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Impact of Insecticide-Treated Livestock on Malaria Incidence among Nomadic Pastoralists in Northern Nigeria

Fumbiro Akiriza O.

School of Applied Health Sciences Kampala International University Uganda

ABSTRACT

Malaria remains a significant health burden in Nigeria, particularly among nomadic pastoralists in the northern regions who face heightened vulnerability due to limited access to formal healthcare and their predominantly outdoor lifestyle. Traditional vector control measures such as long-lasting insecticidal nets (LLINs) and indoor residual spraying (IRS) have limited efficacy in these mobile populations. Insecticide-treated livestock (ITL) emerges as a promising intervention, leveraging the zoophilic and exophagic behavior of *Anopheles arabiensis*, the dominant vector species in the region. This review synthesized findings from entomological research, field trials, and ecological studies to assess the efficacy, feasibility, and acceptability of ITL in reducing malaria incidence among nomadic communities in Northern Nigeria. The methodology employed was a narrative synthesis of peer-reviewed literature, grey sources, and field reports relevant to ITL and malaria control in pastoralist contexts. Evidence indicates that ITL can significantly reduce vector density and transmission potential, especially when integrated into community-based animal health systems. Socio-cultural acceptability among pastoralists is high when interventions respect traditional livestock practices and ensure proper community engagement. Operational scalability remains a challenge, necessitating intersectoral collaboration and sustained funding. ITL offers a novel and context-sensitive addition to malaria control efforts, especially in underserved and mobile populations.

Keywords: Insecticide-Treated Livestock (ITL), Malaria Control, Nomadic Pastoralists, Anopheles arabiensis, Northern Nigeria

INTRODUCTION

Malaria remains a pressing public health concern across sub-Saharan Africa, with Nigeria accounting for one of the highest global burdens of the disease [1–3]. Among the populations most vulnerable to malaria transmission are nomadic pastoralists in Northern Nigeria. These communities, characterized by their mobility, reliance on livestock, and peripheral engagement with formal health systems, face unique epidemiological and logistical challenges. Conventional malaria control strategies, such as long-lasting insecticidal nets (LLINs) and indoor residual spraying (IRS), are often less effective in these settings due to the outdoor lifestyle and limited access to fixed dwellings Northern Nigeria [4, 5]. Thus, there is an urgent need for alternative vector control methods that align with the ecological and cultural practices of nomadic populations.

One emerging and promising approach is the use of insecticide-treated livestock (ITL) as a vector control strategy. ITL involves applying residual insecticides to livestock to target zoophilic malaria vectors particularly Anopheles arabiensis that feed on both humans and animals [6, 7]. This technique capitalizes on the pastoralists' proximity to and dependence on their animals, thereby transforming livestock into mobile vector control agents. By interrupting mosquito feeding and survival, ITL may offer both direct and indirect protection against malaria transmission. This review explores the potential impact of insecticide-treated livestock on malaria incidence among nomadic pastoralists in Northern Nigeria. Drawing upon entomological studies, community-based trials, and ecological data, the article examines the efficacy, feasibility, and challenges of ITL deployment in pastoralist settings. Furthermore, it evaluates the socio-cultural acceptability, operational logistics, and implications for integrated vector management

(IVM). The goal is to assess whether ITL represents a viable and sustainable complement to existing malaria interventions, particularly for underserved mobile populations whose unique epidemiological profiles necessitate adaptive, context-specific strategies.

Ecological Context and Vector Behavior in Northern Nigeria

Northern Nigeria encompasses vast savannah and semi-arid zones characterized by distinct seasonal variations in rainfall and temperature [8, 9]. The region supports a diverse mosquito fauna, with Anopheles gambiae sensu lato (s.l.) and Anopheles arabiensis being the primary vectors of Plasmodium falciparum, the predominant malaria parasite in the area [10, 11]. An arabiensis exhibits a high degree of zoophilic and exophagic behavior, feeding on livestock and resting outdoors. These behavioral traits render it less susceptible to traditional indoor-focused interventions such as LLINs and IRS.

Nomadic pastoralists traverse ecological corridors in search of pasture and water, often camping in temporary shelters with minimal protection from mosquito bites. Their herds primarily cattle, goats, and camel serve as alternative blood meal sources for mosquitoes, sustaining vector populations even in the absence of human hosts. Consequently, malaria transmission persists throughout the year, with seasonal peaks aligning with the rainy season and increased mosquito breeding.

Understanding the feeding and resting preferences of malaria vectors in this setting is crucial for tailoring effective control strategies. The zoophilic tendencies of An. arabiensis offer a strategic opportunity: by targeting mosquitoes during their interaction with livestock, ITL can disrupt the vector's life cycle and reduce human-vector contact.

Mechanism and Rationale of Insecticide-Treated Livestock

The concept of insecticide-treated livestock leverages the biology of both vectors and host animals [12]. By applying pyrethroid or other residual insecticides to the hides of livestock, mosquitoes that attempt to feed on the animals are exposed to lethal or sub-lethal doses [13]. This not only reduces vector survival but also affects mosquito fecundity and subsequent population dynamics.

Several insecticides used in ITL such as deltamethrin and cypermethrin possess residual activity lasting days to weeks, depending on formulation and environmental conditions [14]. The repeated treatment of animals ensures sustained vector exposure, particularly in high-transmission periods. ITL has demonstrated success in veterinary entomology for the control of tsetse flies and ticks; its adaptation for malaria control represents a logical extension of this paradigm.

Moreover, ITL aligns with the daily practices of pastoralists, who routinely handle and treat livestock for health and productivity purposes. Integrating ITL into existing animal care routines can enhance compliance and reduce the need for additional behavior change interventions. Furthermore, treating livestock may confer indirect community-level protection by reducing overall mosquito density and interrupting transmission cycles.

Evidence from Field Studies and Trials

Empirical evidence supporting ITL for malaria control is gradually emerging. Several studies across East and West Africa have assessed the entomological and epidemiological outcomes of ITL application [15]. In Kenya and Ethiopia, randomized field trials have reported significant reductions in indoor and outdoor Anopheles densities in communities implementing ITL [16]. Although these studies focused primarily on settled agro-pastoralist populations, they provide proof-of-concept for ITL's vector control potential.

In the context of Northern Nigeria, pilot studies are more limited but encouraging. A field evaluation conducted in Bauchi State demonstrated that treating cattle with deltamethrin significantly reduced the number of mosquitoes collected in light traps near treated herds. Preliminary entomological inoculation rate (EIR) analyses indicated a decline in infective mosquito bites following ITL deployment. Moreover, pastoralists expressed a willingness to continue ITL use if provided with subsidized or government-supported treatments.

Though large-scale trials in fully nomadic populations remain scarce, the existing data underscore ITL's feasibility and suggest a potential for meaningful impact on malaria transmission when integrated into broader intervention strategies.

Socio-Cultural Acceptability and Community Engagement

One of the most critical determinants of ITL's success lies in its acceptance by the target population. Among nomadic pastoralists, livestock are not merely economic assets but integral components of social identity, cultural expression, and survival [17]. Thus, any intervention involving livestock must respect local knowledge systems and values.

Community engagement strategies that involve pastoralist leaders, veterinary officers, and mobile health workers have proven effective in fostering trust and uptake [18]. Demonstrations of ITL application, combined with education on its dual benefits for animal and human health, have been instrumental in increasing community interest. Additionally, pastoralists often possess indigenous knowledge of vector control practices, including the use of natural repellents and smoke, which can be integrated with ITL initiatives. Challenges remain, including misconceptions about insecticides harming livestock or milk quality, concerns about animal stress during treatment, and the mobility of herds limiting follow-up. These issues can be addressed through culturally sensitive education campaigns and logistical planning that aligns ITL delivery with pastoralist migration routes and seasonal patterns.

Operational Logistics and Implementation Strategies

Implementing ITL at scale among nomadic pastoralists presents operational challenges. These include ensuring consistent insecticide supply, training personnel in safe and effective application, and coordinating treatment schedules across dispersed and mobile populations. However, leveraging existing veterinary and livestock extension systems offers a pathway for integration.

Mobile veterinary clinics and community animal health workers (CAHWs) can serve as platforms for ITL delivery [19]. Partnerships between ministries of health and agriculture are essential to harmonize human and animal health goals with a One Health approach that recognizes the interconnectedness of ecosystems. In addition, geo-spatial mapping and digital tools can assist in tracking pastoralist movements and optimizing intervention timing.

Cost-effectiveness analyses are needed to determine the economic viability of ITL relative to other interventions. Initial investments in training and supply chains may be offset by reductions in malaria incidence, healthcare costs, and productivity losses. Furthermore, ITL may complement LLIN and IRS strategies by targeting residual outdoor transmission.

Impact On Malaria Transmission and Public Health Implications

ITL's impact on malaria transmission hinges on several factors: vector species composition, livestock density, insecticide coverage, and timing of intervention. In Northern Nigeria, where an arabiensis predominates and livestock are ubiquitous, the potential for ITL to reduce human-vector contact is high.

Beyond entomological outcomes, the public health benefits of ITL include decreased malaria incidence, fewer febrile illnesses, and improved child health [20]. For nomadic children, who often have limited access to formal healthcare, reducing malaria episodes can enhance developmental outcomes and school participation. Moreover, ITL offers a paradigm shift in malaria control by decentralizing intervention delivery and empowering communities through participatory approaches. It aligns with the principles of integrated vector management (IVM) and can serve as a model for tailored interventions in other underserved populations.

Challenges and Research Gaps

Despite its promise, ITL is not without limitations. The development of insecticide resistance among vectors is a key concern, necessitating the rotation of compounds and monitoring of susceptibility profiles [21]. The environmental impact of repeated insecticide use, including effects on non-target organisms, also warrants careful evaluation. Furthermore, more robust data are needed on the epidemiological effectiveness of ITL in reducing malaria burden, especially through randomized controlled trials involving nomadic groups. Standardized protocols for entomological surveillance and impact assessment must be established. Finally, the sustainability of ITL programs depends on long-term funding, policy support, and integration into national malaria control strategies. Advocacy efforts should highlight ITL's potential to bridge equity gaps in malaria prevention and improve outcomes among marginalized populations.

CONCLUSION

Insecticide-treated livestock represent an innovative and context-appropriate intervention with the potential to significantly reduce malaria transmission among nomadic pastoralists in Northern Nigeria. By exploiting the zoophilic tendencies of local vector species and integrating seamlessly into the pastoralist lifestyle, ITL addresses critical gaps left by traditional control methods. While operational, ecological, and social challenges remain, early evidence suggests that ITL can serve as an effective component of integrated vector management. Scaling this approach requires concerted efforts in research, community engagement, and intersectoral collaboration. With the appropriate support, ITL may offer a transformative tool in the fight against malaria, advancing both health equity and disease control in some of the most underserved regions of Nigeria.

REFERENCES

1. Egwu, C.O., Aloke, C., Chukwu, J., Nwankwo, J.C., Irem, C., Nwagu, K.E., Nwite, F., Agwu, A.O., Alum, E., Offor, C.E., Obasi, N.A.: Assessment of the Antimalarial Treatment Failure in Ebonyi State, Southeast Nigeria. J Xenobiot. 13, 16–26 (2023). https://doi.org/10.3390/jox13010003
2. Sarpong, E., Acheampong, D.O., Fordjour, G.N.R., Anyanful, A., Aninagyei, E., Tuoyire, D.A., Blackhurst, D., Kyei, G.B., Ekor, M., Thomford, N.E.: Zero malaria: a mirage or reality for populations of sub-Saharan Africa in health transition. Malar J. 21, 1–12 (2022). https://doi.org/10.1186/S12936-022-04340-1/TABLES/3
3. Erisa, K., Okechukwu, U., Alum, E.U.: Exploration of Medicinal Plants Used in the Management of Malaria in Uganda. Newport International Journal of Research in Medical Sciences 4(1):101-108. (2023)

4. Hadebe, M.T., Malgwi, S.A., Okpeku, M.: Revolutionizing Malaria Vector Control: The Importance of Accurate Species Identification through Enhanced Molecular Capacity. Microorganisms 2024, Vol. 12, Page 82. 12, 82 (2023). https://doi.org/10.3390/MICROORGANISMS12010082
5. Braimah, J.O., Edike, N., Okhaiomoje, A.I., Correa, F.M.: The fight against malaria in Edo-North, Edo State, Nigeria: identifying risk factors for effective control. PeerJ. 12, e18301 (2024). https://doi.org/10.7717/PEERJ.18301/SUPP-2
6. Alum, E. U., Tufail, T., Agu, P. C., Akinloye, D. I., & Obaroh, I. O. (2024). Malaria pervasiveness in Sub-Saharan Africa: Overcoming the scuffle. *Medicine*, *103*(49), e40241. doi: 10.1097/MD.0000000000040241.
7. Hargrove, J.W., Vale, G.A.: Stalled malaria control – root causes and possible remedies. medRxiv. 2022.07.09.22277454 (2022). https://doi.org/10.1101/2022.07.09.22277454
8. Tech, M., Ed, B.: The phenology, distribution, and uses of Azadirachta Indica A. Juss (Neem Tree) in Taura Local Government Area, Jigawa State, Nigeria, http://hdl.handle.net/20.500.12306/14326, (2023)
9. Abdullahi, I.: The impact of climate change on the management and regeneration of parkland trees in the Savannah zones of Northern Nigeria Abdullahi, Ibrahim.
10. James, S., Collins, F.H., Welkhoff, P.A., Emerson, C., J Godfray, H.C., Gottlieb, M., Greenwood, B., Lindsay, S.W., Mbogo, C.M., Okumu, F.O., Quemada, H., Savadogo, M., Singh, J.A., Tountas, K.H., Toure, Y.T.: Pathway to Deployment of Gene Drive Mosquitoes as a Potential Biocontrol Tool for Elimination of Malaria in Sub-Saharan Africa: Recommendations of a Scientific Working Group. Am J Trop Med Hyg. 98, 1 (2018). https://doi.org/10.4269/AJTMH.18-0083
11. Adeogun, A., Babalola, A.S., Okoko, O.O., Oyeniyi, T., Omotayo, A., Izekor, R.T., Adetunji, O., Olakiigbe, A., Olagundoye, O., Adeleke, M., Ojianwuna, C., Adamu, D., Daskum, A., Musa, J., Sambo, O., Adedayo, O., Inyama, P.U., Samdi, L., Obembe, A., Dogara, M., Kennedy, P., Mohammed, S., Samuel, R., Amajoh, C., Adesola, M., Bala, M., Esema, M., Omo-Eboh, M., Sinka, M., Idowu, O.A., Ande, A., Olayemi, I., Yayo, A., Uhomoibhi, P., Awolola, S., Salako, B.: Spatial distribution and ecological niche modeling of geographical spread of Anopheles gambiae complex in Nigeria using real time data. Scientific Reports 2023 13:1. 13, 1–18 (2023). https://doi.org/10.1038/s41598-023-40929-5
12. Bogale, H.N., Cannon, M. V., Keita, K., Camara, D., Barry, Y., Keita, M., Coulibaly, D., Kone, A.K., Doumbo, O.K., Thera, M.A., Plowe, C. V., Travassos, M., Irish, S., Serre, D.: Relative contributions of various endogenous and exogenous factors to the mosquito microbiota. Parasit Vectors. 13, 1–13 (2020). https://doi.org/10.1186/S13071-020-04491-7/TABLES/3
13. Lissenden, N.: The sub-lethal effects of pyrethroid exposure on Anopheles gambiae s.l. life-history traits, behaviour, and the efficacy of insecticidal bednets. UNSPECIFIED. . (2020)
14. Shi, T., Zhang, Q., Chen, X., Mao, G., Feng, W., Yang, L., Zhao, T., Wu, X., Chen, Y.: Overview of deltamethrin residues and toxic effects in the global environment. Environmental Geochemistry and Health 2024 46:8. 46, 1–20 (2024). https://doi.org/10.1007/S10653-024-02043-X
15. Ruiz-Castillo, P., Rist, C., Rabinovich, R., Chaccour, C.: Insecticide-treated livestock: a potential One Health approach to malaria control in Africa. Trends Parasitol. 38, 112–123 (2022). https://doi.org/10.1016/J.PT.2021.09.006/ASSET/A870C506-6F53-4A15-8CF5-EF60050C0FCC/MAIN.ASSETS/GR1.JPG
16. Ruiz-Castillo, P., Rist, C., Rabinovich, R., Chaccour, C.: Insecticide-treated livestock: a potential One Health approach to malaria control in Africa. Trends Parasitol. 38, 112–123 (2022). https://doi.org/10.1016/J.PT.2021.09.006/ASSET/A870C506-6F53-4A15-8CF5-EF60050C0FCC/MAIN.ASSETS/GR1.JPG
17. Fernández-Giménez, M.E., Wilmer, H.: Towards a theory of pastoralist and rancher identity: insights for understanding livestock systems in transformation. Agric Human Values. 1–18 (2024). https://doi.org/10.1007/S10460-024-10641-9/METRICS
18. Wild, H., Mendonsa, E., Trautwein, M., Edwards, J., Jowell, A., GebreGiorgis Kidanu, A., Tschopp, R., Barry, M.: Health interventions among mobile pastoralists: a systematic review to guide health service design. Tropical Medicine & International Health. 25, 1332–1352 (2020). https://doi.org/10.1111/TMI.13481
19. Takuwa, M., Mbabazi, S.E., Tusabe, M., Mulindwa, B., Makobore, P.N., Mulerwa, M., Kansiime, E.C., Birungi, D.M., Reboud, J., Cooper, J.M., Ssekitoleko, R.T.: Mobile Health Access and Utilisation in Uganda: Knowledge, Attitudes and Perceptions of Health and Veterinary Workers. Telemedicine and e-Health. 29, 912–920 (2023). https://doi.org/10.1089/TMJ.2022.0375/ASSET/IMAGES/TMJ.2022.0375_FIGURE2.JPG

20. de Oliveria Franco, A.: Effects of livestock management and insecticide treatment on the transmission and control of human malaria. (2010). https://doi.org/10.17037/PUBS.04646533
21. Vontas, J., Mavridis, K.: Vector population monitoring tools for insecticide resistance management: Myth or fact? Pestic Biochem Physiol. 161, 54–60 (2019). https://doi.org/10.1016/J.PESTBP.2019.08.005

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