EVALUATION OF CATTLE HERD STRUCTURE IN THE AGRO-PASTORAL DISTRICTS OF SOROTI AND KATAKWI

By

KHAMIS ASHIRAF

(BU/UP/2020/1402)

A RESEARCH DISSERTATION SUBMITTED TO THE FACULTY OF AGRICULTURE AND ANIMAL SCIENCES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A BACHELORS OF ANIMAL PRODUCTION AND MANAGEMENT OF BUSITEMA UNIVERSITY

FEBRUARY, 2024

DECLARATION

I hereby declare that this research work titled "Evaluation of Cattle Herd Structure in the Agro-pastoral Districts of Soroti and Katakwi," submitted in partial fulfilment of the requirements for Bachelor of Animal Production and Management of Busitema University, is entirely my own work, unless otherwise acknowledged or referenced. This work has not been submitted for any other Degree or examination in any other university or institution.

Khamis Ashiraf

Khamisashiraf1@gmail.com

0703208590

Signed..... **Date**11/03/2024.....

APPROVAL

APPROVAL

I hereby declare that this research dissertation has been done under my supervision as the institutional supervisor and is approved for submission to the University

Dr. Ekou Justine

Senior lecturer

Department of Animal Production and Management

Faculty of Agriculture and Animal Sciences

Busitema University, Arapai campus

P.O Box, 236 Tororo, Uganda

Signed.....

Date...16/03/2024.....

ACKNOWLEDGEMENT

I would like to express my sincere gratitude and appreciation to the following individuals and organizations that have supported and contributed towards my research study.

The faculty and staff of Animal Production at Busitema University, for providing access to resources, research facilities, and a conducive learning environment

My supervisor, Dr. Ekou Justine, for his invaluable guidance, mentorship, and unwavering support throughout this research journey

All the authors and researchers whose works have been cited and referenced in this research, whose contributions have enriched the context and analysis of this study

Special thanks to my Parents Mr. Musaazi Abdul-Karim and Mrs. Kiiza Zaina for their tremendous effort to see that i reach this far

TABLE OF CONTENTS

ABBREVIATIONS OR ACRONYMS

AI	Artificial Insemination
BRD	Bovine Respiratory Disease
CBPP	Contagious Bovine Pleural Pneumonia
EASZ	East African Small Zebu
FAO	Food and Agriculture Organization
FMD	Foot and mouth disease
GDP	Gross Domestic Product
NAGRC & DB	National Animal Genetic Resources Centre and Data Bank
ROU	Republic of Uganda
SPSS	Statistical Package for Social Sciences

ABSTRACT

This study addresses the critical aspects of cattle herd structure in Soroti and Katakwi districts, Uganda, emphasizing the significance of understanding the composition, demographics, and management practices for sustainable livestock farming. Cattle rearing play a pivotal role in the livelihoods of communities in Soroti and Katakwi, yet the industry faces challenges such as poor health practices, limited knowledge, and inadequate market access. The absence of comprehensive information on herd structure hinders effective interventions. This research there for aimed at filling existing gaps in information, providing policymakers, agricultural extension services, and local farmers with valuable insights. The study employed a cross-sectional design, combining qualitative and quantitative approaches. Sixty cattle herds were randomly sampled from three Sub Counties. Data on herd size, breed composition, age structure, and sex ratio were collected between November and December 2023. The mean herd size was 16.5 cattle, indicating substantial variability influenced by economic resources, cultural practices, and reproductive performance. Zebu breeds dominated (64.5%), with Ankole Longhorn, Nganda, and mixed breeds also present, reflecting cattle movement and uncontrolled breeding. Cows constituted the largest portion (37.2%), emphasizing their significance for herd growth and milk production. There was a notable imbalance in the sex ratio, with a higher proportion of females (68.3%) than males (31.7%). The study provides crucial insights into the dynamic cattle herd structure in Soroti and Katakwi. In conclusion, the prevalence of zebu breeds, imbalance in sex ratio, and the significance of cows for milk production underscore the need for targeted interventions and improved management practices. The study recommended need for improved breeding practices, focusing on desirable traits and productivity, education on herd management to improve practices, including breeding, nutrition, and health care, encourage sustainable integration of exotic breeds through controlled crossbreeding, and developing climate-resilient strategies in cattle farming

CHAPTER ONE: INTRODUCTION

1.1 Background

Herd structure refers to the composition of cattle in a herd in terms of age, sex, breed, and production purposes. It reflects the management practices that farmers employ and the dynamics and challenges that they encounter in their livestock farming systems. The global cattle herd structure is diverse, with variations in breed, purpose, and management across different regions (Fordyce *et al.*, 2021).

The breeds that make up the global cattle population are *Bos-taurus* and *Bos-indicus*, among others. Every breed has distinct qualities that are ideal for particular uses, such as production of dairy or beef. Cattle are used for several things, including meat, milk, hides, and draught power. The primary purpose of cattle typically dictates the choice of breed and management techniques (Bett *et al.*, 2013).

The usual members of a cattle herd include bulls, heifers, cows, and calves. A balance between young replacement animals and mature, productive cows is maintained by age structure management. Because females are necessary for the production of both milk and meat, the sex ratio is usually skewed in favour of having more of them (cows and heifers). Fewer bulls, are available for reproduction (Holden & Butler, 2018).

The cattle population in Africa is varied, consisting of both native and foreign varieties. While foreign breeds are frequently introduced for increased output, native cattle are well suited to the local environment. Because they provide many rural people in Africa with milk, meat, and revenue, cattle are essential to their way of life. Additionally, they are essential to social and cultural processes (Mapiye *et al.*, 2020).

Because different management techniques are used in African cattle herds, age structures differ greatly. While some herders maintain a variety of age groups, others place a more priority on holding older livestock. Since cows are needed to provide milk and meat and fewer males are kept for breeding, the sex ratio usually favours more females (Akpa, G, *et al.*, 2012).

The cattle population in Uganda consists of both imported exotic varieties for increased productivity and native types like the Ankole, which are suited to the environment. In Uganda, cattle are mostly employed for cultural and social purposes, as well as for the production of milk and meat. An important component of Ugandan agriculture is dairy farming according to

REFERENCES

Ademun, O. A. R., Ocaido, M., & Opuda, J. A. (2012). Financial performance of cattle and crop production enterprises in selected pastoral and agro-pastoral production systems Uganda. *African Journal of Animal and Biomedical Sciences*, *2*(7), 43–59. https://102.134.147.238/index.php/home/article/view/205/92

Akpa, G. N., Alphonsus, C., & Abdulkareem, A. (2012). Evaluation of herd structure of white Fulani cattle holdings in Zaria-Nigeria. In *Biomed. Sci* (Vol. 7, Issue 1).

Akpa, G, N., Alphonsus, C, Abdulkareem, & A. (2012). Evaluation of herd structure of white Fulani cattle holdings in Zaria, Nigeria. *Scientific Research and Essays*, *7*(42), 3605–3608. https://doi.org/10.5897/sre11.458

Améndola, L., Solorio, F. J., Ku-Vera, J. C., Améndola-Massiotti, R. D., Zarza, H., & Galindo, F. (2016). Social behaviour of cattle in tropical silvopastoral and monoculture systems. *Animal*, *10*(5), 863–867. https://doi.org/10.1017/S1751731115002475

Aranguiz, A., & Ur, W. (2019). *White Paper Pathways to Intensify Sustainable Forage Production in Uganda*. *November*.

Arvidsson, A., Fischer, K., Hansen, K., & Sternberg-lewerin, S. (2022). *Diverging Discourses : Animal Health Challenges and Veterinary Care in*. *9*(March), 1–15. https://doi.org/10.3389/fvets.2022.773903

Asizua, D., Mpairwe, D., Kabi, F., Mutetikka, D., Hvelplund, T., Weisbjerg, M. R., & Madsen, J. (2017). Effects of grazing and feedlot finishing duration on the performance of three beef cattle genotypes in Uganda. *Livestock Science*, *199*(August 2016), 25–30. https://doi.org/10.1016/j.livsci.2017.03.006

Augustine, D. J., Derner, J. D., Fernández-Giménez, M. E., Porensky, L. M., Wilmer, H., & Briske, D. D. (2020). Adaptive, Multipaddock Rotational Grazing Management: A Ranch-Scale Assessment of Effects on Vegetation and Livestock Performance in Semiarid Rangeland. *Rangeland Ecology and Management*, *73*(6), 796–810. https://doi.org/10.1016/j.rama.2020.07.005

Ayanlade, A., & Ojebisi, S. M. (2020). Climate change impacts on cattle production: analysis of cattle herders' climate variability/change adaptation strategies in Nigeria. *Change and Adaptation in Socio-Ecological Systems*, *5*(1), 12–23. https://doi.org/10.1515/cass-2019-0002

Beard, J. K., Musgrave, J. A., Hanford, K. J., Funston, R. N., & Mulliniks, J. T. (2019). The effect of dam age on heifer progeny performance and longevity. *Translational Animal*

Science, *3*, 1710–1713. https://doi.org/10.1093/tas/txz063

Bett, R. C., Okeyo, M. A., Malmfors, B., Johansson, K., Agaba, M., Kugonza, D. R., Bhuiyan, A. K. F. H., Vercesi Filho, A. E., Mariante, A. S., Mujibi, F. D., & Philipsson, J. (2013). Cattle breeds: Extinction or quasi-extant? *Resources*, *2*(3), 335–357. https://doi.org/10.3390/resources2030335

Biscarini, F., Nicolazzi, E., Alessandra, S., Boettcher, P., & Gandini, G. (2015). Challenges and opportunities in genetic improvement of local livestock breeds. *Frontiers in Genetics*, *5*(JAN), 1–16. https://doi.org/10.3389/fgene.2015.00033

Bittante, G., Negrini, R., Bergamaschi, M., Cecchinato, A., & Toledo-Alvarado, H. (2020). Pure-breeding with sexed semen and crossbreeding with semen of double-muscled sires to improve beef production from dairy herds: Factors affecting heifer and cow fertility and the sex ratio. *Journal of Dairy Science*, *103*(6), 5246–5257. https://doi.org/10.3168/jds.2019-17932

Boichard, D., Ducrocq, V., & Fritz, S. (2015). Sustainable dairy cattle selection in the genomic era. *Journal of Animal Breeding and Genetics*, *132*(2), 135–143. https://doi.org/10.1111/jbg.12150

Byrne, A. W., Barrett, D., Breslin, P., Fanning, J., Casey, M., Madden, J. M., Lesellier, S., & Gormley, E. (2022). Bovine tuberculosis in youngstock cattle: A narrative review. *Frontiers in Veterinary Science*, *9*. https://doi.org/10.3389/fvets.2022.1000124

Cole, J. B., & da Silva, M. V. G. B. (2016). Genomic selection in multi-breed dairy cattle populations. *Revista Brasileira de Zootecnia*, *45*(4), 195–202. https://doi.org/10.1590/S1806-92902016000400008

Daros, R. R., Weary, D. M., & von Keyserlingk, M. A. G. (2022). Invited review: Risk factors for transition period disease in intensive grazing and housed dairy cattle. *Journal of Dairy Science*, *105*(6), 4734–4748. https://doi.org/10.3168/jds.2021-20649

de la Fuente, J., Contreras, M., Kasaija, P. D., Gortazar, C., Ruiz-Fons, J. F., Mateo, R., & Kabi, F. (2019). Towards a multidisciplinary approach to improve cattle health and production in Uganda. *Vaccines*, *7*(4). https://doi.org/10.3390/vaccines7040165

Debele, G. (2021). Evaluation of reproduction performance and calf sex ratio of dairy cattle in selected locations of South-East Oromia. *International Journal of Agricultural Science and Food Technology*, *7*, 170–192. https://doi.org/10.17352/2455-815x.000105

Do, C., Wasana, N., Cho, K., Choi, Y., Choi, T., Park, B., & Lee, D. (2013). The effect of age at first calving and calving interval on productive life and lifetime profit in Korean holsteins. *Asian-Australasian Journal of Animal Sciences*, *26*(11), 1511–1517.

https://doi.org/10.5713/ajas.2013.13105

Ducrotoy, M. J., Majekodunmi, A. O., Shaw, A. P. M., Bagulo, H., Musa, U. B., Bertu, W. J., Gusi, A. M., Ocholi, R. A., Bryssinckx, W., & Welburn, S. C. (2016a). Fulani cattle productivity and management in the Kachia Grazing Reserve, Nigeria. *Pastoralism*, *6*(1). https://doi.org/10.1186/s13570-016-0072-y

Ducrotoy, M. J., Majekodunmi, A. O., Shaw, A. P. M., Bagulo, H., Musa, U. B., Bertu, W. J., Gusi, A. M., Ocholi, R. A., Bryssinckx, W., & Welburn, S. C. (2016b). Fulani cattle productivity and management in the Kachia Grazing Reserve, Nigeria. *Pastoralism*, *6*(1). https://doi.org/10.1186/s13570-016-0072-y

E, N. E., Chenyambuga, S. W., & Gwakisa, P. S. (n.d.). *Socio-economic values and traditional management practices of Tarime zebu cattle in Tanzania*.

Emanuelson, U., Brügemann, K., Klopčič, M., Leso, L., Ouweltjes, W., Zentner, A., & Blanco-Penedo, I. (2022). Animal Health in Compost-Bedded Pack and Cubicle Dairy Barns in Six European Countries. *Animals*, *12*(3), 1–9. https://doi.org/10.3390/ani12030396

Engström, F. (2016). *Breeding and Herd Structure in Livestock-based Agropastoralism Systems in Chepareria, West Pokot, Kenya*. http://epsilon.slu.se

Evans, C. A., Pinior, B., Larska, M., Graham, D., Schweizer, M., Guidarini, C., Decaro, N., Ridpath, J., & Gates, M. C. (2019). Global knowledge gaps in the prevention and control of bovine viral diarrhoea (BVD) virus. *Transboundary and Emerging Diseases*, *66*(2), 640–652. https://doi.org/10.1111/tbed.13068

Fao. (n.d.). *Livestock production systems spotlight Livestock Production Systems Spotlight Beef and Chicken Meat*. http://www.fao.org/ag/againfo/programmes/en/ASL2050.html

Florida, S., Patterson, K., & Patterson, K. (2019). *Digital Commons @ University of Is there a social hierarchy in the heifer herd of Finca Paraíso ?*

Fordyce, G., Shephard, R., Moravek, T., & McGowan, M. R. (2021a). Australian cattle herd: A new perspective on structure, performance and production. *Animal Production Science*, *2014*, 410–421. https://doi.org/10.1071/AN20342

Fordyce, G., Shephard, R., Moravek, T., & McGowan, M. R. (2021b). Australian cattle herd: A new perspective on structure, performance and production. *Animal Production Science*. https://doi.org/10.1071/AN20342

G, z., j, e., l, o., p, m., p, e., & j, a. (2017). Occurrence of Mastitis at Cow and Udder Quarter Level in the Agro- Pastoral District of Soroti, Uganda. *Journal of Veterinary Science & Technology*, *08*(02). https://doi.org/10.4172/2157-7579.1000432

Garvey, M. (2022). Lameness in Dairy Cow Herds: Disease Aetiology, Prevention and Management. *Dairy*, *3*(1), 199–210. https://doi.org/10.3390/dairy3010016

Gebrehiwot, N. Z., Strucken, E. M., Aliloo, H., Marshall, K., & Gibson, J. P. (2020). The patterns of admixture, divergence, and ancestry of African cattle populations determined from genome-wide SNP data. *BMC Genomics*, *21*(1), 1–16. https://doi.org/10.1186/s12864-020-07270-x

Gerssen-Gondelach, S. J., Lauwerijssen, R. B. G., Havlík, P., Herrero, M., Valin, H., Faaij, A. P. C., & Wicke, B. (2017). Intensification pathways for beef and dairy cattle production systems: Impacts on GHG emissions, land occupation and land use change. *Agriculture, Ecosystems and Environment*, *240*, 135–147. https://doi.org/10.1016/j.agee.2017.02.012

Gong, Q. L., Chen, Y., Tian, T., Wen, X., Li, D., Song, Y. H., Wang, Q., Du, R., & Zhang, X. X. (2021). Prevalence of bovine tuberculosis in dairy cattle in china during 2010–2019: A systematic review and meta-analysis. *PLoS Neglected Tropical Diseases*, *15*(6), 1–21. https://doi.org/10.1371/journal.pntd.0009502

González-Gordon, L., Porphyre, T., Muwonge, A., Nantima, N., Ademun, R., Ochwo, S., Mwiine, N. F., Boden, L., Muhanguzi, D., & Bronsvoort, B. M. de C. (2023). Identifying target areas for risk-based surveillance and control of transboundary animal diseases: a seasonal analysis of slaughter and live-trade cattle movements in Uganda. *Scientific Reports*, *13*(1), 1–16. https://doi.org/10.1038/s41598-023-44518-4

Gottschall, C. S., Ferreira, E. T., Canellas, L., & Bittencourt, H. R. (2007). The reproductive performance of beef cows of different ages with calves weaned at three or seven months. *Anim. Reprod*, 42–45.

Guliński, P. (2022). Cattle breeds – contemporary views on their origin and criteria for classification: a review. *Acta Scientiarum Polonorum Zootechnica*, *20*(2), 3–18. https://doi.org/10.21005/asp.2021.20.2.01

Guo, Z., Chen, F., Zhao, S., Zhang, Z., Zhang, H., Bai, L., Zhang, Z., & Li, Y. (2023). IL-10 Promotes CXCL13 Expression in Macrophages Following Foot-and-Mouth Disease Virus Infection. *International Journal of Molecular Sciences*, *24*(7). https://doi.org/10.3390/ijms24076322

Hamdi, J., Boumart, Z., Daouam, S., El Arkam, A., Bamouh, Z., Jazouli, M., Tadlaoui, K. O., Fihri, O. F., Gavrilov, B., & El Harrak, M. (2020). Development and Evaluation of an Inactivated Lumpy Skin Disease Vaccine for Cattle. *Veterinary Microbiology*, *245*(April), 108689. https://doi.org/10.1016/j.vetmic.2020.108689

Holden, S. A., & Butler, S. T. (2018). Review: Applications and benefits of sexed semen in dairy and beef herds. *Animal*, *12*(s1), s97–s103. https://doi.org/10.1017/S1751731118000721

Idrissou, Y., Assani, A. S., Baco, M. N., Yabi, A. J., & Alkoiret Traoré, I. (2020). Adaptation strategies of cattle farmers in the dry and sub-humid tropical zones of Benin in the context of climate change. *Heliyon*, *6*(7). https://doi.org/10.1016/j.heliyon.2020.e04373

Kabi, F., Muwanika, V., & Masembe, C. (2016). Indigenous cattle breeds and factors enhancing their variation, potential challenges of intensification and threats to genetic diversity in Uganda. *Animal Genetic Resources/Ressources Génétiques Animales/Recursos Genéticos Animales*, *58*(December), 1–12. https://doi.org/10.1017/s2078633615000326

Kabi, F., Muwanika, V., & Masembe, C. (2017). *Indigenous cattle breeds and factors enhancing their variation , potential challenges of intensi fi cation and threats to genetic diversity in Uganda*. 1–12. https://doi.org/10.1017/S2078633615000326

Kalantari, A. S., Armentano, L. E., Shaver, R. D., & Cabrera, V. E. (2016). Economic impact of nutritional grouping in dairy herds. *Journal of Dairy Science*, *99*(2), 1672–1692. https://doi.org/10.3168/jds.2015-9810

Kasaija, P. D., Estrada-Peña, A., Contreras, M., Kirunda, H., & de la Fuente, J. (2021). Cattle ticks and tick-borne diseases: a review of Uganda's situation. In *Ticks and Tick-borne Diseases* (Vol. 12, Issue 5). Elsevier GmbH. https://doi.org/10.1016/j.ttbdis.2021.101756

Kimaro, E. G., Mor, S. M., & Toribio, J. A. L. M. L. (2018). Climate change perception and impacts on cattle production in pastoral communities of northern Tanzania. *Pastoralism*, *8*(1), 1–17. https://doi.org/10.1186/s13570-018-0125-5

L'Italien, L., Weladji, R. B., Holand, Ø., Røed, K. H., Nieminen, M., & Côté, S. D. (2012). Mating group size and stability in reindeer rangifer tarandus: The effects of male characteristics, sex ratio and male age structure. *Ethology*, *118*(8), 783–792. https://doi.org/10.1111/j.1439-0310.2012.02073.x

Lacetera, N. (2019). Impact of climate change on animal health and welfare. *Animal Frontiers*, *9*(1), 26–31. https://doi.org/10.1093/af/vfy030

Lagu, C., Kugonza, S., Nagitta, O. P., & Andama, M. (2020). Forecasting inputs demands on the quality of animal breeding public services in Uganda : a supply chain perspective. *Journal of Agriculture Food and Development*, *6*(October), 48–57. https://jafdev.com/wp-content/uploads/2020/10/JAFDEVV6A6-Lagu.pdf

Lagu, C., Kugonza, S., Pross Nagitta, O., & Andama, M. (2020). Effect of supply chain planning of liquid nitrogen and frozen semen on the quality of animal breeding public services in the selected cattle corridor districts of Uganda. *International Journal of Agricultural Policy and Research*, *8*(4), 66–78. https://doi.org/10.15739/IJAPR.20.008

Lees, A. M., Sejian, V., Wallage, A. L., Steel, C. C., Mader, T. L., Lees, J. C., & Gaughan, J. B. (2019). The impact of heat load on cattle. *Animals*, *9*(6), 1–20. https://doi.org/10.3390/ani9060322

Li, Y., Mayberry, D., Jemberu, W., Schrobback, P., Herrero, M., Chaters, G., Knight-Jones, T., & Rushton, J. (2023). Characterizing Ethiopian cattle production systems for disease burden analysis. *Frontiers in Veterinary Science*, *10*(September), 1–9. https://doi.org/10.3389/fvets.2023.1233474

Ma, F., Xu, S., Tang, Z., Li, Z., & Zhang, L. (2021). Use of antimicrobials in food animals and impact of transmission of antimicrobial resistance on humans. *Biosafety and Health*, *3*(1), 32–38. https://doi.org/10.1016/j.bsheal.2020.09.004

Makina, S. O., Muchadeyi, F. C., van Marle-Köster, E., MacNeil, M. D., & Maiwashe, A. (2014). Genetic diversity and population structure among six cattle breeds in South Africa using a whole genome SNP panel. *Frontiers in Genetics*, *5*(SEP), 1–7. https://doi.org/10.3389/fgene.2014.00333

Mapiye, O., Chikwanha, O. C., Makombe, G., Dzama, K., & Mapiye, C. (2020). Livelihood, food and nutrition security in Southern Africa: What role do indigenous cattle genetic resources play? *Diversity*, *12*(2). https://doi.org/10.3390/d12020074

McGill, J. L., & Sacco, R. E. (2020). The Immunology of Bovine Respiratory Disease: Recent Advancements. *Veterinary Clinics of North America - Food Animal Practice*, *36*(2), 333–348. https://doi.org/10.1016/j.cvfa.2020.03.002

McGuirk, E., & Nunn, N. (2021). Transhumant Pastoralism, Climate Change, and Conflict in Africa. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3753152

Miyama, t., byaruhanga, j., okamura, i., nakatsuji, h., nakao, t., oikawa, s., mwebembezi, w., & makita, k. (2020). Current Dairy Herd Management Practices and their Influence on Milk Yield and Subclinical Ketosis in an Intensive Dairy Production Region of Uganda. *Journal of Veterinary Epidemiology*, *24*(1), 1–10. https://doi.org/10.2743/jve.24.1

Moore, S. G., & Hasler, J. F. (2017). A 100-Year Review: Reproductive technologies in dairy science. *Journal of Dairy Science*, *100*(12), 10314–10331. https://doi.org/10.3168/jds.2017-13138

Mrode, R., Ojango, J. M. K., Okeyo, A. M., & Mwacharo, J. M. (2019). Genomic selection

and use of molecular tools in breeding programs for indigenous and crossbred cattle in developing countries: Current status and future prospects. *Frontiers in Genetics*, *10*(JAN). https://doi.org/10.3389/fgene.2018.00694

Msimang, V., Rostal, M. K., Cordel, C., Machalaba, C., Tempia, S., Bagge, W., Burt, F. J., Karesh, W. B., Paweska, J. T., & Thompson, P. N. (2022). Factors affecting the use of biosecurity measures for the protection of ruminant livestock and farm workers against infectious diseases in central South Africa. *Transboundary and Emerging Diseases*, *69*(5), e1899–e1912. https://doi.org/10.1111/tbed.14525

Mugisha, A., Kayiizi, V., Owiny, D., & Mburu, J. (2014). Breeding services and the factors influencing their use on smallholder dairy farms in central Uganda. *Veterinary Medicine International*, *2014*. https://doi.org/10.1155/2014/169380

Mushonga, B., Dusabe, J., Kandiwa, E., Bhebhe, E., Habarugira, G., & Samkange, A. (2017). Artificial Insemination in Nyagatare District: Level of Adoption and the Factors determining its Adoption. *Alexandria Journal of Veterinary Sciences*, *55*(1), 1. https://doi.org/10.5455/ajvs.273226

Nalubwama, S., Kabi, F., Vaarst, M., Smolders, G., & Kiggundu, M. (2016). Cattle management practices and milk production on mixed smallholder organic pineapple farms in Central Uganda. *Tropical Animal Health and Production*, *48*(8), 1525–1532. https://doi.org/10.1007/s11250-016-1123-5

Newcomer, B. W., & Chamorro, M. F. (2016). Distribution of lameness lesions in beef cattle: A retrospective analysis of 745 cases. *Canadian Veterinary Journal*, *57*(4), 401–406.

Ocaido, M., Otim, C. P., & Kakaire, D. (2009). Impact of major diseases and vectors in smallholder cattle production systems in different agro-ecological zones and farming systems in Uganda. *Livestock Research for Rural Development*, *21*(9).

Ocaido, M., Otim, C. P., Okuna, N. M., Erume, J., Ssekitto, C., Wafula, R. Z. O., Kakaire, D., Walubengo, J., & Monrad, J. (n.d.). Socio-economic and livestock disease survey of agro-pastoral communities in Serere County, Soroti District, Uganda. In *Livestock Research for Rural Development* (Vol. 17, Issue 8). http://www.lrrd.org/lrrd17/8/ocai17093.htm

Odubote, I. K. (2022). Characterization of production systems and management practices of the cattle population in Zambia. *Tropical Animal Health and Production*, *54*(4), 1–11. https://doi.org/10.1007/s11250-022-03213-8

Ogallo, e. a., wambua, b. n., & mukhovi, m. s. (2022). Household vulnerability and adaptive capacity on impacts of climate change and adaptability solution in Soroti District,

Uganda. *International Journal of Tropical Drylands*, *6*(2). https://doi.org/10.13057/tropdrylands/t060203

Okello, J. (n.d.). *The role of social protection programmes in reducing household poverty and vulnerability in Katakwi District-Uganda A PhD Dissertation Thesis Submitted*.

Okello, W. O., MacLeod, E. T., Muhanguzi, D., Waiswa, C., Shaw, A. P., & Welburn, S. C. (2021). Critical Linkages Between Livestock Production, Livestock Trade and Potential Spread of Human African Trypanosomiasis in Uganda: Bioeconomic Herd Modeling and Livestock Trade Analysis. *Frontiers in Veterinary Science*, *8*. https://doi.org/10.3389/fvets.2021.611141

Okonya, J. S., Syndikus, K., & Kroschel, J. (2013). Farmers' Perception of and Coping Strategies to Climate Change: Evidence From Six Agro-Ecological Zones of Uganda. *Journal of Agricultural Science*, *5*(8). https://doi.org/10.5539/jas.v5n8p252

Oluka, J., Owoyesigire, B., Esenu, B. and, & Ssewannyana, E. (2004). Small stock and women in livestock production in the Teso farming system region of Uganda. *Assets.Publishing.Service.Gov.Uk*, *November*, 15–19.

Ouédraogo, D., Soudré, A., Ouédraogo-Koné, S., Zoma, B. L., Yougbaré, B., Khayatzadeh, N., Burger, P. A., Mészáros, G., Traoré, A., Mwai, O. A., Wurzinger, M., & Sölkner, J. (2020). Breeding objectives and practices in three local cattle breed production systems in Burkina Faso with implication for the design of breeding programs. *Livestock Science*, *232*. https://doi.org/10.1016/j.livsci.2019.103910

Ózsvári, L. (2017). Economic Cost of Lameness in Dairy Cattle Herds. *Journal of Dairy, Veterinary & Animal Research*, *6*(2). https://doi.org/10.15406/jdvar.2017.06.00176

Renault, V., Humblet, M. F., Pham, P. N., & Saegerman, C. (2021). Biosecurity at cattle farms: Strengths, weaknesses, opportunities and threats. *Pathogens*, *10*(10). https://doi.org/10.3390/pathogens10101315

Rocha, J. F., Martínez, R., López-Villalobos, N., & Morris, S. T. (2019). Tick burden in Bos taurus cattle and its relationship with heat stress in three agroecological zones in the tropics of Colombia. *Parasites and Vectors*, *12*(1), 1–11. https://doi.org/10.1186/s13071-019-3319-9

Rotz, C. A., Asem-Hiablie, S., Place, S., & Thoma, G. (2019). Environmental footprints of beef cattle production in the United States. *Agricultural Systems*, *169*(May 2018), 1–13. https://doi.org/10.1016/j.agsy.2018.11.005

Ruegg, P. L., & Petersson-Wolfe, C. S. (2018). Mastitis in Dairy Cows. *Veterinary Clinics of North America - Food Animal Practice*, *34*(3), ix–x.

https://doi.org/10.1016/j.cvfa.2018.08.001

Salisu, I. ., Olawale, A. ., Jabbar, B., Koloko, B. ., Abdurrahaman, S. ., Amin, A. ., & Ali, Q. (2018). *Molecular markers and their Potentials in Animal Breeding and Genetics*. *20*(3), 29–48.

Silva, S. R., Araujo, J. P., Guedes, C., Silva, F., Almeida, M., & Cerqueira, J. L. (2021). Precision technologies to address dairy cattle welfare: Focus on lameness, mastitis and body condition. *Animals*, *11*(8), 1–18. https://doi.org/10.3390/ani11082253

Sosa, S. O., Pelé, M., Debergue, É., Kuntz, C., Keller, B., Robic, F., Siegwalt-Baudin, F., Richer, C., Ramos, A., & Sueur, C. (2019). Impact of Group Management and Transfer on Individual Sociality in Highland Cattle (Bos taurus). *Frontiers in Veterinary Science*, *6*(JUN). https://doi.org/10.3389/fvets.2019.00183

Srivastava, A. K. (2019). Conservation of Indigenous Cattle Breeds. *Journal of Animal Research*, *9*(1). https://doi.org/10.30954/2277-940x.01.2019.1

Stokstad, M., Klem, T. B., Myrmel, M., Oma, V. S., Toftaker, I., Østerås, O., & Nødtvedt, A. (2020). Using Biosecurity Measures to Combat Respiratory Disease in Cattle: The Norwegian Control Program for Bovine Respiratory Syncytial Virus and Bovine Coronavirus. *Frontiers in Veterinary Science*, *7*(April), 1–11. https://doi.org/10.3389/fvets.2020.00167

Talenti, A., Powell, J., Hemmink, J. D., Cook, E. A. J., Wragg, D., Jayaraman, S., Paxton, E., Ezeasor, C., Obishakin, E. T., Agusi, E. R., Tijjani, A., Marshall, K., Fisch, A., Ferreira, B. R., Qasim, A., Chaudhry, U., Wiener, P., Toye, P., Morrison, L. J., … Prendergast, J. G. D. (2022). A cattle graph genome incorporating global breed diversity. *Nature Communications*, *13*(1), 1–14. https://doi.org/10.1038/s41467-022-28605-0

To, i., of, e., of, a., insemination, a., on, t., herds, d., soroti, i. n., district, s., patrick, e., submitted, a. d., the, t. o., of, f., sceinces, a., partial, i. n., requirements, o. f., & the, f. o. r. (2016). *hinderances to and extent of adoption of artificial insemination*.

Twesigye, G., Ssemakula, E., & Bahame, B. D. (2022). Adoption of Supplementary Feeding in Smallholder Dairy Cattle Production in Mbarara District. *American Journal of Agriculture*, *4*(1), 58–88. https://doi.org/10.47672/aja.1069

UBS. (2010). *Uganda Bureau of Statistics, Uganda Census of Agriculture: Vol. II*.

Waiswa, D., Günlü, A., & Mat, B. (2021a). Development opportunities for livestock and dairy cattle production in Uganda: a Review. In *Res. J. Agriculture and Forestry Sci. International Science Community Association* (Vol. 9, Issue 1).

Waiswa, D., Günlü, A., & Mat, B. (2021b). Development opportunities for livestock and

dairy cattle production in Uganda: a Review. In *Res. J. Agriculture and Forestry Sci. International Science Community Association* (Vol. 9, Issue 1). www.isca.me

Wilson, R. T. (2018). Crossbreeding of Cattle in Africa. *Journal of Agriculture and Environmental Sciences*, *6*(1), 16–31. https://doi.org/10.15640/jaes.v7n1a3

World Bank. (2019) U*ganda policy note unlocking Agriculture Finance and Insurance in Uganda: The Financial Sector's Role in Agricultural Transformation*. *August*. www.worldbank.org