Integrating vector-borne disease control in irrigation farming: Balancing food security and vector-borne disease prevalence reduction in sub-Saharan Africa

Key messages

- **Irrigation farming is important in addressing food security but may escalate vector-borne diseases (VBD) prevalence in the surrounding communities.**

- **A systematic review study on interventions to control VBDs in irrigation schemes revealed successes in reducing vector densities, VBD risk and VBD prevalence.**

- **VBD control and management can be integrated into dams and irrigation schemes even after their establishment.**

- **Addressing VBDs around irrigation schemes improves the health of communities and consequently agricultural productivity.**

Context

Climate change in sub-Saharan Africa (SSA) has made rainfed agriculture undependable threatening food security, compelling many countries to intensify construction of dams and irrigation schemes as a response. However, this environmental modification has raised concerns of steady transmission and amplification or introduction of new vector-borne infectious diseases (VBD) in surrounding areas [1].

VBDs like malaria, yellow fever, dengue, schistosomiasis and human African trypanosomiasis (HAT), are human illnesses caused by parasites, including viruses and bacteria, which are transmitted by living agents (vectors) such as mosquitoes, snails, ticks, tsetse flies and lice [2]. VBDs account for 17% of the global burden of all infectious diseases and cause over 700,000 deaths annually [3].

Evidence emerging in SSA shows that VBDs are widespread, many are co-endemic and are a major cause of deaths in under 5 children. Dams and irrigation schemes create new habitats for aquatic vectors leading to their increase, hence increasing VBD risk and prevalence in communities around them. However, integrating VBD control and management interventions in irrigation schemes could reduce the VBD prevalence in these areas.

Objectives and methodology

A systematic review was conducted to explore the applicability and value of integrating various VBD control interventions in irrigation schemes/systems. An analysis was made of studies involving populations in irrigation areas and controlling/managing VBDs with various interventions in SSA. However, available data in SSA was limited to interventions that control and manage malaria, schistosomiasis and onchocerciasis.

LSTM Liverpool School of Tropical Medicine · Kamuzu University of Health Sciences · MAC Communicable Diseases Action Centre · Malawi Liverpool Wellcome Programme · AFIDEP African Institute for Development Policy · Funded by NIHR National Institute for Health and Care Research

Applicable VBD control interventions in irrigation areas

The study found various VBD control interventions applicable in irrigation areas in SSA which controlled malaria, schistosomiasis and onchocerciasis resulting in a reduction in vector densities, VBD risk and VBD prevalence. These interventions include larval source management (LSM), mass drug administration (MDA), long-lasting insecticide-treated nets (LLINs), indoor residual spraying (IRS), mollusciciding, biological control, social behaviour changes and a combination of two or more interventions also known as integrated vector management (IVM).

Integrated Vector Management (IVM)

IVM reported remarkable success in schistosomiasis and malaria control and management in irrigation areas in Kenya, Sudan and Tanzania. Much success was due to the complementarity of interventions [4]. However, it was noted that some IVM interventions may not yield desirable results prompting careful consideration of other factors when identifying the interventions to combine. These factors are geographical setting, community participation and capacity building.

Larval Source Management (LSM)

LSM reported mixed success in Gambia and Ethiopia with tangible effectiveness registered in reducing pupal stage malaria vectors but very limited on adult vectors [5]. Same observation was noted in Tanzania [6]. Other reviews in Africa [7], [8], together with the WHO [9], recommended LSM as a supplementary measure alongside the core interventions. Factors for LSM success were strong local partnership, meticulous planning and reliable funding for the initiatives [10].

Indoor Residual Spraying (IRS)

Regardless of being chemically stabilised or not, IRS was notably highly effective in VBD reduction and is particularly attributed to malaria prevalence reduction in Africa. However, in Kenya, it was observed that agricultural practices involving all year-round irrigation such as sugarcane farming compromise its effectiveness.

Long-Lasting Insecticide-Treated Nets (LLINs)

LLINs, particularly where coverage is high, were effective in reducing malaria cases as recorded in a study in Malawi. Its effectiveness was however compromised by communities' closeness to irrigation schemes [11].

Mass Drug Administration (MDA)

MDA also registered mixed results, with onchocerciasis in Burkina Faso recording effectiveness [12] but schistosomiasis in Kenya recording insignificant change [13]. However, in another study, an MDA programme in Sierra Leone recorded onchocerciasis microfilaridermia (MF) prevalence reduction [14], and an MDA intervention

Photo credit: Linga irrigation scheme nkhotabay on schistosomiasis in Malawi reported positive results after strategic population targeting by extending coverage to communities and schools [15].

Molluscicíding

Use of pesticides in reducing snails was noted to be effective in reducing schistosomiasis prevalence on irrigation farms in Zimbabwe. This improved the health of farm workers, resulting in labour efficiency, positively impacting on agricultural productivity [16].

Behavioural Change

Water, sanitation and hygiene (WASH) behavioural change practices that reduced water contact behaviours amongst pupils in Uganda reportedly reduced Schistosoma cases among them [17]. However, it was noted that risky behaviours are difficult to address, since they are often performed in response to systemic deficits in resources

Biological Control

Apart from being successful, biological control by use of natural predators was deemed inexpensive, environmentally friendly, and nontoxic to many non-target organisms. An example was the case of native prawns in the control of snails which led to schistosomiasis prevalence decline around Diama dam in the Senegal river basin [18].

Value of VBD integration in irrigation farming

The study noted that most irrigation schemes were established to respond to food security with little consideration of their health impacts on communities around them. Regardless, the review demonstrated that VBD control and management interventions can be integrated even after construction of the irrigation schemes. Reducing VBD prevalence improves health outcomes of communities around the irrigation schemes. There is reduced disease burden, improved attendance in school-going children and saving costs of treating VBD cases. This leads to a healthy workforce which brings labour efficiency on the irrigation schemes resulting in improved agricultural productivity.

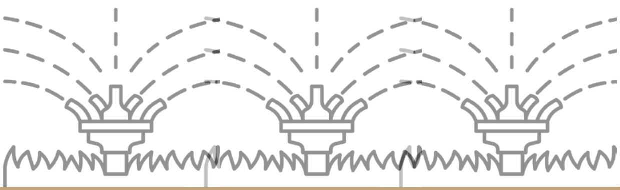

Photo credit: Irrigation in Malawi/Canva.com

Recommendations

To balance the need for food security through irrigation farming, while controlling VBD, policymakers should do the following:

- Ministries of health, water and agriculture should consider making VBD control and management part of the irrigation farming system. This would be through integrating VBD control into irrigation-related policies.
- Ensure community participation in VBD control interventions around irrigation schemes. This will result in swift and higher adoption of VBD control and management practices by communities.
- The Ministry of Health should strategically target populations in VBD control interventions in irrigation areas to avoid escalating drug and pesticide resistance.
- Encourage researchers to investigate the applicability of VBD control interventions in irrigation areas beyond malaria, schistosomiasis and onchocerciasis.

References

1. Chala, B., & Hamde, F. (2021). Emerging and re-emerging vector-borne infectious diseases and the challenges for control: A review. Frontiers in Public Health, 9. https://doi.org/10.3389/FPUBH.2021.715759
2. World Health Organization. (2016). A toolkit for integrated vector management in Sub-Saharan Africa. Retrieved November 3, 2022, from https://apps.who.int/iris/bitstream/handle/10665/250267/9789241549653-eng.pdf?sequence=1
3. World Health Organization. (2017). Global vector control response 2017–2030. Retrieved November 3, 2022, from http://apps.who.int/iris/bitstream/handle/10665/259002/WHO-HTM-GVCR-2017.01-eng.pdf?sequence=1
4. Fillinger, U., et al. (2009). Integrated malaria vector control with microbial larvicides and insecticide-treated nets in western Kenya: A controlled trial. Bulletin of the World Health Organization, 87(9), 655–665. https://doi.org/10.2471/BLT.08.055632
5. Majambere, S., et al. (2010). Is mosquito larval source management appropriate for reducing malaria in areas of extensive flooding in The Gambia? A cross-over intervention trial. American Journal of Tropical Medicine and Hygiene, 82(2), 176–184. https://doi.org/10.4269/AJTMH.2010.09-0373
6. Mazigo, H. D., et al. (2019). Malaria mosquito control in rice paddy farms using biolarvicide mixed with fertilizer in Tanzania: Semi-field experiments. Malaria Journal, 18(1), 1–10. https://doi.org/10.1186/S12936-019-2861-4
7. Tusting, L. S., et al. (2013). Mosquito larval source management for controlling malaria. Cochrane Database of Systematic Reviews, (8). https://doi.org/10.1002/14651858.CD008923.pub2
8. Martello, E., et al. (2022). Mosquito aquatic habitat modification and manipulation interventions to control malaria. Cochrane Database of Systematic Reviews, (11). https://doi.org/10.1002/14651858.CD008923.pub3
9. World Health Organization. (2018). World malaria report 2018. Retrieved November 3, 2022, from https://apps.who.int/iris/bitstream/handle/10665/275867/9789241565653-eng.pdf?ua=1
10. Dambach, P., et al. (2016). Challenges of implementing a large-scale larviciding campaign against malaria in rural Burkina Faso: Lessons learned and recommendations derived from the EMIRA project. BMC Public Health, 16(1), 1–7. https://doi.org/10.1186/S12889-016-3587-7
11. Mangani, C., et al. (2022). Proximity of residence to irrigation determines malaria risk and Anopheles abundance at an irrigated agroecosystem in Malawi. American Journal of Tropical Medicine and Hygiene, 106(1), 283. https://doi.org/10.4269/AJTMH.21-0390
12. Nikièma, A. S., et al. (2021). The impact of ivermectin on onchocerciasis in villages co-endemic for lymphatic filariasis in an area of onchocerciasis recrudescence in Burkina Faso. PLoS Neglected Tropical Diseases, 15(3), e0009117. https://doi.org/10.1371/JOURNAL.PNTD.0009117
13. Lelo, A. E., et al. (2014). No apparent reduction in schistosome burden or genetic diversity following four years of school-based mass drug administration in Mwea, Central Kenya, a heavy transmission area. PLoS Neglected Tropical Diseases, 8(10), e3221. https://doi.org/10.1371/JOURNAL.PNTD.0003221
14. Koroma, J. B., et al. (2018). Impact of five annual rounds of mass drug administration with ivermectin on onchocerciasis in Sierra Leone. Infectious Diseases of Poverty, 7(1), 1–12. https://doi.org/10.1186/S40249-018-0410-Y
15. Makaula, P., et al. (2022). An assessment of implementation and effectiveness of mass drug administration for prevention and control of schistosomiasis and soil-transmitted helminths in selected southern Malawi districts. BMC Health Services Research, 22(1), 1–18. https://doi.org/10.1186/S12913-022-07925-3
16. Shiff, C. J., et al. (1973). Molluscicide for the control of schistosomiasis in irrigation schemes: A study in Southern Rhodesia. Bulletin of the World Health Organization, 48, 299–307.
17. Trienekens, S. C. M., et al. (2022). Variation in water contact behaviour and risk of Schistosoma mansoni (re)infection among Ugandan school-aged children in an area with persistent high endemicity. Parasites & Vectors, 15(1), 1–14. https://doi.org/10.1186/S13071-021-05121-6
18. Sokolow, S. H., et al. (2015). Reduced transmission of human schistosomiasis after restoration of a native river prawn that preys on the snail intermediate host. Proceedings of the National Academy of Sciences of the United States of America, 112(31), 9650–9655. https://doi.org/10.1073/pnas.1502651112

This policy brief was written by Levi Kalitsilo of the African Institute for Development Policy (AFIDEP) based on a systematic review study conducted under the Shire Valley Vector Project. DOI: 10.1371/journal.pone.0302279. The study is funded by the by the National Institute for Health Research (NIHR) [NIHR Global Health Research Group on Controlling Vector Borne Diseases in Emerging Agricultural Systems in Malawi (NIHR 133144)/NIHR Evaluation, Trials and Studies Coordinating Centre (NETSCC)]. The views expressed are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care.