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# Herd growth parameters and constraints of camel rearing in Northeastern Nigeria

A. Z. Jaji<sup>1</sup>, N. Elelu<sup>2\*</sup> , M. B. Mahre<sup>3,4</sup>, K. Jaji<sup>3,4</sup>, L. I. Ghali Mohammed<sup>2</sup>, M. Audu Likita<sup>5</sup>, E. S. Kigir<sup>1</sup>, K. T. Onwuama<sup>1</sup> and A. S. Saidu<sup>6</sup>

## Abstract

The one-humped camel, *Camelus dromedarius*, is an important pack and ride, dairy and meat animal in semi-arid northeastern Nigeria. This study was carried out to document reproductive information for scientists and farmers on camel rearing for improved productivity. A structured open-ended questionnaire on herd growth parameters and constraints of camel-rearing in the region was administered to 147 respondents. Results showed that most camel owners were middle aged, married, Arab men with over 20 years of experience in camel-rearing. The camels were made up of predominantly mixed breeds originating from eastern and northern Africa. Sexually matured heifers are detectable at three years of age, have good body conformation and are receptive to bulls during estrus. They have a long rutting period that stretched from rainy to harmattan seasons (July to January). Length of gestation is 13 months, and pregnancy is detectable by observing a successfully mated cow raising her tail on being approached by a bull at two weeks into pregnancy or the distension of the abdominal region towards mid pregnancy. Up to 60% conception rate was reported while age of cow at first parturition was five years. Other herd growth parameters reported include calf mortality rate of up to 40%, milking duration of one year and productivity of at least 10 calves per cow per life time. Only 4% of respondents in this study consult veterinary care while few (23%) respondents helped the dam to suckle its new born. Abortion, biting flies, trans-border conflicts and armed banditries were the major constraints to camel production in the study area. It was concluded that despite the knowledgeability of camel herders in this study, there appears to be poor herd management that needs to be addressed by adequate education and access to veterinary care in order to improve productivity.

**Keywords:** Camel, Herd growth, Rutting, Constraints, Nigeria

## Introduction

There are an estimated 20 million camels in the world, of which 15 million are found in Africa and 4 million in Asia (Farah 2004). They are kept for a variety of purposes such as conveyance of goods or farm products; as draught animal; as source of hide, milk, and meat (Dorman 1984) or as racing animals in some Middle East countries (Snow 1992). They are very reliable milkers especially during the dry seasons and drought when milk from cattle, sheep and goats is limited (Farah 2004). Camel milk plays a very important role in the nutrition of people from eastern Africa (Farah et al. 2007). They are also increasingly used in land preparation during the rainy season (Mohammed and

Hoffmann 2006). Leeses (1927) classified the dromedary camel based on function into pack and ride types, and Wilson (1997) categorized the West African camels as mixed breeds used as pack or dual purpose animals. The one-humped (dromedary) camel, *Camelus dromedarius*, is also economically important in northern Africa, particularly in Sudan and Somalia as well as in the Arabian states and Indian sub-continent. The two-humped (*Camelus bactrianus*) camel is bred mainly in the former Soviet Union and Central Asia (Arthur and Pearson 1989). Camels have been reported to be diurnal or nocturnal animals and have the ability to utilize vegetation in the desert and semi-desert that other animals usually find unpalatable (Ghaji and Adegwa 1986).

Camels are found mainly in the semi-arid northern part of Nigeria (Mohammed 2000) including Borno, Yobe, Kano, Jigawa, Katsina, Sokoto, Kebbi and Zamfara

\* Correspondence: nusyelelu@yahoo.com

<sup>2</sup>Department of Veterinary Public Health and Preventive Medicine, University of Ilorin, Ilorin, Kwara State, Nigeria

Full list of author information is available at the end of the article

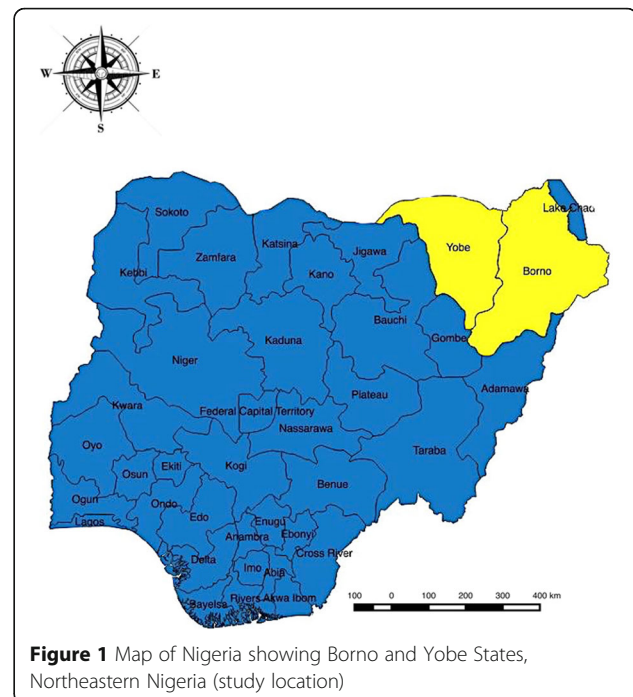
States (Abdussamad et al. 2011). There was an increase in the camel population in Nigeria from about 18,000 in 1978 to about 90,000 in 1994 (Bourn et al. 1994). The increase may be related to the increased camel meat consumption following a decline in supply of cattle meat after a rinderpest outbreak given that camels are relatively resistant (Abubakar et al. 2010). It may also be connected to the relatively cheaper cost of camel meat compared to beef. A study reported that an average of 3,400 camels are slaughtered annually for meat in Maiduguri abattoir in Borno State, northeastern Nigeria (Yahaya et al. 1999). A large number of camel pastoralists were found in northeastern Nigeria and a number of approximately 26,866 camels in the early 1990s (FDLPCS, 1992).

The factors affecting herd structure include the level attained by production parameters common to all animal species: age at sexual maturity, age at first calving, fertility levels and gestation period resulting in the reproductive rate or number of young born per breeding females, nutritional levels affecting growth and perhaps sexual maturity and death rates (Wilson 1984). The FAO stated that 'reproduction is the key to improved livestock performance' (FAO 1990). However, there is limited literature on camels under traditional management in Nigeria as well as camel reproductive data, namely duration of estrus, length of gestation and calving interval (Nigeria Livestock Resource Survey 1992; Abdussamad et al. 2011; Umaru and Bello 2013). The few studies on camels in Nigeria concern the characteristics of slaughtered animals (Umaru 2001); others dwelled solely on health management (Mohammed et al. 2007; Chafe et al. 2008). Therefore, comprehensive data on camel production and reproductive performance is required for better camel husbandry in Nigeria. Hence, this study was carried out to determine the herd growth parameters and constraints to rearing of camel in Northeastern Nigeria.

### Study area and methods

Due to the mobile and less accessible nature of camel pastoralists, to obtain information regarding camel reproduction, herd growth parameters and constraints, a convenience sampling combined with snowballing technique was adopted, based on a previous study by Abdussamad et al. (2011). A first set of camel pastoralists were identified through concerted efforts of the District Veterinary and Animal Production Officers in Borno and Yobe States of Northeastern Nigeria. The selected camel owners in turn helped in identifying their other colleagues. Borno and Yobe States (Figure 1) are semi-arid Savannah or sub-desert, with flooded pastures towards Lake Chad and montane regions in the extreme southeast (Blench 1995).

The interviews were conducted by the use of an Arab interpreter who also understands the Hausa language



**Figure 1** Map of Nigeria showing Borno and Yobe States, Northeastern Nigeria (study location)

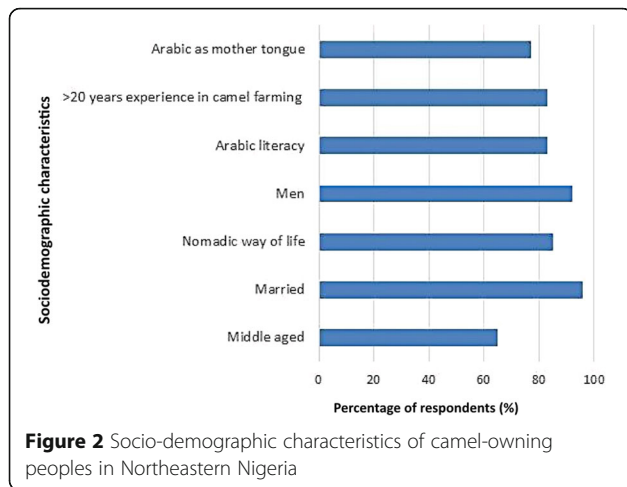
spoken by the researchers. In each of the herds visited, questions were asked on herd growth, problems and prospects of camel rearing in the region using structured open-ended questionnaires. Past studies have shown that pastoralists have good memory about individual animals and are useful in epidemiological data collection (Kaufmann 2005; Shibia et al. 2013). Responses from these interviews were qualitatively analysed. Descriptive statistics, such as frequencies and percentages of data, were presented using the Microsoft Excel worksheet (Microsoft Office 2013 software, Microsoft®).

## Results

### Socio-demographic characteristics of respondents

A total of 147 pastoralists made up of 52 nomadic (35%) and 95 (65%) transhumant took part in the survey. Results from this study showed that most (65%) of the camel owners were aged between 30 and 60 years, 12% were less than 30 years of age, while 23% were greater than 60 years of age. Almost all were married (96%) and Arab (77%); 92% were men with abilities to read and write in Arabic (83%). The majority (83%) of respondents have over 20 years of experience in camel rearing while 17% have less than 20 years of experience in camel rearing as a means of livelihood. They speak Arabic (77%) as their mother tongue while Hausa, Shuwa, Manga, Fulani, Kanuri, Tubo and English were their other spoken languages (Figures 2, 3 and 4).

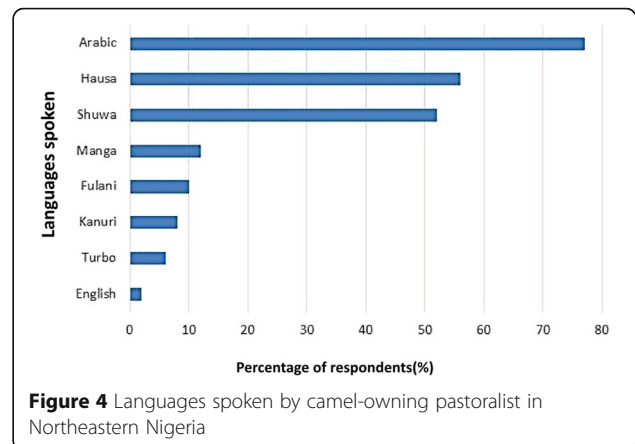
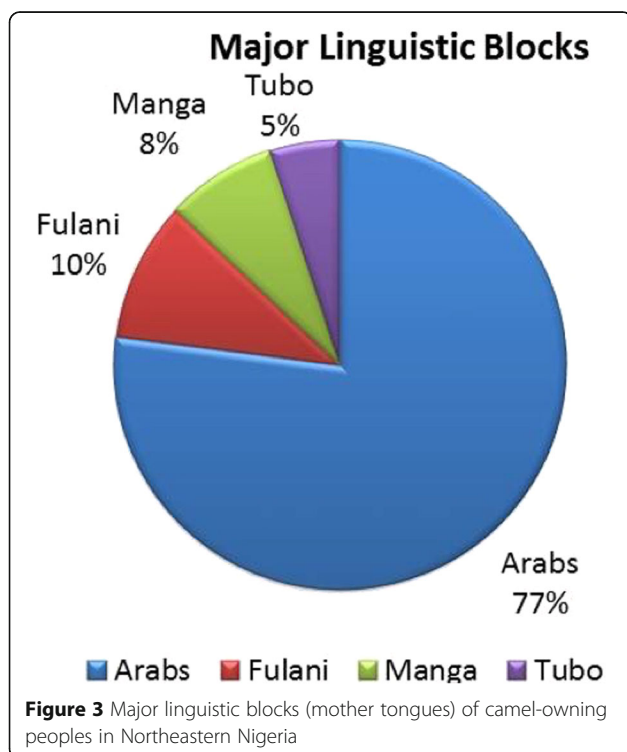
The production of camels examined in this study was by migratory pastoralists and transhumants. The camels are of mix breeds and are used mainly as pack animals.



The owners also use their milk products for dairies and sell them off as meat animals.

**Herd size and origin of camels in northeastern Nigeria**

Most of these camels are mixed breeds and originated from eastern (69%) and northern (21%) Africa. Camel herds pass through major camel markets in Niger and Chad on their way to Borno and Yobe States, Northeastern Nigeria, where the study took place. Livestock owned and herd sizes are shown in Table 1. The camel farmers use the camels as pack and ride animals in addition to



using and selling camel products to dairies, tanneries and for meat.

**Sexual behaviour and pregnancy in the female one-humped camel of Northeastern Nigeria**

Respondents in this study reported that rutting extended from rainy to harmattan seasons (July to January). The ratio of breeding animals (male to female) was 1:50 in the herds studied. According to most camel herdsmen in the study area, sexually mature heifers are detected in the herds by their age (42%), body conformation (54%) and reception to bulls during estrus (54%). A fertile heifer is very receptive to bulls and has good body conformation. Such a heifer first comes on heat at about three years of age.

The majority (84%) of respondents reported that estrus is characterized mainly by restless racing and violence among bulls, and 75% of respondents said each estrus lasts for 7 days. Respondents reported that courtship and mating behaviours in bulls are characterized by sniffing and biting of estral cows' vulva by bulls, restlessness, racing violence, rubbing, hitting and biting of estral cow's necks by bulls, and forceful couching and mounting of cows by bulls with both facing the same direction. About 61% of respondents reported that mating lasts up to 30 min at a frequency of three services per estral cow per estrus.

Conception rate was reported as 60% in most herds (80%) while foetal mortality was up to 50%. Seventy-five percent of respondents detect early pregnancies in their herds by observing raising of the tail by a cow when approached two weeks after a successful mating. Almost all (96%) respondents reported that pregnancy lasts for up to 13 months, and 59% reported that parturition lasted for about one hour. The age of cow at first parturition was reported to be about five years (60 months) by 80% of respondents, and almost all (98%) respondents reported only one calf per calving with no twinning reported. Parturition in most of the herds was

**Table 1** Herd size and origin of camels in Northeastern Nigeria

	Variable	Percentage of respondents				
		Camels	Cattle	Sheep	Goats	Poultry
Herd size	<10	2	32	0	2	92
	10 to 20	5	22	8	9	8
	20 to 30	11	9	12	11	0
	30 to 40	18	15	18	28	0
	20 to 50	18	6	21	15	0
	>50	46	16	41	35	0
Origin of animals	Eastern Africa	69	-	-	-	-
	Northern Africa	21	-	-	-	-

characterized by the normal dilation, expulsion and placental phases as in most mammals. They were reported not to normally need assistance, and post-parturition was not characterized by licking of calves or eating of afterbirths by dams.

Most of the respondents interviewed reported the sex ratio of calves as 1:1 (male to female).

The majority of herders (65%) give no special care to their pregnant cows while only 33% gave some form of care by grazing them away from abortifacient plants.

Calf mortality was reported by respondents to be within the range of 20 to 40%. About 67% of respondents reported up to 12 months inter-calving/milking interval. More than half of respondents reported that duration of sexual activity before menopause was about 20 years and productivity was up to 10 calves per cow per lifetime.

**Health management practices and constraints of camel production**

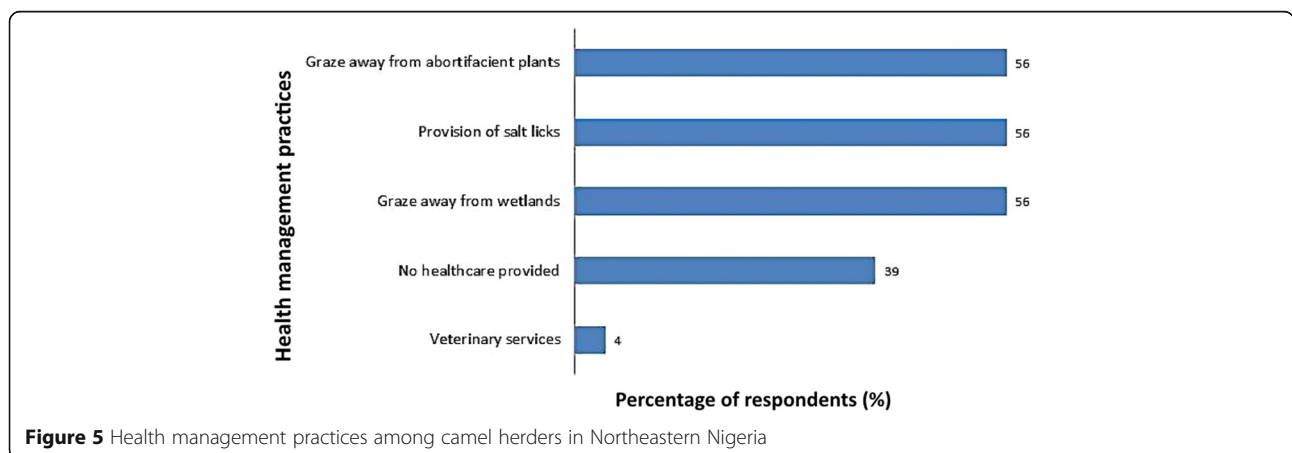
The major management practices for health and productivity (Figure 5) were grazing of herds away from wetlands (58%) and provision of salt licks (56%).

Only 4% of the herders in the study sought veterinary services while 39% had no special practices for health and productivity. Biting flies of *Tabanidae* family was reported by 58% of respondents as a major menace of camel production. Another health constraint to production in this study is eating of abortifacient plants, as reported by 33% of respondents.

The other challenges of camel production reported in the study area included insurgency and trans-border problems, armed banditry and conflicts with crop farmers.

**Discussion**

Socio-demographics of camel owners in this study reveal that the majority of the population is made up of married middle aged Arab men with over two decades of experience in pastoralism of mixed breed camels from north and east Africa. Camel herds pass through major camel markets in Niger and Chad on their way to Borno and Yobe States, Northeastern Nigeria, where the study took place. This is not surprising as arid parts of north and eastern Africa accounts for over 60% of camel population in the world (Farah 2004). Also, past records have documented Niger and northern Nigeria to be linked



**Figure 5** Health management practices among camel herders in Northeastern Nigeria



during the trans-Saharan trade during the medieval periods (as cited by Abdussamad et al. 2011).

Camels are seasonal breeders and are usually sexually active (rutting) only for a few months each year (FAO 1990). Respondents in this study reported that rutting extended from rainy to harmattan seasons (July to January). A previous study in Nigeria reported a shorter rutting season lasting from early-dry season between October and December (Abdussamad et al. 2011). However, rutting has been reported to be influenced by the age and level of nutrition of camels and might explain the difference in rutting season reported between this study and past studies (Mukasa-Mugerwa 1981). The ratio of breeding animals (male to female) was 1:50 in the herds which is in agreement with another study that reported 47.8 cows per bull (Abdussamad et al. 2011). Past studies have also reported 1 male to breed 50 to 80 females (Williamson and Payne 1978). Although the breeding bull has the capacity to serve 50 dams, another study recommended a ratio of 1 male to 20 to 25 females (Marai et al. 2009).

Mating behaviour reported in the present study is broadly consistent with past surveys as reviewed by Umaru and Bello 2013. The 60% rate of conception rate reported in most herds visited is likely due to the extended rutting season reported in this study. This is a trait that is expected to improve productivity. Past studies have reported an overall conception rate of 56.9% in India (Sahani et al. 2003). The majority of respondents in this study are able to detect early pregnancies two weeks after a successful mating. This is similar to pastoralists from central Somali, who are also able to detect pregnancy from 10 days after mating, and this was attributed to their experience in camel breeding (Elmi 1989). However, the most reliable modern methods of detecting pregnancy are palpation of genital organs per rectum (Musa and Abusneina 1976) or *via* real-time ultrasound scanning of the uterus and ovaries (Skidmore et al. 1992) as well as estimation of blood progesterone level (Yagil 1985).

The length of calving reported in this study is double those reported by Abdussamad et al. (2011) and Mukasa-Mugerwa (1981). Foetal factors such as malposition, congenital defects and maternal factors such as failure of cervix to dilate and uterine inertia could result in delayed parturition (Fowler and Bravo 2010). The outcome of analyses of data on age of cow at first parturition in the present study is consistent with earlier studies in other parts of Africa that reported between 58 and 68 months as age at first calving (Kaufmann 2005). The calf mortality rate (20 to 40%) in the area is high. Calf mortality rate of 27% has been reported for the Somali breed of camel (Kaufmann 2005) while another study reported a high rate of 60% (Wilson 1984; Kauffman 1998; Kuria et al. 2011). Calf mortality is a major problem that slows down herd growth in camel

production systems, and it is mainly due to poor management and infectious diseases (Farah 2004).

Most camel owners in the Northeastern Nigeria graze their herds away from wetlands and provide salt licks as part of their health management practices. The dampness of the wetland environment is a major challenge for livestock production because it favours development of biting flies which are potential vectors of trypanosomiasis in camels. Grazing of camels in wetlands may also predispose to foot rot which could lead to high mortality and affect production. Camels have a high salt requirement, up to six to eight times higher than that of other domestic animals (Farah 2004). This salt requirement may be partially satisfied during grazing and should be supplemented by provision of additional salt. This explains why camel herders in this study provide salt licks to their animals.

Only a very small percentage (4%) of the camel owners of the present study consult veterinary services. This is low, considering the important input of veterinary care in animal husbandry. Similarly, a previous study in Nigeria reported low patronage of veterinary services with only 21.1% of camel farmers consulting modern veterinary services, as most respondents prefer traditional methods of treatment (Chafe et al. 2008). However, the low patronage of veterinary services was mainly attributed to lack of available veterinary services (Chafe et al. 2008). The importance of patronizing veterinary care cannot be over-emphasized as past studies revealed that access to veterinary services considerably reduced camel calves' mortality (Simpkin 1985). Access to veterinary care have also been shown to improve sexual maturity, hence reducing age of cow at first calving (Megersa et al. 2008). However, other factors such as inadequate plane of nutrition could also delay sexual maturity (Mukasa-Mugerwa 1981).

The major health constraint of camel production in the study area included bites from flies of *Tabanidae* family. Fly infestation causes significant nuisance to camels, can lead to considerable distress (Soulsby 1982) and are a major transmission agents of trypanosomiasis. Although most African camels live outside the tsetse belt, their trypanosomiasis is caused by *Trypanosom evansi*, which is transmitted mechanically by biting flies and not necessarily dependent on the presence of tsetse flies (Röttcher et al. 1987). Trypanosomiasis is a major constraint to productivity of camels, for example, *T. evansi* has been reported with a high prevalence rate of up to 56.4% using enzyme-linked immunosorbent micro-assay (micro ELISA) (Baumann and Zessin 1992). Trypanosomiasis has been reported to be a leading cause of debility and abortion in camels (Mukasa-Mugerwa 1981).

Abortion was said to be the most important problem of pregnancy among the camels in the study area. Abortion has been similarly reported as the most common

reproductive condition in Nigerian camels, and this was attributed to underfeeding as well as ingestion of abortifacient plants such as *Leptadenia pyrotechnica* and *Leptadenia lancifolia*, among other reasons (Abdussamad et al. 2011). Another study carried out among camels introduced into sub-humid zone of Nigeria reported abortion with prevalence rate of 2.4% as one of the common health problem of the one-humped dromedary (Mohammed et al. 2007). Other infectious causes of abortion in camel include brucellosis, pasteurellosis and salmonellosis as well as febrile conditions, such as pneumonia and camelpox, or nervous excitement (Mukasa-Mugerwa 1981).

Insurgency and trans-border problems, armed banditry and conflicts between camel versus crop farmers also pose serious challenges to camel herding in the region. In the past, camel herds in Northeastern Nigeria exploited vegetation (especially acacias) that is little used by farmers; hence, there was no reason for camel-crop farmer conflict. However, with the expansion in agricultural land cultivation and collapse of stock routes, there is increased pressure for grazing land by pastoralists, hence the conflicts (Blench 2003).

## Conclusions

The camel is a very useful desert animal, and great benefit could be achieved through maximizing the productive potential of the animal. The importance of camels as important food animals cannot be over-emphasized as the dromedary is hardy, relatively resistant to some diseases as well as able to thrive with more limited resources than other animals. It is an important source of protein as well as a beast of burden. In most parts of Northeastern Nigeria, the dromedary is extensively used as a source of meat, but there is paucity of updated information on its reproductive performance needed for improving this group of animals in the region.

In the very early research carried out to study herd growth in camels by Mukasa-Mugerwa (1981), factors that affects herd growth were summarized to include late age at first calving, prolonged calving interval, inadequate nutrition, poor management practices, diseases and abortion. The findings from this study carried out over three decades later still show that these factors (further complicated by conflicts with crop farmers) are still present and are a major hindrance to camel production and productivity in Northeastern Nigeria.

Despite the knowledgeability of camel pastoralists in identifying estrus, courtship, mating and pregnancy, not much has changed in their herd management in spite of its contribution to their livelihood. With the extended rutting season as reported in this survey, there is an opportunity for increased breeding that could translate to cash through milk and meat sales.

There is inadequate patronage of veterinary care as only 4% of respondents in this study have sought veterinary services. Although the nomadic nature of pastoralists makes access to veterinary care a huge challenge, there is need to educate the camel herders on the importance of veterinary care for herd management and also to facilitate improved access to veterinary services. Also, the breeds of camels could be further improved upon both as a milk and meat animal with the modern veterinary practice of artificial insemination and estrus synchronization.

The existing knowledge of the pastoralists studied can be refined and incorporated into camel production methods, to enhance the efficiency of their production systems so as to improve their overall pastoral livelihoods. In addition, there is still more to be done by the relevant governmental agencies in the area of reduction of biting flies, addressing the trans-border problems and security challenges by proffering lasting solutions to herder-crop farmer conflicts for the betterment of camel production in the area.

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## Authors' contributions

JAZ is the main author who was involved in the conception, design, field survey analysis and interpretation of the data. He was also involved in the initial drafting and final correction of the manuscript. EN made substantial input in the data analysis and drafting of the final manuscript. MMB was involved in the field sampling and made corrections in the drafting of the manuscript. JK was involved in the field survey and initial drafting of the manuscript. GMLI made contributions to the data analysis and manuscript writing. AM was involved in the data collection during the sampling stage. KES made substantial contribution during the manuscript writing. OKT contributed to the result interpretation and manuscript data search. SAS assisted substantially with the field survey. All authors read and approved the final version of manuscript.

## Competing interests

The authors declare that they have no competing interests.

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## Author details

<sup>1</sup>Department of Veterinary Anatomy, University of Ilorin, Ilorin, Kwara State, Nigeria. <sup>2</sup>Department of Veterinary Public Health and Preventive Medicine, University of Ilorin, Ilorin, Kwara State, Nigeria. <sup>3</sup>Department of Agribusiness and Information System, Universiti Putra Malaysia, Seri Kembangan, Malaysia. <sup>4</sup>Department of Veterinary Physiology, Pharmacology and Biochemistry, University of Maiduguri, Maiduguri, Borno State, Nigeria. <sup>5</sup>Department of Veterinary Services, Ministry of Agriculture, Damaturu, Yobe State, Nigeria. <sup>6</sup>Department of Veterinary Public Health and Preventive Medicine, University of Maiduguri, Maiduguri, Borno State, Nigeria.

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## References

Abdussamad, A.M., W. Holtz, M. Gauly, M.S. Suleiman, and M.B. Bello. 2011. Reproduction and breeding in dromedary camels: Insights from pastoralists in some selected villages of the Nigeria-Niger corridor. *Livestock Research for*

- Rural Development* 23 (8) 2011. Retrieved January 12, 2017, from <http://www.lrrd.org/lrrd23/8/abdu23178.htm>.
- Abubakar, U.B., F.U. Mohammed, S.A. Shehu, and R.A. Mustapha. 2010. Fetal wastage in camels slaughtered at Maiduguri Abattoir, Borno State, Nigeria. *International Journal of Tropical Medicine* 5: 86–88.
- Arthur, G.H., and H. Pearson. 1989. *Veterinary reproduction and obstetrics*. London: Bailliere Tindall.
- Baumann, M.P., and K.H. Zessin. 1992. Productivity and health of camels (*Camelus dromedarius*) in Somalia: Associations with trypanosomiasis and brucellosis. *Tropical Animal Health and Production* 24: 145–156.
- Blench, R. 1995. A history of domestic animals in Northeastern Nigeria. *Cahiers Des Sciences Humaines* 37: 787–237.
- Blench, R. 2003. *The transformation of conflict between pastoralists and cultivators in Nigeria*. Paper in press for a special issue of the *Journal Africa*, Moritz M (ed). Cambridge.
- Bourn, D., W. Wint, R. Blench, and E. Wooley. 1994. Nigerian livestock research survey. *World Animal Review* 78: 49–58.
- Chafe, U.M., A. Musa, and B. Dogara. 2008. Studies of some health aspects of traditional camel management in Northwestern Nigeria. *Livestock Research for Rural Development* 20 (2) 2008. <http://www.lrrd.org/lrrd20/2/chaf20031.htm>.
- Elmi, A.A. 1989. *Camel husbandry and management by Ceeldheer pastoralists in central Somalia*. Pastoral Development Network Paper 27d. London: Overseas Development Institute. Retrieved June 9, 2010, from <http://www.odi.org.uk/pdn/papers/27d.pdf>.
- FAO. 1990. *Animal health year book*. Rome: Food and Agriculture Organisation of United Nations.
- Farah Z. 2004. An introduction to the camel. In: Farah Z. and Fischer A. (eds) Milk and meat from the camel: Handbook on products and processing. Vdf Hochschulverlag, Zurich, Switzerland, pp15–28.
- Farah, Z., M. Matthias, Y. Mario, and D. Ragge. 2007. Camel dairy in Somalia: Limiting factors and development potential. *Livestock Science* 110: 187–191.
- FLDPC 1992: Federal Department of Livestock and Pest Control Services (FLDPC) 1992. Nigeria National Livestock Survey, Abuja, Nigeria.
- Fowler ME and Bravo PW. 2010. Reproduction. In: Fowler, M.E. and Bravo P.W. (eds), *Medicine and Surgery of Camelids*, 3rd edition, Blackwell Publishing, Hoboken.
- Ghaji, A., and A.O. Adegwa. 1986. The significance of camel production in Nigeria. *Nigerian Journal of Animal Science* 13: 29–35.
- Kauffman, B. 1998. *Analysis of pastoral camel husbandry in Northern Kenya*. Weikershereim: Margraf Verlag.
- Kaufmann, B.A. 2005. Reproductive performance of camels (*Camelus dromedarius*) under pastoral management and its influence on herd development. *Livestock Production Science* 92: 17–29. doi:10.1016/j.livprodsci.2004.06.016.
- Kuria, S.G., Tura, I., Amboga, S., Walaga, H.K. and Lesuper, J. 2011. The current status of camel (*Camelus 10.1186/s13570-017-0089-x dromedarius*) calf management among pastoral communities of northern Kenya. *Livestock Research for Rural Development* 23: 148. Retrieved January 12, 2017, from <http://www.lrrd.org/lrrd23/7/kuri23148.htm>.
- Leeses, A. 1927. *A treatise on the One-humped camel in health and diseases*, Haynes & Son, Stamford, Lincolnshire.
- Marai, I.F.M., A.E.B. Zeidan, A.M. Abdel-Samee, A. Abizaid, and A. Fadiel. 2009. Camels' reproductive and physiological performance traits as affected by environmental conditions. *Tropical and Subtropical Agroecosystems* 10: 129–149.
- Megersa, B., A. Regassa, B. Kumsa, and F. Abunna. 2008. Performance of camels (*Camelus dromedarius*) kept by pastoralists with different degrees of experience in camel keeping in Borana, southern Ethiopia. *Animal Science Journal* 79: 534–541.
- Mohammed, I. 2000. *Study of the integration of the dromedary in the smallholder crop-livestock production system in northwestern Nigeria*, 228. Goettingen: Cuvillier Verlag.
- Mohammed, I., and I. Hoffmann. 2006. Management of draught camels (*Camelus dromedarius*) in crop-livestock production systems in Northwest Nigeria. *Livestock Research for Rural Development* 18: 16. Retrieved January 12, 2017, from <http://www.lrrd.org/lrrd18/1/moha18016.htm>.
- Mohammed, A.K., A.K.B. Sackey, L.B. Tekdek, and J.O. Gefu. 2007. Common health problems of the one humped camel (*Camelus dromedarius*) introduced into the sub-humid climate in Zaria. *Research Journal of Animal Sciences* 1: 1–5.
- Mukasa-Mugerwa, E. 1981. *The camel (Camelus dromedarius): A bibliographical review*. ILCA Monograph 5. Addis Ababa: ILCA. Retrieved November 26, 2010, from [http://pdf.usaid.gov/pdf\\_docs/PNAAAP013.pdf](http://pdf.usaid.gov/pdf_docs/PNAAAP013.pdf).
- Musa, B.E.H., and M.E. Abusineina. 1976. Development of the conceptus in the camel (*Camelus dromedarius*). *Acta Veterinaria* 26: 17–24.
- Nigeria Livestock Resource Survey. 1992. *National synthesis*, vol. II. Federal Government Nigeria Resources Inventory and Management, Nigeria.
- Rottcher, D., Schillinger, D. and Zweggartch, E. (1987). Trypanosomiasis in the Camel. *Review Scientific, Technical Office of International Epizootics* 6:463-470.
- Sahani, M.S., S. Vyas, and Aminu Deen. 2003. Improvement in reproductive efficiency in farm camels under hot arid region. *The Indian Journal of Animal Reproduction* 24(2): 93–98.
- Shibia, M.G., G. Owuor, and B.O. Bebeet. 2013. Evaluation of losses of replacement heifers in pastoral and peri-urban camel herds in semi-arid northern Kenya. *Pastoralism: Research, Policy and Practice* 3: 23, pp 1–8
- Simpkin, S.P. 1985. The effects of diseases as constraints to camel production in Northern Kenya. In *Integrated Project on Arid Lands (IPAL) technical report E-7*, ed. United Nations Educational, Scientific, and Cultural Organization (UNESCO) programme on Man and the Biosphere, 76–160. Nairobi: UNESCO.
- Skidmore, J.A., M. Billah, and W.R. Allen. 1992. *Ultrasonography and videoendoscopic monitoring of early fetal development in the dromedary camel*, Proceedings of the 1st International Camel Conference. Newmarket: R & W Publications.
- Snow, D. H. 1992. An introduction to the racing camel. Proc. 1st Int. camel conf., pp. 215–217.
- Soulsby, E.J.L. 1982. *Helminths, arthropods and protozoa of domesticated animals*, 7th ed. London: Bailliere Tindall.
- Umaru, M.A. 2001. A review of reproduction in the camel. *Danfodio Veterinarian* 2: 1.
- Umaru, M.A. and Bello, A. (2013). Review: Reproduction in the One-humped camel (*Camelus dromedarius*) in semi-arid Nigeria, *Scientific Journal of Biological Sciences*, 2(1) 1–7.
- Williamson, G., and W.J.A. Payne. 1978. *An introduction to animal husbandry in the tropics*, 3rd ed. London: Longman.
- Wilson, R.T. 1984. *The camel*, 83–101. London, New York: Longman.
- Wilson, R.T. 1997. Types and breeds of the one-humped camel. *Journal of Camel Practice and Research* 4: 111–117.
- Yagil, R. 1985. *The desert camel*. Basel, München: Verlag Karger.
- Yahaya, M.S., J. Takahashi, S. Matsuoka, and O. Alaku. 1999. Ovarian activity of the dromedary (single hump) camel (*Camelus dromedarius*) in North-Eastern Nigeria. *Asian-Australasian Journal of Animal Sciences* 12: 868–870.

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