).

According to Table 12, in 86% of the total dairy farms, cows were culled; 47% of the farms located in the Kuku project and 39% of the farms at Saig project. However, testing, isolation, and culling practices were not common in Khartoum State. Financial problems and reduced low yield in the herd were the main reasons for culling<sup>24</sup>. Infertility, mastitis, low milk yield, and accidents were the main reasons for the culling of Friesian dairy cows in Sudan<sup>48</sup>. The most common reasons for voluntary culling were economic, low milk yield, and age, while the reasons for involuntary culling include infertility, chronic mastitis (8.5%), and foot injuries<sup>3</sup>. Moreover, it was found that the dairy farmers culled their cows primarily for poor health, failure to conceive, or conformation problems<sup>19</sup>.

### 3.12. Estimation of risk in dairy camps

Table 13 indicates a significant positive correlation between washing hands and the treatment of disease by the veterinarian ( $p < 0.05$ ). Moreover, the presence of other animals in the cows' pen is significantly correlated ( $p < 0.05$ ) with the treatment of diseases by veterinarians. Both are found to be risk factors. In the previous study, El Hag et al.<sup>25</sup> reported positive correlations between the prevalence of *listeria* spp. and the general hygiene of the farms, animals, and dairy workers. Similarly, in the dairy herds in Khartoum State, poor records were most commonly observed<sup>24</sup>. The farm records were absent and record keeping in most of the dairy farms was considered as a risk<sup>20</sup>. Since farmers do not pay much attention to the importance of keeping records, the recording system is poor.

There was also a low risk of association between the treatment of diseases by the veterinarian and vaccinations (Table 13). Similarly, close relations were found between the poor husbandry practices adopted in the Alrudwan dairy camp and the prevailing over-diagnosed diseases<sup>1</sup>. Meanwhile, isolation of the animals and their vaccination, vaccination of the cows, and change of fodder were not correlated in the current study. However, no risk was found in the association between the change of diet and vaccination with the odd ratio = 0.7 as shown in Table 13. In Khartoum State, Sudan, medication was usually administered by veterinarians, and vaccination against contagious diseases was given by authorized veterinarian<sup>15</sup>. On the other hand, when the herd veterinarian does not routinely and actively inquire about

**Table 13.** Estimation of risk in dairy farms at Kuku and Saig projects in Sudan

Correlation	Within		total	Chi square	Odd Ratio
	Yes	No			
Washing hands	81.3	18.8	100	0.05	0.84
Treatment of diseases by vet	78.6	21.4	100		
Other animals in pen	40	60	100		
Treatment of disease by vet	37.5	62.5	100	0.03	1.1
Isolation	27.2	72.8	100		
Vaccinations	5.3	94.7	100		
Vaccinations	16	84	100	0.27	0.7
Change of fodder	21.1	78.9	100		
Repeat breeder	10.7	89.3	100		
Change of fodder	34.6	65.4	100	7.9	0.226
Repeat breeder	52	48	100		
Monitoring Estrous	50	50	100		
Treatment of disease by vet	77.4	22.6	100	4.4	0.77
Vaccinations	100	0	100		
Records	84	16	100		
Treatment of disease by vet	84.2	15.8	100	0.001	0.98
Repeat breeder	97.3	2.7	100		
Type of mating	100	0	100		
Abortion	8.3	91.7	100	0.32	1.6
Calving intervals	5.2	94.8	100		

the health and performance of calves during regular herd visits, the farm is classified as a high-mortality source dairy farm<sup>49</sup>.

Table 13 indicates that there is no risk for the association between repeat breeders and change in fodder (0.266= odd ratio). It was observed that the correlation for monitoring of estrus and repeat breeder was moderately at risk (1= odd ratio), which might relate to lack of heat in the farms. In addition, due to the poor heat detection and monitoring, a low risk of association between type of mating and repeat breeders (odds ratio =0.93) was found. It was suggested by Buaban et al.<sup>41</sup> that the inclusion of fertility in the breeding goal is necessary to optimize the result of genetic improvement of dairy cattle and feeding practices for growing and postpartum animals. Considerable economic losses in the dairy industry are tied with slower uterine involution, reduced reproductive rate, prolonged inter-conception, and calving interval, negative effect on fertility, increased cost of medication, drop in milk production, reduced calf crop, and early depreciation of potential useful cows<sup>42</sup>.

The present study estimated a moderate risk at the association between abortion and calving interval (odd ratio =1.6, Table 13). The abortion (57.1%) was figured out as the major problem affecting smallholder dairy cattle in central Sudan and most of the abortion cases (76.25%) took place during the third trimester<sup>5</sup>. Clinical endometritis, abortion, RFM, dystocia, and repeat breeding were major reproductive disorders that cause low reproductive performance in dairy cows<sup>43</sup>. Hence the managed interventions regarding the farm biosecurity and hygiene, seeking veterinary services for disease treatment, and selecting sires for ease of calving should be considered<sup>45</sup>.

## 4. Conclusion

It is concluded that the overall performance of dairy

farms located at the Kuku project is better than those reported in the Saig project. Moreover, the control of the disease was not satisfactory, especially in Saig camp, as most laborers treat animals by themselves and most farms are operated on a traditional basis in the absence of records. Training of farm owners, laborers, and milkers to manage and improve the health level is recommended in the current study. Awareness of proper farm building, house design, biosecurity measurement, and disease control is required and the official authorities should provide essential services to improve dairy production.

## Declarations

### Competing interests

The authors declare that they have no competing interests.

### Authors' contributions

Ibtisam E. M. El Zubeir, designed and supervised the research. Sundos G. A. Yousif collected samples and processed the data. Sundos G. A. Yousif analyzed and interpreted the data generated. All authors revised and approved the final manuscript.

### Funding

Not Applicable.

### Availability of data and materials

Data from the current study are available by reasonable request.

### Ethical considerations

Ethical publication issues, including plagiarism, consent

to publish, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy, have been checked by all authors.

## References

- Babiker IA. A case study of dairy camps in Khartoum State, management and health aspects. *Res J Agric Biol Sci.* 2007; 3(1): 8-12. Available at: <http://www.aensiweb.net/AENSIWEB/rjabs/rjabs/2007/8-12.pdf>
- El Zubeir IEM, and Mahala AG. An overview of the management practices and constraints at the dairy camps in Khartoum State, Sudan. Book of abstracts for the 10th world conference on animal production. Wageningen Academic, 2008. DOI: [10.3920/9789086865789\\_347](https://doi.org/10.3920/9789086865789_347)
- Karrar MH, Osman KhM, and Sulieman MS. Culling in dairy cattle farms of Khartoum, Sudan. *Online J Anim Feed Res.* 2017; 7(1): 1-8. Available at: [https://www.ojafr.com/main/attachments/article/125/OJAfr%207\(1\)%2001-08,%202017.pdf](https://www.ojafr.com/main/attachments/article/125/OJAfr%207(1)%2001-08,%202017.pdf)
- Sulieman MS, Makawi SEA, and Ibrahim KEE. Association between postpartum blood levels of glucose and urea and fertility of cross-bred dairy cows in Sudan. *S Afr J Anim Sci.* 2017; 47(5): 595-605. DOI: [10.4314/sajas.v47i5.2](https://doi.org/10.4314/sajas.v47i5.2)
- Elhassan AM, Fadol MA, Elfahal AMA, and El Hussein ARM. A cross sectional study on reproductive health disorders in dairy cattle in Sudan. *J Adv Vet Anim Res.* 2015; 2(2): 101-106. DOI: [10.5455/javar.2015.b57](https://doi.org/10.5455/javar.2015.b57)
- Lean IJ. A hazards analysis critical control point approach to improving reproductive performance in lactating dairy cows. *Asian-Aus J Anim Sci.* 2000; 13: 32-36.
- Ashuma SNS, Bal MS, Gupta MP, Kumar H, Kaur K, Filia G, et al. Occurrence of *Balantidium coli* in diarrhoeic faecal samples of cattle and buffaloes. *Indian Vet J.* 2012; 89(8): 120-121.
- Mustafa E, El Emam M, Abdelhadi O, and Salih A. The contribution of dairying to household welfare of the small commercial dairy keepers in Khartoum North province (KNP), Sudan. *Res Opin Anim Vet Sci.* 2011; 1(1): 55-59.
- Shortall O, Ruston A, Green M, Brennan M, Wapenaar W, and Kaler J. Broken biosecurity? Veterinarians' framing of biosecurity on dairy farms in England. *Prev Vet Med.* 2016; 132: 20-31. DOI: [10.1016/j.prevetmed.2016.06.001](https://doi.org/10.1016/j.prevetmed.2016.06.001)
- Ebrahim WOMK, Elfadil AAM, and Elgadal AA. Seroprevalence and risk factors of anti-brucella antibodies in cattle in Khartoum State, the Sudan. *J Adv Vet Anim Res.* 2016; 3(2): 134-144. DOI: [10.5455/javar.2016.c141](https://doi.org/10.5455/javar.2016.c141)
- Crute IR, and Muir JF. Improving the productivity and sustainability of terrestrial and aquatic food production systems: Future perspectives. *J Agric Sci.* 2011; 149: 1-7. DOI: [10.1017/S0021859611000074](https://doi.org/10.1017/S0021859611000074)
- Mohamed HAA, El Zubeir IEM, and Fadl Elmoula AA. Effect of husbandry practices on milk production in dairy farms in sharg Elneel Locality, Khartoum State U of K. *J Vet Med Anim Prod.* 2014; 5(2): 38-52.
- Saeed SY, and Fadel Elseed AMA. Management practices of dairy farms; Case study: Khartoum North and Eastern Nile localities, Khartoum, Sudan. *Online J Anim Feed Res.* 2015; 5(1): 9-17. Available at: [https://www.ojafr.com/main/attachments/article/108/Online%20J.%20Anim.%20Feed%20Res.%205\(1\)%2009-17,%202015.pdf](https://www.ojafr.com/main/attachments/article/108/Online%20J.%20Anim.%20Feed%20Res.%205(1)%2009-17,%202015.pdf)
- Musa LMA, Omer SK, Alkhider SO, and Elamin KM. Assessment of Kuku dairy cooperative production system in Sudan. *J Vet Med Anim Prod.* 2020; 9(1): 48-57.
- Mohammed AEI, and El Zubeir IEM. Some of biosecurity measurements in different dairy farms in Khartoum State, Sudan. *J Vet Sci Anim Health.* 2015; 7(3): 85-93. DOI: [10.5897/JVMAH2014.0321](https://doi.org/10.5897/JVMAH2014.0321)
- Eltahir HA, Shuipe ES, Elhussien HM, and Abdulshfee MG. A study of management, husbandry practices and production constraints of cross-bred dairy cattle in south Darfur state, Sudan. *Online J Anim Feed Res.* 2015; 5(2): 62-67. Available at: [https://www.ojafr.com/main/attachments/article/113/Online%20J.%20Anim.%20Feed%20Res.%205\(2\)%2062-67,%202015.pdf](https://www.ojafr.com/main/attachments/article/113/Online%20J.%20Anim.%20Feed%20Res.%205(2)%2062-67,%202015.pdf)
- Yousif IA, and Fadl Elmoula AA. characterization of Kenana cattle breed and its production environment. *Anim Genet Resour.* 2006; 38: 47-56. DOI: [10.1017/S1014233900002042](https://doi.org/10.1017/S1014233900002042)
- Elniema AM, Abdelhadi OMA, El Emam MB, and Salih AM. Husbandry management system and its effect on improvement of Sudanese indigenous livestock types in the Prei-uran region of Khartoum North province (KNP). *Glob Vet.* 2011; 6(1): 51-55.
- De Vries A, and Marcondes MI. Overview of factors affecting productive lifespan of dairy cows. *Animal.* 2020; 14(Supplement1): s155-s164. DOI: [10.1017/S1751731119003264](https://doi.org/10.1017/S1751731119003264)
- Mansour AEM, Abdelgadir AE, and El Zubeir IEM. Major causes and risk factors associated with calf mortality in dairy farm in Khartoum State Sudan. *J Vet Med Anim Health.* 2014; 6(5): 14-153. DOI: [10.5897/JVMAH2014.0277](https://doi.org/10.5897/JVMAH2014.0277)
- Shortall O, Green M, Brennan M, Wapenaar W, and Kaler J. Exploring expert opinion on the practicality and effectiveness of biosecurity measures on dairy farms in the United Kingdom using choice modeling. *J Dairy Sci.* 2017; 100(3): 2225-2239. DOI: [10.3168/jds.2016-11435](https://doi.org/10.3168/jds.2016-11435)
- van Schaik G, Schukken YH, Nielen M, Dijkhuizen AA, Barkema HW, and Benedictus G. Probability of and risk factors for introduction of infectious diseases into Dutch SPF dairy farms: A cohort study. *Prev Vet Med.* 2002; 54(3): 279-289. DOI: [10.1016/S0167-5877\(02\)00004-1](https://doi.org/10.1016/S0167-5877(02)00004-1)
- Denis-Robichaud J, Kelton DF, Bauman CA, Barkema HW, Keefe GP, and Dubuc J. Canadian dairy farmers' perception of the efficacy of biosecurity practices. *J Dairy Sci.* 2019; 102(11): 10657-10669. DOI: [10.3168/jds.2019-16312](https://doi.org/10.3168/jds.2019-16312)
- Ahmed MIA, and El Zubeir IEM. Husbandry practices and hygiene in dairy farms in Khartoum. Sudan. *World Vet J.* 2013; 3(3): 55-60. Available at: [https://www.scienceline.com/attachments/article/18/World's%20Vet.%20J.%203\(3\)%2055-60,%202013.pdf](https://www.scienceline.com/attachments/article/18/World's%20Vet.%20J.%203(3)%2055-60,%202013.pdf)
- El Hag MM, El Zubeir IEM, and Mustafa NE. Prevalence of *Listeria* species in dairy farms in Khartoum State (Sudan). *Food Control.* 2021; 123: 107699. DOI: [10.1016/j.foodcont.2020.107699](https://doi.org/10.1016/j.foodcont.2020.107699)
- Sawant AA, Sordillo LM, and Jayarao BM. A survey on antibiotic usage in dairy herds in Pennsylvania. *J Dairy Sci.* 2005; 88(8): 2991-2999. DOI: [10.3168/jds.S0022-0302\(05\)72979-9](https://doi.org/10.3168/jds.S0022-0302(05)72979-9)
- Katakweba AAS, Mtambo MMA, Olsen JE, and Muhairwa AP. Awareness of human health risks associated with the use of antibiotics among livestock keepers and factors that contribute to selection of antibiotic resistance bacteria within livestock in Tanzania. *Livest Res Rural Dev.* 2012; 24(10): 170. Available at: <https://lrrd.cipav.org.co/lrrd24/10/kata24170.htm>
- Addoma FE, Abdelgadir AE, El Nahas A, and El Zubeir IEM. Risk factors associated with antimicrobial residues in the milk consumed in Nyala, South Darfur State, Sudan. *U Khartoum J Vet Med Anim Prod.* 2016; 7(1): 22-32.
- van Schaik G, Klis CH, Benedictus G, Dijkhuizen AA, and Huirne RB. Cost-benefit analysis of vaccination against paratuberculosis in dairy cattle. *Vet Rec.* 1996; 5(1): 47-51. Available at: <https://pubmed.ncbi.nlm.nih.gov/9123788/>
- Hamid IMB, Shuipe ES, El Zubeir IEM, Saad AZ, and El Owni OAO. Influence of *Staphylococcus aureus* mastitis on milk composition of different dairy breeds of cattle in Khartoum State, Sudan. *World's Vet J.* 2012; 2(2): 13-16. Available at: [https://www.scienceline.com/attachments/article/13/World's%20Vet.%20J.%202\(2\)%2013-16,%202012.pdf](https://www.scienceline.com/attachments/article/13/World's%20Vet.%20J.%202(2)%2013-16,%202012.pdf)
- Hayati MA, Hassan SM, Ahmed SK, and Salih DA. Prevalence of ticks (*Acari: Ixodidae*) and *Theileria annulata* infection of cattle in Gezira State, Sudan. *Parasite Epidemiol Control.* 2020; 10: e00148. DOI: [10.1016/j.parepi.2020.e00148](https://doi.org/10.1016/j.parepi.2020.e00148)
- Wolf CA. Producer livestock disease management incentives and decisions. *Int Food Agribusiness Manag Rev.* 2005; 8(1): 46-61. DOI: [10.22004/ag.econ.8179](https://doi.org/10.22004/ag.econ.8179)
- Jewell MT, Cameron M, Spears J, McKenna SL, Cockram MS, Sanchez J, et al. Prevalence of lameness and associated risk factors on dairy farms in the Maritime Provinces of Canada. *J Dairy Sci.* 2019; 102(4): 3392-3405. DOI: [10.3168/jds.2018-15349](https://doi.org/10.3168/jds.2018-15349)
- Green LE, Huxley JN, Banks C, and Green MJ. Temporal associations between low body condition, lameness and milk yield in a UK dairy herd. *Prev Vet Med.* 2014; 113(1): 63-71. DOI: [10.1016/j.prevetmed.2013.10.009](https://doi.org/10.1016/j.prevetmed.2013.10.009)
- Mayne C, McCoy M, Lennox S, Mackey D, Verner M, Catney D, et al. Fertility of dairy cows in Northern Ireland. *Vet Rec.* 2002; 150(23): 707-713. DOI: [10.1136/vr.150.23.707](https://doi.org/10.1136/vr.150.23.707)
- Hamad MA, and Elnasri HA. Determination of some minerals concentrations in cows with retained fetal membranes in Khartoum State, Sudan. *European J Biomed.* 2019; 6(13): 148-152. Available at: [https://www.ejbps.com/ejbps/abstract\\_id/6328](https://www.ejbps.com/ejbps/abstract_id/6328)

37. Njiro SM, Kidanemariam AG, Tsotetsi AM, Katsande TC, Mnisi M, Lubisi BA, et al. A study of some infectious causes of reproductive disorders in cattle owned by resource-poor farmers in Gauteng Province, South Africa. *J S Afr Vet Assoc.* 2011; 82(4): 213-218. DOI: [10.4102/jsava.v82i4.76](https://doi.org/10.4102/jsava.v82i4.76)
38. Hansen SS, Ersbøll AK, Blom JY, and Jørgensen RJ. Preventive strategies and risk factors for milk fever in Danish dairy herds: A questionnaire survey. *Prev Vet Med.* 2007; 80(4): 271-286. DOI: [10.1016/j.prevetmed.2007.03.002](https://doi.org/10.1016/j.prevetmed.2007.03.002)
39. Sulieman MS, Makawi SE, and Ibrahim KE. Incidence and risk factors of milk fever among cross-bred dairy cows in Khartoum State, Sudan. *Bull Anim Health Prod Afr.* 2014; 62: 153-160. Available at: [http://repository.au-ibar.org/xmlui/bitstream/handle/123456789/482/BAHPA\\_62-2.pdf?sequence=1&isAllowed=y#page=49](http://repository.au-ibar.org/xmlui/bitstream/handle/123456789/482/BAHPA_62-2.pdf?sequence=1&isAllowed=y#page=49)
40. Bashir HHA, and El Zubeir IEM. Production and reproduction of Baggara cattle raised in traditional systems of South Kordofan State, Sudan. *J Anim Prod Adv.* 2013; 3(5): 192-202. DOI: [10.5455/japa.20130531093133](https://doi.org/10.5455/japa.20130531093133)
41. Buaban S, Duangjinda M, Suzuki M, Masuda Y, Sanpote J, and Kuchida K. Genetic analysis for fertility traits of heifers and cows from smallholder dairy farms in a tropical environment. *J Dairy Sci.* 2015; 98(7): 4990-4998. DOI: [10.3168/jds.2014-8866](https://doi.org/10.3168/jds.2014-8866)
42. Mengistu DW, and Wondimagegn KA. Evaluation of the reproductive performance of Holstein Friesian dairy cows in Alage ATVET college, Ethiopia. *Int J Livest Prod.* 2018; 9(6): 131-139. DOI: [10.5897/IJLP2018.0469](https://doi.org/10.5897/IJLP2018.0469)
43. Tagesu A. Review on the reproductive health problem of dairy cattle. *Dairy Vet Sci J.* 2018; 5(1): 555655. DOI: [10.19080/DVS.2018.05.555655](https://doi.org/10.19080/DVS.2018.05.555655)
44. Alemayehu T, and Moges N. Study on reproductive performance of indigenous dairy cows at small holder farm conditions in and around Maksegnit town. *Glob Vet J.* 2014; 13(4): 450-454. Available at: <https://www.cabdirect.org/cabdirect/abstract/20143378246>
45. Nyabinwa P, Kashongwe OB, Hirwa CDA, and Bebe BO. Perception of farmers about endometritis prevention and control measures for zero-grazed dairy cows on smallholder farms in Rwanda. *BMC Vet Res.* 2020; 16: 175. DOI: [10.1186/s12917-020-02368-6](https://doi.org/10.1186/s12917-020-02368-6)
46. Esalami M, Bolourchi M, Siefi HA, Asadi F, and Akbari R. Treatment of clinical endometritis in dairy cows by previously used controlled internal drug release devices. *Theriogenology.* 2015; 84(3): 437-445. DOI: [10.1016/j.theriogenology.2015.03.036](https://doi.org/10.1016/j.theriogenology.2015.03.036)
47. Ahmed ME, Ahmed FO, Frah EA, and Elfaki I. Blood biochemical profile of Sudanese crossbred repeat breeder cows. *Afr J Biotechnol.* 2017; 16(8): 366-370. DOI: [10.5897/AJB2016.15372](https://doi.org/10.5897/AJB2016.15372)
48. El Amin AAM, and El Zubeir IEM. The effect of some environmental factors on the disposal rate of Fresian dairy herd in Khartoum State, Sudan. *Sud J Vet Sci Anim Husb.* 2002; 41(1-2): 37-46.
49. Renaud DL, Kelton DF, LeBlanc SJ, Haley DB, and Duffield TF. Calf management risk factors on dairy farms associated with male calf mortality on veal farms. *J Dairy Sci.* 2018; 101(2): 1785-1794. DOI: [10.3168/jds.2017-13578](https://doi.org/10.3168/jds.2017-13578)