African Journal of Agriculture and Food Science
ISSN: 2689-5331
Volume 7, Issue 3, 2024 (pp. 1-9)
www.abjournals.org

# ECONOMIC IMPACT OF TRYPANOSOMOSIS ON CAMELS (*CAMELUS DROMEDARIUS*) IN NORTH-WEST, NIGERIA

**Dakul D. A.[1], Samaila A. B.[2], Abongaby G. C.[3], Ogbole E.[4],**

**Salami O.[5], Eluma M.[6], and Mamman S. A.[7*]**

[1&7]Department of Zoology, University of Jos.

[2]Department of Biological Sciences, Abubakar Tafawa Balewa University, Bauchi.

[3,4,5]Nigerian Institute for Trypanosomiasis and Onchocerciasis Research, Vom, Nigeria.

[6]Nigerian Institute of Medical Research, Yaba, Lagos.

[*]Corresponding Author's Email: mammanshadrach3@gmail.com

**Cite this article:**

Dakul D. A., Samaila A. B., Abongaby G. C., Ogbole E., Salami O., Eluma M., Mamman S. A. (2024), Economic Impact of Trypanosomosis on Camels (Camelus Dromedarius) in North-West, Nigeria. African Journal of Agriculture and Food Science 7(3), 1-9. DOI: 10.52589/AJAFS-2BBZMWHD

**Manuscript History**

Received: 10 Apr 2024

Accepted: 13 Jun 2024

Published: 10 Jul 2024



**ABSTRACT:** *Desert encroachment accelerated by global warming threatens the lives and livelihood of scores of farming families. However, camels can withstand the harsh climatic conditions and provide draught power thereby supporting subsistence agriculture and other economic activities. This study aimed to investigate the economic-impact of camel Trypanosomiasis (Surra) in two communities in North-West, Nigeria using structured questionnaires. All the 99 respondents interviewed were males and over 30 years of age with majority of them having Islamic/Quaranic education. The economic impacts identified include death (42%), poor milk production (38%) and reduced draught power (38%). The mean prices of live camels differ between the two study areas; ₦301,928.57 vs. ₦128,100.00 and ₦184,377.55 vs.₦82,100.00 for healthy adults and young camels in Kano and Katsina states, respectively. About 38−54% loss in value of live camels estimated at ₦114,581.63−₦164,755.09 in Kano and ₦48,850−₦76,100.00 in Katsina was attributed to Surra. Similarly, Surra is believed to account for over 90% loss in milk production in camels, where an estimated daily loss of over ₦7,000.00 was recorded. Although the estimated impacts were based on the opinion of a few randomly selected respondents, the huge financial cost associated with Surra is alarming and deserves attention. It is evident that this disease threatens food security and impedes the achievement of sustainable development goals. These findings bring to fore the socioeconomic importance of Surra in the study area and call for the formulation of cost-effective control measures.*

**KEYWORDS:** Economic Impact, Camel, Trypanosomosis, Prices.


Article DOI: 10.52589/AJAFS-2BBZMWHD
DOI URL: https://doi.org/10.52589/AJAFS-2BBZMWHD

## INTRODUCTION

North-West Nigeria is population-wise the largest among the six-geopolitical zones of the country. It has an estimated population of about 49 million people, which is around 23% of the total population of Nigeria (Danibrahim et al., 2022). Economically, urban centers like the cities of Kano and Katsina constitute economic hubs thereby boosting the national economy. While most rural areas lag behind due to lack of infrastructures and insecurity.

The livestock sector is the world's largest user of agricultural land, considering both grazing and food crop lands, and thus has a major impact on soil, water and air quality as well as biodiversity (Ramankutty et al., 2008: Food Agricultural Organization (FAO), 2017). Nigeria's growing population, rising incomes and urbanization are translating into an increased demand for livestock for livestock products. One estimate suggests that, between 2010 and 2050, beef, poultry meat and milk consumption will increase by 117%, 253% and 577% respectively (FAO, 2018). In the northern region of Nigeria camels served as desert dairy due to the important multipurpose roles it plays in the transportation of grains, water, and other goods as well as for milk and meat production (Mamman et al., 2020). It is also known as the most efficient-domesticated animal in the North-West region and produces more milk and lactate for longer than do any other milky animals raised under similar harsh environmental conditions (Pasha et al., 2013) and contribute substantially to the incomes of numerous countries in Africa (Mohamed et al., 2020).

Trypanosomosis in camels also called surra is caused by protozoan parasites called *Trypanosoma evansi* and is transmitted mechanically from infected camels to healthy camels through biting flies such as *Tabanids*, *Stomoxys*, and *Haematopota*. Surra is widespread and constitutes a major constraint and economic losses to camel production in parts of world where camels are kept (Kakr et al., 2019).The economic impact of Surra is associated with morbidity, mortality, abortion, reduced work resistance, poor carcass performance, weight loss, reduced milk production, low reproductive efficiency, treatment costs, abortion and then death (Abera et al., 2015; Elhaig and Sallam, 2018; Aregawi et al., 2019). Although economic losses due to the camel Trypanosomosis are great, the actual losses are difficult to ascertain (Mochabo et al., 2006). In Nigeria, it is believed that economic impacts of the disease are significant but there is no documented data to confirm this claim. Hence, the study was aimed at determining the economic impact due to camel Trypanosomosis in parts of north-west, Nigeria.

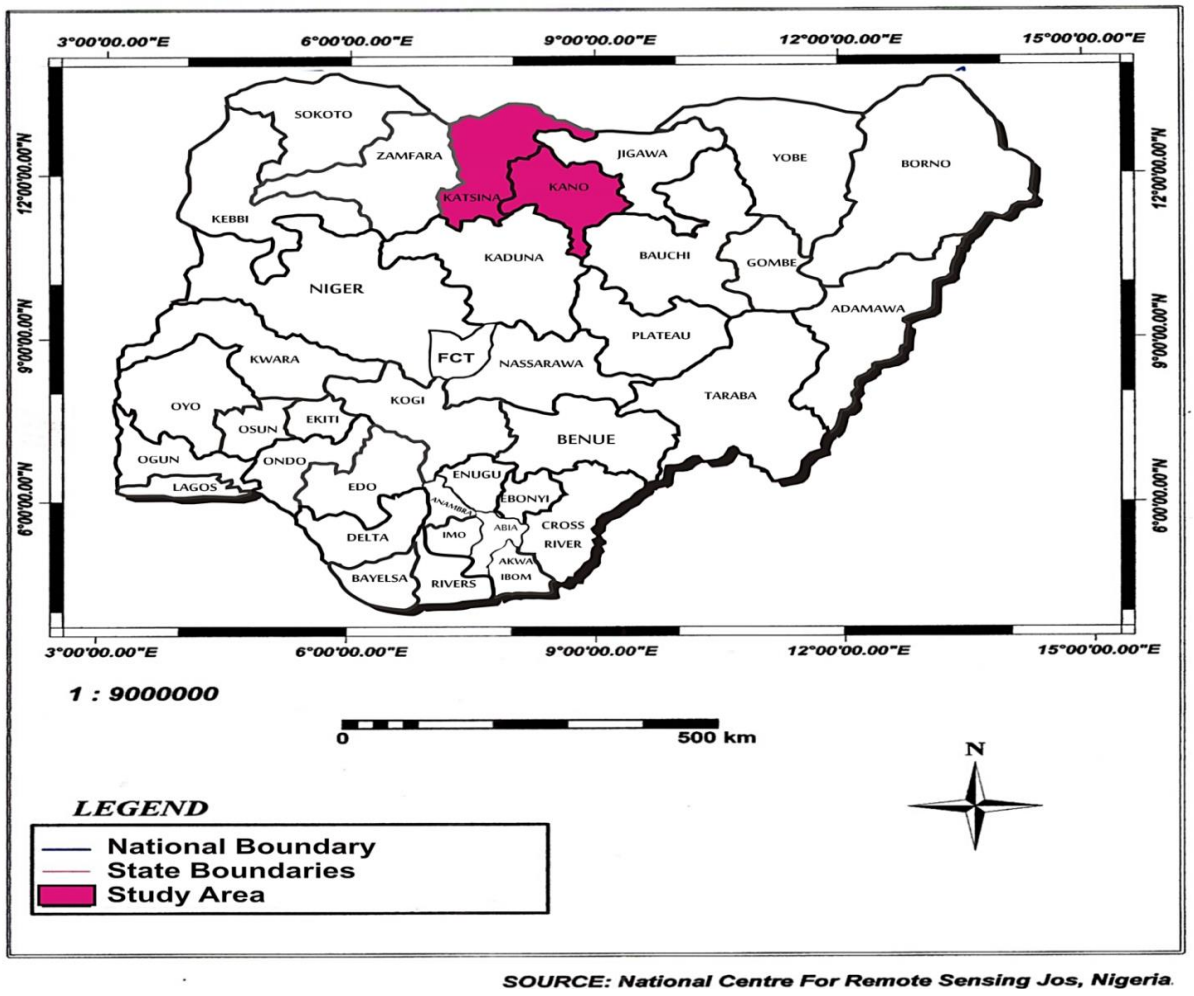
## MATERIALS AND METHODS

### Study Areas

The study was conducted among camels marketers operating within Kano (12° 0′072″ N;8° 31′003″ E) and Katsina (12° 59′ 21′ ′ N ; 7° 36′ 02′ ′ E) states located in the Northwestern region of Nigeria (Fig.1). The climate of the two study areas is composed of two major seasons, the dry and wet seasons. The wet season starts in May and ends in September or early October, while the dry season begins in October and ends in April or early May. The mean annual rainfall is about 690 mm while the mean annual temperature ranges between a maximum of 43 °C and a minimum of 29°C. The vegetation is mainly savanna, climatically defined as Sudan savanna, which is characterized by the presence of scattered trees and


Article DOI: 10.52589/AJAFS-2BBZMWHD
DOI URL: https://doi.org/10.52589/AJAFS-2BBZMWHD

shrubs in open grassland (Wakawa et al. 2016). The choice of Katsina and Kano States in the Northwestern region was based on the presence of camel international markets in these two states and both states are located along the major trans-Saharan animal trade routes to Nigeria.




SOURCE: National Centre For Remote Sensing Jos, Nigeria.

**MAP OF THE STUDY AREAS**

### Study Population

Oral consent was obtained from the respondents before enrolling into the study. A total of 99 respondents (camel owners, butchers, meat and milk sellers), with 50 from Katsina and 49 from Kano study areas participated in the survey.

### Administration of Questionnaire

Interviews were conducted in Hausa language to the respondents in the 2 study areas. The questionnaire was tested among the selected camel marketers in order to remove ambiguities; it was administered by the researcher with the help of a veterinary assistant. The questionnaire incorporated questions regarding the age and academic qualification of the respondents and also on the general impact of the disease in camels, how many liters of milk are produce per day by a healthy camel as well as by surra affected camel, what is the price of healthy adult and young camel as well as surra affected adult and young camels.


Article DOI: 10.52589/AJAFS-2BBZMWHD
DOI URL: https://doi.org/10.52589/AJAFS-2BBZMWHD

### Data Analysis

Data was entered, coded and summarized using Microsoft Excel (2007) spreadsheets and then analyzed by using Epi info 7 software (Centre for Disease Control (CDC), 2014). The coding involved assigning codes to open ended responses after structuring them.

## RESULT

### Respondents who participated in the study

A total of 99 persons participated in the questionnaire survey, 49 of them from Kano and 50 from Katsina state. All the respondents in the two study states were male as the females declined to participate in the study.

### Socio-demographic characteristics

In the Kano study area 44% of the respondents were within the ages of 41-50 years, followed by 34% of those between 31-40 years of age. Only 4% of respondents were below 20 years of age. Similarly, in the Katsina study area 48% were those of ages 31-40 followed by 40% of those within 41-50 years. The least were those between ages 51-60 and constituted 12% of the respondents (Table 1). Majority of the respondents in both study areas had Quranic education compared to western education (Table 1)

**Table 1: Socio-Demographic Characteristics of the Respondents in the Two Study Areas**

| | **KATSINA STATE** | | **KANO STATE** | |
|---|---|---|---|---|
| **Age (years)** | N | % | N | % |
| 20 | 2 | 4 | 0 | 0 |
| 21- 30 | 1 | 2 | 0 | 0 |
| 31- 40 | 17 | 34 | 24 | 48 |
| 41-50 | 22 | 44 | 20 | 40 |
| 51- 60 | 7 | 14 | 6 | 12 |
| **TOTAL** | **49** | | **50** | |
| **Gender** | | | | |
| Male | 49 | 98 | 50 | 100 |
| Female | 0 | 0 | 0 | 0 |
| **Educational level** | | | | |
| Islamic/Quranic | 45 | 90 | 24 | 48 |
| Western | 5 | 10 | 22 | 44 |


Article DOI: 10.52589/AJAFS-2BBZMWHD
DOI URL: https://doi.org/10.52589/AJAFS-2BBZMWHD

African Journal of Agriculture and Food Science
ISSN: 2689-5331
Volume 7, Issue 3, 2024 (pp. 1-9)

www.abjournals.org

**Impact of Trypanosomiasis (Surra) on camels in Kano and Katsina States**

Respondents from Kano state considered 21(42%) as cause of death, reduced milk production 19(38%), reduced farming efficiency 16(32%), emaciation 11(22%), poor meat quality 5(10%), abortion 3(6%) and fever 1(2%).While in Katsina the respondents said the greatest impact is poor meat production 25(50%), followed by inability to carry heavy load 19(38%), poor milk production 14(28%), abortion 7(14%) and death 5(10%). Other impact of Trypanosomiasis in camels according to 2(4%) of respondents was emaciation and difficulty in performing any task (Table 2).

**Table 2: Respondents impact of Surra in Kano and Katsina States, Nigeria**

| | KANO | | KATSINA | |
|---|---|---|---|---|
| **RESPONDENTS VIEW** | **N** | **%** | **N** | **%** |
| Inability to carry heavy load | 16 | 32.0 | 19 | 38.0 |
| Poor milk production | 19 | 38.0 | 25 | 50.0 |
| Poor meat production | 5 | 10.0 | 14 | 28.0 |
| Emaciation | 11 | 22.0 | 2 | 4.0 |
| Death | 21 | 42.0 | 5 | 10.0 |
| Abortion | 3 | 6.0 | 7 | 14.0 |
| Inability to perform work | 0 | 0 | 2 | 4.0 |
| Fever | 1 | 2.0 | 0 | 0 |

**Estimated economic impact of Surra on live camel prices**

In Table 3, estimating the economic impact of meat and milk yield was based on the mean values recorded. The mean estimated cost of healthy and infected adult camels in Kano were ₦301,928.57 (292,428.57− 311,428.57) and ₦164,755.09 (155,224.48− 174,285.72) while in Katsina ₦128,000 (118,600.00 − 137,600.00) and ₦76,100 (66,600.00− 86,600.00) respectively. The estimated loss incurred by a herder per head of adult camel due to surra is ₦137,173.48 representing about (54.4%) of the live value of a healthy adult in Kano while in Katsina state the estimated loss amounts to ₦52,000.00 which is 40.60% of the value of a healthy adult.

For the young camel the mean estimated cost of healthy and infected camels in Kano were ₦184,377.55 (174,877.55− 193,877.55) and ₦114,581.63 (105,081.63−124,082.63) while in Katsina were ₦82,100 (66,600.00−86,600.00) and ₦48,850 (39,300.00−58,400.00), respectively. The estimated amount of income a herder could make per head of young camels if surra is absent is ₦69,795.92 in Kano and ₦33,250.00 in Katsina (Table 3).

The mean estimated quantity of milk lost due to surra in liters and the monetary value in Naira (₦) were calculated by subtracting the mean estimated volume of milk produced by healthy camels with the amount produced by surra infected camels likewise the amount in Naira (₦). In Kano the mean estimate for milk produced by healthy camels was 6.94 liters and the amount was ₦8,328. 00 and that of infected camels was 0.61 liters with ₦732.00 as the amount, which gives us the estimated milk loss due to surra to be 6.33 and the amount lost as ₦7,596.00 representing a loss of 91.2%. (Table 4).In Katsina State the estimated milk yield of a healthy camel was 6.2 liters valued at ₦7,440. However, the milk yield of a surra infected camel was estimated at 0.30 liters resulting in a loss 5.9 liters amounting to ₦7,080 representing a loss of 95.2% (Table 4).


Article DOI: 10.52589/AJAFS-2BBZMWHD
DOI URL: https://doi.org/10.52589/AJAFS-2BBZMWHD

**Table 3: Estimated Economic Impact of Surra on the Market Value of Camel in the Study Areas**

| | Kano | | Katsina | |
|---|---|---|---|---|
| **Variables** | **Adult** | **Young** | **Adult** | **Young** |
| Range (mean) estimated cost of healthy camel (₦) | 292,428.57−311,428.57 (301,928.57) | 174,877.55−193,877.55 (184,377.55) | 118,600.00 − 137,600.00 (128,100.00) | 72,600.00 − 91,600.00 (82,100.00) |
| Range (mean) estimated cost of camel suffering from Surra (₦) | 155,224.48−174,285.72 (164,755.09) | 105,081.63−124,082.63 (114,581.63) | 66,600.00−86,600.00 (76,100.00) | 39,300.00−58,400.00 (48,850) |
| Mean difference (₦) | 137,173.48 | 69,795.92 | 52,000.00 | 33,250.00 |
| Percent loss | 54.4 | 37.85 | 40.60 | 40.50 |

**Table 4: Estimated Economic Impact of Surra on Daily Milk Production in the Study Areas**

| | Kano | | | Katsina | | |
|---|---|---|---|---|---|---|
| **Variables** | **Healthy Camel** | **Surra infected Camel** | **Difference (%)** | **Healthy Camel** | **Surra infected Camel** | **Difference (%)** |
| Mean estimated volume of milk (L) | 6.94 | 0.61 | 6.33 (91.2) | 6.2 | 0.30 | 5.9 (95.2) |
| *Estimated economic value (₦) | 8,328.00 | 732.00 | 7,596.00 (91.2) | 7,440.00 | 360.00 | 7,080 (95.2) |

*A litter of milk was estimated at N1, 200.00

## DISCUSSION

Population explosion in the face of dwindling resources constitutes a serious threat to socioeconomic wellbeing of Nigerians. Added to this is the menace of desert encroachment which makes arable land unsuitable for crop and livestock farming. Camels are adapted to survive under harsh arid environments. They offer a viable option to farmers and serve as means of transportation and support to several agricultural and domestic activities. Overall, they play crucial roles in supporting the livelihood of the rural communities by providing meat, milk and other by-products that serve as a source of income and add value to the populace. Sadly, the full potentials of camels are not realized in northwest Nigeria due to the impact of disease conditions such as Surra. Findings from this study show that the camel


Article DOI: 10.52589/AJAFS-2BBZMWHD
DOI URL: https://doi.org/10.52589/AJAFS-2BBZMWHD

market is dominated by men aged between 40−50 years. This is similar to previous reports (Abdi, 2014; Ghude et al., 2017; Salamula et al., 2017). Male dominance of camel trade reported in this study may be attributed to religious and cultural practices in the study areas, where the female folks are restricted to domestic chores with limited access to livestock markets. Most of the respondents were aware of the impact of Surra on camel production. They attributed such effects as reduced milk production, reduced work efficiency, weight loss and poor meat yield. These observations are in tandem with the reported effect of Surra in camels (Njiru et al., 2004; Swai et al., 2011; Desquesnes et al., 2013). Based on the reported impact of Surra on live camel market value and milk yields in the study area, monetary values were deduced. It was estimated that 38 – 54% loss in market value of camels may be attributed toSurra in young and adult camels. This translates to a loss of between ₦33,250 – 137, 173. 48 depending on the age of the camel and the study area. It has been reported that most farmers prefer to sell their sick animals at low values rather than seek veterinary attention for fear of losing their animals (Ghude et al., 2017; Mamman et al., 2020). Additional loss experienced by farmers due to surra is as a result of reduced milk yield. According to respondents in the study area, healthy camels can produce 6-10 liters of milk daily. However, camels suffering from Surra may cease milk production completely or experience up to 95% reduction in milk yield. Based on the current market value of a liter of milk in the study area, it was estimated that farmers may lose up to ₦7,596.00 daily as a result of surra affected camels. This will amount to substantial annual loss considering the fact that healthy camels may produce milk for up to 12 months. This result on the quantity of milk produced by healthy camels and the value to the farmers is in accord with the report from Kenya (Njoka et al., 2016).

Although this study could not assess the impact of Surra on other activities of camels such as loss of draught power and other by- products, it is obvious that Surra causes economic loss to farmers and threatens food security and poverty eradication. Overall, Surra negatively impacts camel production in northwest Nigeria and deserves urgent attention.

## CONCLUSION

This research has established a baseline data on the economic impact of camel Trypanosomiasis (Surra) in northwest Nigeria. The study assessed the impact of the disease in relation to loss of live market value and milk production. Substantial monetary losses were estimated highlighting the negative effect of Surraon the livelihood of farming communities. Considering the significant role of camels to the livelihood of the populace, there is the need for a planned systematic control measures to curb the socio-economic impact of camel Trypanosomiasis (Surra) infections in the regions.


Article DOI: 10.52589/AJAFS-2BBZMWHD
DOI URL: https://doi.org/10.52589/AJAFS-2BBZMWHD

## REFERENCES

(1) Abera, Z., Usmane, A., Ayana, Z., 2015. Review on camel Trypanosomiasis: its epidemiology and economic importance. *ActaParasitologica. Glob* 6, 117–128. https://doi.org/10.5829/idosi.apg.2015.6.2.94253.
(2) Abdi, C. (2014). Threatened identities and gendered opportunities: Somali migration to America. 39: 459-83. 10.1086/673380
(3) Aregawi, W.G., Agga, G.E., Abdi, R.D. and Büscher, P.(2019). Systematic review and meta-analysis on the global distribution, host range, and prevalence of *Trypanosomaevansi*.*Parasit. Vectors* 12, 67. https://doi.org/10.1186/s13071-019-3311-4
(4) Centre for Disease Control and Prevention (CDC) (2014). Epi Info 7 User Guide. Retrieved from https://www.cdc.govepiinfouser.guide
(5) Danibrahim, N. T., Kohar, U. H. A., &Indiran, L. (2022). Influence of Entrepreneurial Competencies on the Performance of SMEs in Northwest Nigeria. *International Journal of Academic Research in Business and Social Sciences*, 12(5), 858 – 872.
(6) Desquesnes, M., Holzmuller, P., Lai, D. H., Dargantes, A., Lun, Z. R., &Jittaplapong, S. (2013). *Trypanosomaevansi*and surra: a review and perspectives on origin, history, distribution, taxonomy, morphology, hosts, and pathogenic effects. *Biomed research international*, *2013*, 194176.
(7) Elhaig, M.M., and Sallam, N.H. (2018).Molecular survey and characterization of *Trypanosoma evansi* in naturally infected camels with suspicion of a Trypanozooninfection in horses by molecular detection in Egypt. *Microbes and Pathogens*. 123, 201–205. https://doi.org/10.1016/j.micpath.2018.07.017.
(8) Food and Agricultural Organization (FAO). (2018). *Global Livestock Environmental Assessment Model*. Reference documentation – Version 2.0. Revision 5. Rome, Italy.
(9) Food and Agricultural Organization (FAO) . (2017). *Global Livestock Environmental Assessment Model (GLEAM)*. Available online at: www.fao.org/gleam/en/.
(10) Food and Agricultural Organization (FAO) (2017). Building resilience for peace and food security the state of food security and nutrition in the world. Available: http://www.fao.org/3/a-I7695e.pdf
(11) Ghude, M.I. and Maigandi, S.A. (2011). Socio-economic importance of camel production in Northern Nigeria. Procedure of 16th Annual Conference of Animal Science Association of Nigeria (ASAN) held at Kogi State University, Ayingba. 12-15, September, 2011. Pp 471-473
(12) Ghude, M.I., Maigandi, S.A., Mohammed, I.R. and Alkali, H.A. (2017). Socio-economic characteristics of camel (*Camelus dromedaries*) marketers in Mai'adua livestock market, Katsina State, Nigeria. *Nigerian Journal of Animal Production*.4,361-369
(13) Kakr, I., Khan, S., Khan, K. and Ahmed, S.(2019). Economic losses due to Trypanosomiasis of camels in Balochistan. *Journal ofInnovative Sciences*, 5(2): 65-71.
(14) Mamman, S.A., Dakul, D.A., Yohanna, J.A., Dogo, G.A., Peter, J.G. &Kamani, J. (2020).Assessment of the Knowledge Attitude and Perception (KAP) of Camel Trypanosomiasis (Surra) Among Camel Marketers in Northern Nigeria. *European Modern Studies Journal* 4(5), 1-11.
(15) Mochabo, M.O.K., Kitala, P.M., Gathura, P.B., Ogara, W.O., Eregae,E.M., Kaitho, T.D. and Catley, A. (2006). The socio-economic impact of important camel diseases as


Article DOI: 10.52589/AJAFS-2BBZMWHD
DOI URL: https://doi.org/10.52589/AJAFS-2BBZMWHD

perceived by a pastoralist community in Kenya. *Onderstepoort Journal of Veterinary Research*, 269–274

(16) Mohamed, M.A., Mohamoud, A.A., Adow, H.I., Bitrus, A.A., 2020 Seroprevalence of Trypanosomaevansi in dromedary camels from selected dairy farms in Benadir, Somalia. *Advance Animal Veterinary Science* 8, 333–338. https://doi.org/10.17582/journal.aavs/2020/8.3.333.338

(17) Njiru, Z.K., Constantine, C.C., Ndung'u, J.M., Robertson, I., Okaye, S., Thompson, R.C.A. (2004). Detection of *Trypanosomaevansi*in camels using PCR and CATT/*T. evansi* tests in Kenya. *Veterinary Parasitology* 124, 187–199. https://doi.org/10.1016/j.vetpar.2004.06.029

(18) Njoka, J., Yanda, P., Maganga, F., Liwenga, E., Kateka, A., Henku, A., Mabhuye, E., Malik, N. and Bavo, C. (2016).Kenya: Country assessment. Working paper. University of Nairobi. The Centre for Sustainable Dryland Ecosystems and Societies (CSDES) and Pathways to resilience in Semi-Arid economies (PRISE). http://prise.odi.org/wp-content/uploads/2016/01/Low-Res-Kenya-CSA.pdf

(19) Pasha, R.H., Qureshi, A.S. and Khamas, W.A. (2013). A Survey of Camel Production in Three Different Ecological Zones of Pakistan. *International Journal of Agriculture & Biology*,15, 62–82..

(20) Ramankutty, N., Evan, A.T., Monfreda, C. and Foley, J.A. (2008). Farming the planet: 1. Geographic distribution of global agricultural lands in the year 2000. *Global Biogeochemical cycles*, 22, GB1003

(21) Salah, A.A., Robertson, I., and Mohamed, A. (2015). Estimating the economic impact of *Trypanosomaevansi* infection on production of camel herds in Somaliland. *Tropical Animal Health and Production.* 47:707-714. Doi 10.1007/s11250-0780-0

(22) Salamula, J.B., Egeru, A., Asiimwe, R., Aleper, D.K., Namaalwa, J.J. (2017). Socio-economic determinants of pastoralists' choice of camel production in Karamoja sub-region, Uganda. 7.26.10.1186/s13570-017-0096-y

(23) Saini, RK.,Orindi, B.O., Mbahin, N., Andoke, J.A., Muasa, P.N. and Mbuvi, D.M. (2017). Protecting cows in smallholder farms in East Africa from tsetse flies by mimicking the odor profile of a non-host bovid. *PLoS Neglected Tropical Disease*; 11: 1–27. https://doi.org/10.1371/journal.pntd.0005977 PMID: 29040267

(24) Shaw, A., Wint, W., Cecchi, G., Torr, S., Waiswa, C., and Alemu T. (2017). Intervening against bovine Trypanosomosis in eastern Africa: mapping the costs and benefits. Food and Agriculture Organization of the United Nations. PAAT Technical and Scientific Series 11. 2017. Available: http://www.fao.org/documents/card/en/c/4c8c300d-2117-4b1b-a409-5b5148b3c431

(25) Swai, E.S., Moshy, W., Mbise, E., Kaaya, J., Bwanga, S.(2011). First field investigation report on the prevalence of trypanosomosis in camels in northern Tanzania. *Research Opinions in Animal & Veterinary Sciences* (ROAVS) 1, 15–18.

(26) Wakawa, I.D., Adams, L.I. and Bichi, A.M. (2016). Tree species composition within Kano state university of science and technology Wudil, Kano state, Nigeria. *Journal of Research in Forestry, wildlife and environment*. 8(2): 100-111.


Article DOI: 10.52589/AJAFS-2BBZMWHD
DOI URL: https://doi.org/10.52589/AJAFS-2BBZMWHD