



# **Reducing Disease Burden by Design: A One Health Approach**

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## Introduction

Mosquito-borne diseases such as Dengue Fever, Zika, Chikungunya, and Malaria remains one of Uganda's most pressing public health crises, negatively impacting individual well-being, community resilience, and national development. In 2023, for example, Uganda recorded over 12.6 million malaria cases and nearly 16,000 deaths,<sup>i</sup> placing it among the top three global contributors to the malaria burden. Malaria alone accounts for between 30–50% of outpatient visits, 15–20% of hospital admissions, and up to 20% of inpatient deaths in Ugandan health facilities.<sup>ii</sup> The economic costs to a typical Ugandan family are estimated at \$9 per episode, which is equivalent to 3% of annual household income and contributes at least \$500 million in economic losses each year.<sup>iii</sup>

Despite decades of intervention efforts such as insecticide-treated nets, indoor spraying, and antimalarial drugs, Uganda continues to face stable, year-round transmission of numerous mosquito-born disease (and many new and emerging ones) in over 95% of the country.<sup>iv</sup> Their persistence is attributable to biological, environmental, and socioeconomic risk factors. Risk factors include favorable conditions for mosquito breeding, such as standing water and sun-exposed puddles, widespread poverty, outdoor labor, limited access to healthcare, high population mobility, and climate variability. The emergence of drug-resistant parasites and insecticide-resistant mosquitos undermines hard-won gains in disease control. These and other challenges may help to explain why prevalence rate declines for major diseases like malaria have stalled in recent years in East Africa<sup>v</sup>.

Against this backdrop, regenerative landscape design offers a systems-level approach to population health and the interaction between communities and environments. Regenerative design leverages a strength-based orientation to restore and enhance ecological and social systems. This approach integrates principles from landscape ecology, public health, agriculture, and design thinking to create multifunctional spaces that support biodiversity, improve livelihoods, and reduce disease risk. More broadly, the regenerative landscape perspective aligns with the multi-solving paradigm and focuses on solving many problems with a single intervention, program, or design.

A more holistic focus on landscapes aligns with the High Burden High Impact strategy promoted by the WHO, which calls for locally tailored, multisectoral interventions in malaria-endemic regions like Uganda.<sup>vi</sup> Pairing with regenerative landscape is our attention to social science research about the importance of participatory interventions that account for community norms, values, and traditional practices.

This report builds on recent field research in Eastern Uganda, where subsistence farmers face high mosquito-transmitted disease risk due to landscape features that support breeding. It explores how farm and home design, guided by regenerative principles, environmental health, and social epidemiology, can reduce exposure to disease vectors while improving agricultural productivity and community resilience. By leveraging agroecological practices, participatory design, and public health insights, we aim to offer practical, community-driven solutions that mitigate some of the root causes of mosquito-borne diseases.

## Malaria, Mosquitos, & Their Habitats

Mosquito numbers rise and fall seasonally, with peaks during the two rainy seasons when new breeding sites appear. These seasonal patterns are essential for planning public health efforts like bed net distribution and indoor spraying. Where mosquitoes breed also matters; their breeding sites are often created by human activity and are commonly found near homes and farms. Small ponds, lagoons, and lowland farming areas, especially rice fields and irrigation canals, are ideal habitats for malaria-carrying mosquitoes. Mosquitos carrying the most common viral diseases (e.g., Dengue, Zika, West Nile) thrive in small, sunlit pools of water such as puddles, hoof prints, tire tracks, roadside ditches, and man-made water collection sites. Practices like leaving cocoa pod husks in sunny spots can also increase breeding near subsistence farms.

Temporary water sources pose a hidden risk. Because they don't last long, people often overlook temporary water sources as health hazards. Still, their proximity to homes gives mosquitoes easy access to people, further spreading disease. Another concern is growing plastic waste on rural farms, which creates more additional mosquito breeding sites.<sup>1</sup>

## Redesigning Farms to Reduce Malaria Risk

Land use and agricultural practices have a direct impact on mosquito ecology. Poor drainage, monocropping, and deforestation create ideal mosquito breeding grounds. Epidemiological studies show that increased agricultural cover increases malaria risk, especially in areas with little vegetation. By integrating ecological design principles such as agroforestry and improved water management practices into farming, communities can reduce mosquito habitats and improve soil health and crop yields. This multi-solving approach aligns with the One Health framework<sup>1</sup> and emphasizes the interconnectedness of human, animal, and environmental health.

Some practical strategies include planting shade trees, which lowers the temperature, reduces mosquito breeding habitat, and, when properly selected, constitute a renewable fuel source. Cover cropping and mulching improve soil health and minimize water pooling. Filling small depressions in tree stumps and foot paths with soil or rocks helps prevent water accumulation and reduces local breeding sites. Planting along sun-soaked stream banks reduced another common mosquito breeding site. Moving away from monocropping to a diversified cropping strategy can reduce the need for irrigation, improve soil health, and reduce food insecurity among subsistence farmers. Because increased agricultural activity often results in more breeding grounds, especially when vegetation is sparse, filling breeding sites with soil, stones, or organic waste remains one of the most effective and affordable disease reduction strategies in resource-scarce rural contexts.

## Home Design as Malaria Prevention

Housing design also plays a critical role in the prevention of mosquito-borne diseases. For example, most malaria transmission in sub-Saharan Africa occurs indoors, especially at night. Mosquitoes enter homes through open windows, unsealed eaves, and wall gaps. Public health research has shown that raised homes, sealed structures, and improved ventilation can substantially reduce mosquito entry. These cost-effective and culturally adaptable interventions make them ideal for rural settings such as Kamuli.

Homes elevated one to three meters above ground experience significantly fewer mosquito entries, because most mosquitoes fly close to the ground. Sealing gaps between walls and roofs can reduce mosquito entry by as much as 80%, and covering windows, doors, and water containers with fine mesh, such as repurposed old mosquito bed nets, adds another layer of protection. Studies show that residents of modern homes have substantially lower odds of malaria infection, and that heat discomfort is a primary reason people avoid using nets. Enhancing airflow with additional windows or shaded design features can make indoor environments more comfortable, encouraging bed nets and family time in the home during the critical high-risk dusk hour. Designing mosquito-proof and comfortable homes promotes consistent use of bed nets and other protective measures. Despite their efficacy for malaria reduction, few homes in rural areas of Eastern Uganda are designed to enhance airflow, maximize light, and minimize mosquito access.

## Community Participation

The literature on public health, agricultural extension, and economic development emphasizes the importance of participatory approaches in which communities are substantively involved throughout the planning and implementation process. This approach can extend benefits beyond the immediate project (e.g., home design, breeding ground reductions) and spur additional innovations. Broad participation, particularly from women, ensures that interventions are inclusive and address the needs of all household members. In the context of malaria



women (mothers) are often more attuned to and responsible for the health needs of children, making them a particularly important collaborator.

Demonstration farms and inclusive training programs can build trust, increase adoption of pro-health farm practices, and spur local solutions to some of these long-standing problems. When people see tangible benefits such as higher yields or fewer illnesses in the family, they are more likely to adopt and sustain new methods. Demonstration farms allow farmers to observe new techniques and farm designs in action, which can also improve adoption rates. Local workshops and training sessions provide farmers with hands-on guidance in implementing changes in agricultural practice. We envision an innovation paired with the 'model farm' concept and One Health principles to design whole farmsteads that embody best agricultural and community health practices

## Benefits Beyond Malaria Prevention

We propose that farm and family health can benefit from an integrated approach that looks to minor, but significant design changes to farms and homes. Environmental health research shows that agroecological practices improve soil fertility, water retention, and biodiversity, leading to higher yields, better nutrition, and more stable incomes. In the context of malaria and other mosquito borne diseases, these same interventions can reduce disease prevalence. By aligning health and agricultural goals, communities can achieve multiple benefits from a single set of interventions (e.g., multi-solving).

For example, agroforestry systems that include fruit and nut trees contribute to dietary diversity, household nutrition, improved soil management and better overall yields. Healthier soils and diversified cropping systems improve water retention, reduce erosion, and buffer against droughts and floods, while timber, honey, and other byproducts from diverse farms offer additional income streams, fuel sources, and healthier environments for rural families. This approach has been shown to support carbon sequestration and pest control too. In short, mosquito-borne disease prevention strategies that incorporate regenerative agriculture and public health principles can deliver wide-ranging social, economic, and ecological benefits.

## Challenges to Consider

There are several legitimate reasons why this approach has not been widely implemented and adopted. The environmental and development literature identifies barriers such as limited land tenure, lack of access to capital, and labor constraints. Short-term costs, the time required to learn new methods, and the effort and resources to adopt them all discourage implementation. Overcoming these challenges requires supportive policies, community partnerships, access to affordable materials and training, and, most importantly, locally tailored approaches that leverage cultural assets.

Many of the interventions we have proposed require knowledge, training, time, and labor, and a few, such as redesigned homes, require more significant capital investments. These are not trivial barriers for subsistence farmers in Eastern Uganda. Soil degradation, pest pressures, and climate variability compound the challenges. Limited literacy, low access to information (remote, rural, and disconnected from digital information), and misconceptions about risks and benefits of various practices make implementing new programs difficult. Overcoming these barriers will require coordinated efforts to improve infrastructure, build capacity, and ensure that interventions are accessible, affordable, and aligned with local realities. And in the east central Uganda context, that means overcoming low collective efficacy.<sup>1</sup>



## APPENDIX 1: Illustrative Model Farm Schematics to Prototype One Health Landscapes

By way of concept for a new approach, our team developed two “model cocoa farm” designs for the Eastern Uganda context. These are only prototype design concepts, but they reflect our synthesis of our own recent field research observations, agroecological best practices, regenerative landscaping concepts, and public health insights. They are intended to spark dialogue and adaptation among farmers, extension agents, and designers. We created two maps, one for a large cocoa farm (10+ acres) and one for a smallholder farm (0–5 acres), to illustrate how an integrated farmstead design can simultaneously reduce malaria risk, improve agricultural productivity, and support community health. The model farms incorporate spatial planning strategies that separate high-risk zones (e.g., latrines and livestock) from living areas, optimize tree placement for shade and airflow, and embed food production, composting, and water management systems into the landscape.

We like the concept of a model farm because it is well-established and has been widely used in agricultural development to demonstrate best practices and initiate on-farm behavioral change. In the context of malaria prevention, model farms show how landscape interventions such as shade tree selection, drainage improvements, and housing modifications reduce mosquito habitats and improve health outcomes. By embedding One Health principles into farmstead design, we can move beyond crop yields or disease control to a more holistic and integrated approach that promotes ecological resilience, food security, community health, and sustainable agriculture. We don't view these as prescriptive blueprints, but rather as flexible frameworks that communities can adapt to their own needs, resources, and cultural contexts. We believe this conceptualization of the ‘model farm’ represents a promising step forward in the co-design of healthier rural landscapes and sustainable rural livelihoods.

## APPENDIX 2: Mosquito Intervention Toolkits That Translate Field Insights into Action

Fieldwork in July 2025 included 16 interviews and three focus groups with more than 60 subsistence cocoa farmers in the Busoga region of Eastern Uganda and detailed GIS site mapping of 16 farms. The objective of this work was to understand the landscape-level and on-farm, mosquito-borne disease risk factors and to understand the knowledge and practices of subsistence farmers to prevent and treat these illnesses.

Through interviews, site observations, expert consultations, photo documentation, and GIS data collections, we documented a range of beliefs and practices rural farmers deployed to reduce malaria prevalence. These insights informed the development of a prototype intervention toolkit, designed to bridge the gap between current practices and evidence-based strategies for reducing mosquito habitats and lowering transmission rates in rural communities.

The toolkit is intended as a practical resource for agricultural extension workers, community health educators, and local leaders in Kamuli District. It visually contrasts high-risk features with simple, and often low-cost improvements that can be implemented at the household and farm level. From covering water containers and sealing eaves to improving drainage and tree placement, this toolkit offers actionable steps that can be taken to reduce disease burden. Distributing these materials through trusted community channels can raise awareness and increase the adoption of integrated prevention strategies that align with One Health and regenerative design principles.



# Citations

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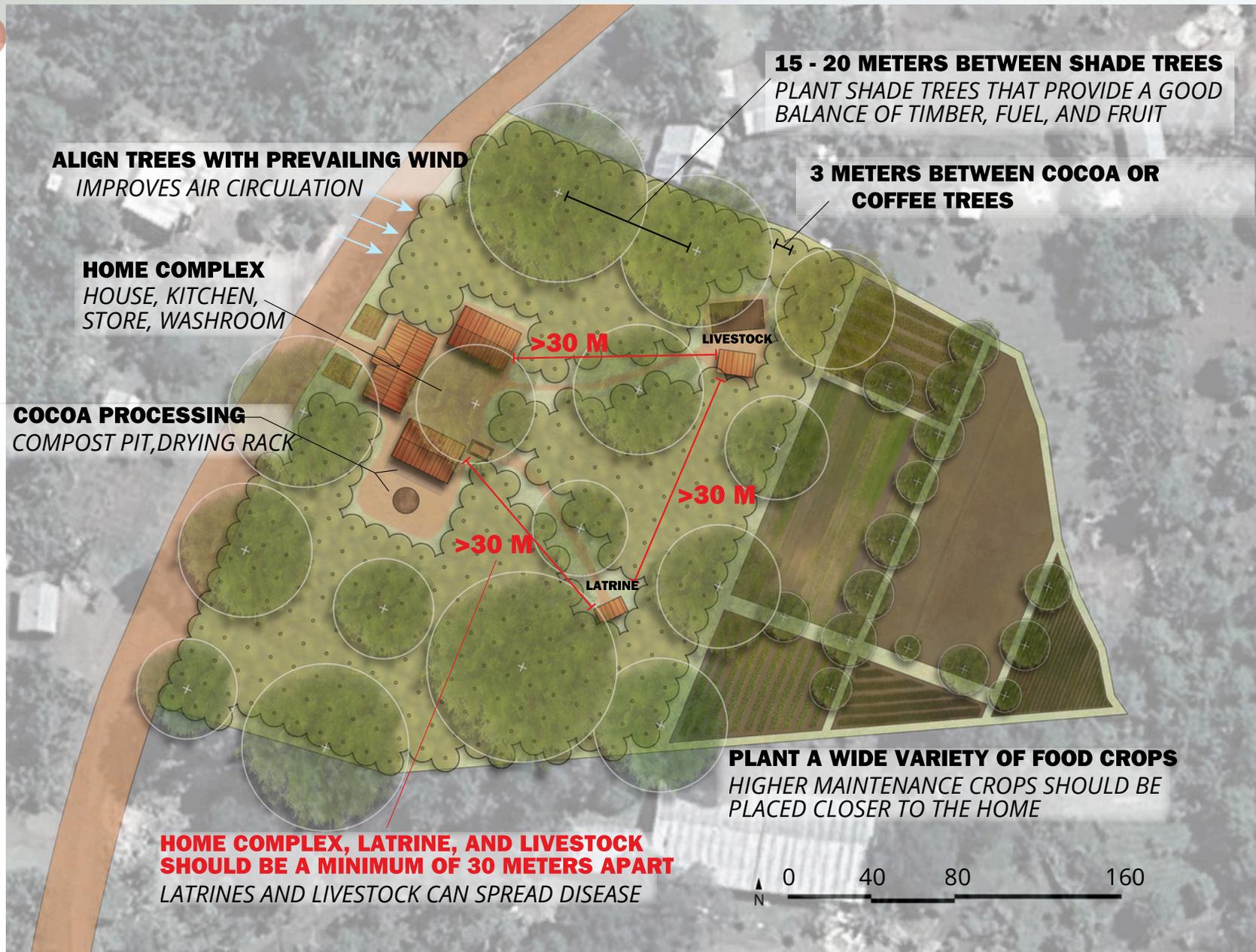


## **APPENDIX 1: ILLUSTRATIVE MODEL FARM SCHEMATICS TO PROTOTYPE ONE HEALTH LANDSCAPES**



**LARGE COCOA FARM** (10+ ACRES)

EXAMPLE - SITE0001



**SMALL COCOA FARM** (0-5 ACRES)

EXAMPLE - SITE 0007



## **APPENDIX 2: MOSQUITO INTERVENTION TOOLKITS THAT TRANSLATE FIELD INSIGHTS INTO ACTION**



# FIELD INTERVENTIONS

## MALARIA RISK REDUCTION

### RISKS



### IMPROVEMENTS



- **Standing water** is a **breeding habitat** for mosquitoes
- **Holes in trees or tree stumps** often **collect water**
- **Fill all areas that may collect water** with dirt
- **Tools and equipment**, like wheelbarrows, buckets, jerry cans, and shovels, **can collect standing water**
- **Overturn or cover objects** to avoid water collecting
- **Tools** can also be **placed inside or under shelter**
- **If buckets or jerry cans** are being **used to collect water**, **cover with lids, cloth, or screens**
- Ensure **mosquitoes** have **no access to the water**
- **Lids** with raised edges or lips **may collect water**
- Use **lids that have smooth tops**



# FIELD INTERVENTIONS

MALARIA RISK REDUCTION

## RISKS



- **Water-collection tanks** can also be a **breeding site** for **mosquitoes**



- **Cover opening with a lid**
- **Drill small holes less than 8 mm** in lid

OR



- **Cover opening with a screen**
- **Ensure screen is well-sealed**



- **Drainage** from **washrooms** can be a **breeding site** for **mosquitoes**



Step 1

- **Dig a small hole** under the drain port, **where water collects**



Step 2

- **Fill the hole with rocks or broken bricks**
- The **rocks** will help the **water absorb** into the **soil**



Step 3

- **Fill** the rest of the **hole** with **coarse sand or dirt**
- Consider planting **water-loving plants** nearby, like **yams**



# BUILDING INTERVENTIONS

## MALARIA RISK REDUCTION

### RISKS



### IMPROVEMENTS



- **Open doors, windows and eaves increase** the risk of **being bitten by a mosquito**, particularly in the home
- **Place nets or screens** on all windows, eaves, and openings
- **Ensure** that **all edges** between the screen and the building **are sealed**
- **Prioritize openings near the ground**
  
- **Small holes** still **present risks**
- **If holes** are **larger than 8 mm**, **mosquitoes may enter** screens or net holes larger than 8 mm
- Even if all windows, eaves, and openings are sealed, **sleeping under bed nets is still advised**
  
- **Holes and openings** can also be **filled with mortar, concrete, or mud**
  
- The **surface** can be **covered in plaster or concrete** to ensure **no gaps** can be found