CGIAR MULTIFUNCTIONAL LANDSCAPES

Synthesis Report on the Evidence of the Multifunctional Performance of LVB Landscape

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1. Executive Summary

This synthesis report consolidates existing evidence on the multifunctional performance of the Lake Victoria Basin (LVB) landscape in western Kenya and supports the implementation of Areas of Work 2 and 6 of the CGIAR Multifunctional Landscapes Science Program (MFL SP). The report integrates agronomic, economic, environmental, and social dimensions of landscape performance to inform the Vision-to-Action (V2A) process and the co-design of landscape-specific assessment frameworks.

The LVB landscape is characterized by high population density, smallholder-dominated agriculture, and strong reliance on rainfed systems, with climate variability increasingly influencing yield stability. Persistent yield gaps in staple crops, suboptimal livestock productivity, widespread soil fertility constraints, and limited access to modern inputs contribute to low agricultural performance. At the same time, economic diversification remains limited by weak value chains and financial constraints. Environmental pressures arising from climate change, land degradation, and water pollution threaten ecosystem services, while social vulnerabilities related to food insecurity, youth unemployment, and gender inequities persist. Western Kenya, including Kakamega, Bungoma, Busia, Kisumu, Siaya and Vihiga counties (~10 million people), faces similar patterns of low productivity, high food insecurity, and limited economic diversification (KNBS, 2023; KNBS, 2022). The inclusion of these counties provides a more complete representation of landscape multifunctionality in Western Kenya. Despite these challenges, opportunities exist to enhance multifunctional performance through nature-positive and agroecological approaches that integrate soil health restoration, agrobiodiversity enhancement, and inclusive governance frameworks (FAO, 2025; Adoyo et al., 2025).

2. Purpose and Scope of the Synthesis Report

This report synthesizes existing scientific, geospatial, and grey literature on the multifunctional performance of landscapes where the CGIAR Multifunctional Landscapes Science Program (MFL SP) operates. It consolidates existing knowledge to support evidence-informed decision-making, stakeholder dialogue, and the development of landscape-specific assessment frameworks. The report is designed as a living document, reflecting the status of evidence as of 2025 and updated as new data become available. The synthesis focuses on agronomic productivity, economic conditions, environmental integrity, and social outcomes, emphasizing trade-offs and synergies that inform sustainable landscape planning. Evidence will support joint multistakeholder workshops in the Vision to Action (V2A) process and the co-design of landscape assessment frameworks. The synthesis now explicitly includes Kakamega, Bungoma, Busia, Kisumu, Siaya and Vihiga counties to provide a regional view of Western Kenya and guide policy and landscape-level interventions.

3. Description and Context of the LVB Landscape

3.1 Landscape Location and Context

The Lake Victoria Basin (LVB) landscape in western Kenya encompasses diverse agroecological zones, ranging from lowland floodplains near Lake Victoria to mid-altitude mixed farming systems and densely populated highland areas. Kisumu County is characterized by lake-adjacent lowlands, peri-urban systems, and mixed crop-livestock agriculture, while Vihiga County features predominantly hilly terrain and intensive smallholder farming. The region's historical and current agricultural significance is underscored by its contribution to local food supplies and economic activity (Kenya Red Cross Society, 2017; GoK, 2015). Western Kenya's additional counties (Kakamega, Bungoma, Busia, Siaya) are characterized by smallholder agriculture, sugarcane farming (Bungoma), and agro-processing (Kakamega). These counties are linked by cross-border trade and fisheries, especially along Lake Victoria (KNBS, 2023). Population estimates for the expanded region reach ~10 million, emphasizing the scale of livelihoods dependent on multifunctional landscape services.

The socio-ecological dynamics of the LVB are influenced by its position within an important freshwater basin, supporting fisheries, agriculture, and livelihoods for millions of people. The Nile perch and tilapia fisheries contribute significantly to local diets and income, though fish stocks have been altered by overfishing and changes in species composition over time. The basin's land use is composed of agricultural fields, pastures, residential areas, and pockets of natural vegetation, reflecting the multiple demands placed on the landscape.

3.2 Biophysical Context

The LVB region has a humid, equatorial climate with bimodal rainfall patterns. Average rainfall ranges between 1,000 and 1,500 mm annually, with short rains from March to May and long rains from October to December, though variability has increased under climate change (Adoyo et al., 2025). Soils across the landscape vary widely, encompassing weathered Acrisols, Cambisols, and other types that exhibit low organic matter, variable pH, and limitations in available nitrogen and phosphorus. Recent soil baseline surveys show that soil organic carbon ranges from very low to moderate levels, and macronutrient concentrations vary significantly across farm sites, indicating localized fertility constraints (Figure 1 and 2). Biological soil communities are dominated by diverse phyla such as Pseudomonadota, Actinomycetota, Planctomycetota, and Myxococcota, with genera like Bradyrhizobium, Sphingomonas, and Streptomyces contributing to nutrient cycling and disease suppression. These microbial profiles suggest substantial potential for biological soil function enhancement through practices that build organic matter and reduce disturbance, aligning with principles identified in agroecological research (Kaushal et al., 2025). Soil erosion intensity varies significantly across Western Kenya, with high-risk areas in the steep hills of Vihiga and Kakamega, ranging from 13–36 t/ha/year, moderate zones 0.8–3 t/ha/year, and low-risk areas 0.2–0.5 t/ha/year (Mati, 2015). These spatial variations affect productivity, water quality, and sedimentation in Lake Victoria.

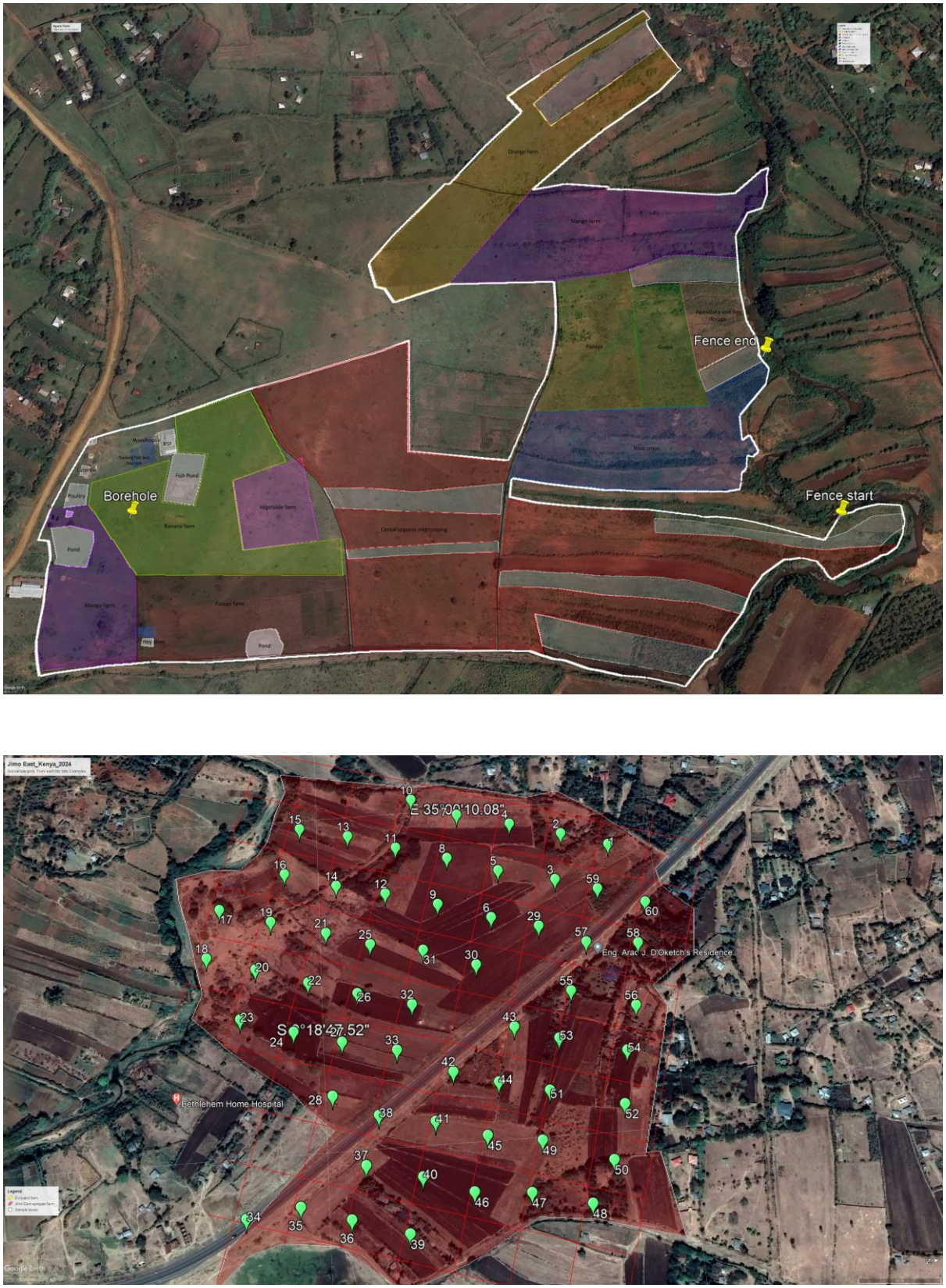
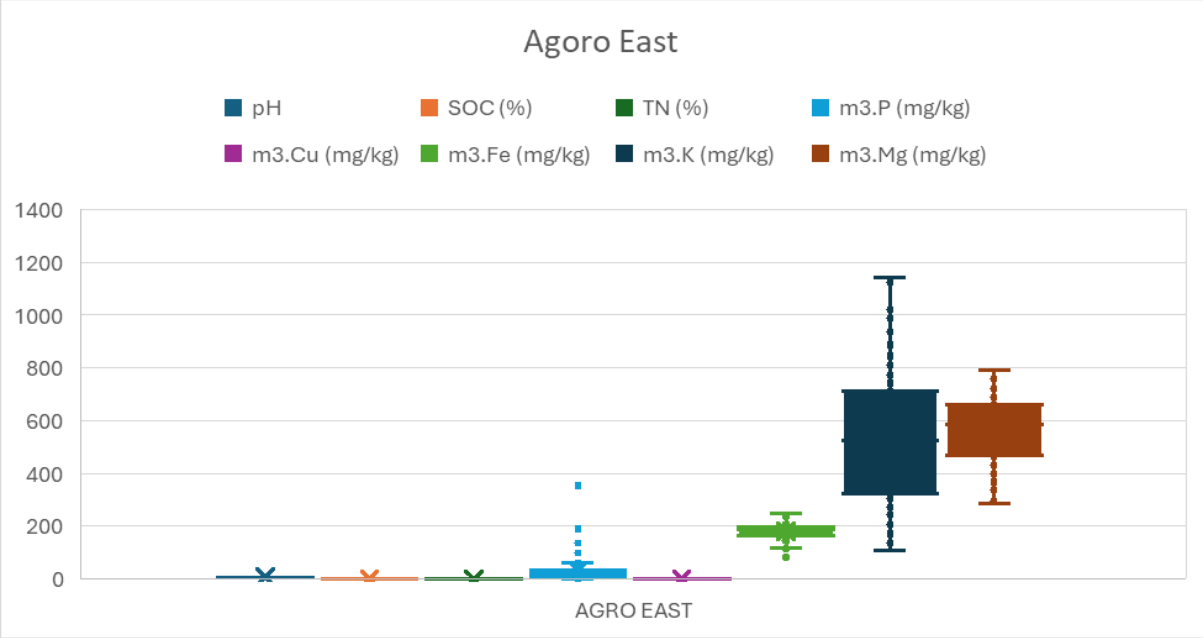
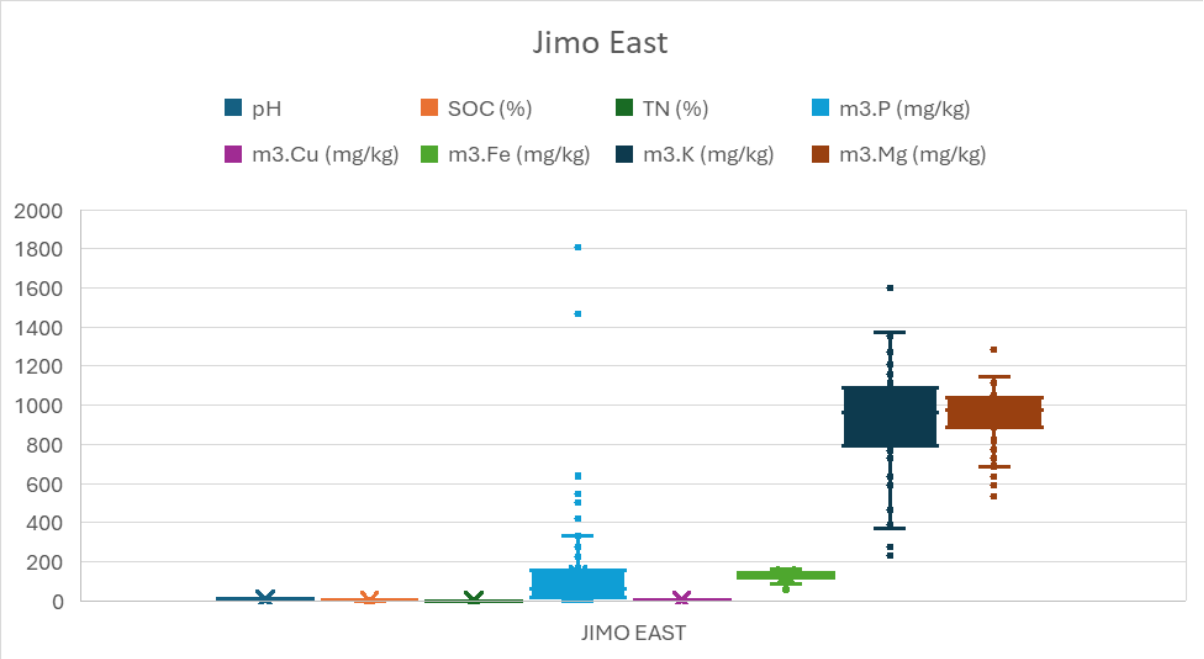


Fig. 1 Aggregated farm locations and maps in Agoro East (above) and Jimo East (below) in Kisumu.


Agoro East
pH
SOC (%)
TN (%)
m3.P (mg/kg)
m3.Cu (mg/kg)
m3.Fe (mg/kg)
m3.K (mg/kg)
m3.Mg (mg/kg)
1400
1200
1000
800
600
400
200
0
AGRO EAST


Jimo East
pH
SOC (%)
TN (%)
m3.P (mg/kg)
m3.Cu (mg/kg)
m3.Fe (mg/kg)
m3.K (mg/kg)
m3.Mg (mg/kg)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
JIMO EAST

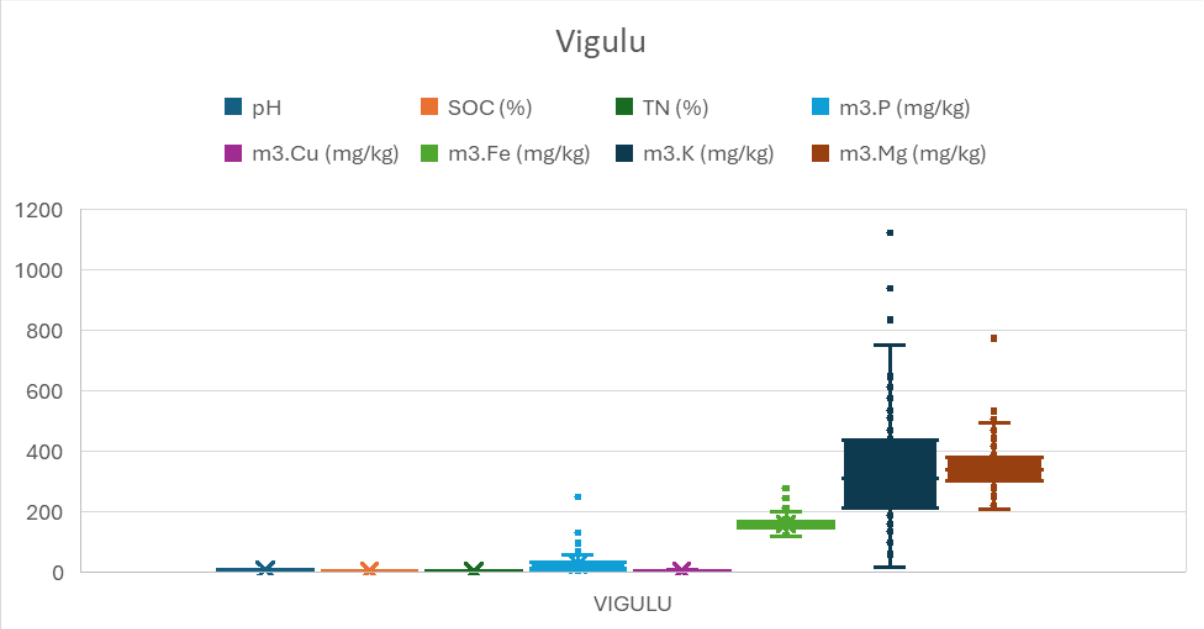


Fig. 2 Soil physical and chemical properties across Agoro East, Jimo East, and Vigulu (Vihiga).

3.3 Socio-Economic Context

The socio-economic LVB landscape is dominated by smallholder agriculture, with a majority of households relying on crop farming, livestock, informal trade, and wage employment for livelihoods. Poverty remains prevalent, with substantial portions of the population in Kisumu county living in informal settlements, where risks related to sanitation, climate exposure, and livelihood insecurity are elevated (GoK, 2015; Kenya Red Cross Society, 2017). Vihiga shows relatively lower inequality but still exhibits modest welfare levels and limited economic diversification.

In Kakamega, Bungoma, Busia, and Siaya, agriculture remains the primary livelihood, with ~85% of the population engaged in crop and livestock production. Poverty rates range between 30–45%, with food insecurity affecting ~32% of households (KNBS, 2023). Youth unemployment is particularly high (~25–35%), and gender disparities persist in land ownership, access to credit, and decision-making (KNBS, 2022). Households often combine multiple income sources to manage risk, but value addition in agricultural sectors remains weak, and access to markets and financial services is constrained. These socio-economic conditions limit the ability of smallholders to invest in productivity-enhancing technologies or adopt climate-resilient practices, reinforcing cycles of low productivity and vulnerability.

4. Agronomic Performance of the LVB Landscape

Agronomic performance in the LVB is characterized by a diversity of crops and livestock systems but marked variability in productivity. Maize, beans, cassava, sweet potatoes, bananas, and horticultural crops such as tomatoes and cabbage dominate crop production. Average maize yields in Kisumu (approximately 2.3 t/ha) and Vihiga (2.1 t/ha) are substantially below potential yields of 6–8 t/ha, reflecting constraints linked to soil fertility, limited use of certified inputs, pest and disease pressures, and weak extension services (Table 1).

Soil fertility studies have documented variable pH levels from 5.4 to 8.5, wide ranges of organic carbon content, and nutrient imbalances that compromise crop yields. For example, nitrogen levels are generally low, likely due to historical land use and nutrient depletion, while phosphorus and potassium levels vary significantly, indicating areas with potential nutrient constraints for specific crops (Kaushal et al., 2025). These findings align with broader landscape-level analyses showing that nutrient management remains a key challenge to agronomic performance.

Table 1 – Representative Crop Yields and Yield Gaps in Western Kenya

Crop	Avg Yield (t/ha)	Potential Yield (t/ha)	Yield Gap (%)	Notes
Maize	2.1–2.3	6–8	65–75%	Smallholder constraints
Beans	0.8–1.0	1.5–2.0	40–60%	Input and soil fertility issues
Sweet Potatoes	8–10	15	30–40%	Limited adoption of improved varieties

Livestock systems include dairy cattle, goats, poultry, and some sheep. Dairy cattle produce an average of 6–8 liters of milk per cow per day, constrained by feed quality, health challenges, and limited veterinary services. Aquaculture, particularly tilapia farming, offers potential for increased production but remains below potential yields due to feed constraints, water quality challenges, and disease outbreaks. These limitations reflect broader challenges in integrating livestock and aquaculture systems into multifunctional landscape strategies.

Smallholder family farms typically practice crop rotation, intercropping, and application of organic inputs, but adoption of modern inputs such as hybrid seeds and fertilizers remains limited due to cost barriers and technical knowledge gaps. Fertilizer use rates in the region often fall below recommended levels, contributing to persistent nutrient deficiencies and yield stagnation. These conditions underscore the need for enhanced input use strategies, improved soil management, and investment in extension services to support agronomic intensification.

5. Economic Performance of the LVB Landscape

The economic landscape of LVB landscape reflects the predominant role of agriculture, but also the increasing influence of non-agricultural sectors (Table 2). In Kisumu, approximately 62% of households derive income from crop farming, yet the county's economy is evolving with notable growth in transport, logistics, and urban services. Vihiga's economy remains more agrarian, with agriculture employing about 85% of people and contributing roughly 34% of the county's gross product. Households commonly combine crop farming, livestock, informal trade, and wage work to sustain livelihoods.

Table 2 – Economic Activity Indicators

County	Primary Economic Drivers	Notes
Kisumu	Mixed agriculture, services, transport	Lake trade linkages
Vihiga	Crop and livestock farming	Smallholder dominated
Kakamega	Crop, forestry, agro-processing	Largest population
Bungoma	Sugarcane, maize	Industrial linkages
Busia	Maize, beans, cross-border trade	Border economy
Siaya	Maize, fisheries	Lake-adjacent livelihoods

Despite diversified income strategies, value addition remains weak, particularly in agro-processing and formal value chains. Formal investment and remittance flows play significant roles in supplementing locally generated income, but limited access to formal finance and investment capital constrains economic transformation. Weaknesses in market access and productive infrastructure further limit smallholder integration into higher-value markets, reinforcing cycles of low productivity and economic vulnerability. These economic conditions interact with agronomic and environmental challenges, such that low productivity and limited economic resilience reinforce systemic vulnerability. Strengthening economic performance therefore requires integrated strategies that enhance productivity, value addition, market access, and financial inclusion.

6. Environmental Performance of the LVB Landscape

The environmental performance of the LVB landscape is strongly shaped by climate variability, land-use pressures, and resource extraction. The region experiences recurrent flooding, particularly along low-lying areas of Kisumu adjacent to Lake Victoria, and periodic droughts in both Kisumu and Vihiga counties (Kenya Red Cross Society, 2017; Ogallo et al., 2019). Climate change is amplifying the intensity of these events, disrupting farming calendars and threatening livelihoods. Soil erosion is particularly pronounced in Vihiga and Kakamega, with rates of 13–36 t/ha/year on steep slopes. Nutrient runoff contributes to eutrophication and algal blooms in Lake Victoria, compromising water quality (Aloo et al., 2019). Deforestation in Busia and Kakamega reduces carbon sequestration capacity and increases vulnerability to landslides and flooding (Barton et al., 2019). Flooding contributes to infrastructure damage, water-borne disease outbreaks, and loss of agricultural produce, while droughts reduce soil moisture availability and pasture productivity, highlighting the vulnerability of rainfed agricultural systems (Intergovernmental Panel on Climate Change, 2022).

Land degradation is a critical concern, with Vihiga's steep hills experiencing significant soil erosion, while sedimentation in Lake Victoria from agricultural runoff and deforestation affects water quality and fish habitats. Water quality in both counties is compromised by nutrient runoff from farms, untreated sewage, and industrial effluents, contributing to eutrophication, algal blooms, and reduced biodiversity in aquatic ecosystems (FAO, 2025). Forested areas and tree-based systems act as carbon sinks,

but deforestation and land conversion for agriculture continue to threaten these ecosystems (Figure 3).

Energy use in the landscape is dominated by biomass (wood and charcoal), leading to localized deforestation and air pollution, although adoption of solar energy is increasing, providing opportunities for cleaner energy solutions (Rural Energy Agency, 2017). Overall, environmental performance is constrained by both natural and anthropogenic pressures, reinforcing the need for integrated land and water management strategies.

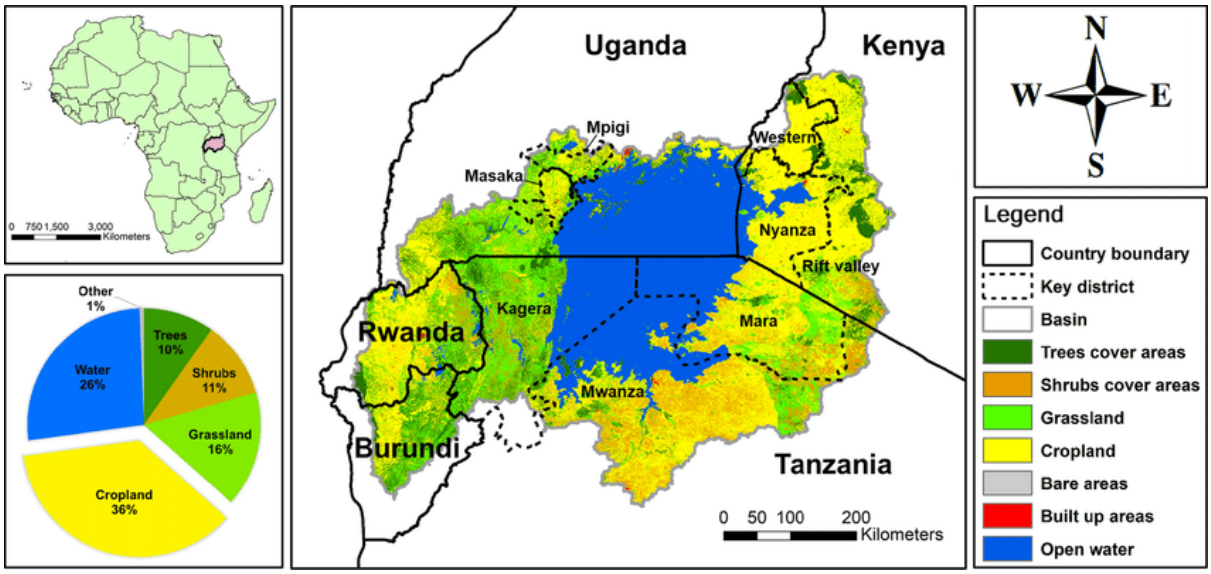


Figure 3. Land cover map for the Lake Victoria Basin. Bold lines represent country boundaries and dotted lines represent key districts for countries in the basin (adapted from Hao et al., 2022)

7. Social Performance of the LVB Landscape

Social outcomes in the LVB landscape reveal persistent challenges in food and nutrition security, youth employment, and gender equity. Kisumu exhibits high levels of food insecurity, with many households dependent on purchased food and seasonal imports. Vihiga shows improvements in child nutrition indicators but still faces vulnerabilities, particularly among households with limited land or income (Schipper et al., 2014; Adoyo et al., 2025).

Table 3 – Poverty and Food Insecurity Indicators (Western Kenya, 2022)

Indicator	Value	Notes
Overall poverty	39.8%	~20 million individuals
Food poverty	31.7%	~16 million cannot meet minimum food needs
Rural food consumption from own production	16.8%	Down from 20% in 2021

Youth unemployment is particularly high in LVB, with young women disproportionately affected. This limits livelihood diversification, adaptive capacity, and resilience to climate shocks. Gender disparities persist in access to land, inputs, credit, and decision-making, further constraining household-level productivity and social welfare. Informal settlements in Kisumu experience elevated exposure to climate-related hazards, poor sanitation, and limited access to basic services, compounding social vulnerability. Multisectoral strategies addressing nutrition, food systems, and social inclusion exist but face challenges in implementation, monitoring, and the collection of disaggregated data (Figure 4). Strengthening social outcomes requires targeted interventions for youth, women, and vulnerable households, integrated with broader landscape-level governance and resource management initiatives.

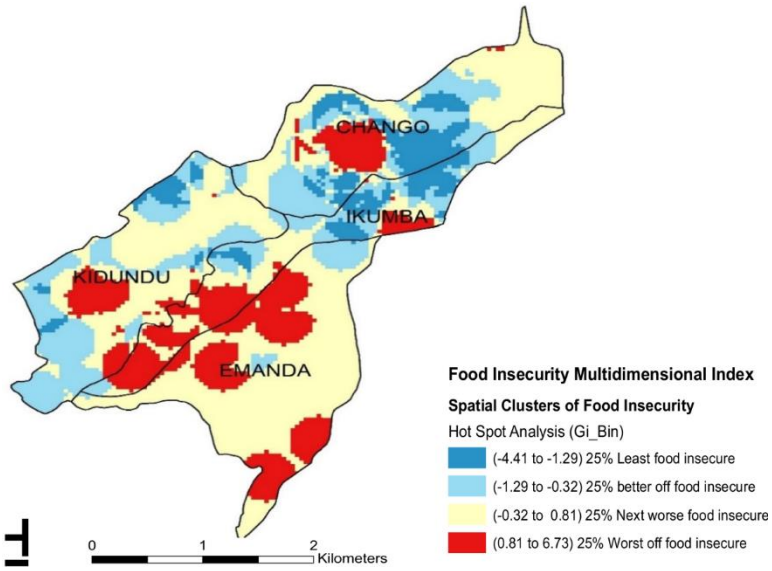


Figure 4. Spatial distribution of household food insecurity hotspots in Vihiga County, Western Kenya, based on GIS-derived multidimensional food insecurity indicators (hot spots shown in red, higher insecurity; blue indicates relatively food secure areas) (adapted from Mathenge et al., 2022).

8. Synthesis of Multifunctional Landscape Performance

Integrating evidence across agronomic, economic, environmental, and social dimensions demonstrates the strong interconnections and trade-offs in the LVB landscape. Low crop yields and livestock productivity reinforce poverty and food insecurity, while environmental degradation—soil erosion, water pollution, and deforestation—further undermines resilience. Climate shocks exacerbate these challenges, highlighting the vulnerability of smallholder systems.

Across Western Kenya, interventions targeting soil health restoration, integrated nutrient management, and agroforestry have potential to increase yields, improve ecosystem services, and enhance social outcomes. The expanded coverage emphasizes multi-county coordination for integrated governance and landscape-level interventions. At the same time, opportunities exist for enhancing multifunctional performance. Restoration of soil health through organic amendments, integrated nutrient management, and promotion of beneficial microbial communities can increase crop yields and ecosystem services (Kaushal et al., 2025). Diversified farming systems, agroforestry, improved water management, and climate-smart agriculture provide pathways for synergies

between productivity, environmental stewardship, and social inclusion. Integrated governance frameworks that include stakeholders from local communities, government, and private sector are critical to unlocking these multifunctional benefits.

9. Evidence Gaps and Knowledge Limitations

Despite extensive documentation, key knowledge gaps persist. Spatially explicit data on land degradation, climate vulnerability, and biodiversity trends are limited, reducing the ability to target interventions effectively. Longitudinal data assessing the impacts of agroecological, regenerative, and nature-positive interventions are scarce, constraining evaluation of multifunctional outcomes. Social indicators, particularly disaggregated data on gender and youth, are unevenly collected, making it difficult to fully capture equity impacts. Bridging these gaps will require systematic monitoring, geospatial data integration, and participatory research.

10. Implications for Vision-to-Action and Assessment Frameworks

The synthesized evidence provides a strong foundation for the Vision-to-Action process. Priority areas include addressing soil fertility constraints, promoting climate risk management strategies, enhancing youth employment, fostering gender equity, and supporting value-chain development. Assessment frameworks should integrate biophysical, socio-economic, and governance indicators at landscape scale, with attention to trade-offs and synergies. Indicators should be spatially explicit, temporally resolved, and sensitive to gender and social inclusion to ensure equitable landscape interventions (Adoyo et al., 2025; FAO, 2025). Western Kenya's expanded coverage underscores the need for multi-county coordination, harmonized monitoring, and policy alignment for sustainable landscape transformation.

11. Conclusions and Way Forward

The LVB landscape faces interconnected agronomic, economic, environmental, and social challenges requiring integrated, landscape-level solutions. Key priorities include improving soil health, increasing productivity, enhancing livelihoods, restoring ecosystems, and fostering inclusive governance. Achieving multifunctional outcomes will depend on coordinated investments, robust data systems, iterative learning, and stakeholder engagement. This synthesis report provides a baseline for adaptive management under the MFL SP and supports evidence-based decision-making for sustainable landscape transformation. Including various counties in LVB landscape provides a broader regional perspective, emphasizing that interventions should be multi-county, coordinated, and context-specific.

12. Methodological Approach

This report is based on a comprehensive desk review of scientific and grey literature, CGIAR knowledge products, national and subnational statistics, and geospatial datasets, supplemented by expert knowledge. The synthesis prioritizes integration across agronomic, economic, environmental, and social dimensions rather than exhaustive coverage of all individual indicators. Emphasis was placed on identifying multifunctional outcomes, synergies, trade-offs, and evidence gaps to inform landscape-level interventions.

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14. Figure Legends

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