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Protecting Tanzania's Food Security: Addressing Plastic Pollution Through Plant-Based Polysaccharide Enhanced Sand Filtration

Introduction

Plastic pollution has emerged as a major environmental challenge worldwide, particularly in Sub-Saharan Africa. In Tanzania, where food systems depend heavily on farmland, inland lakes, rivers, and other freshwater resources, plastic waste increasingly threatens food production and the natural systems that support it.

National assessments estimate that approximately 29,000 tonnes of plastic leaked into Tanzania's oceans, rivers, and lakes in 2018, highlighting the scale at which plastic contamination now affects the country's aquatic and terrestrial environments (IUCN 2021). Plastic debris and microplastics can accumulate in farmland through runoff, improper disposal, flooding, and contaminated irrigation water, creating pathways for plastic pollution to enter agricultural soils (Kato et al. 2024; Mwesiga et al. 2025).

Plastic pollution in Tanzania is therefore not only an environmental issue, but an emerging food-security challenge. By contaminating soil and the soil resources farmers depend on, it can threaten the long-term resilience of Tanzania's food system.

Country Background

Tanzania's food system remains closely tied to agriculture, which accounted for approximately 64.6% of total employment in 2025 (World Bank 2025). Agriculture also contributes roughly one-quarter of Tanzania's economic output (World Bank 2025). Smallholder farmers make up much of the agricultural sector, making healthy farmland and reliable water resources important to food production. Yet approximately 59% of Tanzanian families cannot afford a nutritious diet (WFP 2025). Protecting the natural resources that farmers depend on is therefore important to strengthening the resilience of Tanzania's food system.

Challenge and Impact

Although plastics can reach agricultural land through several pathways, recent research in Dar es Salaam identifies irrigation as a particularly important connection between polluted freshwater and farmland. A 2025 study of the Msimbazi River found microplastics in water used for irrigation and in soils of adjacent vegetable gardens. Downstream water contained an average of 14.33 particles per 10 mL, with concentrations reaching as high as 1,953 particles per liter, while nearby vegetable-garden soils contained up to 44.3 particles per gram (Mwesiga et al. 2025). The researchers also identified similar plastic polymers in the river water and agricultural soils and concluded that irrigation water appears to be a primary source of these particles entering these vegetable gardens.

This pathway is especially relevant at the Mabibo Bonde la Mchicha Farm in Dar es Salaam, where plastic contamination has been documented throughout agricultural soils. Researchers detected microplastics in every soil sample collected from depths of up to 15 centimeters, with concentrations ranging from 4.8 to 82.2 particles per gram (Kato et al. 2024). Fibers were the most common form, accounting for 49.7% of identified microplastics, followed by fragments and films (Kato et al. 2024). The researchers identified surface-water irrigation, along with agricultural practices such as the application of chicken manure, as contributors to particle accumulation at the farm. A subsequent 2026 ecological-risk assessment at Mabibo found mean concentrations of 29.5, 32.1, and 18.9 particles per gram across the three sampled soil depths and identified potentially hazardous polymers including polyamide and PVC (Kato et al. 2026).

Exploring Solutions

Tanzania has already begun addressing plastic pollution through national and local waste-management initiatives. In the Msimbazi basin specifically, the World Bank-supported Msimbazi Basin Development Project includes watershed restoration, litter management, community-based solid-waste collection, materials-recovery facilities, and improved recycling and collection systems (World Bank, 2025). Recent implementation reports show that a community cooperative model for waste collection, recycling, and litter control is being developed across seventeen sub-wards of the lower basin (World Bank, 2025). However, they do not directly address microplastics already present in irrigation water or prevent those particles from being transported onto agricultural land. Protecting food-producing soils therefore requires an intervention that complements upstream waste reduction by interrupting contamination closer to the point of irrigation.

Several technologies could potentially remove microplastics from contaminated water, but their suitability differs for a localized agricultural intervention. Constructed wetlands can achieve high microplastic retention through substrates, vegetation, and other physical processes, but their performance can vary under field conditions and retained particles can accumulate within the treatment system (Miloloža et al. 2025). Coagulation can also remove microplastics from water, but it requires control of treatment conditions and creates concentrated residual material that must subsequently be managed (Sahini and Banyikwa, 2026). These limitations make such approaches less immediately suited to a small agricultural intervention whose purpose is to treat irrigation water at the point of use.

Fine-sand filtration offers a more direct fit for agricultural irrigation because it can be incorporated into existing water-delivery systems rather than requiring treatment of the entire river. A 2026 *Environmental Research* study tested sand filtration specifically on microplastic-contaminated irrigation water and found that finer media performed best: 0.5–1.0 mm sand removed 89.9% of microplastics overall, compared with 79.9% and 55.6% for progressively larger media (Zhou et al. 2026). The filter was particularly effective for larger and fibrous microplastics, although removal fell to only 17.3% for 100–200 μm particles. However, its demonstrated effectiveness, relatively simple physical mechanism, and compatibility with irrigation make it a strong candidate for testing whether one major pathway of plastic contamination entering Tanzanian farmland can be reduced.

Recommendation

Because microplastics can move from freshwater systems into agricultural soils through irrigation, Tanzania needs a way to reduce that exposure before contaminated water reaches food-producing land. I

recommend a 12-month pilot of a modular fine-sand filtration system at Mabibo Bonde la Mchicha Farm in Dar es Salaam, where farmers rely on surface water for vegetable production (Kato et al. 2026). Rather than assuming a filtration system developed elsewhere will work the same way in Tanzania, the pilot would test whether a low-cost system can be adapted to local irrigation conditions and reduce microplastic contamination before water reaches crops.

The proposed system would be installed at the farm's irrigation intake or reservoir, allowing water to pass through a fine-sand filter before reaching vegetable plots. The pilot would begin with a 0.5–1.0 mm sand medium based on research testing sand filtration in irrigation water. That study reported 89.9% overall microplastic removal with 0.5–1.0 mm sand, compared with 79.9% and 55.6% for larger media, although removal fell to 17.3% for 100–200 μm particles (Zhou et al. 2026). Because the study used Yellow River water rather than water from the Msimbazi Basin, this configuration would serve as a starting point rather than a guaranteed solution. The pilot would adjust the system according to local water conditions and measure its actual performance.

The pilot would also investigate whether plant-derived polysaccharides could improve filtration, particularly for smaller microplastics. Srinivasan et al. (2025) found that polysaccharides from fenugreek and okra enhanced microplastic removal through polymer bridging in tests conducted with water from the Colorado River and Port Lavaca, Texas. However, these findings do not establish whether polysaccharides from other plants would produce similar effects. Baobab offers a potentially promising local source: baobab trees and fruit value chains are present across farmland and other landscapes in Kilolo and Iringa (Ngole et al. 2024), and baobab fruit pulp contains extractable water-soluble polysaccharides (Bougatef et al. 2023). The pilot would therefore test baobab-derived polysaccharides as a filtration-enhancement step, assessing whether they increase the removal of smaller microplastics without requiring a separate intervention. The 12-month pilot would proceed through baseline assessment, filtration optimization, and field operation.

Timeline	Activity	Expected Outcome
Months 1-2: Baseline & Design	Measure microscopic concentrations in irrigation water and agricultural soil; characterize particle types and sizes; measure irrigation flow; document existing irrigation practices.	Establish baseline contamination levels and determine local conditions needed to design the filtration system.
Months 3–4: Filter Testing & Optimization	Install the initial 0.5–1.0 mm sand configuration; test and adjust sand media, flow conditions, and filtration performance under local conditions.	Identify a filtration configuration suited to Mabibo’s water quality and irrigation system
Months 5–12: Field Operation	Operate the optimized filtration system and regularly compare treated and untreated irrigation water; monitor filter performance and maintenance.	Determine whether filtration consistently reduces microplastic concentrations while remaining practical and affordable for farmers.
Months 5–12: Monitoring, Evaluation, &	Measure microplastics in irrigation water and soil; track particle size and type, flow rate, clogging, backwashing, downtime,	Evaluate filtration effectiveness, agricultural practicality, and costs to determine whether the system should be adapted and tested in other

Long-term Recommendation	maintenance labor, operating costs, and crop production.	Tanzanian communities using contaminated surface water for food production, or discontinued if it doesn't demonstrate the sufficient benefit.

Mabibo provides a strong setting for testing this approach because microplastics have been documented in both the surrounding irrigation pathway and agricultural soils. Research on the Msimbazi River found concentrations reaching 1,953 particles per liter in irrigation water and 44.3 particles per gram in nearby vegetable-garden soil, identifying irrigation as a likely contamination pathway (Mwesiga et al. 2025). At Mabibo, microplastics have been detected throughout sampled soils at concentrations of 4.8–82.2 particles per gram, with fibers the most common particle type (Kato et al. 2024). These findings do not prove that filtration will improve food security, but they identify a pathway where an intervention can be directly tested.

The pilot would be designed around farmers' existing practices. Farmers should help select the system location and evaluate maintenance requirements and effects on irrigation. The system should use locally obtainable materials and require limited technical expertise. Excessive labor, frequent replacement, or high costs would be important findings: a system that works in the laboratory but cannot be maintained by farmers would not be a sustainable intervention.

The project could also build on existing environmental work in the Msimbazi Basin, which already addresses waste management, watershed conditions, pollution, and flood resilience (World Bank, 2026). Funding could come through partnerships among Tanzanian research institutions, local government, existing environmental-development programs, and organizations supporting water and food-system resilience.

The short-term goal would be to determine whether fine-sand filtration can consistently reduce detectable microplastics in irrigation water under Tanzanian conditions. A pilot target of at least a 70% mean reduction would provide a measurable benchmark, while the actual result would remain an empirical question. The medium-term goal would be to determine whether the system can operate reliably, limit continued soil contamination, and remain economically practical. The long-term goal would be to adapt and test the approach in other Tanzanian communities where contaminated freshwater is used for food production.

This recommendation does not attempt to solve all of Tanzania's plastic pollution at once. Instead, it targets one documented pathway: contaminated freshwater entering agricultural land through irrigation. By testing an intervention at that point of entry, Tanzania could determine whether preventing microplastics from reaching agricultural soils is a feasible way to strengthen local food-system resilience.

Stakeholders, Funding, and Cultural Relevance

The pilot would require collaboration among farmers, researchers, local government, and organizations, such as the World Bank, already working in the Msimbazi Basin. Farmers at Mabibo would be the primary stakeholders because filtration would directly affect their irrigation practices. Research on urban agriculture in Dar es Salaam shows that farmers already use rivers, canals, shallow wells, reservoirs, pumps, buckets, and watering cans to obtain and distribute irrigation water (Wessels et al. 2024). Designing the filtration system around these existing practices would reduce the need for major changes

to how farmers access water. Farmers should also help determine the system's location and evaluate its effects on irrigation, maintenance, and crop production.

Funding should build on existing institutions rather than require a new national program. The World Bank-supported Msimbazi Basin Development Project already supports watershed management, pollution reduction, waste collection, recycling, and institutional strengthening in the basin (World Bank 2026). A small pilot could therefore be supported through partnerships among Tanzanian research institutions, local government, the existing basin project, and participating farmers. Pilot costs should initially be covered by these partners rather than transferred to farmers before the technology demonstrates value.

The intervention is also culturally and practically relevant because it would adapt to, rather than replace, existing farming and irrigation practices. Farmers would help determine whether the system's maintenance, labor requirements, and operating costs are realistic. Their participation would ensure that technical effectiveness is evaluated alongside local practicality.

Impact, Limitations, and Scalability

The immediate impact of the pilot would be measured at the point where irrigation water enters agricultural land. If filtration reduces microplastic concentrations in irrigation water, fewer particles would be introduced into Mabibo's vegetable-growing soils through this pathway. Comparing filtered and unfiltered plots over time could then indicate whether reduced irrigation contamination slows additional microplastic accumulation in soil.

The food-security impact would be longer-term and preventative. Agricultural soil is a resource on which farmers depend, so reducing additional contamination could contribute to the resilience of food production. However, current research does not establish that reducing microplastics in irrigation water will directly increase crop yields, improve vegetable safety, or reduce food insecurity. These outcomes should therefore be measured rather than assumed. Crop production, soil conditions, irrigation reliability, and farmer costs should be evaluated alongside microplastic removal.

The pilot also has technical limitations. Sand filtration is less effective for very small microplastics, while runoff, flooding, manure, and other practices may continue introducing particles into farmland. The system must therefore be evaluated as a targeted intervention rather than a complete solution to agricultural plastic contamination. If filtration meaningfully reduces contamination while remaining affordable and compatible with farmers' irrigation practices, the longer-term goal would be to adapt and test the approach in other Tanzanian communities using polluted surface water for food production. If it does not, the pilot would still provide local evidence before resources are committed to wider expansion.

Conclusion

Plastic pollution poses a growing challenge to Tanzania’s food system as microplastics enter freshwater and agricultural soils through irrigation. Piloting modular fine-sand filtration at Mabibo would test whether this pathway can be interrupted before additional contamination reaches farmland. By targeting a documented pathway and requiring evidence of effectiveness, affordability, and practicality before expansion, Tanzania can address plastic pollution where it directly intersects with food production. Protecting food security does not require solving the entire problem at once; it can begin by preventing contamination from continuing to enter the systems that produce food.

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