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Full Length Research Paper

Biosecurity estimations in diverse dairy cultivates in Khartoum State, Sudan

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Ninety dairy farms were surveyed in Khartoum State to investigate their veterinary supervision, management, husbandry, biosecurity and hygienic practices. The information was collected by using questionnaire, visits and direct interviews with farm owners. Supervision of the dairy farms revealed highly significant (P < 0.001) variations and mostly done by the owners and herd keepers (60.8%). Cows alone as the main milk producing animals represent 60% and the predominant herds were cross breed dairy cows. Medication was usually given by the veterinarians assisted by farm owners and laborers (47%). Vaccination against some contagious diseases as a routine was done in 65.2% of the farms. The data showed that dairy cattle come in contact with other animals from different herds or farms through natural mating (56.3%), during feeding (20.7%) and drinking (23%). Dipping areas, cleaning of milkers' hands before milking, cleaning of udder, and keeping records were rare. Quarantine of newly introduced cows was practiced in 34.4% of the studied farms and 64.4% of farms owners keep their dairy cows inside the farms without grazing. Dung removal within regular intervals was practiced by 61.1% of the dairy farms and the single use of disposal syringes for one animal was practiced in 45% of the farms. Well designed pens were observed only in 13.3% of the farms, while 70% of pens were designed with local materials. The current study showed high prevalence of mastitis (90%), thileriosis (66.7%) and tick infestation (88.9%) in the surveyed dairy farms and that diseases control were not satisfactory. Hence the present study recommended the training of animal producers and laborers (formal and vocational training) to increase awareness on house designing, rearing, herd management and biosecurity and health supervision of their herds.

Key words: Dairy farms, biosecurity, health supervision, hygiene.

INTRODUCTION

The term “Biosecurity” is concerned with the protection and safety of dairy cows (Cullor, 2004). Therefore,

biosecurity is increasingly important to include in daily routines for farm management as well as veterinary practice (Anderson, 2010). Dairy farms considering expansion will have to respect sound biosecurity measures in order to maintain disease free herds and sustain maximum production. Infectious diseases can enter a herd through purchased additions or be carried onto a farm by other animal species including humans (Wallace, 2003). Therefore, strict quarantine procedures, more thorough sanitation, increased testing for pathogens and less contact between animals are important (Cullor, 2004). By identifying some of the diseases that are likely to be of greatest risk, prevention and control measures can be developed and implemented to focus on the ones that are most likely to create problems (Wallace, 2003).

Ahmed and El Zubeir (2013) reported that in the majority of the farms in Khartoum - Sudan, the general hygiene and sanitation measures were not satisfactory, as mastitic cows are milked directly on the floor of the pens in 83% of the farms. In another study, Mansour et al. (2014) reported that most of the farms under investigation did not quarantine the newly introduced cows and 75% of the farms did not apply proper disposal of dead calves which might be risky for dairy farms and public health. Similarly, Vasilev et al. (2007) in Bulgaria reported that the presence of high number of dirty animals has constituted the precondition for presence of high number of somatic cells in milk and increased risk of subclinical mastitis. However, Abdalla and El Hagaz (2011) found that the application of some hygienic practices prior to milking cows is an important factor in reducing the bacterial load of raw milk to produce safe milk for consumption. Hence, in order to recommend suitable, applied and economical ideal health (biosecuriy) management program, the present study is designed to study the current situation of biosecurity practices for health management in dairy farms in Khartoum State, Sudan. It also aimed to test the association between the health supervision of the farms and the management practices.

MATERIALS AND METHODS

Study area description

Khartoum, the capital of Sudan, consists of three towns; Khartoum, Khartoum North (Bahri) and Omdurman. These three towns are situated along the riverbanks where the White and Blue Nile merge to form the River Nile. The city, with its annual average rainfall of 161 millimeters during July to September is situated in the arid and semiarid tropics. Ecological zone is between latitude 15 and 16.4° north, longitude 31 and 34.4° east (Ministry of Agricultural, Animal Wealth and Irrigation of Khartoum State, 2011). The average minimum and maximum temperatures range from 28 to 38°C during September and 16 to 31°C during January.

Animal populations and management systems

The animal population of Khartoum State is 1, 513, 409 head (cattle 262,258; camels 6,735; sheep 552,398 and goats 692,018) as reported by Ministry of Agriculture, Animal Wealth and Irrigation of Khartoum State (2011). This was estimated by using the annual growth rate (cattle 3%, camels 0.5%, sheep 2.5% and goats 3.5%) based on the total agricultural estimation for the year 2008. The human population of Khartoum is approximately six million people. This urban area has a great demand for foods, including animal products. The management systems in the study ranged from completely closed modern to grazing-based traditional systems.

Questionnaire and data collection

During four months between July and October, 2011, a 9 pages questionnaire was designed. Ninety commercial dairy cattle herds (producing milk for sale), representing large urban farms, were randomly chosen. The questionnaire included 3 parts: the first part (n = 8 questions) questions regarding general information about the farmers and farms. The second part (n = 8 questions) was about dairy cattle health and health problems, and the third part (n = 16 questions) covered current management and husbandry practices used on the selected dairy farms. The farms were selected according to the responders ability to participate and the 90 questionnaires were filled by direct interviewing of the responding farm' owners from Khartoum, Omdurman and Khartoum North. Observations were carried out to determine farm conditions and to identify potential problems encountered. Herds were stratified into three groups (according to the herd size). The herd size was estimated in numbers of heads in each herd, including both adult productive animals and heifers and calves for recruitment and bulls for breeding as follows: < 50 cattle; small producers, n = 41, from 51 to 100 cattle; medium producers, n = 31 and > 101 cattle; large producers, n = 18.

Statistical analysis

The data obtained were managed in Microsoft Excel (Microsoft Corporation, Redmond, WA, USA). The analysis of the data was done using Statistical Package for Social Science (SPSS) computer program (SPSS Institute Inc., Cary, NC, USA). Descriptive analyses and Chi-Square were conducted using SPSS version 16. Correlation was also made between health supervision and some of the managemental factors.

RESULTS

Almost all of the current studied farms were privately constructed and managed dairy farms (97.8%) compared to only two farms which were constructed by government sector capitals (Table 1). More than 55% of the farmers have more than ten years experience in dairy farming. Farmers with ten years experience were reported in 17 farms (18.9%). Newly introduced producers with only five year's experience were found to be 25.6% of total farms studied. All farmers own cross bred dairy cattle with unknown extend of foreign blood level. Some farmers had 5 to 10 years of experiences in dairy farming, owned

Table 1. General information about the dairy farmers and farms at Khartoum State.

Type of producer	Location of the farms (%)			Ownership of the farm (%)		Education level (%)				Farming experiences (%)		
	Khartoum	Khartoum North	Omdurman	Private	Governmental	Illiterate	Primary and intermediate	Secondary	University	> 5 years	5-10 years	>10 years
Small producers	11 (26.8)	17 (-41.50)	13 (-31.70)	41 (100)	0 (0.0)	7 (-17.10)	12 (-29.30)	13 (-1.70)	9 (22.0)	13 (31.7)	7 (-17.10)	21 (-51.20)
Medium producers	14 (-45.2)	7 (-22.60)	10 (-32.30)	30 (96.8)	1 (3.2)	6 (19.4)	10 (-32.30)	9 (-29.00)	6 (19.4)	8 (25.8)	6 (-19.40)	17 (-54.80)
Large producers	5 (-27.8)	6 (-33.30)	7 (-38.90)	17 (94.8)	1 (5.6)	3 (-16.70)	8 (-44.40)	5 (-27.80)	2 (11.1)	2 (11.1)	4 (-22.20)	12 (-66.70)
Total	30 (-33.30)	30 (-33.30)	30 (-33.30)	88 (97.8)	2 (2.2)	16 (-17.80)	30 (-33.30)	27 (-30.00)	17 (18.9)	23 (-25.60)	17 (-18.90)	50 (-55.60)

Table 2. Type of dairy farm in Khartoum State.

Type of producer	Specialized dairy farms (%)	Diversified dairy farms (%)					Total (%)
	Cows only	Sheep	Goats	Camels	Sheep and Goats	Poultry (Biological predators)	
Small producers	26 (-63.40)	4 (-9.80)	4 (-9.80)	1 (-2.40)	6 (-14.60)	9 (-22.00)	24 (-26.70)
Medium producers	18 (-58.10)	1 (-3.20)	11 (-35.50)	0 (0.00)	1 (-3.20)	7 (-22.60)	20 (-22.20)
Large producers	10 (-55.60)	1 (-5.60)	2 (-11.10)	1 (-5.60)	4 (-22.20)	7 (-38.90)	15 (-16.70)
Total	54 (-60)	6 (-6.70)	17 (-18.90)	2 (-2.20)	11 (-12.20)	23 (-25.60)	59 (-65.60)

local breed and cows that were crossbred with exotic breed.

The results obtained from farms visits and the questionnaire, showed that the majority of the dairy farms (60%) were specialized dairy farms (Table 2). However, the diversified dairy farms represent 40%: in which the camels, sheep and goats were found to be reared together with cows for economical values. Poultry (especially local breeds) was found in 25.6% of the dairy farms (Table 2).

Provisional specialist contributing in dairy herds' management was reported in only 5.6% farms, full-time farmers managed their animals were 6.7%, while both farmers and laborers managing the farm were found in 53.3% of the farms (Table 3). Moreover all dairy cows (100%) were milked twice a day manually; early morning (2 to 4 am) and at evening (2 to 4 pm). Farm owners milking their cows were reported in 10% of the total farms; 19.5% was in the small size producers and only 3.2% belong to the medium size farms. Herd men milking the cows were represented in the large size farms(33.3%) as shown in Table 3. The same table reflected that the small and medium producers give more care for their cows in order to reduce the risk of management and to lower the cost of production compared to large scale producers ($P > 0.05$). Results of this study indicated that the majority (98.9%) of the dairy farms are under veterinary supervisions, either resident veterinarian (7.9%), through regular visits (24.7%) or on call (66.3%) as shown in Table 4. Regarding the treatment of diseased animals, the present study found that medication was usually done by the veterinarians with farm owners and laborers (43.33%) compared to the medications practiced by the veterinarian alone (18.9%). Vaccinations against contagious diseases such as anthrax, black quarter, contagious bovine pleura-pneumonia and hemorrhagic septicemia, were found to be practiced in 65.2% of the investigated

Table 3. Dairy herd's management and milking among dairy farms in Khartoum State.

Producer	Herds managers (%)				Herds milkers (%)			
	Owners	Herds keepers	Owners + herds keepers	Owners + herds keepers + Provisional specialist	Owner	Herds keepers	Owners + herds keepers	Herds keepers+ owner's children
Small producers	4 (5.06)	13(16.5)	21 (26.9)	0 (0.0)	8 (10.8)	18(24.3)	12 (16.2)	1 (1.4)
Medium producers	1 (1.3)	4 (5.06)	19(24.05)	3 (3.8)	1 (1.4)	12(16.2)	9 (12.2)	4 (5.4)
Large producers	1 (1.3)	3(3.8)	8(10.1)	2 (2.5)	0(0.0)	6(8.1)	2 (2.7)	2 (2.7)
Total	6 (7.6)	20(25.3)	48 (60.8)	5 (6.3)	9(12.2)	36(48.6)	23(31.1)	7(9.5)
Level of significant			0.001				Ns	

Significant difference (P< 0.001) ns: non-significant.

Table 4. Veterinary supervision medications and vaccination against contagious diseases in the dairy farms at Khartoum State.

Producer	Veterinary supervision of the dairy farm (%)				Administration of medication (%)					Vaccination (%)	
	Resident	Regular visits	On call	Non	Vets	Owner	Vets +herds keepers	Vets + owners	Vets + owners + herds keepers	BQ HS CBPP and anthrax	Absent of vaccination
Small producers	1 (-1.10)	10(-11.20)	29 (-32.60)	1(-1.10)	7(-8.40)	1 (-1.20)	5(-6.02)	11(-13.30)	16(-19.30)	25 (-28.10)	15(-16.90)
Medium producers	3 (-3.40)	8(-9.00)	19 (-21.30)	0 (0.00)	4(-4.80)	1 (-1.20)	5(-6.02)	5(-6.02)	15(-18.10)	20 (-22.50)	11(-12.40)
Large producers	3 (-3.40)	4(-4.50)	11 (-12.40)	0 (0.00)	6(-7.20)	0 (0.00)	2(-2.40)	1(-1.20)	8(-9.60)	13 (-14.60)	5(-5.60)
Total	7 (-7.90)	22(-24.70)	59 (-66.30)	1(-1.10)	17(-20.50)	2 (-2.40)	12(-14.50)	17(-20.50)	39(-47.00)	58 (-65.20)	31(-34.80)

Vet: Veterinarian; HS: Hemorrhagic septicemia; CBPP: Contagious bovine pleura-pneumonia; BQ: Black quarter.

farms. Vaccination against Brucella was rarely used, while vaccinations against foot and mouth disease and enterotoxaemia were not reported. Some dairy cows (56.3%) come in contact with other cows during mating, and also contacted other cows, camels, sheep and goats during feeding and/or drinking water in 23% of the farms investigated (Table 5). Through investigation carried out by visiting the farms and questionnaires outcome, the farmers stated that they are sometimes faced with diseases such as foot and mouth disease (24.4%) and contagious bovine pleuropneumonia (20%). Cases of mastitis, thieleriosis and spread of ticks were claimed to be high; mastitis occur in more than 90%.

Some of dairy keepers exchange breeding bulls for natural mating (borrowing of breeding bulls) which is practiced by small producers (26.4%) compared to others. A restriction of dairy cows to the farms only, was found to be practiced by 64.4% of total farmers. Large size farms revealed low percentages (11.1%) of restrictions (Table 5). The farm owners restricted their cows without awareness to the restriction of laborers movements and acceptance of visitors, veterinarians and other professional without disposal or clean boots and coveralls (Table 6). The quarantine of introducing new cows to the herds was practiced in 34.4% of farms studied, the small producers adopted high rate (14.6%), compared to the medium (10%) and large producers(8.9%). Quarantine of introducing new animals has positive correlation to veterinary supervision ($r = 0.029$) as shown in Table 6. In this study, 61.1% of herds' keepers remove dung

T**able 5.** Cows come in contact during feeding, sharing water, and/or natural mating, dipping areas and cup strips.

Producer	Contact during feeding (%)	Sharing water (%)	Contact during Mating (%)	Dipping areas (%)	Cup strep (%)
Small producers	7 (8.04)	8(9.2)	23 (26.4)	0 (0.0)	0 (0.0)
Medium producers	5 (5.7)	5(5.7)	17 (19.5)	0 (0.0)	0 (0.0)
Large producers	6 (6.9)	7 (8.04)	9 (10.3)	0 (0.0)	0 (0.0)
Total	18(20.7)	20(23.0)	49(56.3)	0 (0.0)	0 (0.0)

within one day to three days intervals followed by 30% weekly intervals, 6.7% at15 days intervals and only 2.2% of the farms were cleaned once per month (Table 6). The majority of farms in Khartoum State showed the absence of general hygiene and sanitation measures, most of the pens appeared heavily contaminated with dung. Regarding the using of disposed syringes, more than 51.3% of dairy farmers used one syringe for more than one cow injections (Table 6) . However, dairy farmers who were adopting single use of disposal syringes were 45%. A single needle was used on multiple cattle by 35% bovine practices.

The space required by the animals was not considered and the buildings designed with local materials were observed in more than 70% of farms investigated. The walls of pens were built either from mud or corrugated irons. Five farms (8.47%) have no pens roof and fences building included red bricks in 44.07%, iron pipes (35.59%) muskeet stem (*Prospis Julifora*) in 5.08% and zinc in 35.5% of farms.

The veterinary extensions provided by veterinary hospitals, universities and extensions' offices were available in 61.1% of the total farms investigated (Table 8). The extension received from veterinary hospitals and universities was in 12.2% of total farms, while the veterinary extensions received from extension offices was found in 13.3% of the total farms investigated. Extensions provided by both veterinary hospitals and extension offices were found to be the majority (35.6%) in the farms. Results in Table 8 indicated that the majority of dairy cow pens (74.4%) were supplied by drinking water from general water network, while farms supplied from their own wells were 16.7% and farms that brought water to farm using donkey carts or tankers were reported as 7.8% of the total investigated farms.

DISCUSSION

Data in Table 1 constituted with Mohamed (2011) who reported that most farmers constructed their farms with private capital. This may be attributed to the low education levels among the dairy cattle producers and the absence of dairy societies which organize the governmental funds. The result regarding the farming experience goes in line with Millogo et al. (2006) who reported that the full-time farmers in Burkina Faso had more than 10 years experience in farming and their herds were essentially composed of local breeds. The dominant of cross bred dairy supported El Zubeir and Mahala (2011) who reported that the dairy herd keepers in Kuku project are older compared to those of Alrudwan project, they attributed that to the recent establishment Alrudwan project (1993), while the dairy farmers owned the cultivated lands in Kuku project since 1960.

Although the diversified dairy farms were common in Sudan, the present result showed lower value (40%) compared with the specialized one (Table 2). The farmers stated that they reared dairy cows only with no other animals or other activities because the size of land is small that make them to worry from additional costs. Poultry (especially local breeds) was found in the small producers farms mainly as biological predators to reduce the numbers of mites and ticks.

These findings were similar to that reported by El Zubeir and Mahala (2011) who reported that the dairy cow keepers in Kuku rear the cows as the main milk producing animals (60%) and few sheep (16%) and goats (4%) in addition to chicken (20%). In Alrudwan, they keep cows (60%) and chicken (40%) which were used as biological control for mites.

Provisional specialist contributing in dairy herds' management was rare; most of the farmers depend on laborers management of the farm (Table 3). This might be attributed to the involving of farmers in other works in the urban area and the limitation of understanding of farm owners regarding the advantages of consulting a veterinarian or animal specialist about managing their dairy farms. El Zubeir and Mahala (2011) and Mohamed (2011) reported similar findings. Also, the milking routine and methods were similar to those reported by Mohamed (2011) who found in his study that the hand milking was practiced twice a day in all investigated dairy farms.

The majority (98.9%) of the dairy farms are under veterinary supervisions (Table 4). This is because of the availability of graduated skilled veterinarians in Sudan

Table 6. Biosecurity and hygienic practices (dung removal and dealing with disposal syringes) in dairy cattle farms at Khartoum State.

Types of producers	Biosecurity			Interval dung removal (%)				Uses of syringes (%)		Keeping records (%)
	Cows restricted to the farm only (%)	Quarantine for new cows (%)	Specialist for a group of cows (%)	1 to 3 days	7 days	15 days	30 days	Single use	Use for the second time	
Small producers	29 (32.2)	14(15.6)	0 (0.0)	22 (24.4)	16(18.0)	2 (2.2)	1 (1.1)	18(22.5)	17 (21.6)	0 (0.0)
Medium producers	19 (21.1)	9 (10.0)	1 (1.1)	23 (25.6)	5(5.6)	3 (3.3)	0 (0.0)	11(13.8)	16 (20.0)	1 (1.3)
Large producers	10 (11.1)	8(8.9)	0 (0.0)	10 (11.1)	6(6.7)	1 (1.1)	1 (1.1)	7(8.8)	8 (10.0)	2 (2.6)
Total	58 (64.4)	31(34.4)	1 (1.1)	55 (61.1)	27(30.0)	6 (6.7)	2 (2.2)	36(45.0)	41 (51.3)	3 (3.9)
Level of significant						0.01				

Significant difference (P< 0.001).

and the wide spread of the private veterinary clinics in Khartoum State. Similarly, Mohamed (2011) reported that the veterinarian's roles in dairy farms were either resident 18.33%, visited the farm at regular intervals 16.67% and on call 65.0%. Similarly, Millogo et al. (2008) found that all farmers worked with veterinarians when the animals need treatment against disease. However, the medication done by the veterinarians was only 18.9%. This is because, in Sudan, the medicines are available for any producer to buy from pharmacies in the cities; without prescription (Adam, 2014). Furthermore, Said Ahmed et al. (2008) was able to detect antibiotic residues in 22.2% of the milk samples collected from the dairy farms. However the farmers seek the help of the veterinarian to examine purchased cattle before they entered the herd. This is similar to Hoe and Ruegg (2004) who reported that the proportion of herds that performed reproductive exams was highly associated with herd size and it is possible that small producers are aware of the importance of such practices, but financial constraints or simply less frequent contact with veterinarians may be limiting factors for implementation of preventive measures.

The availability of vaccination is due to the fact that the governmental authorities have continuous programs for diseases control, this service was observed to be provided freely at Khartoum State. However some small producers did not respond to the vaccination programs as they believed that vaccination causes diseases to their cows. However vaccination against Brucella was rarely used, while vaccinations against foot and mouth disease and enterotoxaemia were not reported. These findings agreed with Ahmed and El Zubeir (2013) who reported that Brucella vaccines and foot and mouth disease vaccines were rarely used. Schaik et al. (2011) reported that vaccination did not prevent losses in milk production; it reduced the infection pressure and the clinical signs of the disease.

Some dairy cows (56.3%) come in contact with other animals (Table 5). Limitations of land size and feeding and watering facilities might be some of the reasons. Cullor (2004) reported that the three pillars of any biosecurity program are isolation, sanitation and restricted movement. Moreover large size farms revealed low percentages (11.1%) of restrictions, which could be due to owing of cultivating lands with fodder crops, which might not be available for small and medium size producers (Table 5). Risk associated with animal movements can be reduced by pro-ducers only purchasing animals from farms with a known disease history and through isolation, disease testing and prophylactic treatment of purchased stock (Brennan and Christley, 2012). Culler (2004) reported that biosecurity program will differ from farm to farm; the overriding concerns are to keep everything as free of germs as possible and to limit contact between animals as much as possible. The farm owners restricted their cows without awareness to the restriction of laborers movements in case of infectious diseases outbreaks and acceptance of visitors, veterinarians and other professional without disposal or clean boots and coveralls (Table 6). However, Hoe and Ruegg (2004) reported that veterinarians (93%), inseminators (88%) and nutritionists (73%) who visited the farms washed their boots or wore new disposable boots every time they visited the farm. Quarantine of intro-ducing new animals has a small positive correlation

Table 7. Frequencies of diseases outbreaks on the studied dairy farms at Khartoum State.

Types of producers	Frequencies of diseases occurrences (%)		
	Contagious bovine pleuropneumonia (CBPP)	Foot and mouth disease (FMD)	CBPP + FMD
Small producers	7(7.8)	12(13.3)	10(11.1)
Medium producers	8(8.9)	7(7.8)	5(5.6)
Large producers	3(3.3)	3(3.3)	3(3.3)
Total	18(20.0)	22(24.4)	18(20.0)

to veterinary supervision, which might be attributed to the understanding of herd keepers to the infectious diseases transmissions and spreads through herd contact. Also grouping of lactating cows to facilitate health observations and shared responsibilities with milkers on healthy environments maintenance was observed in one farm only (Table 6). This might be documented to the lacking of long term and expert laborers.

Mansour et al. (2014) reported non significance between hygiene, quarantine and presence of veterinary services in dairy farms at Khartoum State. The majority of farms in Khartoum State showed the absence of general hygiene and sanitation measures, most of the pens appeared heavily contaminated with dung (Table 6). This agreed with Mohamed (2011) who reported that general hygiene, cleaning programs and sanitation practices were poorly obtained. He also found that the majority of the farms had no dipping area and calving fens. Ahmed and El Zubeir (2013) also reported that the general hygiene and sanitation measures such as dung removal, disinfection, cleaning programs and maintaining minimal contamination during milking process could not be observed in the majority of dairy farms in Khartoum State. The farmers who practice one to three days and weekly dung removals, sell the animal manure to cover some of the daily farm expenditure. Similarly, Mustafa et al. (2011) reported that selling daily manure was practiced by 87.8% of the farm householders. Some of the farmers who remove the animals manure after 15 or 30 days used it as bedding of herds. However accumulations of manure with the urine might subject dairy animals to foot rot and other health problems. Cashman et al. (2008) reported that animal waste and hygiene management was applied on 56% of the farms. The single use of the disposed syringes (Table 6) could be attributed to the awareness of some farmers that clean syringe removes the risk of disease transmission, which was learned from the extension services provided by the veterinarian. Anderson (2010) reported that the principle of “one needle per cow, one cow per needle” was reported by 31% of bovine practices. It was noted that even in the farms which keep the records; the records are not well organized and unreliable since a lot of missing data was encountered. This may be due to the ignorance of owners to the importance of records keeping. El Zubeir and Mahala (2011) reported that producers at Kuku who kept records were 64%, while only 7% kept record at Alrudwan camp. Mohamed (2011) reported that farm records were found in 36.6% of the farms at Khartoum North.

The space required by the animals was not considered in many of the investigated dairy farms. Hoe and Ruegg (2004) reported that the animal housing should be associated with herd size and providing good comfort for milking cows and other herds. The grooves in the mud walls and timber in the roofs provides good environment for ticks and other diseased insects. Also the old cars irons and woods will subject animals to injuries which increase the chances of transmitting the diseases through wounds. However, some of the pens have no access to shades; which might subject the animals to the heat stress. Similarly, Mohamed (2011) reported that metal, wood and plastic materials are used for roof in dairy farms in Khartoum North, which was also supported by Ahmed and El Zubeir (2013).

Through investigation carried out by visiting the farms and questionnaires outcome showed that diseases outbreaks such as contagious bovine pleuropneumonia (CBPP) and foot and mouth disease (FMD) occurred in more than 64% (Table 7). This attributed to poor hygienic practices during milking and absence of drying off cows programs. El Zubeir et al. (2006) reported that mastitis routine testing is very important because most of mastitis infection persist as subclinical, which will not be detected by herdsmen. Hoe and Ruegg (2004) pointed that most mastitis control practices were significantly associated with herd size, which was reflected in differences of milking systems or animal housing. Similarly, the high level of ticks might attributed to the presence of grooves in the mud walls and timber which provides good environment for ticks and other diseased insects besides lacking of dipping and sprays programs (Singh et al., 2000). The high incidence of ticks subject cows to theileriosis (Dua et al., 2012). The high incidence of

Table 8. Services provided to the dairy cattle farms at Khartoum State.

Types of farms	Veterinary extensions (%)			Sources of water (%)		Other sources (donkeys carts) (%)
	Veterinarians and Universities	Extension office	Veterinarians + extension office	Water network	Water wells	
Small producers	4 (4.4)	1 (1.1)	17 (18.9)	27 (30.0)	8 (8.9)	5 (5.6)
Medium producers	6 (19.4)	3 (3.3)	15 (16.7)	28 (31.1)	2 (2.2)	1 (1.1)
Large producers	1 (5.6)	8 (8.9)	0 (0.0)	12 (13.3)	5 (5.6)	1 (1.1)
Total	11 (12.2)	12 (13.3)	32 (35.6)	67 (74.4)	15 (16.7)	7 (7.8)

of infectious diseases may have direct effects on livestock productivity and metabolism, increased mortality and decreases rates of reproduction, weight gain and milk production (Mustafa et al., 2011; Ashuma et al., 2012).

This finding concluded that veterinary extensions provided by veterinary hospitals, universities and extension offices were available in 61.1% of the total farms investigated (Table 8). However, Mustafa et al. (2011) reported that the majority (88%) of householders indicated unavail-ability of extension services from governmental authorities and 6.1% stated that the services were available but they did not receive it (Mustafa et al., 2011). Results in Table 8 indicated that the majority of dairy cow pens (74.4%) were supplied by drinking water from general water network. This attributed to the wide distribution of general water network.

CONCLUSION AND RECOMMENDATIONS

The current study concluded that since biosecurity programs take time to achieve, it is advisable for Sudan dairy producers (Khartoum State) to begin thinking about proper management of their farms and to control the infectious and non-infectious diseases to ensure successful enterprises. This could be achieved via provision of essential services such as health care, vocational education and training to the dairy farmers on good dairy farming practices. Enforcement of legislations and laws, adoption of standard methods and establishment of programs to control the diseases transmission (e g. HACCP) are needed for clean milk production.

Conflict of interests

The authors declare that they have no competing interests

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