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ADMINISTRATIVE CHALLENGES IN IMPLEMENTING SOIL FERTILITY IMPROVEMENT PROGRAMS FOR HORTICULTURE PRODUCTION IN SUB-SAHARAN AFRICA: A REVIEW

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ABSTRACT

Soil fertility remains one of the most pressing agricultural challenges in Sub-Saharan Africa, where the majority of the population relies on farming as a primary livelihood. Declining soil fertility caused by over-cultivation, land degradation, deforestation, and climate variability continues to undermine horticulture production, food security and rural development across the region. While governments, development partners, and non-governmental organizations have introduced several soil fertility restoration and improvement programs, their effectiveness has been severely constrained by administrative challenges. This paper explores the major obstacles hindering successful implementation of such programs, focusing on weak institutional capacity, poor policy coordination, corruption, inadequate funding, and limited farmer participation. It argues that these governance-related issues often overshadow the technical innovations and financial investments introduced to enhance soil fertility management practices and horticultural crop yields. Furthermore, the study highlights how inadequate extension services and lack of accountability mechanisms diminish the adoption of soil fertility improvements practices at the grassroots level. The paper draws from existing literature and policy reports to analyze the recurring administrative bottlenecks and their implications for sustainable horticultural development programs. Findings revealed that unless these administrative barriers are addressed, efforts to improve soil fertility status will remain fragmented and unsustainable. The paper concludes by recommending stronger institutional frameworks, increased funding, transparent governance, inclusive farmer engagement as critical pathways for enhancing the success of soil fertility restoration and improvement programs. Ultimately, addressing administrative challenges is essential for achieving long-term food security, promoting rural livelihoods, and advancing agricultural transformation and horticultural production levels in Sub-Saharan Africa.

Keywords: Challenges, Community, Productivity, Programs, Soil.

INTRODUCTION

Public participation has become a central pillar in horticulture-based soil and water conservation (SWC), as projects designed without community input frequently fail to achieve long-term sustainability. In horticultural systems—where soil fertility, moisture retention, and microclimate control directly influence crop quality and yield—the involvement of farmers in planning, decision-making, and implementation is essential (Ajayi et al., 2021). Participatory processes ensure that conservation interventions such as mulching, drip irrigation, terracing, and compost application are not only technically appropriate but also socially acceptable and aligned with local farming realities. Scholars noted that inclusive participation enhances legitimacy, reduces resistance to new horticultural practices, and increases compliance with conservation measures (Mutua and Mwangi, 2021). For instance, while several state-led horticultural projects in Nigeria experienced low adoption, community-driven agricultural programs such as Fadama III recorded broad success due to the use of participatory rural appraisal tools that reflected farmers' needs and priorities (World Bank, 2021). Meaningful participation also strengthens accountability and reduces dependency, as farmers contribute knowledge, labor, and local resources, becoming co-owners rather than passive beneficiaries of horticultural SWC interventions (Ogunleye and Ojo, 2023). Nevertheless, participation varies widely in quality, from tokenistic meetings to genuine decision-making power, raising concerns about inclusivity, elite capture, and the representation of marginalized groups, particularly women and youth who play critical roles in horticultural production (Pretty, 2020; Gwali et al., 2022).

Community-Based Approaches (CBAs) further institutionalize public participation by embedding horticultural conservation responsibilities within local structures. Community-Based Natural Resource Management (CBNRM) has proven especially effective in promoting sustainable horticultural practices such as rainwater harvesting, terracing for vegetable gardens, fruit tree agroforestry, and organic soil restoration. Evidence from Sub-Saharan Africa shows that CBNRM initiatives contribute to reduced soil erosion in vegetable farms, improved water storage for irrigated horticulture, and enhanced food security when supported by government and NGOs (FAO, 2022). In Kenya, self-help groups have successfully rehabilitated degraded horticultural terraces, while Ethiopia's Farmer-Managed Natural Regeneration (FMNR) has restored landscapes by promoting the regrowth of fruit and multipurpose trees that support horticultural systems (Reij and Winterbottom, 2020). In northern Nigeria, community forest management committees have contributed to combating desertification by establishing windbreaks and shelterbelts that protect horticultural plots from erosion (Akinsanmi, 2021). However, CBAs are often constrained by limited funding, inadequate technical knowledge of modern horticultural technologies, and weak institutional frameworks (Adeleke, 2023). These challenges highlight the importance of hybrid models that

combine grassroots participation with state-led extension services and international technical support.

Public participation and CBAs also play a vital role in integrating indigenous horticultural knowledge with scientific innovations to develop more resilient SWC strategies. Traditional horticultural practices such as terracing, contour ridging, mulching with crop residues, and the use of organic manure have long been central to soil and water conservation (Mwangi and Kariuki, 2022). In northern Nigeria, indigenous techniques like Zai pits, stone bunds, and traditional organic mulching have been revitalized and integrated with agroforestry and improved irrigation methods to restore degraded horticultural lands (Buba and Waziri, 2023). Such hybrid approaches strengthen soil structure, increase moisture retention, and enhance biodiversity within horticultural systems. By valuing indigenous knowledge, participatory horticulture projects avoid imposing unfamiliar or unsuitable techniques that communities may resist. However, effective integration requires sustained capacity building, farmer training, and supportive institutional mechanisms that validate local knowledge and link it with scientific horticultural innovations (FAO, 2022; Ogunleye and Ojo, 2023).

Another central dimension of participation in horticultural SWC is community-led monitoring and evaluation (M&E). Unlike top-down monitoring systems that focus on bureaucratic reporting, participatory M&E empowers farmers to track soil moisture, irrigation efficiency, pest pressures, and the performance of conservation structures such as terraces, trenches, or mulched beds (Adeleke, 2023). Evidence from Kenya and Tanzania demonstrates that when horticultural communities participate in water governance, conflicts over irrigation access decline while compliance with conservation norms increases (Gwali et al., 2022). In Nigeria, community monitoring committees under watershed management initiatives have played crucial roles in identifying erosion threats in vegetable gardens and coordinating rapid responses (Ogunleye and Ojo, 2023). Despite these benefits, the effectiveness of participatory M&E may be hindered by low literacy, gender exclusion, and inadequate technical training, highlighting the need for consistent institutional and capacity-building support.

The long-term effectiveness of public participation and CBAs in horticulture-based SWC is significantly influenced by broader governance and policy contexts. Weak institutional structures, inadequate access to horticultural finance, and political interference often undermine community efforts (Pretty, 2020; Mutua and Mwangi, 2021). In Nigeria, community-driven horticultural and afforestation initiatives contribute to land rehabilitation, yet their impact is limited by poor legal recognition, inconsistent government support, and short-term donor-driven agendas (Akinsanmi, 2021; Reij and Winterbottom, 2020). Addressing these challenges requires policies that institutionalize participation, fund community horticulture programs, strengthen extension services, and ensure the inclusion of women, youth, and other marginalized groups who are central to horticultural practices. With the right governance framework, participatory and community-based approaches can become truly transformative strategies for sustainable horticulture-based soil and water conservation.

The fertility status of soil constitutes the bedrock of agricultural productivity, underpinning livelihoods and food security across Sub-Saharan Africa (SSA), where the overwhelming majority of the population depends on rain-fed subsistence farming (Chakib and Freeman, 2024). Nevertheless, years of continuous over-cultivation—driven by population growth and diminishing fallow periods—paired with rampant deforestation, have severely depleted both nutrient levels and organic matter in soils across the region (Olderman, 1990; Lal, 1995; Jones, 2013). SSA's soils, already ancient and highly weathered, were never endowed with high inherent fertility; without regular replenishment, they rapidly lose productivity (Olderman, 1990; Jones, 2013). Compounding this, widespread soil erosion—exacerbated by steep landscapes, heavy rainfall, and extensive land clearing—further strips away topsoil and organic reserves, causing stark declines in both crop yields and ecological resilience (Olderman, 1990; FAO, 1986; FAO, 1986 in Chapter 4). Meanwhile, climate change is amplifying these pressures: erratic rainfall, more frequent droughts or floods, and truncated growing seasons are projected to slash cereal yields by up to 40% and shorten the agricultural season by roughly 20% by mid-century (Lobell et al., 2011; Frontiers Editorial, 2022). It's estimated that two-thirds of SSA's land suffers soil degradation, further entrenching cycles of poverty, malnutrition, and environmental decline (Chakib and Freeman, 2024).

In response to these alarming trends, governments and multilateral bodies have launched a variety of soil-fertility improvement programs. The World Bank, for instance, inaugurated the Africa Regional Hub for Fertilizer and Soil Health under the AICCRA initiative—allocating US\$10 million over five years—to coordinate sub-regional efforts in monitoring soil health, developing agronomic recommendations, and reinforcing fertilizer efficiency (Chakib and Freeman, 2024). Similarly, the TerrAfrica Partnership—a twelve-year initiative backed by the African Union, the World Bank, the UN, and the European Commission—invests in sustainable land management across SSA; to date, it has channeled approximately US\$2 billion into national projects, including watershed rehabilitation in Ethiopia and agroforestry restoration in Rwanda (TerrAfrica Partnership, 2025). Complementing these government and donor initiatives, the International Fertilizer Development Center (IFDC) operates "smart subsidies" and in-field demonstrations across East, West, and Southern Africa, promoting Integrated Soil Fertility Management (ISFM), improved access to quality inputs, and farmer training in technologies like Fertilizer Deep Placement (IFDC, 2025).

Despite these ambitious efforts, the impact of many programs remains muted, predominantly due to administrative and governance bottlenecks. Weak institutional capacity manifests through fragmented policy frameworks, poor coordination

among implementing agencies, and limited extension services—particularly in remote or rural zones—obstructing the timely delivery of support to smallholder farmers (Chakib and Freeman, 2024; IFDC, 2025). Financial constraints compound the problem; fertilizer use in SSA averages only 22 kg/ha—substantially below the global average (146 kg/ha)—and remains highly sensitive to fluctuating input prices and supply volatility, reducing uptake by resource-poor farmers (Chakib and Freeman, 2024). Moreover, tenure insecurity discourages long-term investment in soil health, particularly when farmers lack formal land rights or expect short-term access at best (Sustainable Soil Degradation study, 2015). This is particularly troubling because integrated approaches—such as combining organic amendments, mineral fertilizers, agroforestry, and conservation agriculture—have proven more sustainable and effective in restoring soil fertility status than conventional methods (Frontiers Editorial, 2022; PMCID article, 2025), yet their adoption remains low. Behavioral inertia, risk aversion, delayed gains, and high upfront labor or cost deter farmers from embracing innovations like agroforestry, contour ridging, or biochar—even though meta-analyses show such measures can significantly enhance soil N, P, and organic carbon (meta-analysis, Agron. Sustain. Dev., 2019).

In totality, the convergence of institutional fractures, financing shortfalls, and policy/incentive misalignment severely constrains the efficacy of soil-fertility interventions across SSA. This paper systematically explores this triad—institutional, financial, and governance-related obstacles—through a comprehensive literature review, aiming to illuminate how administrative weaknesses have undercut soil-restoration initiatives. In doing so, the paper aspires not only to deepen understanding of the systemic barriers but also to identify pathways for reform that could unlock the full promise of soil-fertility programs and drive more sustainable horticultural productivity in particular and agricultural productivity as a whole across Sub-Saharan Africa.

CONCEPTUAL FRAMEWORK

The persistent and accelerating degradation of soil fertility in Sub-Saharan Africa represents a direct and severe threat to the region's food security, economic development, and social stability (Sanchez, 2019). This problem as shown in figure 1, is epitomized by widespread nutrient depletion, with studies indicating that African soils lose an estimated 30 kg N, 7 kg P, and 22 kg K per hectare annually, far exceeding inputs and creating a massive net negative nutrient balance that undermines the very basis of crop production (Vanlauwe et al., 2017). The consequences are starkly visible in the form of stagnating and declining agricultural yields, increased poverty among smallholder farmers, and heightened vulnerability to climatic shocks, thereby perpetuating a cycle of hunger and environmental degradation (Tittonell and Giller, 2019). While the technical remedies for reversing this decline—such as integrated soil fertility management (ISFM), appropriate fertilizer use, composting, agroforestry, and conservation agriculture—are well-known and scientifically validated (Zingore et al., 2021), their widespread adoption and sustained implementation have remained critically low and geographically fragmented. The central problem, therefore, is not a lack of technical knowledge but a profound failure in the administrative and institutional mechanisms responsible for delivering these solutions to millions of smallholder farmers (World Bank, 2019).

This failure manifests as a critical disconnect between policy design and on-the-ground reality, where well-funded programs are consistently undermined by a complex web of administrative dysfunctions. Key among these is the chronic institutional weakness within agricultural extension services, which are often plagued by severe underfunding, inadequate training, and a lack of logistical resources, rendering them incapable of effectively disseminating knowledge or providing tailored support to farmers (Anderson and Feder, 2021). Furthermore, flagship programs like national fertilizer subsidy schemes, while politically popular, are frequently crippled by logistical delays, elite capture, corruption, and a narrow focus on a limited number of fertilizers that fails to address the diverse and site-specific nutrient deficiencies found in SSA's soils (Liverpool-Tasie and Takeshima, 2019; Morris et al., 2021). Compounding these issues are governance failures, including a top-down approach that excludes smallholder farmers from the planning and decision-making processes, leading to interventions that are misaligned with local needs, cultural practices, and ecological conditions (Kansanga et al., 2021). Financial mismanagement, bureaucratic red tape, and a lack of coherent policy integration across different government ministries further erode the effectiveness of interventions, ensuring that even the most promising programs fail to achieve scalability or long-term sustainability (Huang et al., 2020). Consequently, the core problem this paper addresses is the systematic investigation of how these institutional, financial, and governance-related administrative challenges collectively act as the primary impediment to successful soil fertility improvement in Sub-Saharan Africa, thereby locking the region into a state of preventable agricultural underperformance and food insecurity.

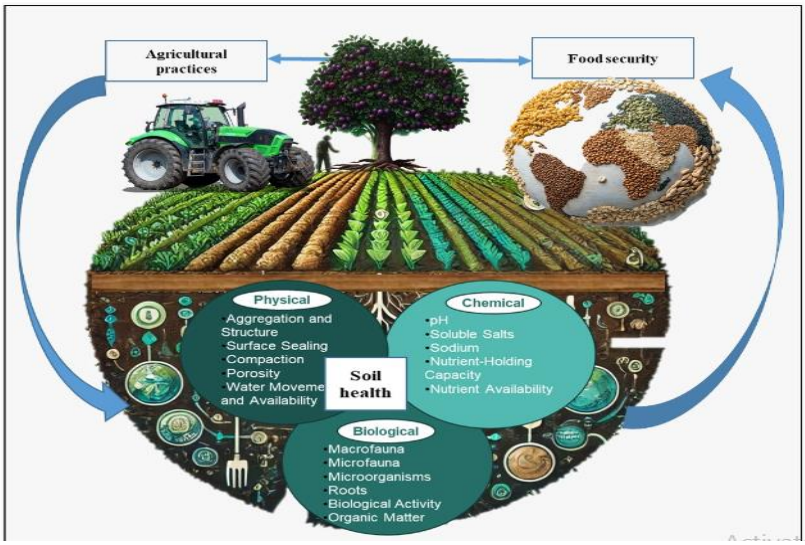


Figure 1. Interconnections between soil health, agricultural practices, land degradation and food Security. Source: Topa, et al, (2025).

PREVIOUS PERSPECTIVES

A substantial body of scholarly work has established that the limited success of agricultural development programs in Sub-Saharan Africa is less frequently a failure of agronomic science and more commonly a failure of administration and governance (World Bank, 2019; Andersson and Sjöberg, 2022). Previous studies had consistently identified a triad of interconnected administrative bottlenecks, institutional, financial, and governance related stands that systematically undermine the implementation and sustainability of soil fertility improvement programs for horticultural production (SFIPs).

Institutional and Structural Challenges

A primary theme in the literature concerns the weak and fragmented institutional frameworks governing agriculture. Research indicates that multiple, often overlapping, ministries and agencies (e.g., Agriculture, Environment, Finance) are involved in SFIPs, leading to contradictory directives, bureaucratic turf wars, and a severe lack of coordinated action (Huang et al., 2020). This institutional pluralism creates confusion at the implementation level and dilutes accountability, making it nearly impossible to assign responsibility for failures (Ackrill and Kay, 2021). Furthermore, the frontline institutions responsible for execution, particularly agricultural extension services, are described as chronically under-resourced. Extension agents face immense challenges, including inadequate training on modern soil management practices, a crippling lack of transport and operational budgets, and caseloads far exceeding manageable limits, which collectively prevent the effective dissemination of knowledge and support to farmers (Anderson and Feder, 2021; Djido et al., 2021).

However, documented administrative barriers undermining soil fertility programs in Sub-Saharan Africa is the weak institutional capacity of agricultural ministries and related agencies. Many countries face significant deficits in technical expertise, weak research–policy linkages, and under-equipped agricultural departments, which limit their ability to design, implement, and monitor large-scale soil fertility improvement initiatives (Bambi et al., 2024). National Agricultural Research Systems (NARS) often lack adequate numbers of trained soil scientists and agronomists, leaving governments dependent on external expertise from international organizations (Lal, 2024). The absence of coherent institutional frameworks also results in gaps in soil data collection, monitoring, and evaluation, which are critical for evidence-based decision-making (Tindwa et al., 2023). Consequently, programs are often designed with limited contextual knowledge and executed with poor oversight capacity, leading to inefficiencies and limited sustainability.

Financial and Resource Management impediments

The literature extensively documents financial constraints as a critical barrier. While funding is often allocated to national programs, studies show that it is frequently insufficient, unpredictable, and subject to significant delays due to complex bureaucratic procurement and disbursement processes (Liverpool-Tasie et al., 2021). A more pernicious problem highlighted by numerous scholars is the issue of "leakage" and corruption within subsidy programs. Resources, particularly fertilizers, are often diverted from their intended beneficiaries—smallholder farmers—and captured by political elites, larger commercial farmers, or illicit networks (Mason and Jayne, 2021; Morris et al., 2021). This not only represents a direct financial loss but also erodes public trust in government initiatives. Additionally, the financial model of many programs is criticized for being unsustainable, relying heavily on volatile donor funding or short-term government budgets rather than fostering self-sustaining, market-based systems (Kansanga et al., 2021). Another persistent administrative challenge is inadequate and unstable financing.

Soil fertility programs in SSA are heavily reliant on donor funding, and many collapse or shrink once external support ends (Chakib and Freeman, 2024). National governments often allocate insufficient budgetary resources to agriculture, with spending falling below the 10% commitment outlined in the Maputo Declaration of 2003 (AGRA, 2023). Furthermore, when funds are allocated, delayed disbursements and weak financial management systems reduce program efficiency (IFDC, 2024). These financing challenges make it difficult to provide critical services such as soil testing, extension outreach, and affordable access to quality inputs. The dependence on donors also undermines program ownership and sustainability, as external priorities sometimes overshadow local needs.

Corruption and Mismanagement

Corruption and mismanagement present another layer of administrative dysfunction in soil fertility initiatives. Numerous studies have shown that fertilizer subsidies and input-support programs are vulnerable to elite capture, diversion of resources, and manipulation in beneficiary selection (U4 Anti-Corruption Resource Centre, 2021). Leakages and smuggling in subsidy programs not only reduce their effectiveness but also distort input markets, undermining private-sector participation (IFDC, 2024). Weak monitoring and accountability mechanisms further exacerbate these issues, as program implementers often operate without adequate oversight (Bambi et al., 2024). Corruption erodes farmer trust, discourages participation, and inflates program costs—ultimately negating intended benefits.

Limited Farmer Participation

Farmer participation in program design and implementation remains limited across SSA, weakening the effectiveness of soil fertility interventions. Policies are often formulated in top-down fashion, with little consultation of smallholder farmers who constitute the majority of land users (Suri et al., 2024). As a result, programs may recommend technologies or practices that are misaligned with farmers' socio-economic realities, leading to resistance or non-adoption (Agwu et al., 2023). The lack of participatory frameworks also prevents governments from tapping into indigenous knowledge and locally adapted practices that could enrich soil management strategies (Ledermann et al., 2024). Without adequate involvement, farmers perceive programs as externally imposed, which diminishes both ownership and sustainability.

Weak Extension Services

Finally, weak agricultural extension services limit the dissemination and adoption of soil fertility practices at the grassroots level. Across SSA, extension systems are plagued by inadequate staffing, poor farmer-to-agent ratios, insufficient training, and lack of resources such as transport and digital tools (Agwu et al., 2023). The COVID-19 pandemic further exposed these weaknesses, as mobility restrictions and resource shortages constrained extension outreach in many countries (Ledermann et al., 2024). Even where programs exist, extension agents often lack up-to-date knowledge on integrated soil fertility management, making it difficult to transfer relevant innovations to farmers (Abate et al., 2023). These systemic weaknesses restrict the flow of information and slow the diffusion of practices such as organic amendments, agroforestry, and precision fertilization, thereby limiting the overall success of soil fertility programs.

Governance and Participatory Deficits

Governance failures are identified as a cross-cutting theme that exacerbates institutional and financial problems. A significant critique found in the literature is the pervasive top-down approach to policy design and implementation. Scholars argue that programs are frequently conceived by central governments and international experts with minimal consultation of the end-users—the farmers (Tittonell and Giller, 2019). This exclusion leads to the promotion of technologies and practices that are misaligned with local socio-economic realities, cultural preferences, and the complex risk-management strategies of smallholders, resulting in low adoption rates (Kansanga et al., 2021; Zingore et al., 2021). The lack of transparency in how decisions are made, budgets are allocated, and outcomes are evaluated further fuels mistrust and disengagement. Moreover, the absence of robust monitoring and evaluation (M&E) frameworks means that programs are rarely held accountable for their performance, allowing ineffective approaches to be perpetuated indefinitely (Andersson and Sjöberg, 2022).

In synthesis, the existing literature provides a clear consensus: administrative bottlenecks are the fundamental constraint on soil fertility improvement in SSA. While these challenges—institutional fragmentation, financial malfeasance, and poor governance—are well-diagnosed, less research has focused on the intricate interplay between them or on contextualized, practical solutions that address this administrative triad holistically. This review establishes that any effective strategy must move beyond technical fixes to undertake deep structural and governance reforms within the administering institutions themselves.

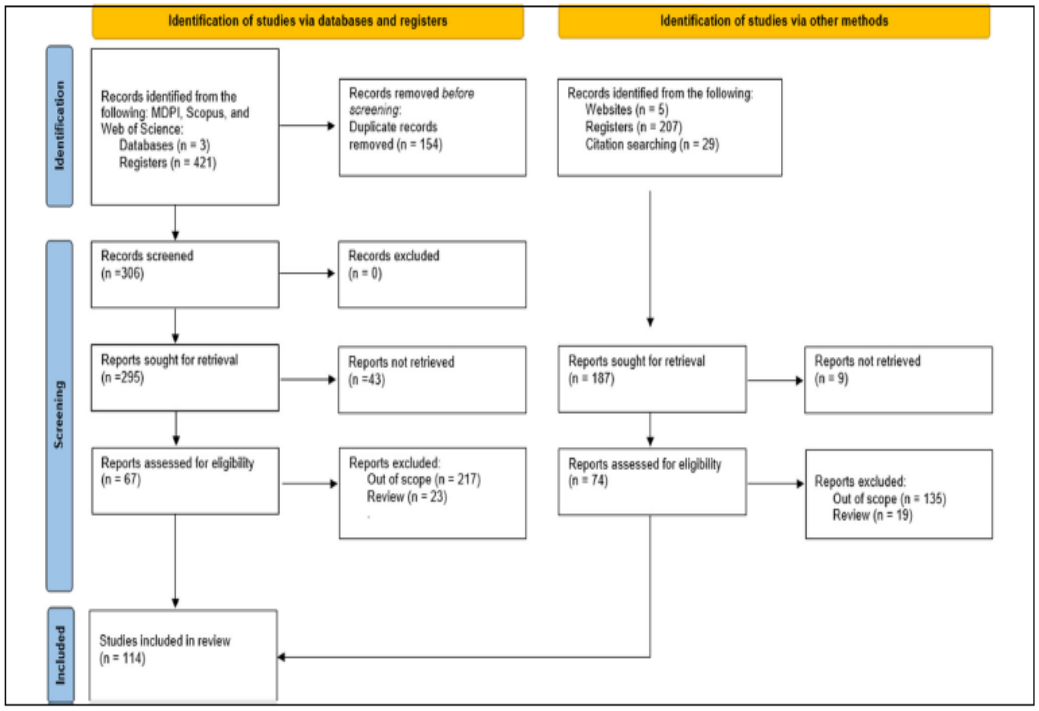
METHODOLOGY

This paper adopts a qualitative research design that relies primarily on the systematic review of secondary data sources as indicated in figure 2. Qualitative approaches are considered particularly suitable for policy- and governance-related inquiries because they allow for the exploration of patterns, meanings, and contextual dynamics that are not easily quantifiable (Creswell and Poth, 2018). By synthesizing insights from existing literature, this study focuses on identifying recurrent administrative barriers that undermine soil fertility improvement programs for horticultural production across Sub-Saharan Africa (SSA). The data reviewed for this paper draws from a wide range of sources including peer-reviewed academic articles, government policy briefs, institutional reports from organizations such as the African Union, Alliance for a Green Revolution in Africa (AGRA), International horticulture society (IHS), International Fertilizer Development Center (IFDC), and World Bank, as well as relevant grey literature and case studies. The inclusion of diverse sources enables a triangulation of

perspectives, thereby enhancing the robustness and credibility of findings (Bowen, 2009).

The analytical process entailed thematic categorization, in which secondary data was reviewed and coded into broad themes such as institutional weaknesses, financial constraints, and governance challenges. This thematic approach facilitates the identification of patterns and recurring issues across national contexts and allows for comparison of administrative challenges that are common to multiple countries (Nowell et al., 2017). The paper emphasizes the cross-country perspective rather than the evaluation of single-country case studies, because soil fertility declines and related governance challenges are regional in scope and often shaped by similar structural conditions such as under-resourced agricultural ministries, policy fragmentation, and weak extension services (Bambi et al., 2024). This approach ensures that findings reflect not only isolated experiences but also wider systemic trends.

Furthermore, the study applies a critical review methodology that goes beyond descriptive reporting to assess how administrative obstacles affect both implementation effectiveness and program sustainability. For instance, literature indicates that even well-intentioned fertilizer subsidy programs have faltered in SSA due to leakages, elite capture, and weak monitoring mechanisms (U4 Anti-Corruption Resource Centre, 2021). In this sense, the methodology pays particular attention to linking administrative structures with outcome effectiveness. Rather than testing hypotheses through statistical models, this qualitative review evaluates causal linkages through interpretive reasoning supported by the existing evidence base. By situating administrative challenges within the broader discourse on soil fertility management and agricultural development, the study provides insights relevant to policymakers, scholars, and development practitioners concerned with designing more effective interventions.



Source: Topa, et al., (2025).

Figure 2. Methodology used for choosing and filtering articles PRISMA 2020 Systematic review flow diagram.

PRESENT PERSPECTIVES

Status of Horticulture production in Nigeria

Horticulture in Nigeria encompasses the production of fruits, vegetables, ornamental plants, medicinal plants, and plantation crops that contribute significantly to nutrition, household income, food security, and employment. The sector plays a critical role in rural livelihoods, especially in regions prone to land degradation and erratic rainfall. However, horticultural productivity in Nigeria remains low due to poor soil fertility, water scarcity, erosion, climate variability, and unsustainable land-use practices. These constraints underscore the need for effective Soil and Water Conservation (SWC) and integrated land-management systems that improve soil health and water availability for horticultural crops.

Impacts of Soil and Water Conservation on Horticultural Productivity

The review reveals that SWC techniques have a direct and measurable impact on horticultural performance in Nigeria:

Improved Soil Fertility

Horticultural crops such as tomatoes, pepper, cabbage, mango, and citrus depend on fertile, well-structured soils for optimal yields. Conservation practices like mulching, cover cropping, composting, and organic amendments significantly enhance soil organic matter, nutrient retention, and biological activity. Terracing and contour bunds reduce nutrient loss through runoff, ensuring nutrients remain available for root uptake.

Enhanced Water Use Efficiency

Many horticultural crops are highly sensitive to water stress (e.g., watermelon, cucumber, leafy vegetables). Methods such as drip irrigation, zai pits, tied ridges, and micro-catchment systems help store and channel water directly to plant roots, increasing water-use efficiency by up to 60–80% compared to conventional practices. Mulching reduces evapotranspiration, enabling crops to thrive even during prolonged dry periods.

Improved Soil Structure and Reduced Erosion

Vegetables and fruit crops require loose, aerated soil for root expansion. Conservation tillage, agroforestry, and vegetative barriers limit soil compaction, maintain soil porosity, and reduce erosive forces that commonly affect horticultural fields.

Integration of Horticulture into Watershed and Land-Management Systems

Although the original review focused on watershed management, integrating horticulture into watershed-level SWC introduces several benefits:

Agroforestry for Horticultural Benefits

Fruit trees such as mango, guava, cashew, and citrus are widely used in agroforestry systems.

They stabilize slopes, prevent gully formation, and contribute to carbon sequestration. Leaves and pruning improve soil organic matter, indirectly benefiting vegetables grown below the canopy.

Buffer Zones and Riparian Horticulture

Planting horticultural crops in buffer zones reduces sediment load while providing additional income for farmers. Bananas, plantains, pawpaw, and vegetables thrive in moist riparian environments when managed sustainably.

Home-Garden and Peri-Urban Horticulture

Small-scale horticultural plots around households, common in Nigerian landscapes, contribute to watershed stability through dense vegetation cover. These gardens act as natural soil protectors and promote biodiversity within degraded watersheds.

Socioeconomic Benefits of SWC-Enhanced Horticulture

The review indicates that when horticulture is supported by proper SWC, communities experience:

Increased Household Income;

Vegetable and fruit farming generates quick and steady income streams, especially during dry season farming facilitated by water-harvesting technologies.

Improved Nutrition and Food Security;

Horticultural crops supply essential vitamins, minerals, and dietary fiber. The adoption of SWC stabilizes production throughout the year, reducing malnutrition, particularly among children and pregnant women. Employment and Youth Engagement; Irrigated horticulture creates jobs in:

Production, processing, packaging and marketing. This diversifies income sources and reduces rural–urban migration.

Challenges Affecting Horticulture production in Northern Nigeria

Some persistent challenges highlighted include: Poor adoption of modern irrigation systems

Limited extension services, High cost of inputs such as seedlings, organic fertilizers, and water-saving technologies, Land tenure issues restricting long-term investment, Climate-related shocks such as floods and droughts. These constraints indicate that SWC alone is insufficient without complementary policy and institutional support.

Opportunities for Enhancing Horticultural Development through SWC

The review identifies several pathways for improving horticultural productivity in Nigeria: Scaling up climate-smart irrigation technologies (solar pumps, drip systems). Encouraging community-based watershed management that integrates horticulture. Promoting organic horticulture supported by composting and mulching. Developing horticultural value chains (storage, processing, and packaging). Strengthening extension services for farmers.

The review further established that administrative inefficiencies constitute one of the most significant obstacles undermining the success of soil fertility improvement programs in Sub-Saharan Africa for horticulture production systems. Although technical solutions such as fertilizer subsidies, organic composting, integrated soil fertility management, and agroforestry have proven effective in specific contexts in other instance as reflected in figure 3, their broader impact is often constrained by weak governance structures, limited institutional capacity, and fragmented policy implementation (Bambi et al., 2024; Lal, 2024). For instance, programs that provide subsidized fertilizers frequently fail to reach smallholder farmers because of elite capture, poor targeting mechanisms, and the absence of effective monitoring frameworks (U4 Anti-Corruption Resource Centre, 2021). Furthermore, reliance on donor-driven interventions tends to generate short-term outcomes rather than fostering long-term sustainability, since many initiatives collapse once external financing is withdrawn (Chakib and Freeman, 2024).

This creates a cycle where farmers are exposed to short-lived programs that neither build local capacity nor promote ownership, thereby reducing trust in government-led initiatives. Another important finding is that insufficient farmer participation in policy design and execution undermines adoption of soil fertility practices. Farmers are often treated as passive recipients of external technologies rather than active partners in developing context-specific solutions. As studies show, when farmers are excluded from decision-making, interventions risk being misaligned with local socio-economic realities, leading to low uptake and poor

sustainability (Suri et al., 2024; Agwu et al., 2023). This is particularly evident in large-scale fertilizer subsidy programs, which may overlook the potential of indigenous soil fertility management techniques such as intercropping, crop rotation, and the use of organic matter. Similarly, weak extension services reduce the effectiveness of dissemination channels, leaving farmers without the necessary technical knowledge to apply recommended practices effectively (Ledermann et al., 2024). Inadequate staffing and poor farmer-to-agent ratios exacerbate this gap, highlighting how administrative failures diminish the transformative potential of otherwise well-designed technical interventions.

The discussion also reveals that corruption and mismanagement are central to the inefficiency of soil fertility initiatives. Leakages in fertilizer subsidy programs, diversion of inputs to politically connected elites, and the manipulation of beneficiary lists compromise the credibility and effectiveness of government programs (IFDC, 2024). Such practices not only increase the financial burden on governments but also discourage private-sector actors from engaging in input markets, further weakening agricultural systems (AGRA, 2023). Moreover, limited accountability and poor monitoring frameworks reinforce systemic inefficiencies, allowing maladministration to persist unchecked. This suggests that addressing soil fertility challenges requires not only technological solutions but also deep institutional reforms to strengthen governance, enhance accountability, and create inclusive platforms that engage farmers and civil society in program oversight (Bambi et al., 2024).

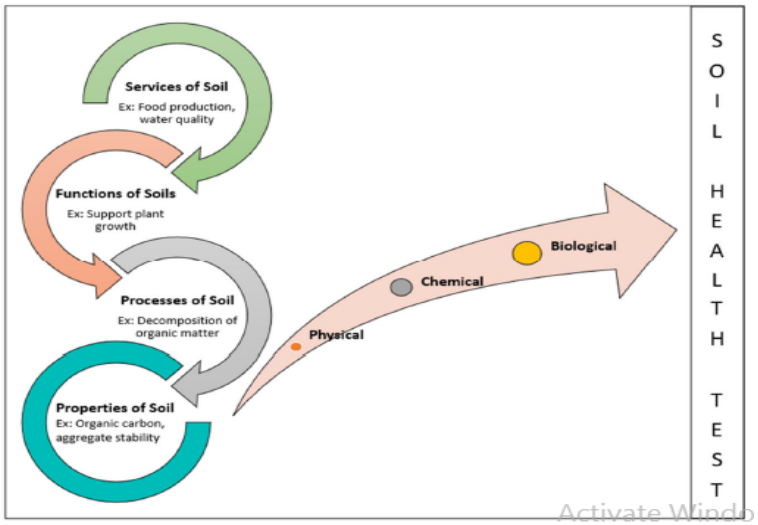


Figure 3. Soil health conceptual view; Source: Futa, et al., (2024).

CONCLUSION

This review has demonstrated that horticulture in Nigeria is deeply dependent on effective soil and water conservation (SWC) and sustainable land-management practices. Although horticulture is one of the fastest-growing agricultural sectors—contributing significantly to food security, nutrition, rural income, and employment—the sector remains constrained by land degradation, soil infertility, erratic rainfall, and climate variability. These challenges reinforce the critical role of SWC techniques in enhancing horticultural performance. The findings show that SWC practices improve soil fertility, increase moisture availability, minimize erosion, and support long-term soil health, all of which are essential for the successful cultivation of fruits, vegetables, and ornamental crops. Conservation measures such as mulching, agroforestry, drip irrigation, terracing, contour farming, organic amendments, and water-harvesting technologies have proven highly beneficial in improving horticultural yields across diverse ecological zones in Nigeria.

Furthermore, integrating horticulture into watershed and landscape management systems strengthens environmental stability by reducing runoff, enhancing biodiversity, and restoring degraded lands. Horticultural activities—especially fruit-tree planting, home gardens, and riparian cultivation—create environmentally protective vegetation cover while generating significant economic and nutritional benefits for communities. However, despite the clear advantages, the widespread adoption of SWC-enhanced horticulture in Nigeria remains limited by inadequate extension services, limited access to modern irrigation technologies, high input costs, weak institutional support, and climate-related uncertainties. Without addressing these systemic constraints, horticulture cannot reach its potential as a driver of sustainable livelihood improvement and ecological resilience. Hence, effective SWC is not optional but fundamental for transforming the horticultural sector in Nigeria. Enhancing horticultural productivity requires deliberate investment in land conservation, climate-smart water management, farmer

capacity building, and supportive policies that link environmental sustainability with agricultural development.

RECOMMENDATIONS

The review proposed to strengthen horticulture production by improved soil and water conservation and land management practices through: Enhance Adoption of sustainable Soil and Water Conservation Practices via Promoting mulching, cover cropping, conservation tillage, composting, and crop rotation to improve soil structure and fertility for horticultural crops, farmers to be encourage to construct terraces, contour bunds, trenches, and micro-catchments in erosion-prone areas, particularly in northern Nigeria. Furthermore, Expand Access to Efficient Irrigation and Water-Harvesting Technologies either by Government or NGOs and should subsidize or support access to drip irrigation, solar-powered pumps, watering cans, and rainwater-harvesting systems. Strengthen community-level water-harvesting infrastructures such as check dams, ponds, and small reservoirs for dry-season horticulture. Integrate Horticulture production systems into Watershed and Landscape Management Plans. Also, State and local governments should integrate horticultural development into watershed rehabilitation, reforestation initiatives, and land-restoration projects. Encourage planting of fruit trees (e.g., mango, citrus, guava, and cashew) as part of agroforestry systems to stabilize degraded landscapes. Strengthen Farmer Education and Extension Services to **p**rovide training on climate-smart horticulture production, pest management, modern SWC techniques, and sustainable irrigation. Recruit and deploy more horticulture-focused extension workers, particularly in rural communities. Improve Access to Inputs, Finance, and Market Infrastructure**.** Establish community-based nurseries to provide quality seedlings for fruits and vegetables. Expand agricultural credit schemes tailored specifically for smallholder horticultural farmers. Improve rural access roads, storage facilities, and market linkages to reduce post-harvest losses. Promote Research and Data-Driven Innovations**.** Universities and research institutes should increase research on drought-resistant horticultural varieties, soil health mapping, and localized SWC technologies. Encourage collaboration between researchers, policymakers, and farmers to ensure innovations meet local needs. Strengthen Policy and Institutional Support Develop clear policies that promote sustainable land use, climate adaptation, watershed protection, and horticultural value-chain development. Enhance monitoring and enforcement of land-degradation regulations, especially in erosion-prone regions.

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